The Wireless Age

October, 1919

The WIRELESS Age

Volume 7

Dancing to Music Wirelessed from an Airplane

Wireless in the A. E. F.

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

` TO THE NAVY

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R.ES.
ɔts

INSULATION
"MADE IN AMERICA"

ƆEAN IN AIR

ıcy Currents Used by UNITED
.reless Telegraph and Telephone
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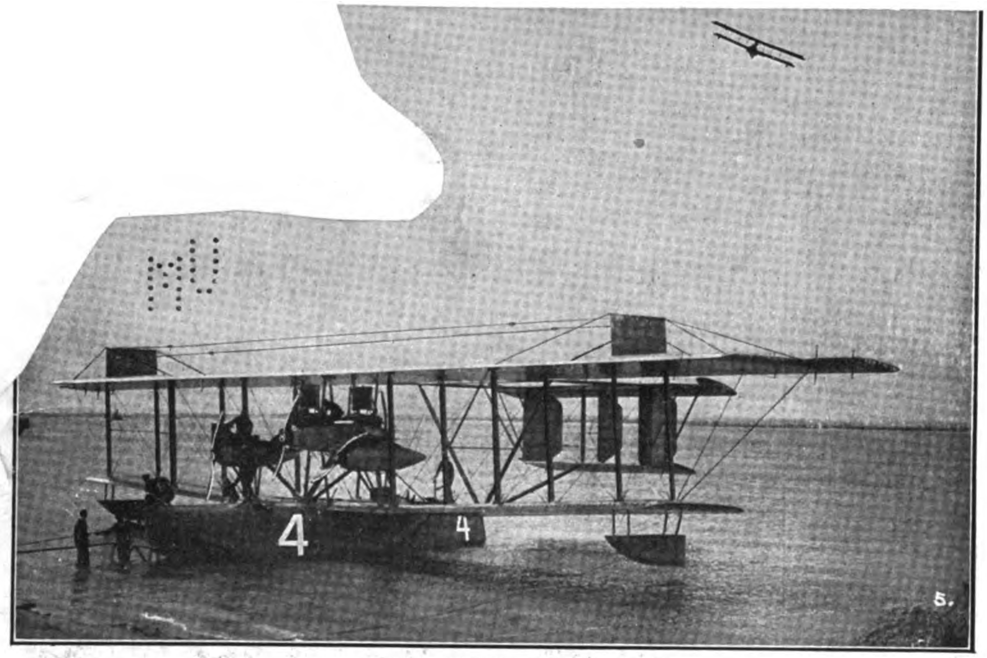
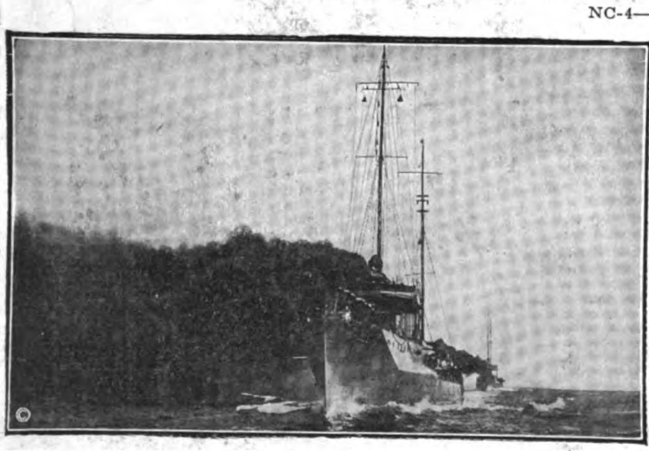
"By courier, coach and sail-boat, it took days for the news of Waterloo to reach London. During Lieut. Commander Read's flight to Halifax, Assistant Secretary Roosevelt in Washington sent a radio message to NC-4, of whose position in air he had no knowledge. In three minutes he had a reply."

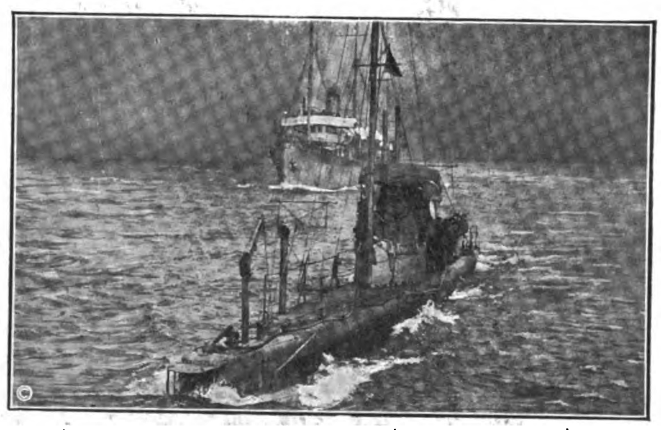
Extract from New York World, June 3, 1919.



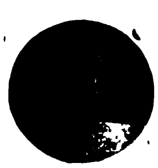
NC-4—ELECTROSE Equipped.



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



U. S. S. G-2—ELECTROSE Equipped.



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

ELECTROSE
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The Wireless Age

Edited by J. ANDREW WHITE

Vol. 7 — No. 1

Contents for October, 1919

Index of Equipment

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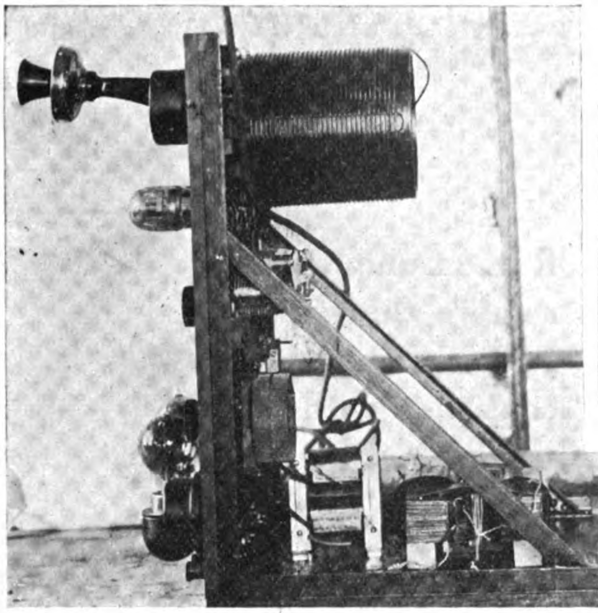
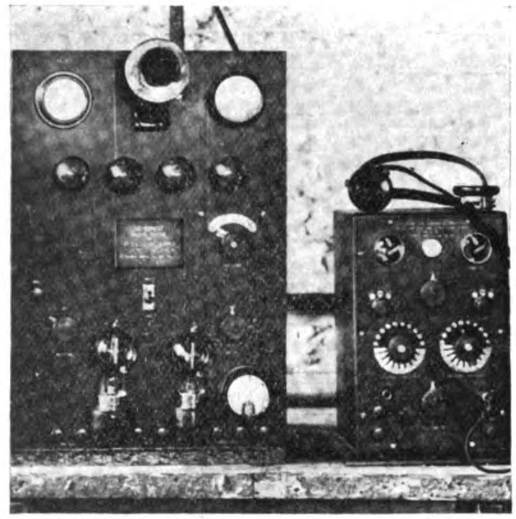
A NEW 'PHONE

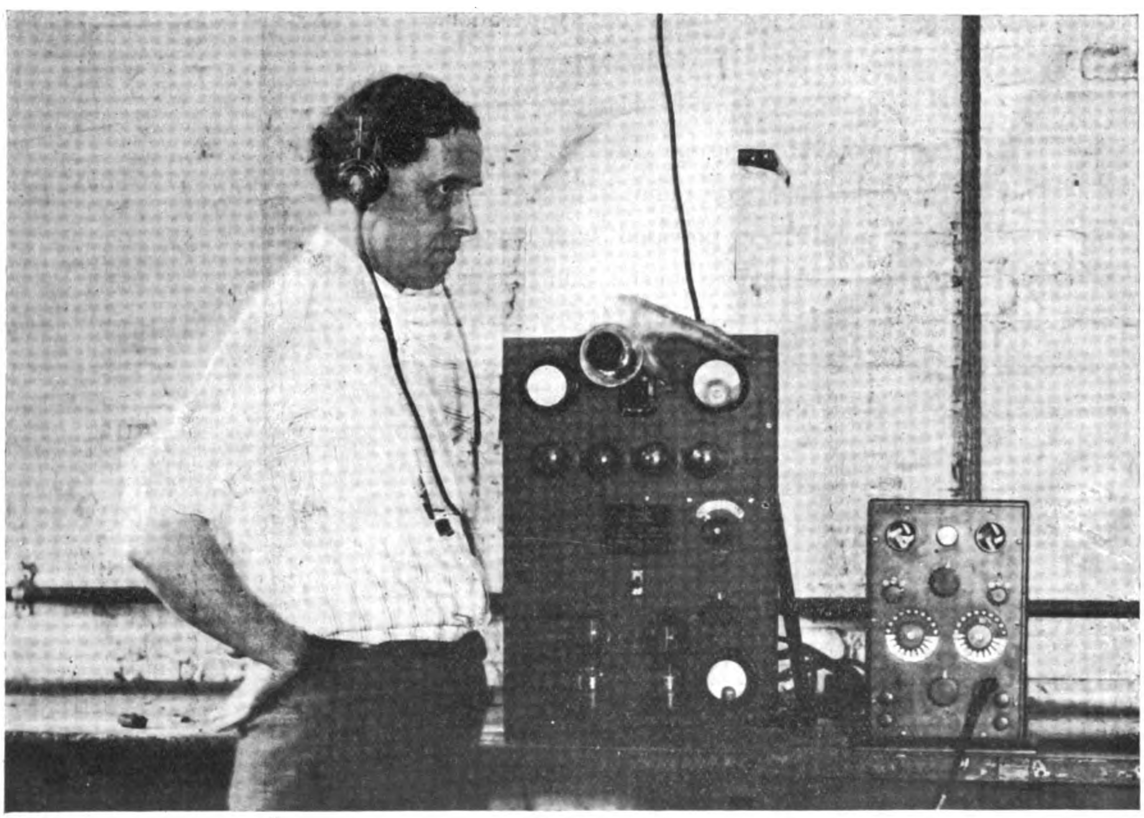




Above: The transmitter, and on the right the combination V. T. detector and amplifier

To the left: Assembly of the apparatus as seen from the side of the transmitter panel

Graphic News



The complete wireless 'phone set, plugged into an ordinary electric light socket. The transmitting range is said to be from ten to twenty miles, according to conditions

VOL. 7. No. 1. OCTOBER, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

The Unprecedented Demand for Wireless Operators

THE United States Shipping Board is in immediate need of qualified radio operators, and can furnish employment to any man who possesses a first grade commercial license issued by the Department of Commerce. In accordance with the new wage scale recently established, the first operator is paid $125 per month, the second operator $100 per month, in addition to all expenses. The radio operator is considered an officer and is provided with superior accommodation.

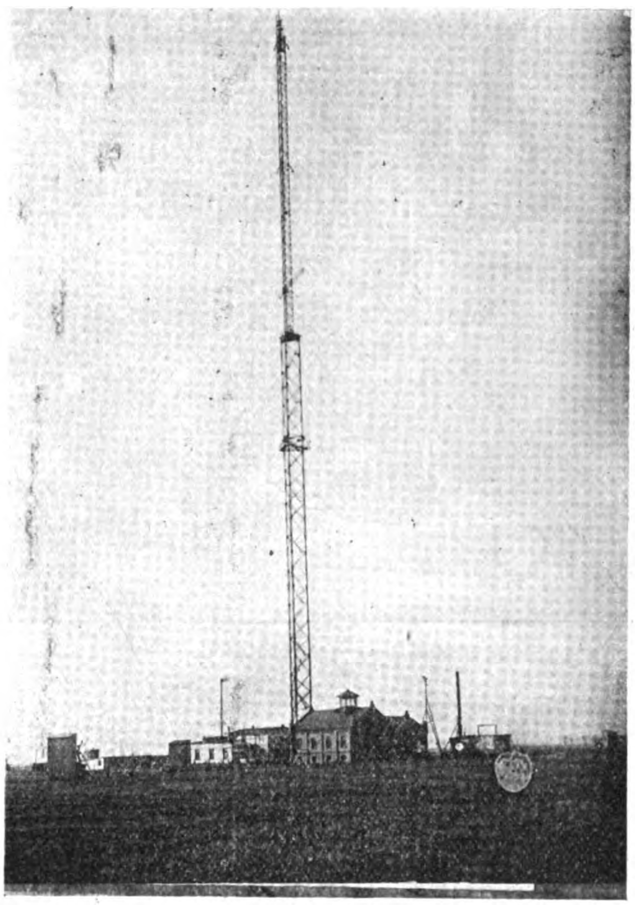
All Shipping Board vessels carry one or two radio operators. When a ship carries two operators an experienced man is generally put in charge as first operator, with an assistant as second operator. In case the ship only carries one operator, he is usually rated as first operator, and should be a man who has made at least one voyage. During the war, a large number of radio operators secured training at the expense of the Government for both the army and the navy. Any of these operators who desire employment have only to secure a commercial radio operator's license, issued by the Department of Commerce after passing the required examination.

Foreign Trade Council Opposes Government Operation of Wireless and Cables.

THE National Foreign Trade Council's committee on Foreign Communications has declared strongly in favor of the establishment and maintenance of adequate systems of transoceanic communications under private enterprise and for the speediest possible release of Government control of such private commercial systems as have not already been returned to their owners.

At the same time the committee took measures looking to the early establishment of additional means of communication across the Pacific so as to bring to an end as promptly as possible the present intolerable conditions in transpacific cable and wireless communication. The committee went on record as definitely opposed to Government ownership, control or operation of commercial systems of cable or wireless in time of peace; but pending the return to private operation of such commercial systems as are still under Government control, the committee favors the continuance of the Naval Radio stations in commercial service, in order to afford as much relief as possible from present conditions, especially across the Pacific. It was brought to the attention of the committee that there is a tendency in different Government departments to use cable or wireless at times for communications more or less routine in character and that such traffic increases the delay in transmission of commercial messages that are essential to the transaction of important international business.

The committee called this situation to the attention of the President and to the heads of various Government departments with the request that the volume of Government business which now takes precedence over all commercial business shall be reduced as far as practicable, and that Government messages which are not urgent should be transmitted without the right of precedence over commercial business.



Tower of the Nauen station from which messages are sent direct to America

British Aircraft to Have Use of Government Wireless

AT a recent meeting of those interested in commercial aircraft held in London to discuss with representatives of the Air Ministry the ultimate disposal of Government airships Maj. Gen. Seeley, Under Secretary for Air, who presided, said that the Air Ministry and Admiralty would offer existing machines and those in various stages of construction to those who would undertake the formation of commercial air schemes.

The Government's assistance would include the use of wireless stations.

Belgian Girl Who Destroyed Enemy Wireless Visits U. S.

MARIE LOUISE GOMBIER, a Belgian heroine, wore the Croix de Guerre with two palms when she came ashore recently from a French steamer.

Her war record began when, with two other girls, she escaped from Brosges convent, which was surrounded by Germans, and fled to her father's home in Brussels. Two days later the Germans entered Brussels and a German officer was billeted in the Gombier home at Dickebusch farm. A wireless plant was installed.

One day when the wireless room was left unwatched, Marie slipped in and broke the delicate machinery with her shoe. It took forty-eight hours to repair the damage. Marie made a second attempt at sabotage, using a bottle for a hammer.

The popular wireless novelty of experimenting with tree antennae

She had partly wrecked the plant when two soldiers caught and beat her. An officer ordered her to be shot, and only by the intercession of the officer billeted in her home was the sentence changed to imprisonment.

For five weeks she was kept prisoner with two French soldiers in a cart. While the cart was on its way to the rear of the German lines the Ninety-fifth Canadian Regiment arrived and Marie escaped.

China Protests Against Japanese Stations

IT is announced from Shanghai that, under the guise of trying to get actual practice for their wireless engineering students, the Japanese have established a wireless station at Kung Tsuling, Feng Tien, Manchuria. The station is in the railroad zone of South Manchurian Railway and is surrounded by barracks. It is fully equipped and in constant communication with Japan.

Asserting that this is a violation of the Chefoo cable agreement, wherein Japan pledges not to establish wireless stations in China, the Chinese Government has vigorously protested. Japan has another wireless station in Chinese territory at Hankow.

Swedish Engineering Party Uses Wireless

WORKING parties engaged in regulating the Lule River, Swedish Lapland, are keeping up communication by wireless, the first recorded use of it for practical purposes in Sweden. This avoids the risk of telephone and telegraph communications being cut by snowstorms or avalanches.

Uncensored News to the Orient via Radio

AMERICAN news for the Orient will hereafter be sent free of charge by the United States Radio Service. The arrangement is the result of many months of effort to free American events and policies from the censorship and filtering processes used by the foreign governments, to further their own trade interests.

News will be handled by radio to the Orient through Honolulu, Manila and Vladivostok, for a further relay by the latter port to Peking and Shanghai.

Wireless 'Phone Reports Forest Fire

FOR the first time, probably, in the world, a wireless telephone instrument has been installed successfully on the top of a large mountain for communication with stations below.

Early in August, so the story goes, Elijah Coalman, lookout on the summit of Mount Hood, stood 11,125 feet above the level of the sea, silhouetted against the white of a snow bank and spoke eagerly into a small black instrument. G. C. Maroney, his assistant, waited impatiently by his side.

C. M. Allen, telephone engineer, United States forest service, stood eight miles away and held a wireless telephone receiver in his hand. He was 7225 feet below. Every word spoken was clearly heard. A fire on an Indian reservation was reported.

The installation is more than a successful scientific achievement on the part of the United States forest service. It is a long sought source of protection against forest fires, a guard with an eye that can see hundreds of miles and a voice that can shout, if necessary, all over two states.

Power will be supplied for the time being by storage batteries. Later on wind-mills will be erected to utilize the powerful wind always present on the mountain top.

Flying Club Proposes Cross-Continent Radio Chain

THE American Flying Club has inaugurated a radio information service with a view of keeping the general public and newspapers in touch with aerial activities, according to an announcement made by the club. A wireless set has been installed in the New York clubhouse, and with its automatic recorder has been picking up wireless flashes from transatlantic vessels.

"We have arranged to furnish individuals and newspapers in the various cities with all information of aeronautical activities," an officer of the club said. "Each city will have a radio station assigned to it to give immediate reports of aviation events on schedules of every half hour. In this way we hope to stimulate public interest in the development of aviation in this country."

New Military Station for the Border

IT WILL be but a short time until the new military wireless station at Fort Brown, Texas, is finished and placed in operation. It is said to be the most powerful station on the Mexican border.

Wireless in the A. E. F.

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

By Lieut. Col. L. R. Krumm

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

and Capt. Willis H. Taylor, Jr.

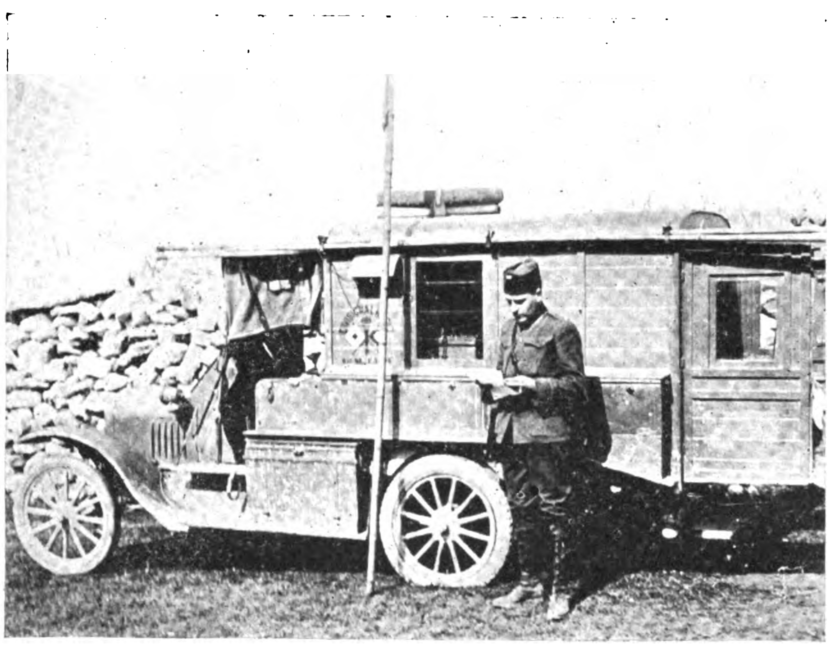
Co-ordination Officer, Radio Division, Signal Corps, A. E. F.

Part II

"OUR telephone lines were cut beyond repair by shell fire; radio was relied upon to maintain the necessary liaison."

Such was the tribute paid to wireless communication in many of the reports of major and minor engagements of American troops which were submitted to the Chief Signal Officer of the American Expeditionary Forces. It emphasizes the importance of radio work.

The goal, at which all efforts were aimed, was to make radio communication a reliable means for maintaining liaison during emergencies in battle. Types and kinds of equipment to be used were the first consideration. Close upon this, in order of importance, was organization of the operating personnel and the formulation of instructions for operation of the equipment, comprehending such details as call letters, wave-length assignments and traffic regulations. These details were of the greatest order of importance in carrying on radio communication efficiently and with the least possible interference.



A Ford Tractor equipped with the Divisional Headquarters Radio Set Type E-3 or Type E-3 bis.

In a previous article it was pointed out that French apparatus had been adopted as the standard radio equipment for all American units, pending the development and production of equivalent material in the United States. This French equipment proved satisfactory in most respects, although the material used by the first of our troops left much to be desired, but as the war progressed and the later types of vacuum tube undamped wave sets came into more general use in our army the radio service became increasingly more satisfactory. These later sets reflected the long experience of the French army with radio communication, and also divulged the fact that the French engineers were considerably more conversant with the possibilities of the vacuum tube than we anticipated. In the circuits presented with this article the same tube was utilized for both transmitting and receiving. An innovation that immediately attracted the American signal officer's eye was the high frequency amplifier circuits developed and used by the French. At the time of our entry into the war, high frequency amplifiers had not passed the laboratory stage in the United States. In France they were being extensively used in the field, and with complete success. It is interesting to note that the British army took up the development of this type of amplifier with wonderful success and reports were current of a 19-stage amplifier in use by a land station in England which copied the bridge buzzer sets of the German fleet at anchor in the Kiel Canal — the Huns being so confident of their security from a wireless standpoint that they transmitted in plain German, much to the edification of the British Admiralty.

However, at the beginning, great was the scorn of the American operator—who had probably been a progressive amateur at home—when he was assigned to operate a spark set working on a plain antenna circuit. This type of equipment was used throughout a division at the beginning of our activities. In the trenches they were operated with an antenna elevated only about four feet above the ground, as shown in the illustrations, and were not very effective when so used. Higher antennae were possible at brigade and division headquarters, however, and here they were surprisingly effective, considering the amount of interference that naturally resulted from this type of equipment. Immediately, the American propensity to experiment became evident and it was indeed an exception to find a station in which the operator had not constructed loading coils to enable him to receive communications from Eiffel Tower on 2,500 meters, although his receiver was only intended for a maximum wave-length of 550 meters. Many a case of complaint against a station for not replying to a call was gravely answered by the commanding officer with the statement that the fault could not be with his station as he had about that time received a copy of the French communique from his operator, showing that he and his set were effectively operating. The fact that the station was 2,000 meters off the wave-length of his net meant nothing in the busy life of a non-technical officer.

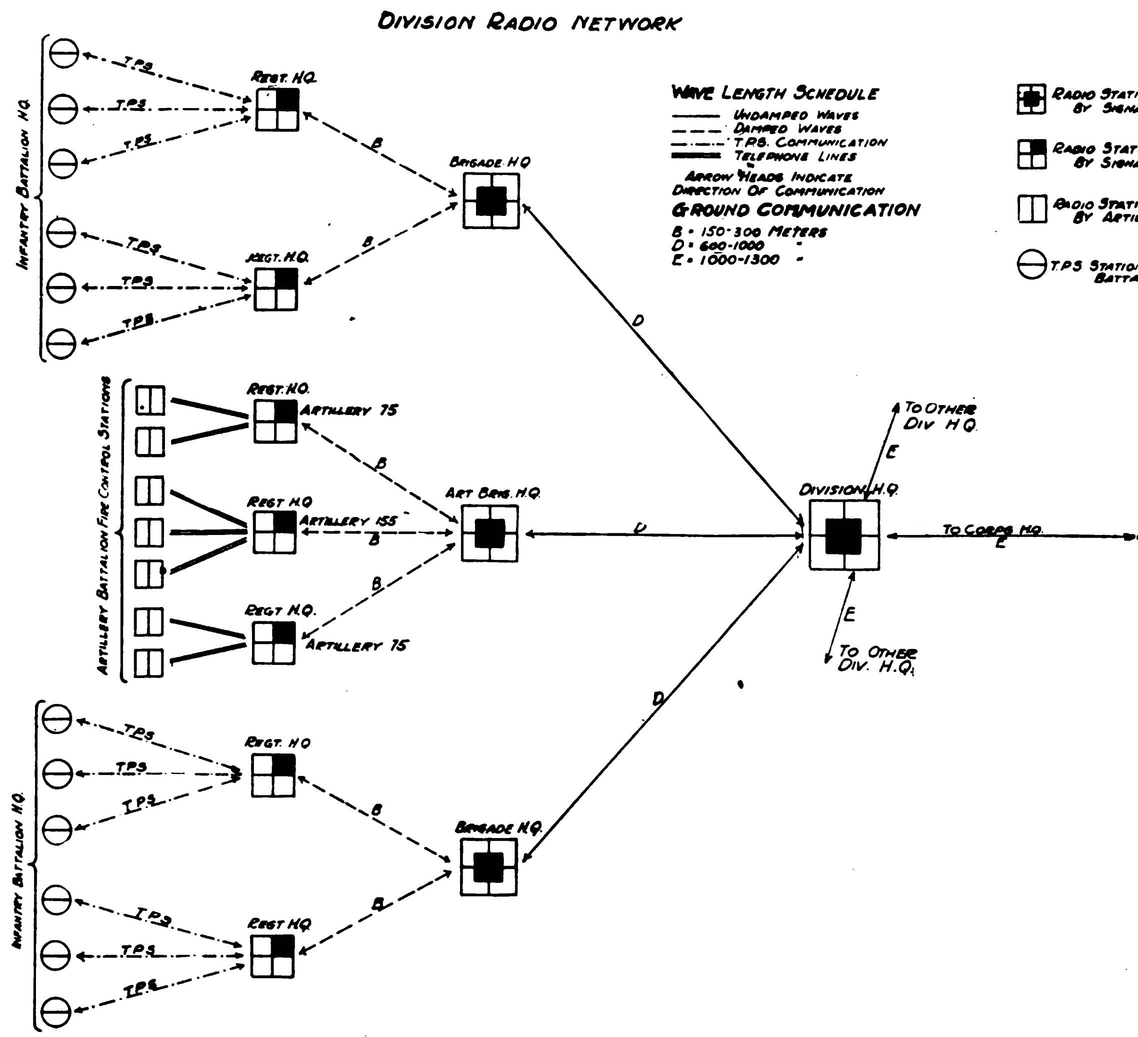
It must be kept in mind that under no other condition do the best laid plans of men go so much agee as in warfare, so in contemplating the carefully outlined plans shown hereafter, it must be kept in mind that radio, like all other branches of the army, was usually greatly disarranged from the operating plan. Under these circumstances it is obvious that the best radio man in wartime is one who can meet conditions as they arise and maintain communication in spite of all contingencies; and it must be said that the resourceful man was nowhere more in evidence than in the radio work of the army.

The French radio authorities, like ourselves, had the impression that vacuum tube sets were too complicated and frail for use except at considerable distances back of the line, and only the simplest spark sets were in use when our troops first went into the lines. Later, undamped wave sets were put in use down to and including brigade headquarters, and in the Argonne many of these sets were with the front line troops accompanying brigade commanders who wanted their headquarters up with the very foremost.

The supply of the necessary storage batteries was perhaps the most difficult question which arose in the operation of our radio stations. The hand generator used with the American army's pack set never was very popular, but it at least saved our army in its previous military efforts from one of the hardest problems we encountered in France. Charging stations were erected for each divisional area, and in special cases, with brigades. From these centers, storage batteries were distributed by automobile, motor-cycle, and by men—and in a few cases by airplane—to different units. In trench warfare they were delivered to the forward stations at night.

All French sets were operated from storage batteries with the single exception of a bicycle driven set which was used to a very limited extent. At first thought it might seem that the use of storage batteries as the primary source of power for wireless sets was entirely impractical, and so it first appeared to us. But their extensive use and the resultant type of radio equipment were entirely due to several years of trench or stationary warfare, a condition which affected our Allies' perspective. After their use was thoroughly established and the moving warfare stage developed it was then too late to change; a system of supply was developed in emergency, however, that was effective far beyond what would seem possible. The Germans used storage batteries, but they had also developed and were using many spark sets in which the power was provided by a gasoline engine and generator.

The details of organization of the radio operating personnel and the actual operation of the radio equipment in the various networks were so inter-related that no attempt will be made to discuss each one sep-



arately. Instead, an outline of the scheme of radio networks and wave-length schedules is given, through which one can arrive at a fair understanding of the details of the organization.

In the beginning—that is the beginning for the Americans—everything seemed simple enough. We had but few divisional artillery regiments equipped,

Interior of a Ford Radio Tractor for Divisional Headquarters showing the Radio Set Type E-3 bis mounted therein

practically no combat or observation airplanes, no anti-aircraft batteries or sectors, no railway or other heavy artillery, and no tanks. Our wave-length schedule and transmission systems were not complicated by innumerable networks and the radio communication system was briefly as follows:

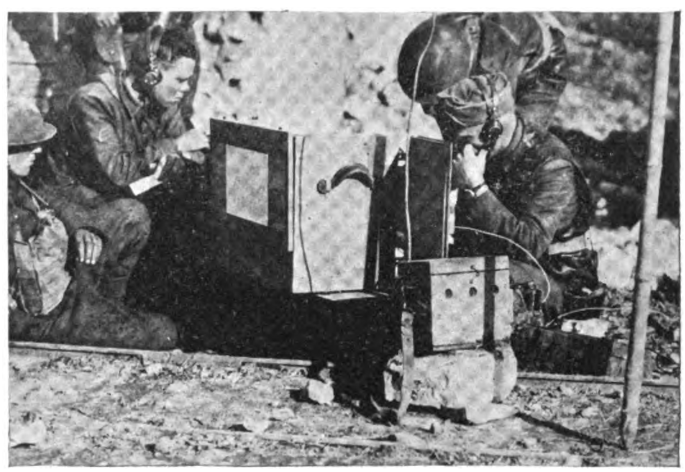
Ground telegraphy (T. P. S.) was provided for communication between regimental headquarters and battalion headquarters. The induction coil, plain antenna set, which will be described, was provided forward of divisional headquarters and down to regimental headquarters; undamped or continuous wave transmission was used between adjoining divisional headquarters and from divisional headquarters to army corps headquarters. At this time the army as a unit had not been organized; for that matter, army corps were novelties even in the early summer of 1918.

The divisional artillery was expected to have its shell fire controlled by radio from French observation and fire control airplanes, but it was sometime before satisfactory operations of this kind were obtained; more success was attained when American airplanes and operators worked with our artillery.

The wave-length assignments called for the allotment of 150 to 300 meters to regimental and brigade headquarters. This small wave-length range of 150 meters, together with the transmitting set, portable type, No. 4 (the small, plain antenna set already referred to) was the bane of many an otherwise religious sergeant's existence. The only way to change or adjust the wave-length was to change the height or the length of the antenna. A chart was actually compiled and distributed to some units showing what wave lengths would be obtained when an antenna of a given length was stretched between the 4-foot supports—providing, of course, that you had not lost the supports. Consider that divisional headquarters had to communicate with its three component brigade headquarters, two infantry brigade and one artillery brigade headquarters; also consider that each infantry brigade had two regimental headquarters and that the artillery brigade had three regimental headquarters. To this day it appears nothing short of miraculous that any reasonable continuity of communication was established through the interference. But it is a fact that, while the brigade and regimental interference was bad, divisional, brigade and regimental messages were successfully transmitted and received.

The undamped wave radio transmission between divisional headquarters and between divisional and army corps headquarters worked well from the beginning. The wave-length range assigned for this continuous wave communication was 600-1000 meters, giving a working range of 400 meters for this important radio service.

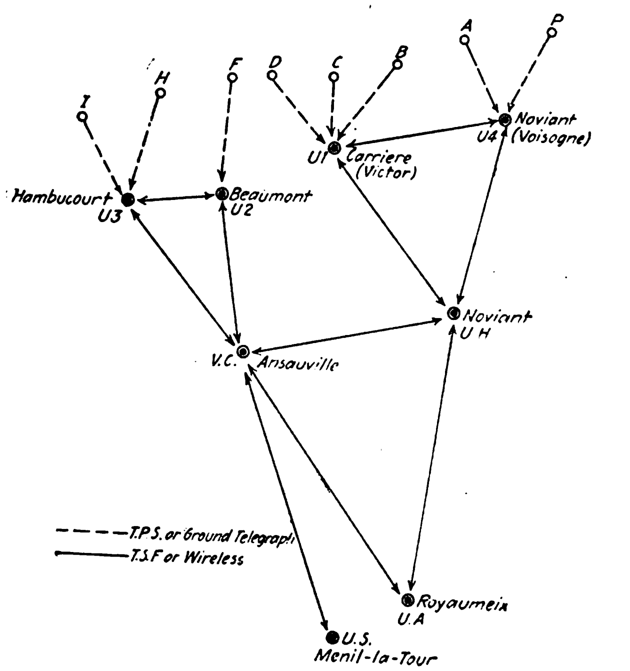
The equipment used for this service and wave-length assignment was a transmitting and receiving set known as Radio Set Type E-3. It was mounted on a Ford truck as shown in the photographs accompanying this article. These Ford trucks were originally ambulances, but were the only suitable vehicles available at the time we entered the war. One truck carried the radio equipment and a second one the charging set, extra storage batteries, charging switchboard and cooling tank for the water-cooled gasoline engines. The little flivver never essayed to perform a harder task and while many of them were in service until the last it was soon found that the car was too light for the work and a heavier truck of the Fiat make was utilized as they became available. All these trucks were rebuilt and equipped in France and were



The real thing—A Brigade Headquarters radio station in action. This clearly illustrated the need of a light trailer to transport the E-10 bis set

so satisfactory that recommendations were made that all sets, even those with brigades, be mounted in light trailers. In the Argonne the trucks could not keep up with the troops in many cases because of lack of roads or other causes and the apparatus was dismounted by the operators and carried by hand. When it is remembered that it was vacuum tube equipment with its storage batteries, weighing from 200 to 300 lbs. some idea can be had of what this meant.

The system of radio liaison as outlined above was successfully employed by the 1st Division, when it took over the first sector held exclusively by a United States Army unit. This sector was in the St. Mihiel or Toul sector and the divisional headquarters were located at Menil-la-Tour, while Rambucourt, Beaumont and Ansanville will be remembered by many A. E. F. veterans as regimental and brigade headquarters since many divisions received their first baptism of fire in this sector. The accompanying radio liaison diagram shows the scheme of communication using T. P. S. and radio by the 1st Division in this sector.



The first radio liaison plan of the A. E. F. (that of the 1st Division) when first occupying the Toul sector

During this embryo stage of the American army's radio activity the details for the future complicated schemes of radio liaison were being worked out. The successful operation of the E-3 type undamped wave tube sets, described later, had indicated to the French the advisability of a more general use of undamped waves. They developed the E-10 types which were simpler and more compact sets than the portable and sturdy E-3 sets, but considerably less powerful. This set was a distinct achievement on the part of the French radio engineers and was the keystone to the network schemes in use at the end of the war. In these networks the ground radio liaison, 100-150 meters wavelength was allotted to trench radio and a two-way tuned, damped wave loop set was contemplated to provide and maintain trench, company headquarters, battalion headquarters and regimental headquarters communication. This loop set was to be strictly an American apparatus inasmuch as none of the Allies had a corresponding set. The only loop sets were used by the British, but they were not entirely satisfactory and were only one-way sets. A two-way loop set designed by Major E. H. Armstrong and Lieutenant Wm. H. Priess was actually constructed and successfully operated in the A. E. F. during tests before the date of the armistice. This set will be described later.

The range of 150-300 meters was allotted to regimental headquarters to communicate with adjoining regiments and with brigade headquarters. A tuned combined receiving and transmitting set was to be provided for this radio communication to take the place of the plain antenna set previously used, but due to the signing of the armistice the old French transmitting set, portable type No. 4 and the receiving set type A-1, were never replaced.

As a new departure the scope of undamped or continuous wave radio communication was extended to include brigade headquarters and the wave-length range of 600-1000 meters was allotted for brigade to division and brigade to adjoining brigade radio communication. This same wave-length range, 600-1000, was also used by Tanks to communicate with brigade or divisional commands. The set used for this service was known as Radio set E-10 bis, and was a portable transmitting and receiving set utilizing the same type vacuum tubes for both transmission and reception.

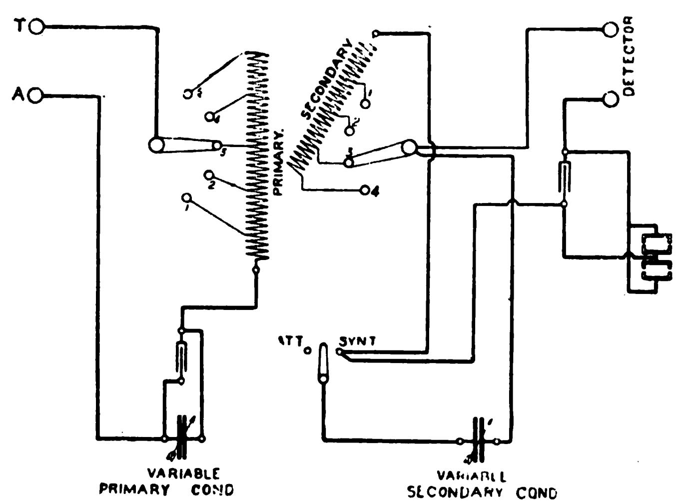
The radio liaison between division and army corps was allotted a wave-length range of 1000-1350 meters. This wave-length range was allotted to maintain radio liaison between a division and its adjoining divisions, between army corps headquarters and the army corps artillery headquarters, between army corps headquarters and the army corps air service headquarters, and between army air service headquarters and army corps air service headquarters.

The airplanes for observation and artillery fire control were allotted wave-length ranges as follows:

100-300 meters to airplanes communicating with and directing the fire of the divisional artillery. The same airplanes when operating as infantry contact airplanes communicated by radio to regimental or brigade posts of command on the same range, 100-300 meters. The set used for this service was a French wind driven generator spark set and was known as the transmitting set airplane type Y.

The wave-length range of 300-500 meters was allotted to airplanes communicating with and directing the fire of the army corps artillery and army artillery. The type Y airplane set was also used for this radio service.

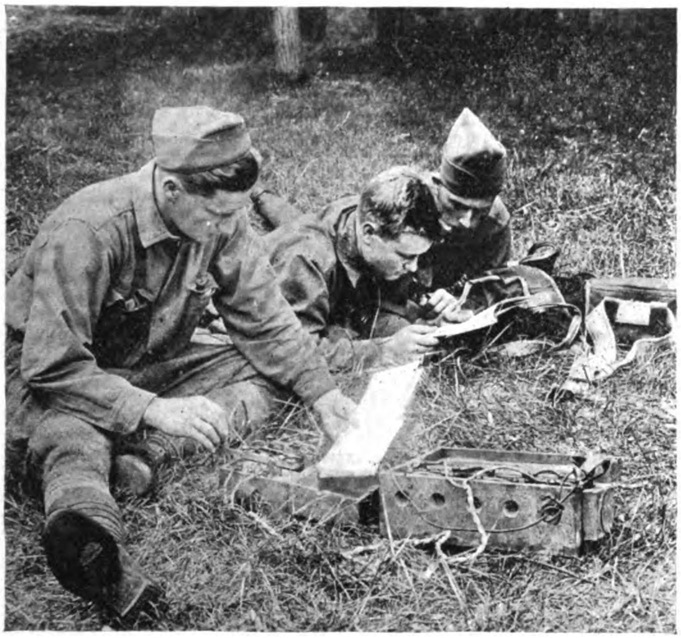
The wave-length range of 550-750 meters was allotted to airplanes for directing and controlling the fire of long-range railway and similar artillery and radio communication was maintained by undamped or con-



Circuit Diagram Receiver of Radio Sets Type E-3 and E-3 bis

tinuous wave sets for two-way communication. The airplane set was known as the E-10 airplane set and the ground apparatus was known as the E-10 artillery set. Unfortunately the transmission range of the ground set was insufficient and the airplane set was not powerful enough for consistently successful use.

After the wave-length range assignments were made, an organization was required to enforce them. This necessitated a compilation of rules and regulations for the operation of the various stations and also a systematized organization of the radio services. The proper organization of an Army suggests that the radio stations of each unit be controlled and operated separately. This can be done by having the stations of a regiment grouped and operated on one wave-length under control by the station at regimental headquarters. A divisional net would consist of the station at the division headquarters controlling the stations at the three brigade headquarters of that division, all of them working on the same wave-length. Adjoining nets were assigned different wave-lengths to reduce interference. It will be noted, however, that most stations required two sets, as they really are in



Practice Transmitting with Transmitting Set T. P. S. No. 2 bis

two nets, the lower unit which they command and the higher network to which they belong.

Each of the stations in a net was identified by means of a call composed of a letter and a figure; a letter and two figures; two letters. In certain nets these calls were changed daily according to the proposed plans. In each radio network or "net," the station which belonged to the highest military command unit was called the P. C. T. or Master Station. All of the other stations in the net were known as secondary stations and were under direct orders of the P.C.T., which controlled the traffic within the net when the net was working under control. The nets were named after the highest command to which they pertained and were: the Army Net, the Corps Net, the Division Net, the Advance Net and the Air Service Net.

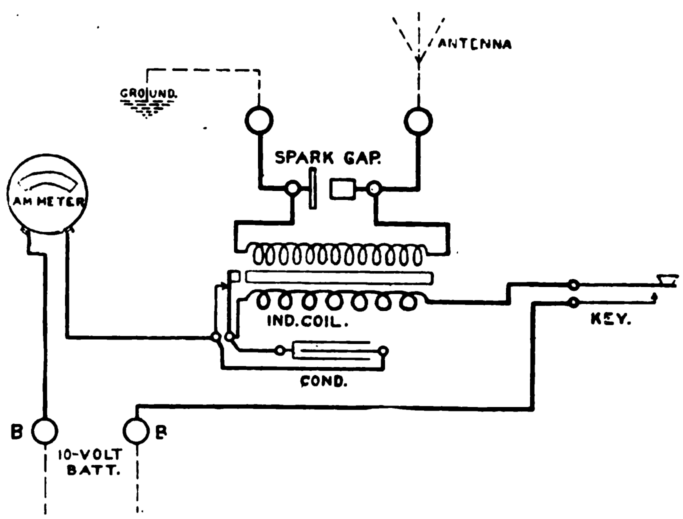
The Army Net included the stations at Army headquarters and the stations at the headquarters of each Army Corps, Army Artillery headquarters and Army Air Service headquarters. The Corps Net included the stations at Army Corps headquarters, the stations at the headquarters of the Divisions comprising the Army Corps and the Army Corps Air Service Group. The Division Net included the Divisional headquarters station and the stations at the headquarters of the Brigades of that Division, the Advance Center of Information and the Artillery Brigade headquarters of the Division. The Advanced Net included the Brigade headquarters station and the Regimental headquarters comprising the Brigade.

The exact wave-length, selected from the allotted wave-length range, to be used during operation in each net was fixed by the Radio Officer of the Army in which the net operated. This regulation of net operation was effected by means of radio liaison plans which were issued from time to time. When a net was operating, all of the stations in the net were listening. This necessitated that each station be sharply tuned to the prescribed wave-length and that the operator of each station have his head phones on and be following the traffic in the net. At no time was any station without an operator on duty, after the station had once reported into the net.

A net was operated either as a "free net" or as a "controlled net." When operating as a "free net" the P. C. T. or control station never interfered, but listened in to see that the secondary stations observed the operating rules. A station having a message to send called the addressed station after having previously listened in to guard against interference. In case there was disorder in the net the P. C. T. usually assumed control of the net by sending the conventional R. D. followed by the P. C. T. call, making it necessary for a secondary station to obtain permission from the P. C. T. before calling another station in the net. The P. C. T. sent the signal R. L. when the net was released from control and the net then became free.

The Network Charts and Wave-length Schedule accompanying this article will give some idea of the complexity of the network systems and the plans for the employment of radio-telegraphy will show what an undertaking it was to assign wave-lengths and call letters to all of the stations in the various networks, if interference was to be reduced to a minimum.

The assignment of equipment to stations can be noted on the network chart. It is described in detail



Circuit diagram of Transmitting Set Portable Type No. 4

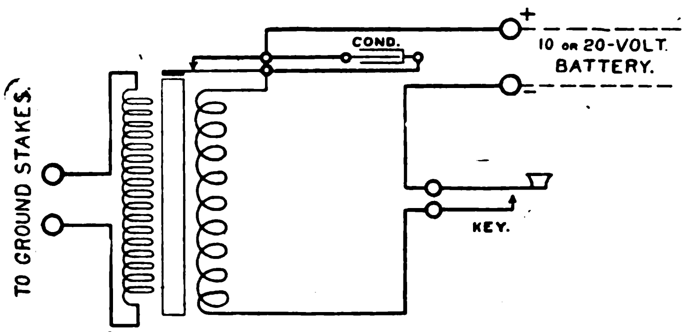
and illustrated by the accompanying photographs and circuit diagrams.

The list of standard French radio equipment was as follows:

- Ground Telegraphy
  - Transmitting Set T. P. S. No. 2 bis
  - Receiving Set T. P. S.
- Radio Telegraphy
  - Transmitting Set Portable Type No. 4
  - Receiving Set Artillery Type A-1
  - Amplifier—Type 3 ter
  - Radio Set, Type E-10 bis
  - Radio Set Type E-10 Artillery
  - Radio Set Type E-3 bis
  - Radio Set Type E-3 ter.

The Transmitting Set T. P. S. No. 2-bis, consists of a high power buzzer operated by a 10-volt storage battery with its secondary, as shown in the diagram, connected into a line of well insulated field wire whose ends for efficient operation were grounded by means of metal stakes at points varying from 150 to 300 feet apart. The interrupter of the buzzer carried a slidable weight which could be used to vary the frequency of vibration from about 300 to 750 per second providing a distinctive note. Naturally no tuning was involved in the receiving.

The key was inserted in the primary circuit of the buzzer whereby it was possible to send pulses of alternating current into the ground where they spread out and set up currents in a similarly grounded line at the receiving station. Telegraphic signals were thus transmitted from one station to another. The maximum normal distance of reliable transmission by T. P. S. was about 2,000 yards. The receiving set T. P. S. comprised a low frequency three-step vacuum tube amplifier, whose circuits are shown in the diagram herewith, connected by insulated wire to a pair of ground stakes in the same manner as the transmitter. Inasmuch as audio frequency currents are set up by the transmitter no detecting action is necessary at the receiver. For best results the two base lines, or the line of ground stakes, of the transmitter and receiver should be parallel or approximately so, and laid out with the aid of a compass.

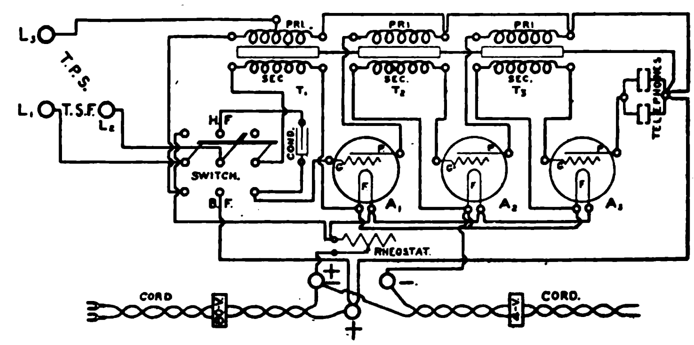


Circuit diagram of Transmitting Set T. P. S. No 2-bis

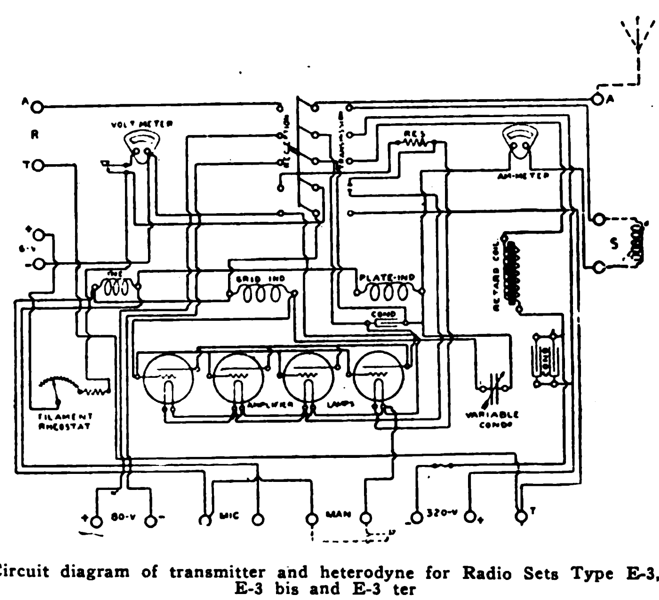
Receiving with Receiver Type A-1 and Amplifier Type 3 ter

The American equivalents of the French T. P. S. transmitter and receiver are known as S. C. R.-71 and S. C. R.-72 respectively. The two-way American S. C. R.-76 T. P. S. set was a combination of the two above types, which eventually would have replaced the French equipment, but it was never available in quantities for distribution to American Signal troops. It was considered superior electrically and mechanically to the French equipment.

The amplifier type 3 Ter.—a very useful piece of apparatus—was an integral part of any sets, such as, the receiving set T. P. S. and the E-3, E-3 bis. and E-3 Ter. sets. It was also a useful adjunct, as in connection with the receiving set type A-1. The amplifier 3-Ter. comprised three standard French vacuum tubes coupled by means of transformers—shown in the diagram—and supplied with current by storage batteries giving 4 volts for the filaments and 40 volts between plates and filaments. A rheostat in the filament circuit was the only means provided for varying the degree of amplification. Two leads were provided and a triple-pole double-throw switch for changing from connections whereby the amplifier acted as a low frequency amplifier for T. P. S. reception or for use as an amplifier, in conjunction with a crystal detector, to connections whereby the instrument might be used as a simultaneous detector and amplifier of radio signals. In this latter case the first of the three vacuum tubes acted as a detector and the other two as low frequency amplifiers. As soon as the availability of this amplifier became known to our operators, they immediately failed to get any results with their crystal detectors. Artillery operators complained that every time a battery fired the sensitive points on the crystals were lost and other stations complained that every time a shell exploded they were in the same predicament, no matter how far they might be from the disturbance. It was decided to restrict the use of the amplifier to simplify the storage battery supply which was required with them, but in the end nearly every spark

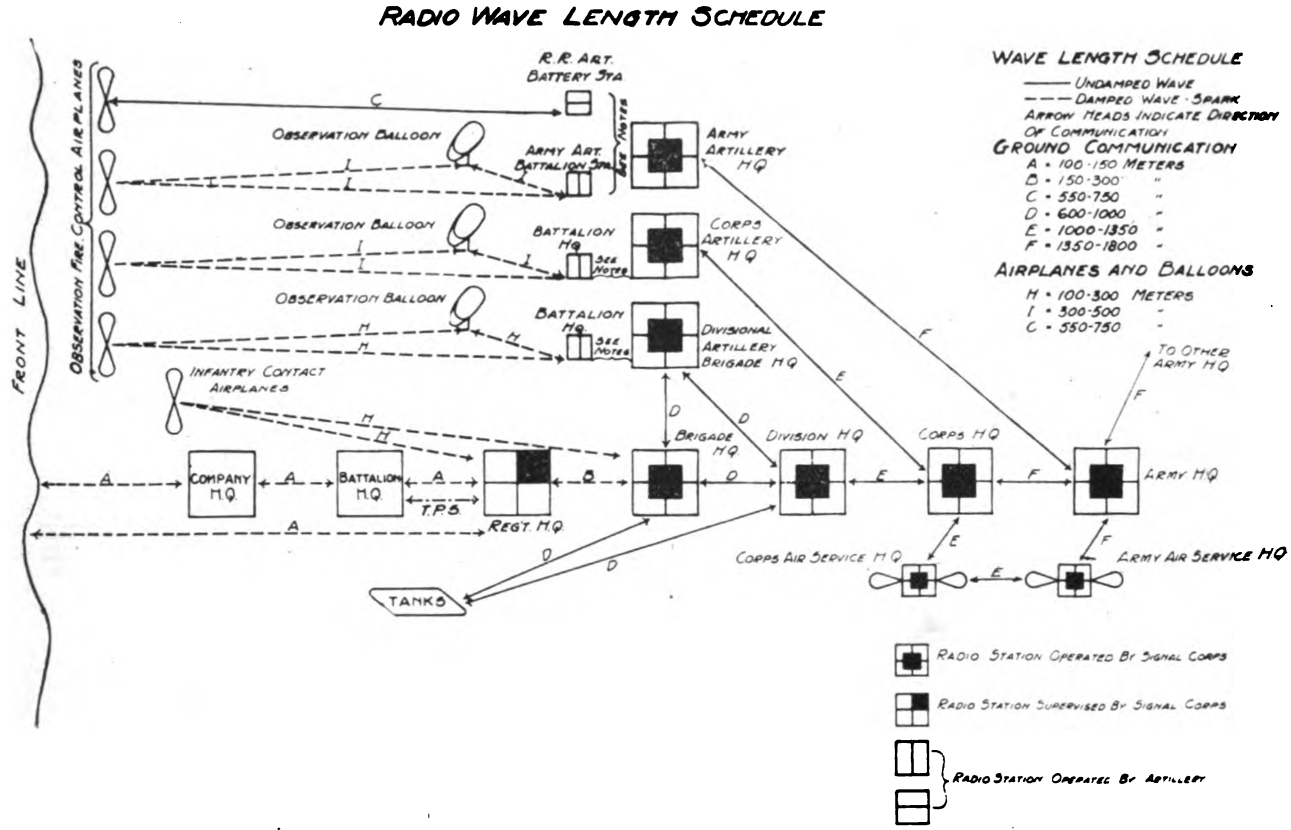


Circuit diagram of Amplifier Type 3-ter



Circuit diagram of transmitter and heterodyne for Radio Sets Type E-3, E-3 bis and E-3 ter station had an amplifier and it must be admitted that the operators were probably justified in their attitude. Future practice of the Signal Corps will probably provide valve detectors and amplifiers with all spark receivers. As stated above the S. C. R.-72 was the American equivalent of this amplifier, except that it did not operate as a detector.

The receiving set artillery type A-1 was probably the most widely used piece of radio apparatus in the A. E. F. It was a simple form of receiver for damped waves, using crystal detector or the above amplifier with a wave-length range of 100 to 550 meters. It was practically fool proof, extremely simple to manipulate and available in large quantities. The receiver of this set comprised a box containing a primary and secondary circuit,as shown in the wiring diagram,each made up of a variable air condenser and an inductance. The primary coil was provided with four taps and the



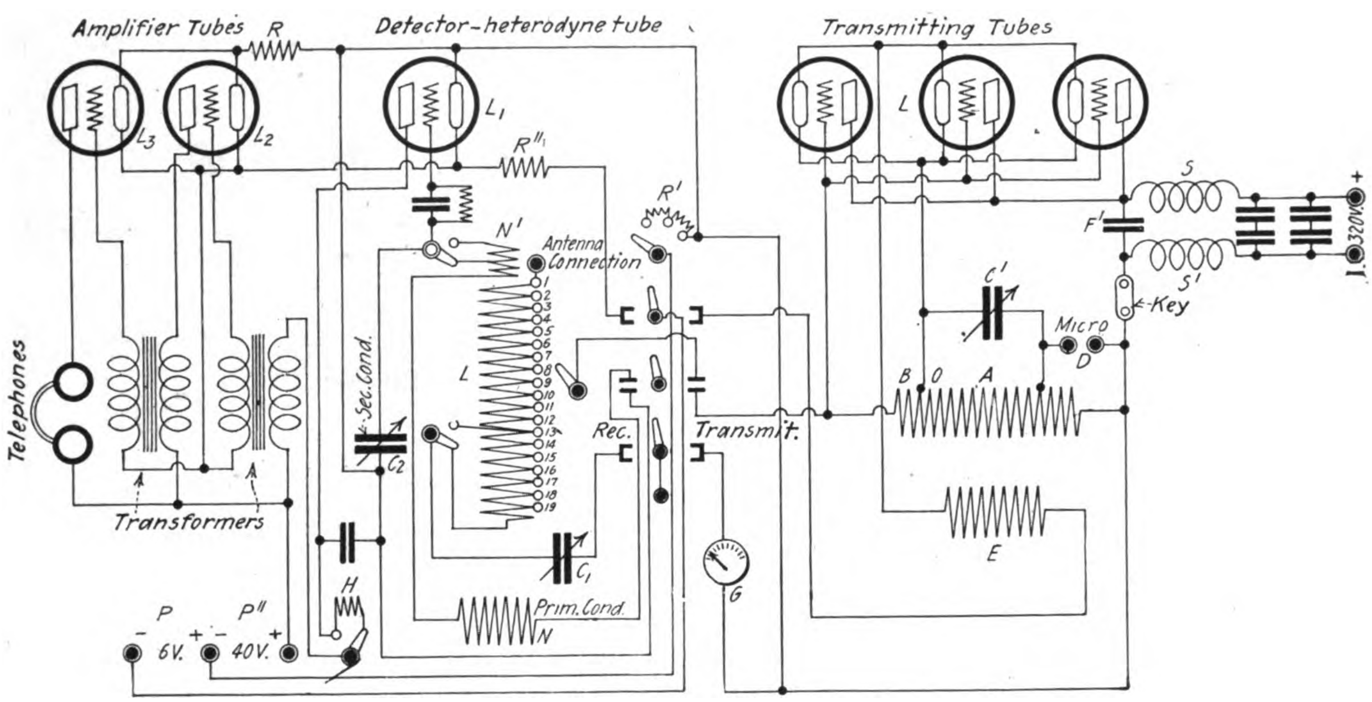
Receiving practice with an American made SCR 54 Receiver and a French Amplifier Type 3 ter secondary coil with five taps connected to the contacts of corresponding dial switches. The terminals of the primary circuit were connected to the ground and antenna respectively. Across the terminals of the secondary coil was connected the detector circuit which consisted of a galena crystal detector and a pair of telephone jacks, shunted by a small condenser. The secondary condenser was arranged to be cut out of the circuit by means of a switch, thereby making the secondary circuit a periodic for receiving signals of unknown wave-lengths. The receiving set Artillery type A-1 was complete with sectional bamboo antenna poles for the erection of a V type antenna.

The transmitting set portable type No. 4 which has been mentioned above consists of an induction coil, as shown in the accompanying diagram, operated by a 10-volt storage battery which supplied about 3 amperes to the primary for efficient operation.

The spark gap in the secondary circuit of the coil is connected to the ground and antenna circuits directly. The antenna for use in the trenches consists of a single wire from 75 to 100 feet long stretched between two supports about 4 feet above ground. The interrupter should make about 100 vibrations per second. There is no provision for tuning and the wave-lengths emitted depend upon the length and height of the antenna. The radius of transmission was normally about 2½ miles under favorable conditions.

This set made many an American operator, who had long known this type of set as an amateur, decidedly homesick at first and then decidedly doubtful as to its utility in war. However, it had been adopted because of its simplicity and, with a slightly higher antenna which was possible at regimental stations, it could be relied upon for transmission over 5 or 6 miles. Its defects soon became evident and efforts were immediately started in the Radio Division to obtain better equipment for the front lines as the necessity for more reliable communication and sharper tuning became necessary.

The best undamped wave communication was probably obtained by means of the radio set E-10 bis, for the reason that it was the most compact and rugged of all the undamped wave standard French radio apparatus utilized by American signal troops. It is true that it had its disadvantages, but it can be said that it certainly was the most popular piece of undamped wave radio apparatus in the A. E. F. The E-10 bis set was designed to transmit undamped wave signals and receive either damped or undamped wave signals. Six standard French vacuum tubes were used, three for transmitting and three for receiving. In transmitting, oscillations are generated by three vacuum tubes operating in parallel as shown in the accompanying diagram, a potential of 200-320 volts being applied to the plate-filament circuit and 6 volts to the filaments. When connected to a horizontal V-shaped antenna, 29 meters on a side and supported 4 meters above the ground on bamboo poles, the set will transmit on wave-lengths ranging between 600 and 1,000 meters. For wave-lengths between 600 and 800 meters the lead from the apparatus to the point of the V should be 10 meters long; for longer waves it should be 12-15 meters long. This set could also be used with a single wire antenna 40 meters long including the lead to the set and supported 1 meter above the ground.



Circuit diagram of Radio Set Type E-10 bis

When used with the antenna described, a good ground and with 300-320 volts on the plates, the input into the antenna should be about 0.5 ampere for the short waves and 0.6 amperes for the longer waves. Under favorable conditions the efficient range between two sets was usually from 50 to 60 kilometers. The plate voltage for undamped wave transmission in general was supplied either by eight 40-volt storage batteries or by the American made 12-320 volt Westinghouse dynamotor which was furnished from the United States during the latter part of the war. Though only available in limited quantities, eventually all sets would have been provided with this efficient source of plate potential.

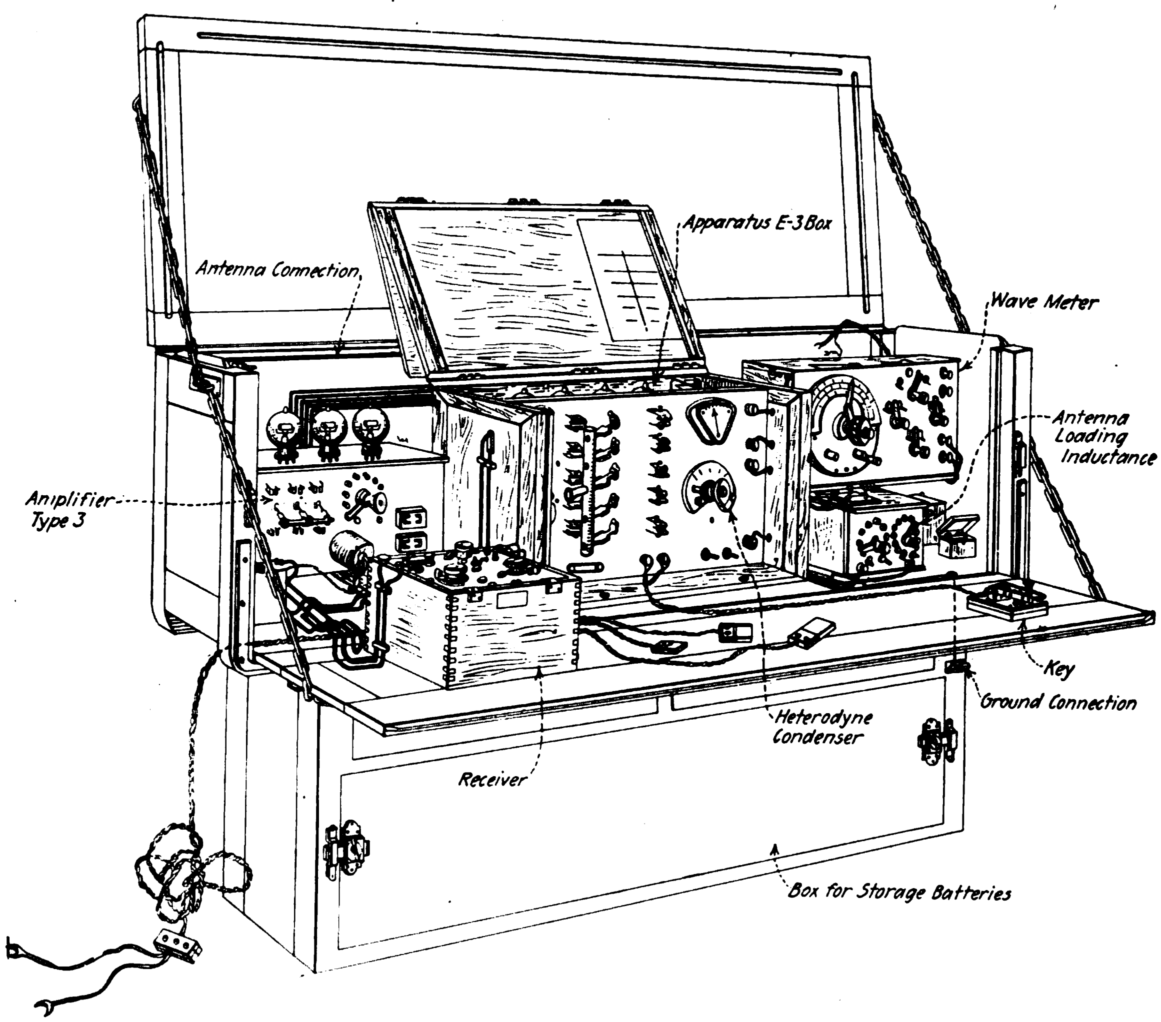
For receiving radio signals, damped or undamped, the E-10 bis set was provided with three vacuum tubes, as above described. When undamped signals were to be received one of the tubes acted as a detector and heterodyne, while the remaining two tubes amplified the detected low frequency signal impulses. The same 6-volt filament storage battery was used for both transmitting and receiving. The plate potential for the receiving tubes was furnished by a 40-volt storage battery. This storage battery should not be one of the series of 8-40 volt plate batteries used for transmitting.

An interesting piece of radio equipment which accompanied the E-10 bis sets was the wavemeter type T-1 which comprised a variometer and a fixed condenser, forming an oscillatory circuit, as against the fixed inductance and variable condenser commonly used. A small incandescent lamp was connected in circuit, as shown in the diagram, and was heated to a dull redness by a dry cell. The lamp served to indicate the resonance point when the transmitter was adjusted to the proper wave-length. A small buzzer in the wavemeter box may be used when it is desired to calibrate receiving circuits.

An American equivalent of the E-10 bis set was being developed in the United States at the termination of the war, but none were ever available to the A. E. F.

The series of E-3 sets—the radio sets E-3, E-3 bis and E-3 Ter—were practically identical in so far as design is concerned and the accompanying sketch may be considered as representative of this series of sets. The E-3 set became obsolete because its wave-length range 600-1,000 meters was assigned to the E-10 bis sets described above. The E-3 bis had a wave-length range of 1,000-1,350 meters and the E-3 Ter a range of 1,350-1,800 meters.

The accompanying schematic and circuit diagrams show the main features of these sets. Both the E-3 bis and E-3 Ter sets transmitted undamped wave signals and the continuous oscillations therefor were set up by four standard French vacuum tubes operating in parallel. Six volts is provided for the filament and 320 volts for the plate potential. These sets put about 6 to 8 amperes into the V-shaped antenna, 50 meters on a side with a 60° central angle and about 5 meters off the ground.

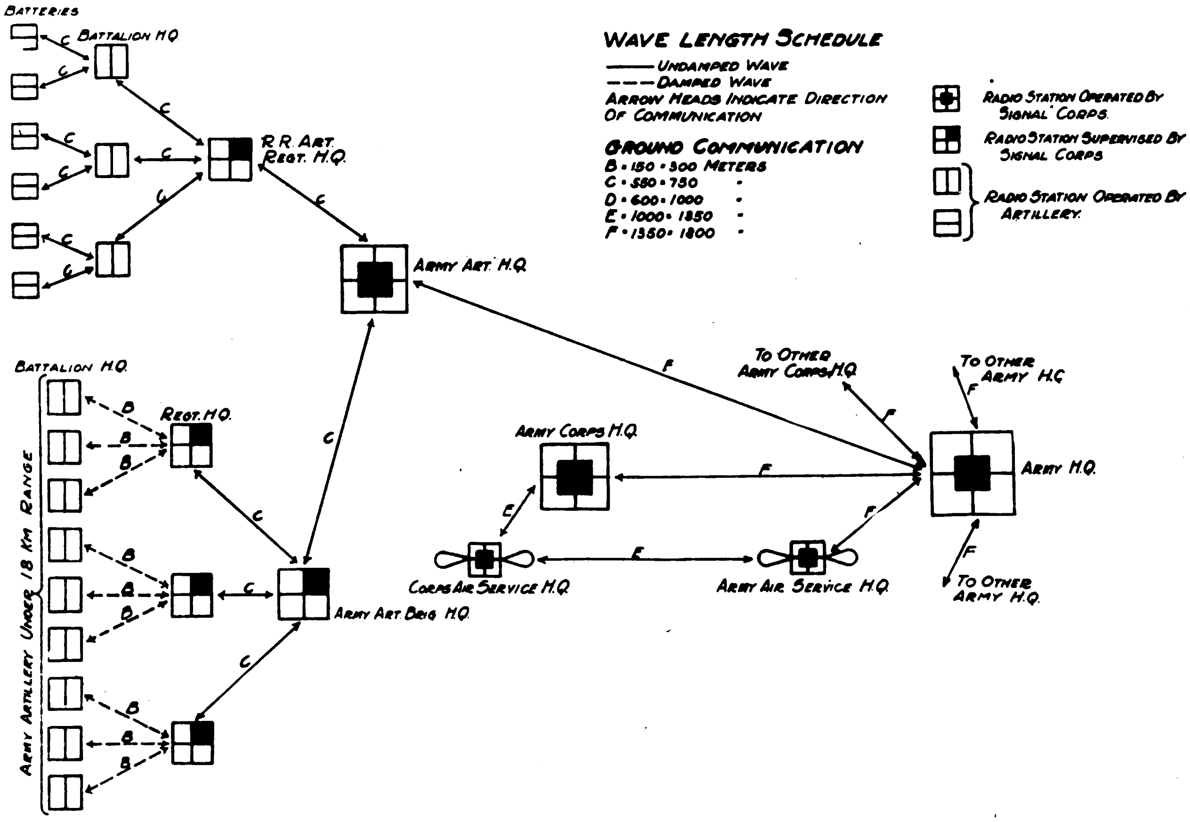


Sketch showing method of mounting the various component parts of Radio Sets Types E-3, E-3 bis and E-3 ter

The E-3 bis and E-3 Ter sets were adapted to receive damped and undamped signals of a range of wave-lengths somewhat greater than that for transmission. The transmitting box circuit with one vacuum tube oscillating is used for the purpose of a separate heterodyne and the amplifier 3 Ter, as the detector and amplifier. The usual practice was to use 40 volts as the plate potential of the heterodyne tube.

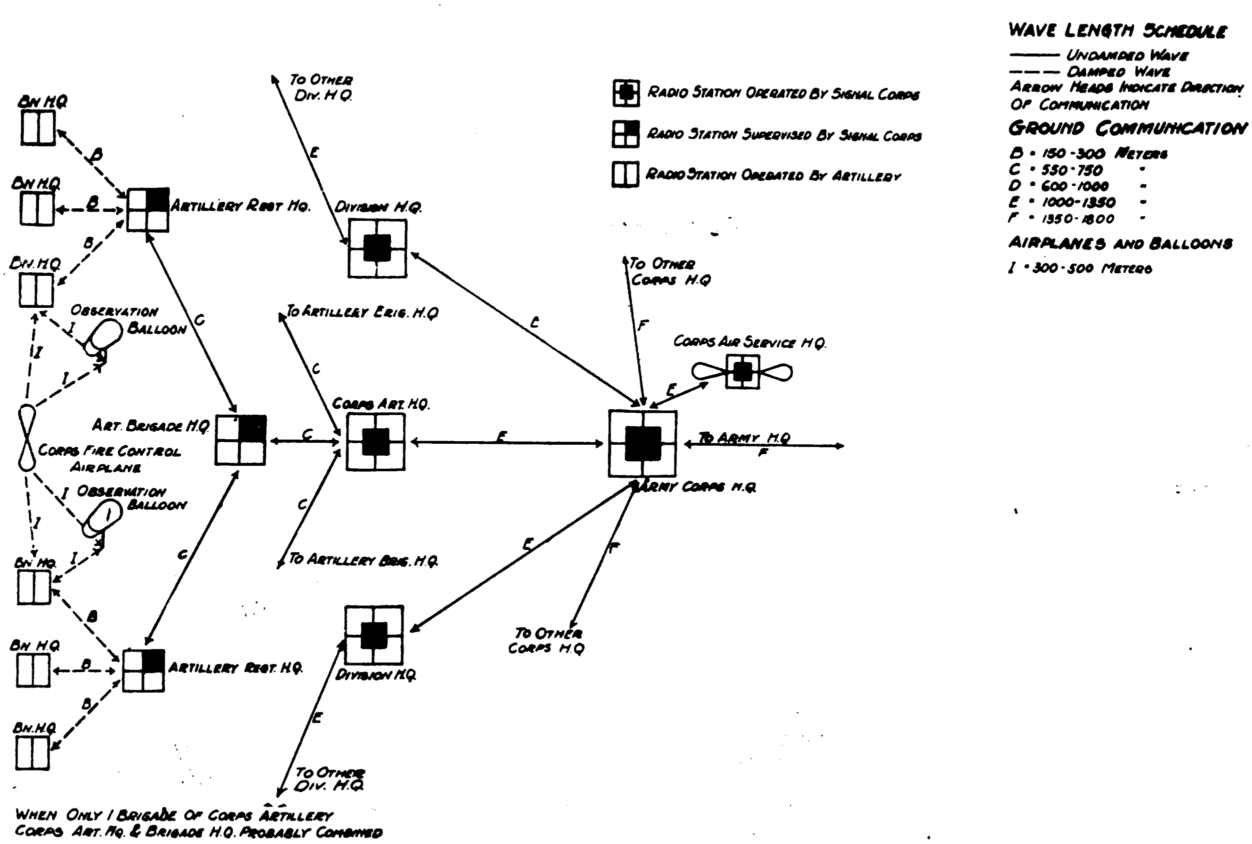
Shortly before the signing of the armistice a new set was developed by the French known as radio set type E-13. This set was found to be very efficient in operation and was extremely compact, as compared to the bulky E-3 bis or E-3 Ter sets. The wave-length range was from 1,200-2,800 meters. It was planned to reduce the lower figure to 1,000 meters in order that it might be used as a set to replace both the E-3 bis and E-3 Ter sets. The accompanying schematic diagrams show the circuit arrangements of this set.

ARMY RADIO NETWORK

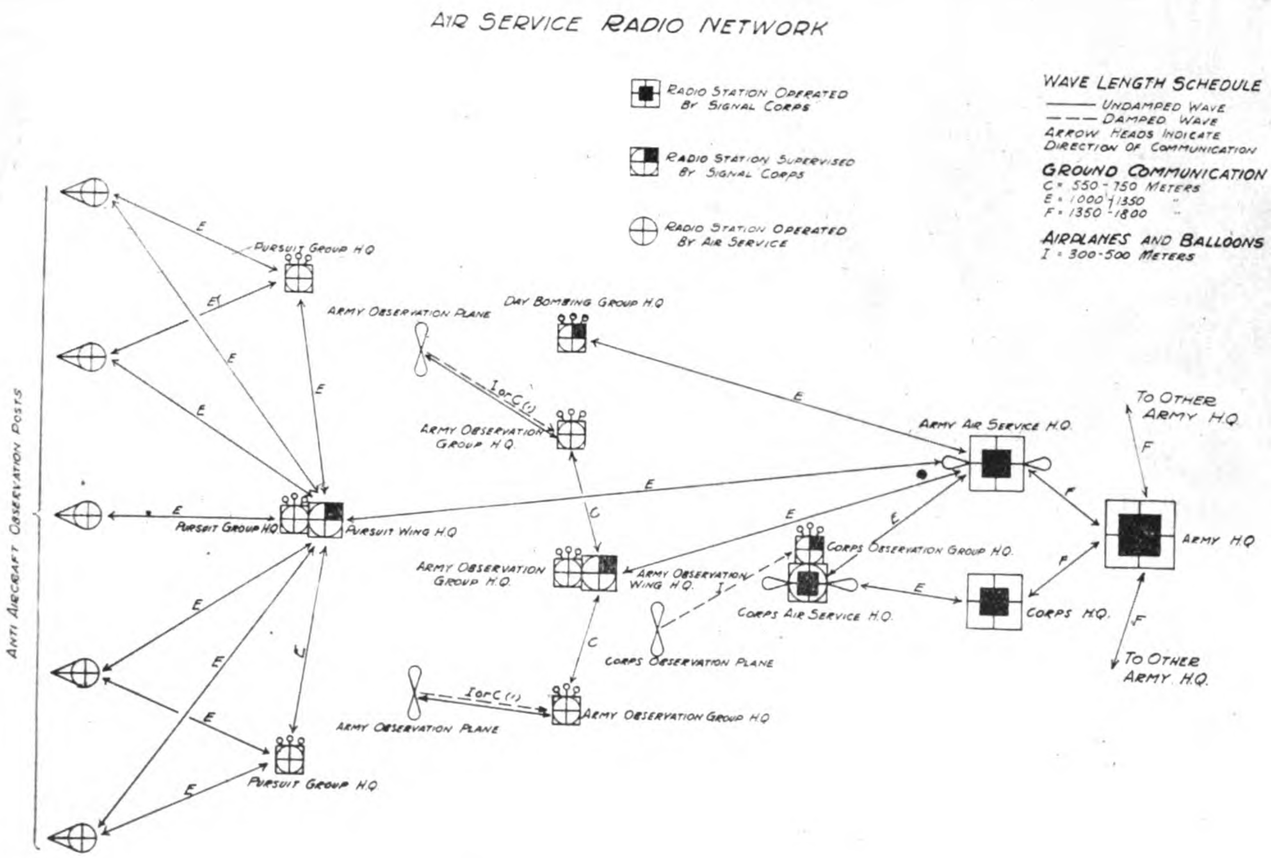


For transmission four standard French vacuum tubes operating in parallel generate the undamped oscillations. It will be noted that the grid is coupled to the plate and also to the antenna loading inductance. The maximum efficiency in the transfer of energy to the antenna is obtained by means of the arrangement

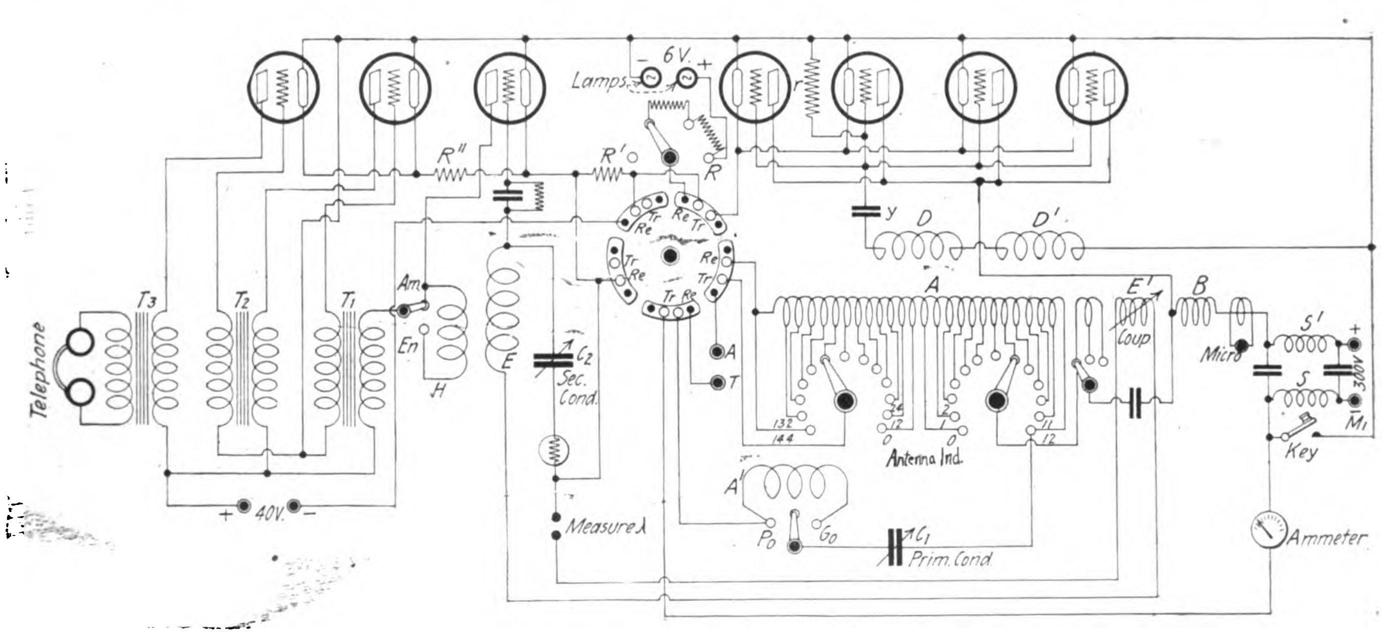
ARMY CORPS RADIO NETWORK



of the antenna loading inductance A and a coil B in the plate circuit wound on the same ebonite tube. The two grid coils D' and D are in series and link with the coils A and B respectively. The coil D' is placed within



the coil A giving a close coupling and the coil D is outside and adjacent to the coil B being thereby loosely coupled to it. It is obvious that when the inductance in the antenna is increased the coupling between the coils D and A is increased. This arrange-



Circuit diagram of Radio Set Type E-13

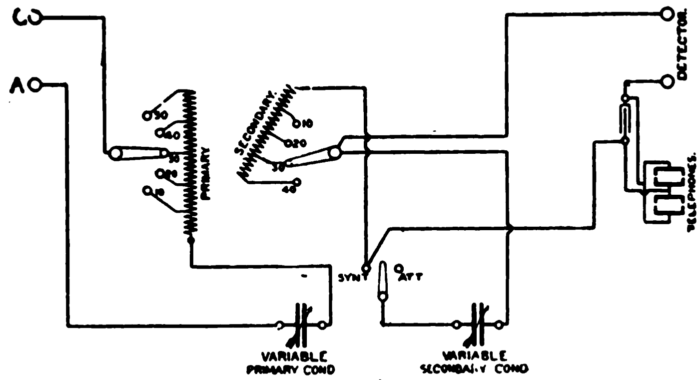
ment makes possible a favorable value of coupling for all wave-lengths within the range of this set.

The coils S, S[1] and the condenser M[1] serve to smooth out current variations when a dynamotor is used to provide the 320 volts for the plate potential. The condenser N in the antenna circuit prevents the plate current from flowing in the antenna circuit.

A key in the plate circuit is used for telegraph signals and an auxiliary coil wound around the coil B and in series with a microphone permits the set to be used for radio-telephony, in which case the key is short circuited. For reception three standard French vacuum tubes are used for receiving either damped or un damped waves. When receiving damped wave signals, one of the tubes acts as a detector and the other two

Transmitting practice with Transmitting Set Portable Type No. 4

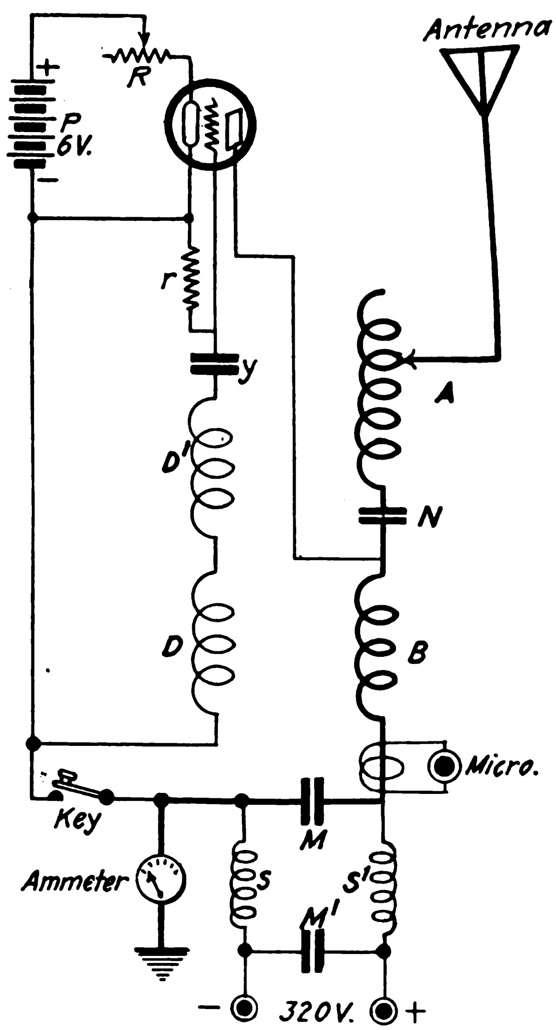
become low frequency amplifiers. It will be noted that the receiver secondary circuit comprises the variable condenser C-2 and two fixed inductances E and E. The inductance E is not coupled to the antenna circuit but it is mounted, together with the inductance A of the antenna, in the form of a variometer. Tuning of the antenna circuit is accomplished by means of the condenser C and by the inductance A^1 in series with the



Circuit diagram of Receiver Type A-1

inductance A. The coil A^1 may be entirely or partly used, or cut out of the circuit. When receiving undamped or continuous waves the coil H coupled to the coil E serves to maintain the local oscillations by the tube L for heterodyne reception. The coil H may be cut out of the circuit when damped waves are received. The tubes L-2 and L-3 comprise a low frequency amplifier and they are coupled by the transformers T-1 and T-2. The telephones are coupled to the plate circuit of the tube L-3 through the transformer T-3. The commutation switch provides for rapid changeover from receiving to transmitting.

It will be noted by reference to the circuit diagrams of the French undamped wave vacuum tube sets, that provision was made for radio-telephony, the sets being

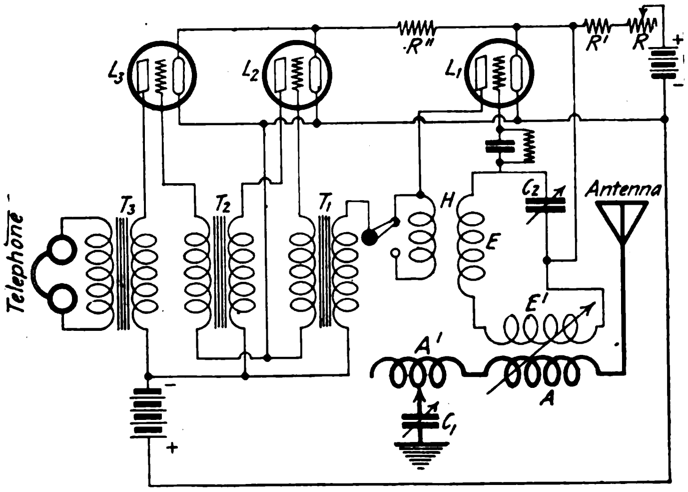


Simplified diagram of Radio Set Type E-13 transmitting tube circuit

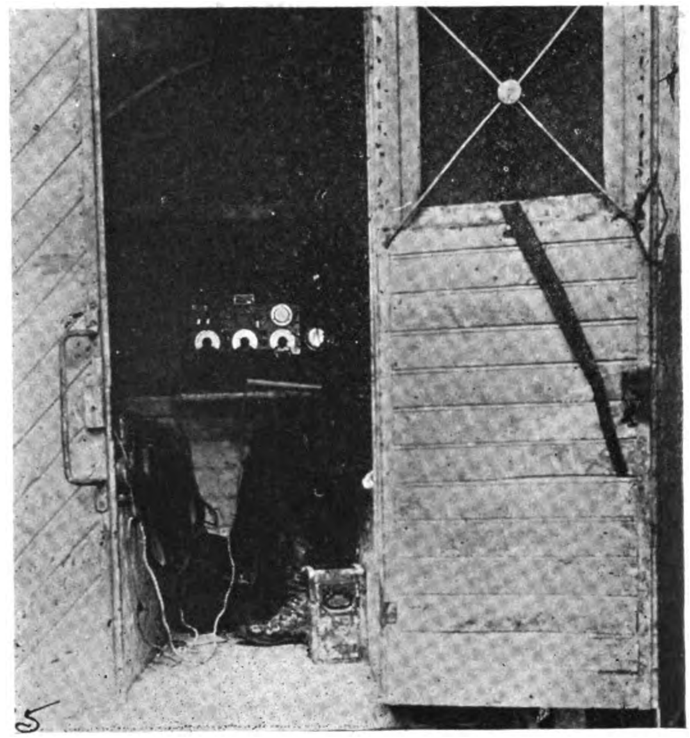
A Ford Radio Tractor, Divisional Headquarters Radio

fairly efficient though never so used in the armies. We have already indicated the difficulty in suppressing indiscreet language over wired telephone circuits where theoretically, at least, they could be made secret. It need not be explained what would have resulted if radio-telephony had been utilized to intercept stations the Germans were operating against us. The slang phrase "I'll tell the World" would have had a real meaning in that case.

This article outlines in a technical way the offensive or communication radio service in our army. It does not picture the problem of the individual stations or their operators, who by their efforts made their particular station efficient and reliable and thus contributed to the successful entity. Imagine yourself the operator of a regimental or brigade headquarters station located in a muddy dugout, with a gas curtain over your dugout entrance and you with a gas mask on trying to get a message through, hoping the next shell doesn't take away your antenna, or that you are the operator of a station in an abandoned French home in a tiny village, or in the kitchen of an old stone house which could not have been very comfortable at its best, but now damp, cold and bare of everything that suggests a human habitation, is your combined workshop and habitation. If it is winter it is cold and clammy and you yourself are covered with the grey mud of northern France. This is not a very encouraging condition under which to operate your station, but it may at any moment become the only means of communication and you are always one of the important links that make the various networks outlined above effective. You are left mainly on your own responsibility, your personal trials and tribulations would make interesting reading, but unfortunately they could not be recorded in this article.



Simplified diagram of Radio Set Type E-13 receiving tube circuits



View showing interior of Fiat Tractor in which was mounted both an E-3 bis Set and an E-10 bis Set. The E-10 bis equipment can be seen through the open door

Radio Restrictions Removed

It is announced by the Navy Department that restrictions on amateur, technical and training schools and experimental stations are removed on

October 1st

Applications for transmitting licenses will be received by mail only at the local offices of the Radio Inspector, Department of Commerce.

A Summer on the Great Lakes

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

By Julian K. Henney

IV—People and Visits

AT Detroit a small incident occurred which made it somewhat evident that the wireless man's life is, so to speak, a matter of official record. The Radio Inspector paid us a visit.

A few minutes before sailing time I went aboard and stopped at the Purser's office to get the mail. There were several letters for Snell and I went aft to where he was soundly sleeping. As I approached the bunk room I noticed that the radio room door was open and that someone was inside, writing for all there was in it.

"Ha!" thought I, "a German spy on board!"

But when I accosted the stranger he tersely introduced himself as the Government Radio Inspector.

There are those who, on occasion, refer to the monotony of life on shipboard. They seem astounded to learn that there is no such thing

"What's your name? where's your license?" he demanded.

I assumed an air of extreme civility. "The license hangs on the wall in front of your nose and my name is on it," I answered without cordiality, for I had looked over his shoulder and saw that he had already copied my name, age and everything else in the way of information contained in the license.

He was not impressed with my independence. " 'What is your name?' I said," he snapped. "Name of your captain? Where are you bound? Ever worked before? What are your call letters? Have you monkeyed with the connections? Are you red, or black, and if married state why?"—and so on.

He got all of this off in one breath, meanwhile working everything in sight from the spark to the auxiliary power plant. I felt that we were going to have an argument, and with the growing conviction that we were to hear unpleasant things about swiping the Tionesta's tuner, I answered all of his questions as shortly and truthfully as possible.

Then he switched the subject. "What's your pardner's name? Where is he? Is he the first, or second, operator? What's the name of this ship? Where are you bound from and how long do you expect to live"—a rattling fire of questions came from the lips of the austere and important Radio Inspector; I had to think pretty fast and furious. Then came the stunner!

"Where is your pardner's license?" . . . Where is *he*?" Doesn't he *know* he is liable to arrest for being aboard without a license? *Where* is that license, I say!"

It was evident that an attempt at diplomacy was waste effort. "Well now, Mr. Jones," said I, in the most soothing manner I could summon, "perhaps it would be just as well for you to speak to Mr. Snell about those little things. The boat leaves in five minutes and I have several matters to attend to before that time." Over my shoulder, I observed that in the event of delay the fare to Mackinac was about sixteen dollars.

Poor Snell! He had forgotten his license. (It was only a chance thought of the Radio Inspector that made me hang my own up ten minutes before landing at Detroit). But the worst of all—Snell told Jones he "didn't have room for it in his suitcase!"

The idea of a sheet of paper the size of the license overburdening a suitcase was a little too much for the official. He demonstrated his excellent command of a vocabulary of invective. But vain were his efforts to get Watson interested, or even awake. The job was hopeless, and at the blow of the whistle, the inspector rushed to the skipper's room where he spread the news that Snell would have to get off at Duluth.

For five minutes the Captain—good friend that he was—argued it out; then the inspector was escorted to the dock. The ship slowly warped away from the crowded pier and turned her nose toward the upper lakes. I breathed a sigh of relief. . . . Snell was already fast asleep.

Soon afterward we received "General Orders" to this effect: "All operators will have their licenses posted in the radio room where they may be inspected at all times by the proper authorities. Any operator who violates this rule will be relieved from further service at once."

* * *

There are those who, on occasion, refer to the monotony of life on shipboard. They seem astounded to learn that there is no such thing.

To one who is interested in life, in people, in daily happenings, life on a steamer is brimful of interest. A radio operator has ample opportunity to observe many things of more than passing interest, and with duties that are far from confining there are many chances to get the passenger's viewpoint on these same affairs.

I remember one trip that seemed crowded with occurrences. We left the dock at Buffalo on a day about midway in July, a time of year when the sun beats down on the river at Buffalo, seeming to intensify the stream's odor to its very worst, a time when people in general are out of sorts with themselves and the world.

From early morning, Snell, as usual, had been disporting himself on one of Buffalo's numerous bathing beaches. He returned not ten minutes before sailing time. I always intended to go with him, but when the time came, and I thought of the hot sun, the mobs of people, and the hour's street car ride, the shaded afterdeck of the Juniata looked better for the two days in Buffalo. Time could be found for sleep, to see a couple shows, and to sit out under the canvas and pound off a few letters. The process of loading the ship and the coaling which took place at night, also gave me plenty to see and hear.

So I was there on the deck on the day of which I write. Across the river from our berth were several Shipping Board boats in various stages of camouflaged construction; the sound of hammers at times floated over the Juniata in an inspiring roar. A roving glance engaged a contrasting scene. Not far from us was the Tento, a British vessel which had returned for repairs after being damaged on the way to the St. Lawrence. Ever so often her white-suited officers showed themselves on deck, and one could always see a few men—not so immaculately clad—puttering around with a can of paint and a brush. Here were no signs of hurry. In line of vision, too, were the ruins of the old Northwest, a well known Great Lakes steamer which burned in Buffalo harbor several years ago. The blackened steel hull, even tho cut in two and with stacks and masts removed, looked immense to us across the river. I thought of her sister ship, the Northland, driving through the heavy swells off the coast, doing her part in supplying the great demand for ocean tonnage.

Sailing time came. From a vantage point—the sun deck—we engaged ourselves in the process of "looking over" the arriving passengers. The warm weather had brought us a "full house" for the trip.

The warning blast sounded. Mates, steward, and cooks hastened aboard; the captain slowly climbed to his place on the bridge. The steamer slowly warped away from the dock. Suddenly there was a cry from the after gangway; people began running in all directions. Clear and sharp then came the cry: "Man overboard!"

Cliquot, one of the head waiters, was the unfortunate. He was struggling in the red muck of the harbor, vainly trying to grasp the side of the steamer, and at the same time keep from being crushed against the pier. It was plain that he was in a tight fix, but his wild thrashing about, somehow, appeared amusing. Perhaps it was because his suitcase gave up the ghost so promptly; after one or two uncertain bobs it opened with a big lurch and went down stern foremost.

There was no excitement. The captain did not bother to stop the engines. He calmly watched the process of throwing a rope to Cliquot and the consequent rescue—too late to get the boat.

It later developed that the waiter and several others of the dining room force made a belated appearance because they had been told that the Juniata was scheduled to leave later than usual on this particular trip. Cliquot was more zealous than the rest and had tried to jump the widening distance between the steamer and the dock. He had two suit cases, and they together with a package ruined his chances of making the boat. Noting this, he decided to throw one of the suitcases aboard, and then jump with the other, but the weight pulled him into the water before his foot touched the deck.

Poor Cliquot was a sorry sight when they pulled him from the river, his new clothes were ruined by the dirty water, and his black face was covered with oil from the many vessels. Incidentally, within the lost suitcase was his entire wardrobe and other rarer things designed for interior embellishment.

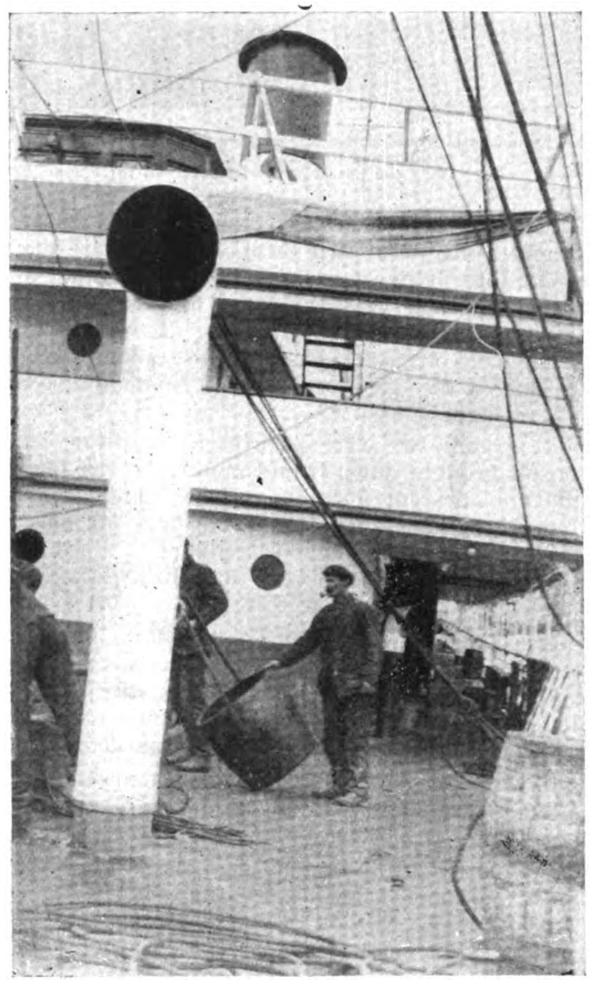
As soon as dinner was served, we noticed that there were others missing; all told, seven waiters and the buffet man had been left behind. All evening the half-deaf steward tried to accommodate the patrons, each of whom had a method all his own for mixing drinks, with a result that proved a lasting entertainment.

Not long after leaving the harbor we struck up acquaintance with two young fellows who were decidedly anxious to appraise the feminine resources aboard ship.

They were college students; one, a Harvard man, announced that his name "whereby to be known" was Bunny: the other, whose illuminating appelation was Skeet, had attended Yale. Bunny was a sick man, so he told us, and was going to his uncle, a mine owner in the copper district, to recuperate. Skeet was going along to do the work and to keep him company.

From the start they conducted themselves in non-orthodox invalid style. They managed to secure introductions to every member of the fair sex on our passenger list, alternating dances in the dining room with tete-a-tete on deck or rendering select ballads on the mandolin.

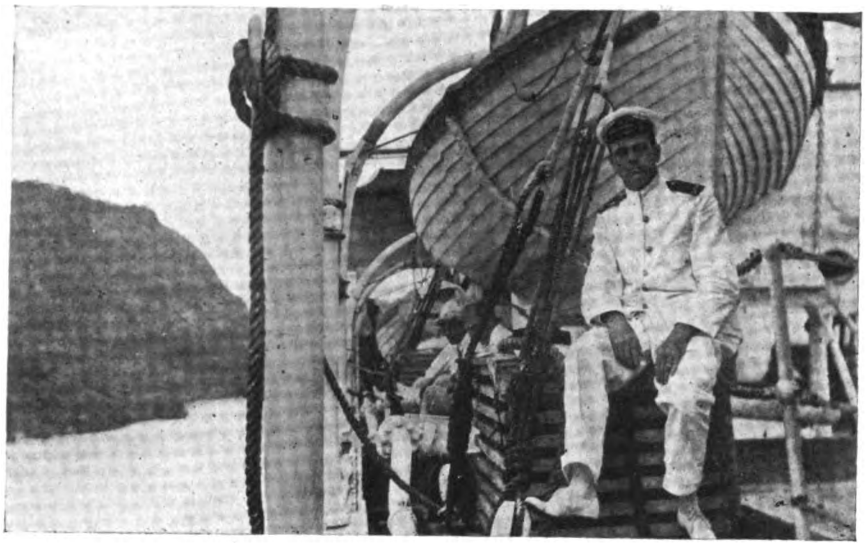
The second night out, Bunny—the sick one—said life on shipboard was too slow for him. He guessed he would have to have some exercise. The next morning the engineer told me that both of them had put in a trick and a half during the night—passing coal! At Mackinac Island, Bunny suggested a race to the top of the fort, some three



The process of loading the ship gave me plenty to see and hear

hundred feet up the hill. Over one hundred steps had to be climbed before we reached the top. Bunny won. That night the four of us ran races around the deck. We heard about this from the captain; some peevish passenger told him: "somebody ran a wheelbarrow around the deck all night." The skipper remarked to us that exercise was beneficial, but he suggested that we postpone the midnight races until later in the season . . . after the Juniata had been safely laid up for the winter for example.

Bunny and Skeet entertained all of us, and particularly the ladies, with alternate mandolining and yodeling until we reached Houghton. There they left us for the opulent uncle and the much needed rest. They were to do absolutely nothing for three weeks, Skeet remarked dolefully as he explained the terrible physical condition in which Bunny found himself. Uncle Douglas had promised a car and a man to drive it, so they would not have to overtax their strength walking or working.



A radio operator has ample opportunity to observe many things of more than passing interest, and with duties that are far from confining there are many chances to get the passenger's viewpoint on these same affairs

thrown into the molten copper to burn out the oxygen. We learned that in a shaft farther up the hill five men had been working for several years, trying to get deep enough to reach a vein that ran at an angle to the surface. Not until this vein should be struck would the remainder of the mine be constructed. The blast furnaces and the various stages of the refining process before the copper ingots were formed in their moulds provided an entertaining hour's trip through the works of the mine. It was rather surprising to see our restless companions at all composed in the presence of such mundane surroundings.

Two hours later we went back to the steamer and said a reluctant farewell to our new-found hosts. I assure you not a thought was given to the "monotony" which some people think is the wireless operator's portion.

On the next trip we were yet far from the wharf when Snell and I made out two forms, so wildly gesticulating from the tops of two posts that both the captain and the mate trained their glasses on the figures, thinking that something was wrong with the ship. As we drew nearer we recognized out two college friends, tanned dark as Indians, one of the effects of loafing "something terrible," Bunny explained.

Quite grandly we were escorted to a waiting machine, a monster brought down from Calumet for the special use of the convalescent and his nurse. Quite slowly, we started up the long hill to town, but once out of sight of the dock the speedometer took a jump. "We discovered yesterday," Skeet announced, "that she'll do sixty-three. Not bad for an old tub like this, eh?"

I agreed that it was pretty good as I jammed my uniform cap tightly over my ears. Bunny was driving, and telling Snell about six or seven dances which he had attended the last week. "But I thought uncle said you went to bed at eight o'clock," my partner remarked.

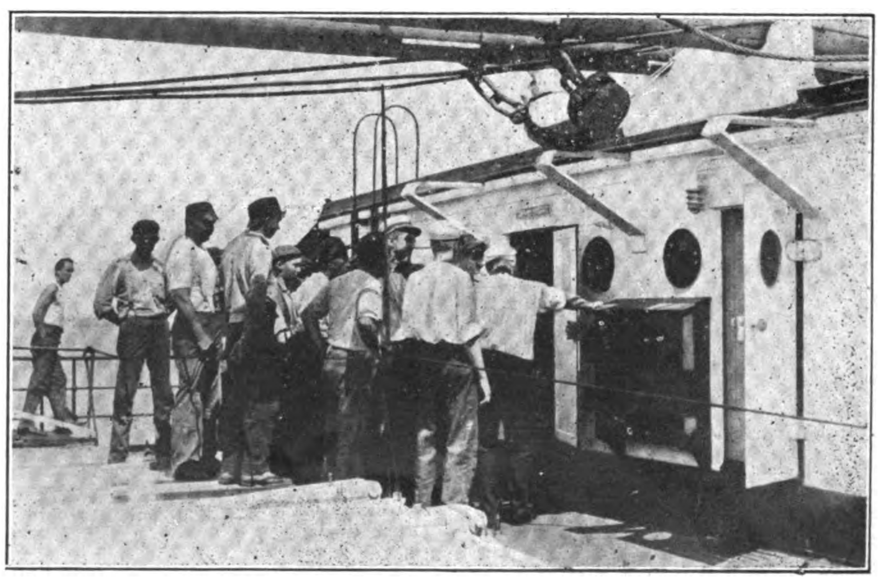
"Oh, we do," asserted Skeet. "So does uncle. He sleeps soundly, too, and our window is not very far from the ground."

After the invalid had taken us, at breath-taking speed, out past the School of Mines and had shown us facilities they used at the club house, the swimming and tennis—unknown to Uncle—we returned to town. Suddenly Skeet sat bolt upright, thumped Bunny on the back and pointed up the street: Uncle Douglas coming toward us in earnest conversation with another man. Instantly, the car slowed down to a mere walking pace, and our two friends put on their long and tired countenances.

I thought of her sister ship, the Northland, driving through the heavy swells off the coast

After a short conversation relating mainly to hopes of getting well, and not overtaxing their strength, Mr. Douglas moved on. Slowly the car moved off, until the old gentleman had turned a corner, when the former speed was resumed.

A mile or so beyond the town limits we came upon a copper mine. The huge piles of slag and of copper ore were of absorbing interest when we had been initiated into the mysteries of smelting copper ore. At one place we saw trainloads of logs waiting to be



The warning blast sounded—Mates, steward and cooks hastened aboard

Some Modern Vacuum Tube Circuits and Their Operation

By J. Scott-Taggart

IN view of the innumerable circuits which have been devised from time to time, many of which are due to American research workers, the ones which follow can lay no claim to originality. They are the outcome of practical work based on the fundamental circuits evolved by such eminent scientists as E. H. Armstrong, H. J. Round, Lee DeForest, and others. From the point of view of practical utility, economy, and facility of construction and operation, as well as efficiency, the circuits given here may be of interest.

A "Stand-by" and "Tuned" Continuous-Wave Receiver

The reception of continuous waves is accompanied in many cases by equally strong signals from stations transmitting with damped waves. Perhaps the simplest meth-

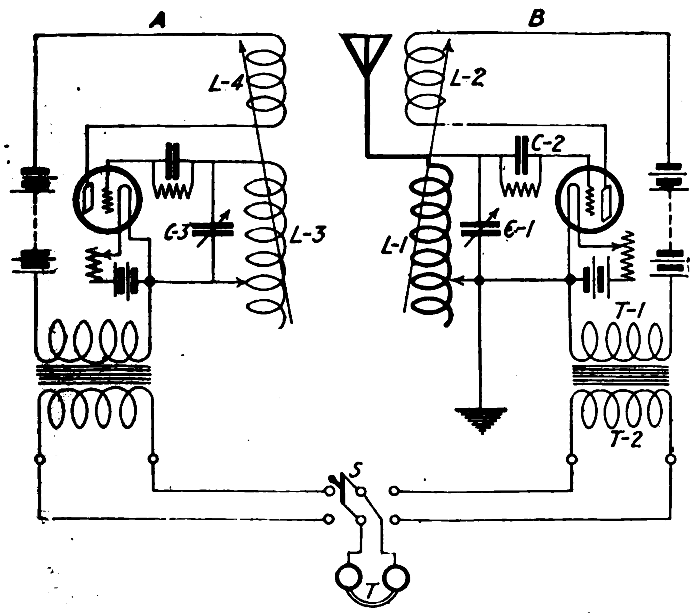


Figure 1—Circuit diagram of the "stand-by" and "tuned" continuous-wave receiver

od of lessening this interference is to use a very loose coupling between an aerial circuit and a closed oscillatory circuit slightly mistuned. The distance between the circuits may be in the neighborhood of three feet, in which case the spark interference is almost altogether eliminated. The strength of the continuous wave signals is, of course, lessened at the same time, but not to the same extent.

Many interesting conclusions may be drawn by constructing two circuits A and B separated by a distance of about one foot. The circuit B is an ordinary simple regenerative receiving circuit, which by tightening the coupling between the aperiodic coil L-2 and the inductance L-1, may be set into self-oscillation at a frequency mainly determined by the position of the variable tapping from L-1 and the value of the condenser C-1. The plate oscillatory circuit consists of an aperiodic coil whose natural wave-length should be less than that of the smallest wave-length to be received on the circuit. Detector action is obtained by means of a condenser C-3 shunted by a resistance of about 2 megohms. This resistance may conveniently consist of several scratches on a piece of rough ebonite filled with graphite by rubbing an ordinary lead pencil across the grooves until a resistance tester connected across the terminals indicates the correct resistance. Instead of a pair of high-resistance telephones in the plate circuit, a step-down telephone transformer T-1, T-2 may be used, the high resistance winding of which may have a value of, say, 10,000 ohms. The low resistance winding T-2 should have a resistance equal to that of the 'phones (usually about 120 ohms). It should be of heavier wire than the winding T-1 which latter may conveniently have about 5 times as many turns as T-2. The switch S when swung over to the right brings the telephones T into the B circuit.

The circuit A is a somewhat similar one except that no aerial or earth connections are made to it. The coupling between L-4 and L-3 is variable and the vacuum tube is used to rectify as well as to produce regenerative action or self-oscillation. By swinging the change-over switch S to the left, the telephones are connected in the A circuit.

When the 'phones are connected in the B circuit, the latter of itself is capable of receiving continuous waves. The coupling between L-2 and L-1 is tightened until a rustling sound is heard in T. The vacuum tube is now generating oscillations. On touching the aerial, a sharp click will be heard in T; if L-1 is variable in steps by means of studs and a radial switch, on moving the switch across the studs clicks should be heard; the same result is obtained when C-2 is shorted, as it usually can be, by turning it to zero or maximum reading. Since these effects are not produced when the vacuum tubes are not oscillating, they may be used as an indication. The best indication, however, is the reception of continuous waves.

When receiving continuous waves, the circuit B is made to oscillate at a frequency slightly different to that of the incoming waves by a suitable adjustment of L-1 and C-1. The beats produced will be rectified by the tube

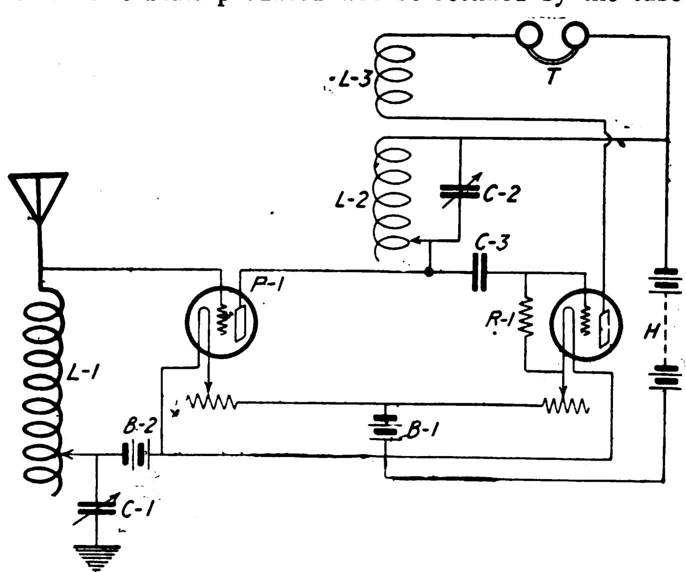


Figure 2—Diagram of connections of the general receiving circuit for damped or undamped waves

and will give signals in T. This circuit has at least two disadvantages. The first is that the strength of the local oscillations in B is not smoothly variable; for maximum strength of signals it should be, as has been pointed out by Armstrong. A certain amplitude (greater than that of the incoming waves) gives the best results. The second, and very important disadvantage, is that since we have mistuned our local circuit, the aerial circuit will be slightly out of tune with the incoming waves. This results in a weakening of the incoming oscillations which, however, retain their frequency and force themselves into the circuit. The higher the beat note received, the greater will have been the mistuning of the aerial circuit and consequently the greater the opposition to incoming waves. This effect lessens the strength of weak signals considerably and explains why the lower beat notes are the loudest on this type of circuit, whereas the most pleasing frequency is about 1,000 per second. When the aerial circuit is perfectly in tune with the incoming signals the local oscillations will have the same frequency as the incoming ones and no beats are produced. If the local circuit be tuned to either side of this silent interval, beats will begin again and a note will be heard in T. Thus by adjustment of the condenser C-2 until no beats occur, we have a very accurate method of tuning our circuit to the wave-length of the incoming signal.

Continuous wave signals are very easily picked up on this circuit which is, therefore, convenient for use when "standing-by" or when searching. Once the station has been picked up, we may eliminate interference by using

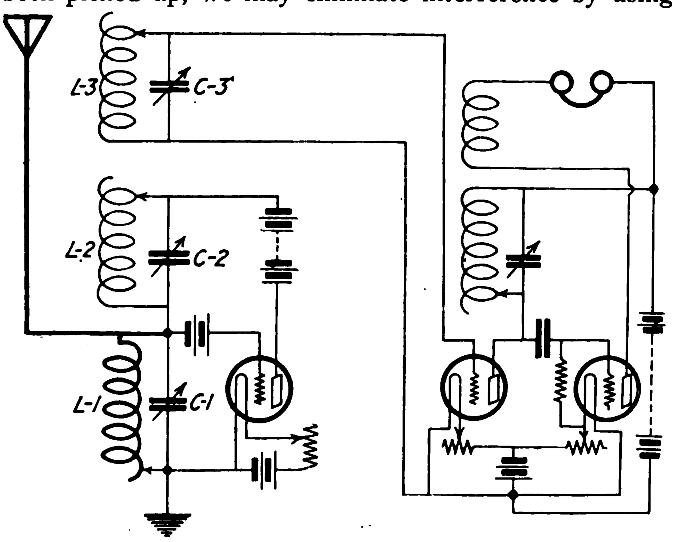


Figure 3—Circuit of a highly selective receiver

the "tuned" circuit brought into operation by moving S to the left. The circuit B is first adjusted for no beats with the incoming signal. The filament current (or plate voltage) is then decreased until the vacuum tube ceases to oscillate of its own accord; the coupling between L-2 and L-1 might be loosened if desired. The tube is now acting in a regenerative manner and is strengthening the incoming signals. These are then induced in the circuit A which is in a state of self-oscillation. Interfering Spark signals are lost in the coupling but the continuous oscillations interact with those of A and cause beats which are audible in T.

A rapid method of adjusting these circuits is as follows: Switch S to the right; increase the filament current of A until the circuit oscillates; tune C-2 until signals are heard; tune to the silent point of these signals so that the latter are heard if C-1 be varied either way. Switch S over to the left; see that circuit A is oscillating of its own accord; tune C-2 until a beat note is heard due to the oscillations of B. Decrease filament current of B till that circuit ceases to oscillate; the loud beat note in T due to B will cease, but by slight careful adjustment of C-2 the incoming oscillations will produce audible signals. The circuit A should be removed as far as possible from B, without decreasing too much the signals in T. If, while signals are being heard in T, the condenser C-1 is slightly turned either way, the strength of signals in T will decrease (owing to the mistuning of B) but the frequency of the beat note will remain unaltered since it depends on the local frequency of A.

The same disadvantages which applied to the B circuit alone still apply to the loose-coupled arrangement of A and B with the telephones in the B circuit. A considerable amount of spark interference may, however, be eliminated. Moreover, by suitably adjusting the coupling between L-2 and L-1 the incoming oscillations may be considerably strengthened by regenerative action. The signals in T will be weaker if advantage is not taken of this effect.

Having adjusted the "tuned" arrangement, let us now change back the telephones to the B circuit. Very loud signals will now be heard probably twice as loud as those heard on the B Circuit alone, and three or four times as loud as when the switch S is over to the right. The action of the circuits is now as follows: The B circuit is now accurately tuned to the incoming frequency and no loss is experienced through mistuning; also the oscillations are reinforced through the regenerative action of the coupling between L-2 and L-1, the degree of this coupling being just less than that required to set up self-oscillation in B. The A circuit, which is oscillating at a frequency slightly different to that of the incoming waves, induces oscillations in B which, acting on the oscillations already existing there, produce audible beats. The circuit B is not as receptive to local oscillations from A as it might be, but this is no disadvantage since the amplitude of the induced oscillations forced into the circuit may be adjusted to any value by varying the distance between the circuit A and B.

In the above circuits, high resistance telephones might be permanently connected in the plate circuits of A and

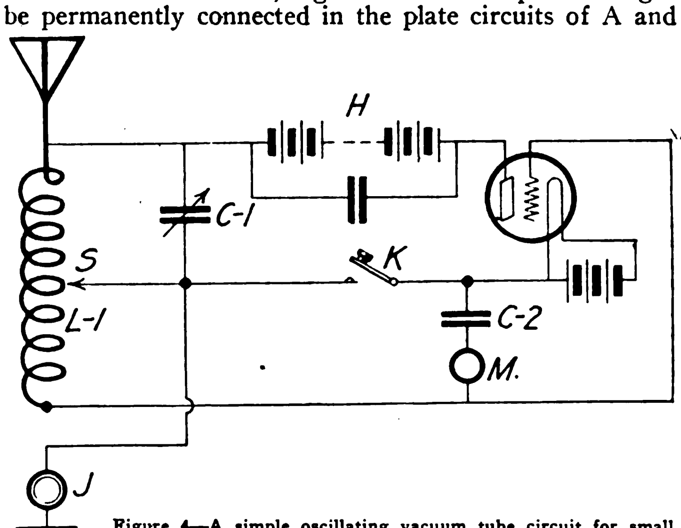


Figure 4—A simple oscillating vacuum tube circuit for small power continuous wave transmission

B, the operator changing the receivers as required. There is no objection to the filaments of the two vacuum tubes being heated by the same accumulator.

A Circuit for General Reception

The second circuit (Fig. 2) is intended for use as a general receiving circuit for damped or undamped waves. It has a particular advantage in that it does not radiate continuous waves while receiving this class of waves from outside. A circuit such as B in Fig. 1, when used as a receiver of continuous waves, is in a state of self-oscillation and radiates feeble waves of a slightly different frequency than that of the incoming waves. These feeble waves can generally be heard over distances of several miles so that another operator using a continuous wave receiver in the neighborhood will, if tuned, hear the vacuum tube of the other station oscillating. A continuous note will be heard. Two operators using a circuit similar to B of Fig 1 and searching for a certain transmitting station may completely prevent each other carrying out any work. Another phenomenon experienced sometimes is that of receiving continuous waves on an ordinary non-oscillating circuit. This happens when the receiving station is near another station (using an oscillating B circuit) which is tuned to receive the continuous waves. The two sets of oscillations are received, heterodyne each other, and are detected by the non-oscillating detector.

With the two circuits of Fig. 1 used in conjunction there is practically no radiation of continuous waves when receiving since the B circuit does not generate oscillations. With the circuit of Fig. 2 there is no radiation. Continuous waves pass inwards but are prevented by the first vacuum tube from passing out. The arrangement is, therefore, effective as a trap, and is likely to be made compulsory in the future.

The circuit consists of two vacuum tubes, the first one of which is used purely as a radio frequency amplifier and the second as a combined amplifier, heterodyne and detector. The aerial circuit is shown directly connected to the grid and filament of the first vacuum tube, in the grid circuit of which is a small dry cell B-2 connected so that the grid is made negative and therefore, prevented from taking an appreciable current. Magnified oscillations are set up in the plate circuit of the first tube which consists of the plate P, the oscillatory circuit L-2, C-2, the battery H and the filament. Oscillating potentials are set up across L-2 and are communicated to the grid of the second valve through the condenser C-3 of about 0.0003 mfd. A resistance R-1 of about 2 megohms is connected directly across the grid and filament and serves the usual purpose of a grid leak. If connected across C-3 (the more usual position) the plate battery H would affect the grid potential. This form of connection is applicable to many similar circuits.

In the plate circuit of the second vacuum tube is a small aperiodic coil L-3, a pair of high-resistance telephones (or a telephone transformer) and the battery H. The coil L-3 is coupled to the inductance L-2 so that the coupling may be smoothly variable. By tightening the coupling the circuits may be made to oscillate continuously at a frequency determined by the values of L-2 and C-2. These oscillations will not be communicated to the aerial circuit.

When standing-by for "spark" signals the capacity of C-2 is adjusted to zero, or the condenser may be switched out of circuit. The value of L-2 is kept fairly low and the coupling between L-2 and L-3 is made loose. All tuning is now done on the aerial circuit. The coil L-2 is then aperiodic and responds to all waves which are then rectified by the second vacuum tube.

When the station has been picked up, the plate oscillatory circuit L-2, C-2 is tuned to the incoming wave length, the coupling between L-3 and L-2 being adjusted to give suitable regenerative amplification.

When continuous waves are to be received, the aerial tuning inductance is varied in steps and search is made on the condenser C-2 which varies the frequency of the local oscillations which are to interfere with the magnified incoming oscillations passing through L-2. The coupling between L-3 and L-2 is, of course, tightened sufficiently to cause the second vacuum tube to oscillate of its own accord.

A Highly Selective Receiving Circuit

The circuit of Fig. 3 is one which may be used for receiving damped waves or continuous waves with a minimum of interference from other stations. The first vacuum tube is used as regenerative amplifying arrangement, the circuit being one suggested by Professor L. A. Hazeltine. The peculiarity and advantage of this circuit is that although waves to which L-1, C-1 and L-2, C-2 are tuned are amplified, the circuit tends to damp out and absorb waves of a length on either side. The amplified oscillations are now induced into the circuit L-3, C-3 and thence to a circuit similar to Fig. 2 in which they may be amplified regeneratively, or, in the case of continuous waves, heterodyned. The inductances L-1, L-2, L-3 may conveniently be wound on three cylindrical tubes sliding on a common central square rod.

A Simple Continuous Wave Transmitter and Wireless Telephone*

Fig. 4 is a simple oscillating vacuum tube circuit which may be used for small power continuous wave transmission. Only one inductance L is necessary along which slides a variable contact A. A variable condenser C-1 is connected across the inductance L for tuning purposes and for altering the coupling between grid and plate oscillatory circuits. The battery H is of about 400 volts. Sending is accomplished by means of the tapping key K. A small flashlight bulb J is inserted in the earth lead and gives the brightest light when the circuits are correctly adjusted and the key depressed. This circuit will give an aerial current of about 0.4 ampere and will transmit a distance of about 30 miles. For wireless telephony, a condenser C-2 and microphone M are connected across the grid oscillatory circuit to modulate the steady stream of oscillations when the key is kept depressed. The range of such a wireless telephone is only a few miles. A suitable receiving circuit is an oscillating vacuum tube whose associated circuits are turned to the same frequency as the "carrier wave." No beats are received but only the speech.

*See also the author's notes on the use of small power continuous wave sets, "Wireless World," April, May, June, 1919.

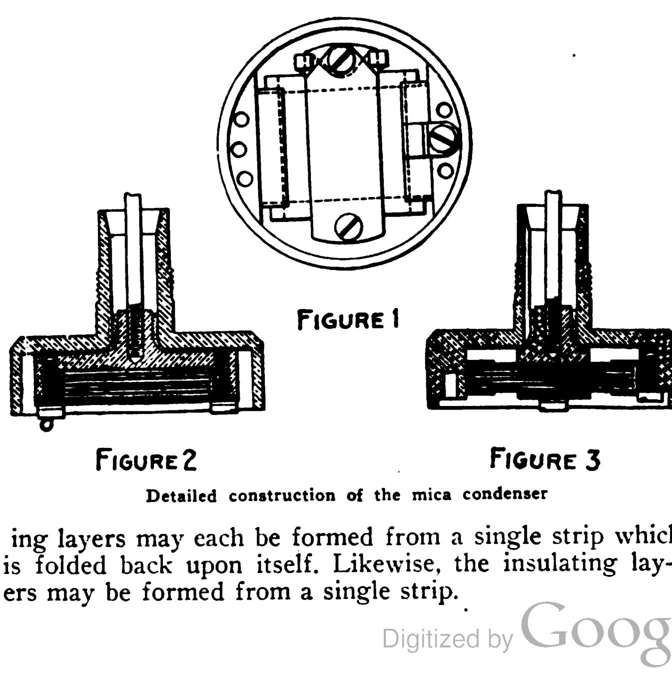
Novel Mica Condenser Construction

Ernest Ansley Watson has devised a very simple and practicable means of providing terminals for a copper foil mica condenser for use in ignition magnetos or wherever a compact form of condenser is required.

The alternate sheets of mica and conducting material are arranged so that the ends of the conductors or armatures project beyond the mica, the whole pile being clamped together by two metal clamps as shown in the accompanying drawing and which at the same time make contact with the two sets of conducting leads.

He has also arranged the pile so that, if desired, both ends of the conducting plates may project in each case in order that instead of two clamps and one connection to each set of plates, four clamps and two connections to each set of plates may be had, in which latter case the armatures are so placed that their projecting ends are on the opposite edges of the mica. This method of construction provides a solid and rigid condenser which effectively avoids the occurrence of trouble due to extreme vibration.

In a modification of this device, the alternate conducting layers may each be formed from a single strip which is folded back upon itself. Likewise, the insulating layers may be formed from a single strip.



Detailed construction of the mica condenser

EXPERIMENTERS' WORLD

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

A Simple Two Hundred Meter Radiophone

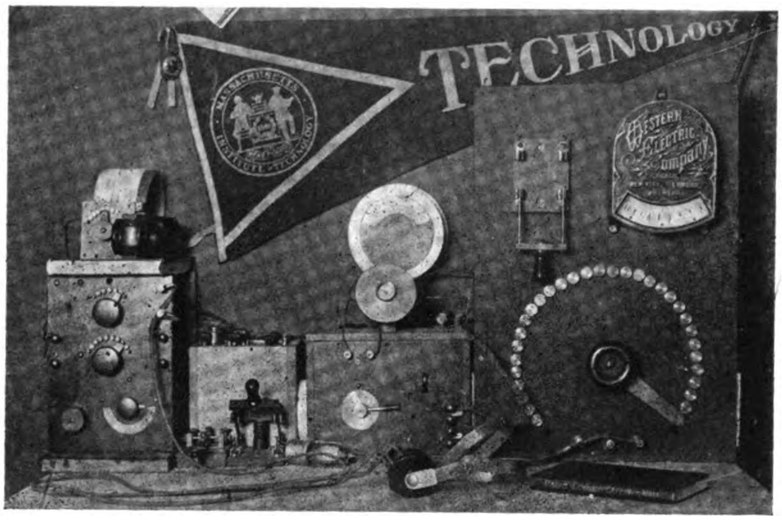
By Francis R. Pray

MY experience indicates that for radio telephony the simple circuit will give the amateur the best results and I am writing this article in an effort to show just how simple a small radiophone transmitter can be.

In the circuit shown a very simple method of securing back-coupling is used as this method seems to be best for the small antenna. If a small coated filament power tube is available for use in connection with the set which I am about to describe, and reliable source of power and good antenna system is available, no difficulty should be experienced in covering distances up to 25 miles. Few amateurs perhaps, will be so fortunate as to possess a tube such as the Western Electric V. T. 2, but the Marconi vacuum tube may be used in a transmitter circuit as well as in a receiving circuit. For transmitter work, voltages up to 500 volts may be impressed on the plate and a transmitting range conservatively estimated at fifteen miles, may be expected from such a tube under favorable conditions.

Before building the outfit some consideration must be given to the source of plate current. There are four means of securing this aside from the use of a motor generator. First, 110 volt A. C. lighting current may be transformed to the potential desired by means of a small closed core transformer. After being stepped up, the A.C. may be changed to pulsating direct current by means of two ordinary vacuum tubes in which the plates and grids have been connected together, the vacuum tube in this case acting as a rectifier. This high voltage alternating current may also be rectified by the use of an ordinary four jar chemical rectifier. In both these methods the resulting direct current is, as above stated, pulsating and must be smoothed out before being suitable for radio telephony. It may be done by shunting the pulsating direct current line with a 4 mf. telephone condenser. A large choke coil is then placed in each side of the line and each coil shunted by a 2 mf. condenser, and the line again shunted by a 4 mf. condenser. This combination of coils and condensers may be placed in a separate cabinet and such a device is usually termed a "filter." Small home-made storage batteries provide another source of high voltage plate current. For charging, these batteries may be connected in multiple and in series for discharge. Still another source of supply is to be had by use of flash light batteries. Although expensive, in the long run many amateurs no doubt will adopt this method.

The details of the apparatus used in the oscillating circuit are clearly shown in the drawings. The standard bulb with the four prong base is used in a standard socket and supported by a brass angle piece as shown. A piece of sponge rubber may be inserted between the angle piece and the panel to take up chance shocks, although this is not really essential since the cabinet is to remain constantly upon the operating table. The variable condenser should have a capacity of .0007 mf., of the General Radio type. The circuit should be calibrated and the wavelengths marked on the scale of the condenser, thus making it possible to set the transmitter at any



On the extreme right is the control panel which supplies variable D. C. to the plate circuit of the radiophone. In back of the panel is the rectifier (source of supply is 110 v. A. C. lighting current) as well as the filter box, for changing the derived pulsating D. C. to pure D. C. Next in line is the radiophone itself containing the oscillating circuit and power bulb. The microphone transmitter is shown on top. In actual practice, this will be replaced by a regular radiophone microphone. Above the radiophone is the hot-wire ammeter. The rest of the photo needs no description, being the usual receiving apparatus

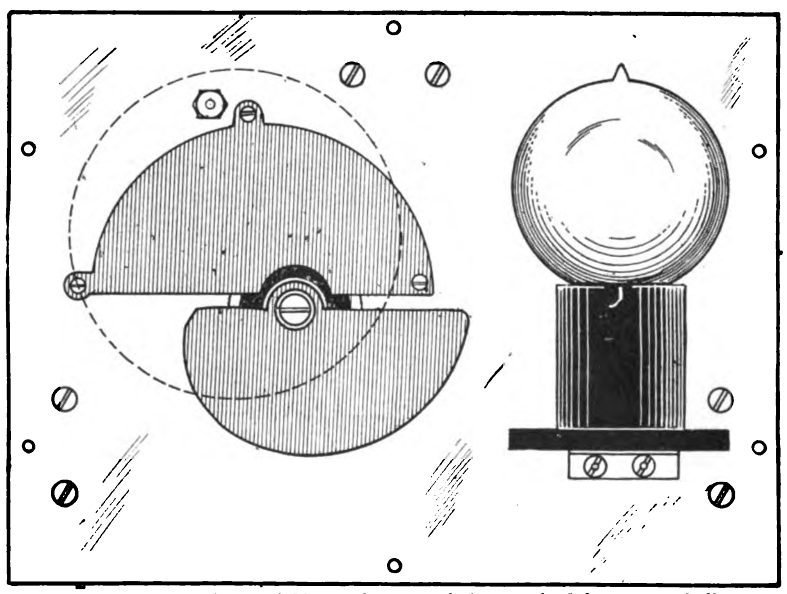


Figure 1—Showing variable condenser and the standard four-prong bulb

wavelength within range, and avoiding in this way interference at the receiving station.

The inductance may be wound on a turned wooden disc 3½" in diameter. 26 turns of No. 22 D.C.C. wire will be required and will cover about ⅞". This coil will have an inductance of about 7 centimeters, and with the .0007 mf. condenser a maximum wave-

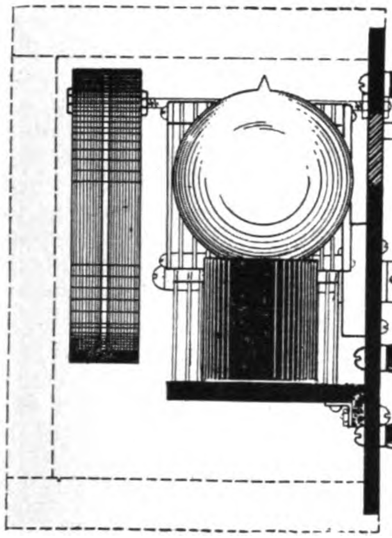


Figure 2—Side view of panel with instruments in place

length of 245 meters will be available. It is important that the coil be tapped at the 13th turn, and connected to the filament. The grid leak is of the order of 2 megohms, and may be made by placing a drop of Higgins India ink under the grid and filament binding posts and drawing a line (of ink) the thickness of which may be found by test, between the two. This is then allowed to dry.

The simplest method of modulating the high frequency current emitted is by placing the telephone transmitter in the ground circuit.

Since the filter box, generator, and rectifier need not be kept on the operating table, the radiophone takes up very little space, allowing plenty of room for the high power spark set for interstate communication. Such a radiophone as the one described is very convenient and will probably become standard for local work. A photo-

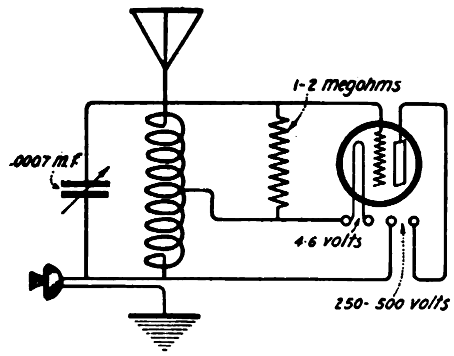


Figure 3—Circuit diagram used

graph showing the outfit described is printed herewith, a description of which may not be amiss. On the extreme right is the control panel which supplies the variable direct current for the plate circuit. Back of this control panel is the rectifier (source of supply is 110 volts A. C. lighting current) as well as filter for smoothing out pulsations of the rectified alternating current. To the left of the control panel is the radiophone itself, containing the oscillatory and power bulb. The microphone is shown on top. Above the microphone is the hot wire ammeter. The rest of the apparatus has to do with the receiving circuit which is similar to the one described by Mr. Sterns in a late WIRELESS AGE, and which uses but one inductance and one capacity in the tuning circuit. It will be noted that the receiving vacuum tube is mounted in the rear of panel and observed through a hole.

Later research along this line shows that if the coupling between the halves of the inductance in the oscillating circuit is made variable, the

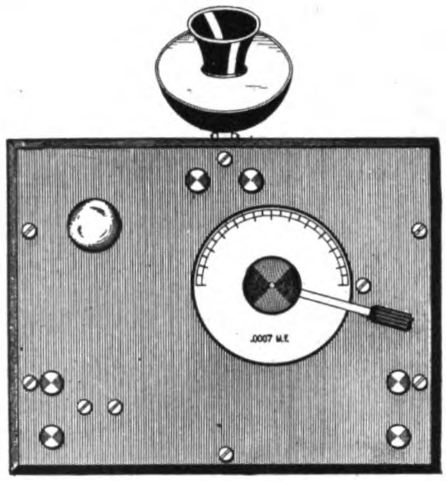


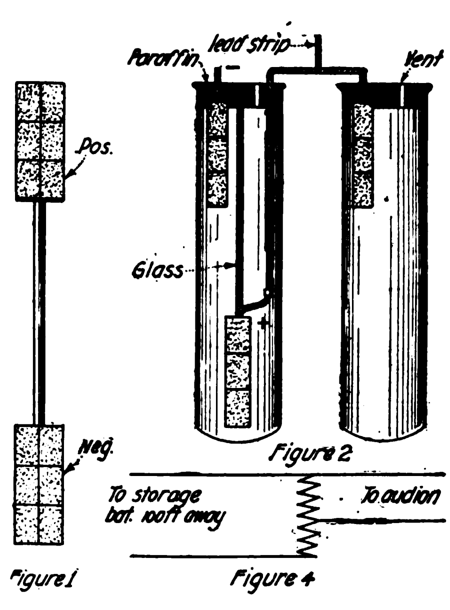
Figure 4—Radiophone containing the oscillatory and power bulb with microphone on top

bulb will oscillate better if a Marconi VT is used.

In congested sections of the country, it would be best to connect the antenna circuit inductively to the oscillating circuit, instead of conductively, as shown in hookup, in order to provide sharper tuning. Otherwise, the wireless phone may interfere with the regular traffic. This third coil may have the same diameter as the other two coils but with about 10 turns of the same size wire, depending on the antenna constants.

"B" Battery for Audions

TWO or three years ago, I made a 20 cell "B" battery of strips of lead inserted in test tubes ¾" in diameter and 6" long. This battery was not satisfactory as it lost its charge in a few hours even if not used. A few weeks ago I decided to try again and now believe I have solved the problem of a cheap and very satisfactory storage battery, and one that is very easily and quickly made. The positive and negative plates of some worn out batteries were sawed into strips—as is shown in figure 1—of the width of 2 rectangles and length of 3 rectangles and a strip of lead about ¼" wide and 1/16" thick was soldered to the part of the grid that formed the outside edge of the original plate. Unless all pieces are cut from the outside of the plate, difficulty will be encountered in soldering connections to the frail inner frame-work of the grids. The length of the connecting lead strip can be made to suit the size of the test tube used.



Detailed construction of the "B" battery

Figure 2 shows the position of the plates in the test tubes. One plate is above the other and is kept from coming in contact with the lead strip of the bottom plate by a piece of glass as wide as the upper plate and long enough to reach the top of the lower electrode. On 10 of the cells, I soldered a strip of lead about 2.5 inches long, shown in figure 2, to which the wires leading to the variable voltage switch were soldered. These were then coated with hot paraffine to prevent creeping of the acid, and the tops of the test tubes were also filled about ½" deep with melted paraffine after the acid had been poured in. With a warm file, vent holes were made through these wax plugs for the escape of gas and for filling when necessary. The cells were charged for several hours at a rate of ½ ampere to 1 ampere. They held their charge with no appreciable decrease for a long time; how long I cannot say as I have not yet tested that out fully.

Another idea which I believe is new, for I have never seen it suggested, is to place the voltage regulating switch, figure 3, on the frame-work of the "B" battery. This requires only two wires from the battery to the audion. All the short wires connecting the cells to the switch points are eliminated and the "B" battery can be placed at a convenient place outside. The notion that the "B" battery has to be near the audion is erroneous as I shall show by the following: I connected the terminals from a 40-volt storage battery which was used to ring bells, run clocks and telephones, to a plain audion circuit. This battery is about 100 feet away and is connected to circuit, extending over a large three story high school building. The signals come in just as clear and loud from NAA and NAJ and other stations as they do with a regular "B" battery. The only objection is the audible click of the clocks every minute. With this battery I do not need to change the voltage; changing the filament temperature suffices. I presume the voltage just happens to be right for this particular bulb.

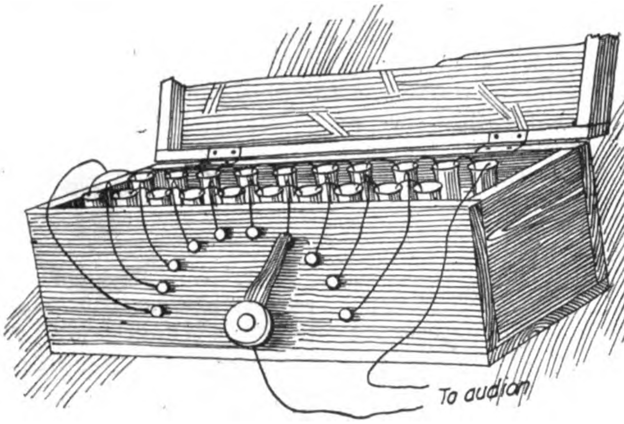


Figure 3—Voltage regulating switch

For my regenerative set the bulb requires a lower voltage and I solved this by shunting in a resistance coil to the battery, taking .1 ampere. A sliding contact was shunted from this as shown in figure 4. This set works as well as the other but the self-induction, when the circuits of the clocks are broken, sometimes chokes the audion and for this reason it is not desirable. However, it proves that placing the "B" battery a short distance from the audion is not essential to loud signals. I am hearing NWW every night and his signals are painfully loud, using either the "B" battery described above or the arrangement shown in figure 4.

In conclusion, I want to relate an experience of Friday night, April 18th, I was listening to NWW whose signals were coming loud and clear when all at once they stopped, seeming to indicate that a lead had snapped. Static drowned out everything on both long and short waves and the audion could not be coaxed to work at all. I tried opening the aerial switch when to my great surprise I heard NWW loud enough to read. I closed the switch, but the signals were drowned out again by static. NWW was heard again on opening the switch. I did this repeatedly for about 10 minutes when conditions became normal and NWW came roaring in on the aerial, but could not be heard with the aerial switch open. Will someone explain this peculiar occurrence?

Jacob Jorjon—*Ind.*

Mounting the Panel Loose Coupler

It is reasonable to assume that anyone undertaking the construction of a panel radio set is sufficiently advanced in the art to be quite capable of deciding for himself the arrangement of instruments, switches and controls he desires, and it is not the writer's intention to inflict another design on his equally competent fellows.

However, there is one feature of these sets so far submitted that may well bear improvement, namely, the method used in mounting the coupler and converting the reciprocating action of its secondary into a rotary motion at the control knob.

We will not consider the so-called "ring" tuners with rotating secondaries as the mounting of this type presents little difficulty. One soon finds that with this type all signals come in at maximum intensity with the secondary parallel to the plane of the primary. Likewise all signals fade together with the change of secondary angle, selectivity in this case being a matter of the strongest signal hanging on till the last.

The standard form of coupler is still the favorite and the mounting scheme shown in figure 1 will no doubt be of use to those who are casting around for ideas prior to building.

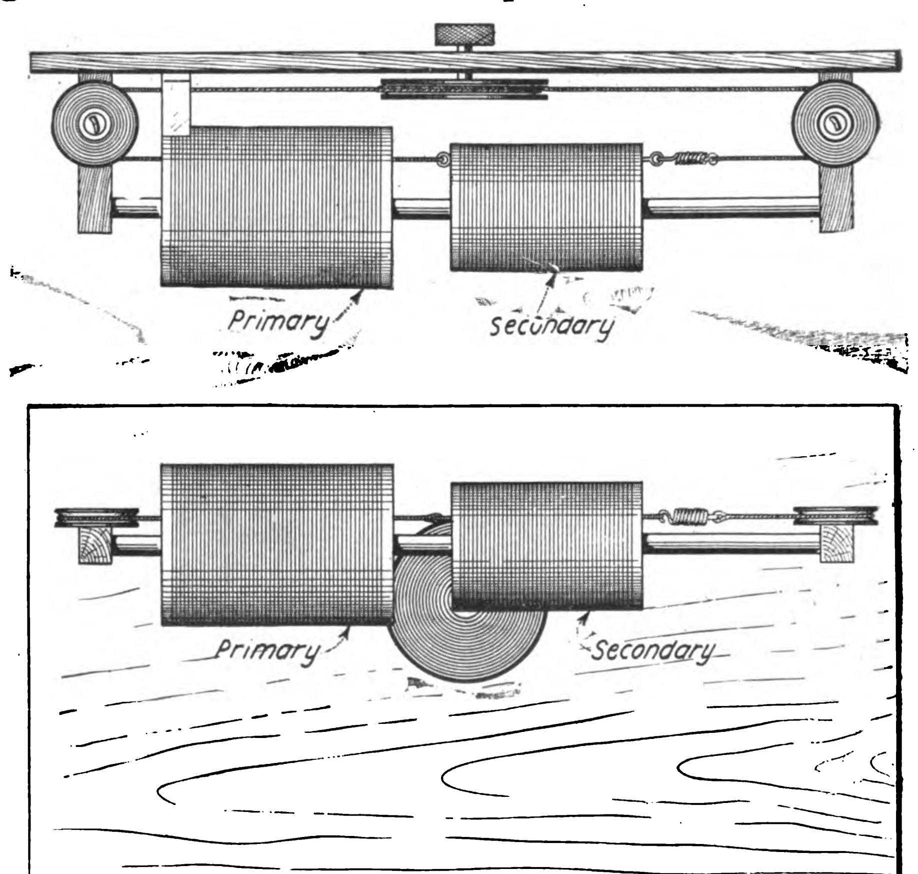


Figure 1—Standard form of coupler and method of mounting

The secondary slides on one slide rod only as the tension on the control cord counteracts any tendency for it to turn. This makes for less metal within the field of the coils and reduces friction and binding resulting from poor alignment. It is apparent that the removal of this one rod permits of easy access to all parts of the tuner.

If the grooved pulleys are made of wood, they will work best when bushed with short lengths of brass or fibre tubing. Hard rubber is more suitable and is satisfactory without bushing.

The main pulley is mounted on the shaft of the control knob and may carry an indicating scale on the side adjacent to the panel, the reading appearing through a small aperture as

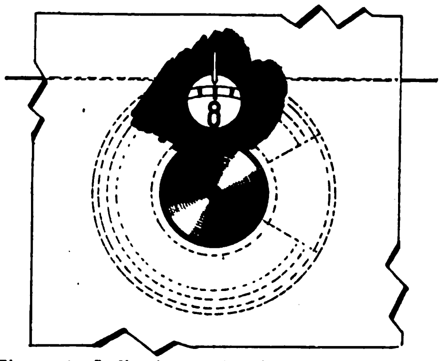


Figure 2—Indicating scale of the secondary coil

shown in figure 2. Obviously, the circumference of the pulley should somewhat exceed in length the total distance that the secondary traverses.

Each division on the scale indicates a uniform movement of the secondary and a small spiral spring will keep sufficient tension on the control cord to prevent slippage.

The primary mounting is standard in many makes of apparatus and consists of a strip of hard brass, bent to a convenient bracket form, and fastened to the panel independent of the secondary mount. When rigged as shown, a clockwise rotation of the knob loosens the coupling. This action can be turned about by mounting the primary at the reverse end.

C. H. Biron—*Massachusetts.*

Direct Current Transmitting Apparatus

L. M. COCKADAY of New York City has developed a transmitting apparatus which operates off a direct current and which he claims will give 500 sparks per second, without difficulty.

It is to be noted that the circuits of figure 1 indicate the usual connections of a spark transmitter but there is included in the primary circuit of the transformer a rotary interrupter D-1 mounted on a shaft which also carries a rotary spark gap D-2. Contacts C equally spaced around the disc D-1 makes connection with two brushes which close the circuit to the primary of the transformer.

Discs D-1 and D-2 are set on the shaft so that the electrodes on D-2 will come into the sparking position just as the brushes on the disc D-1 break the primary circuit. The potential of the secondary of the transformer is then at the maximum and accordingly a spark will occur at D-2. By suitably shifting the stationary electrodes of the disc D-2, a position can be found where the maximum discharge can be

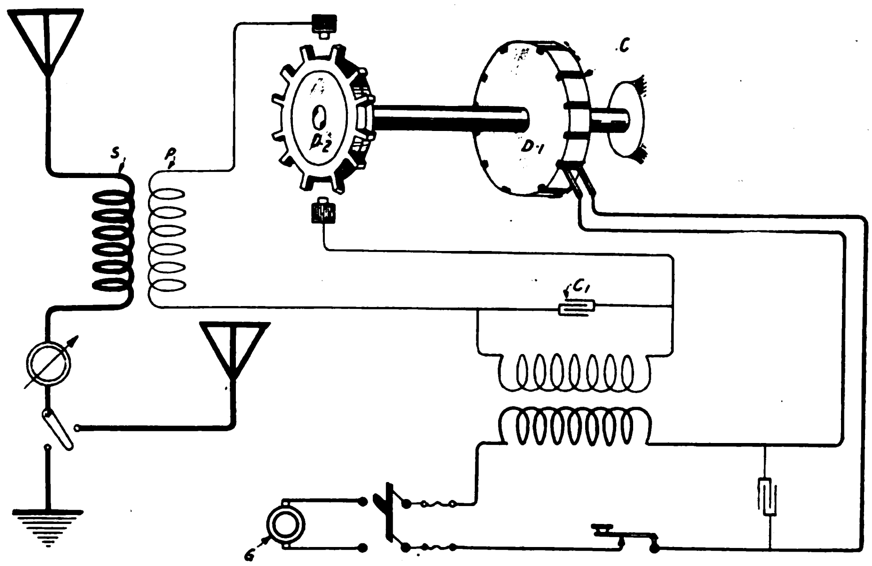
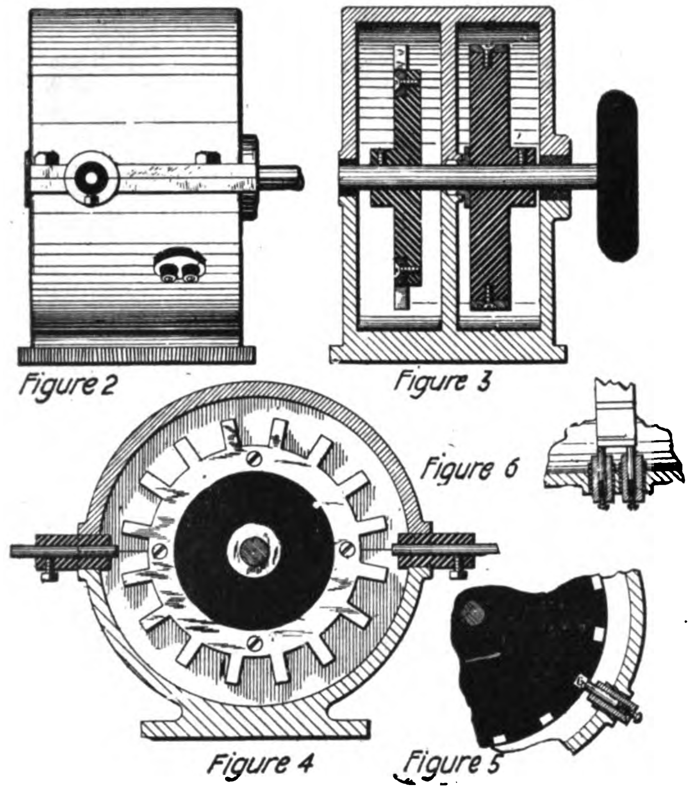


Figure 1—Circuit diagram and connections for the rotary interrupter

obtained from the primary interruptions.



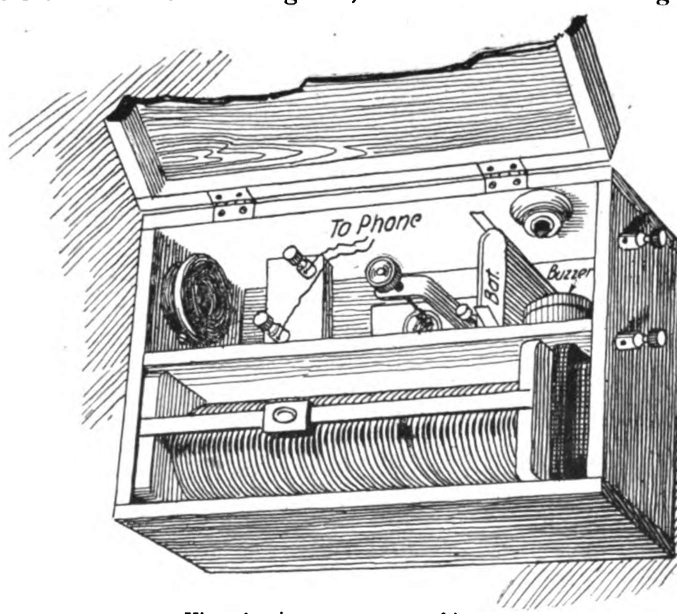
Detailed construction of the direct current transmitting apparatus

transformer of usual construction fed with direct current. The source G is a direct current generator of a potential varying between 110 and 125 volts.

The inventor claims that he has operated this system with a 500 cycle

Portable Receiving Set

THIS small receiving set adds greatly to the enjoyment of a camping trip or a hike. The box in which the instruments are placed is 8" x 6" x 5". The set consists of a tuning coil, fixed coupler, condenser, detector and buzzer tester which is made up of a small flash light battery, buzzer and push button. The tuning coil is 7" long and 4" in diameter, wound with No. 28 B&S wire. The fixed coupler is made of three circles of cardboard, two 4" and one 3" in diameter. These are separated a half inch from each other. The primary is wound with No. 24 and the secondary with No. 26.



View showing arrangement of instruments

The detector is a large binding post with a cat whisker and a cup to hold the mineral. The condenser is of the fixed type; a small Murdock or a home-made one will serve the purpose. The buzzer is used to test the mineral. A flash light battery furnishes power.

CHARLES WILDONGER—*New Jersey*

First Prize—A 200-Meter Oscillation Transformer

By M. P. Koopman

THE average amateur does not come very close to getting the most out of his outfit. There are many reasons

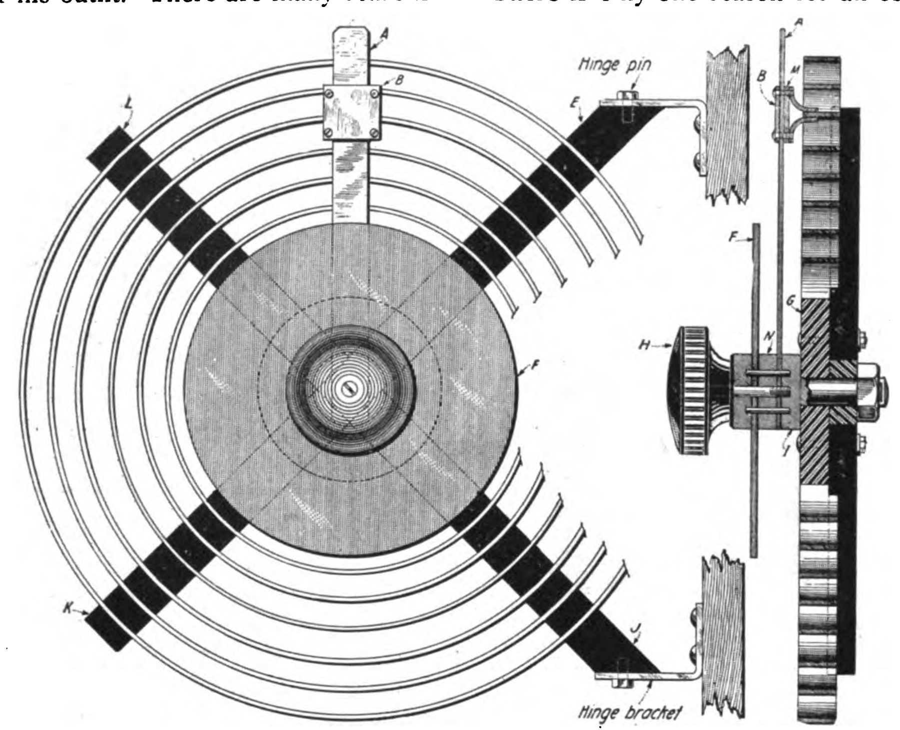


Figure 1—Assembly of the secondary of the oscillation transformer

for this. The most common and inexcusable of these is the use of excessively long leads between the high tension condenser, the spark gap and the primary of the oscillation transformer. There are cases, of course, where there is no way out of the difficulty, but usually, given an oscillation transformer

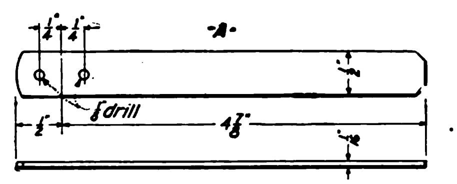


Figure 2

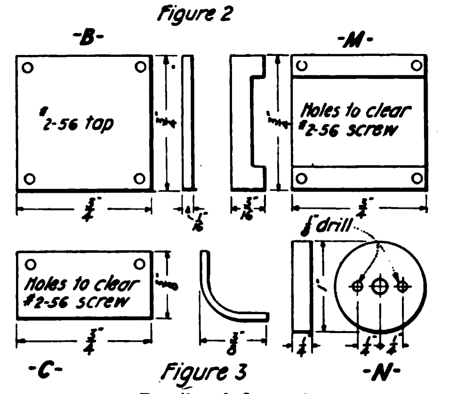


Figure 3
Details of figure 1

of the proper mechanical and electrical design, it is a very simple matter to so shorten these connecting leads that that portion of the inductance in the closed circuit which is external to the oscillation transformer primary itself is negligible.

There is only one reason for an oscillation transformer. It is used to couple the closed circuit to the antenna. It can easily be proven that the percentage of electro-magnetic coupling between two circuits depends, among other things, upon what part of the whole inductance of the two circuits lies in the coupling coils.

It is very apparent that if it were possible to reduce the required number of turns of inductance in the closed circuit to one small turn the resistance

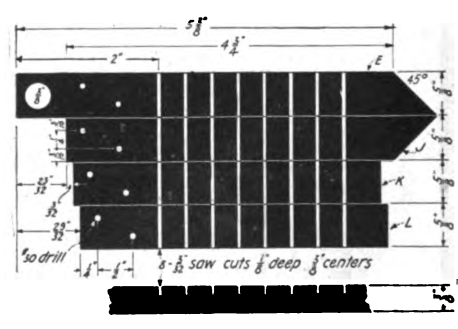


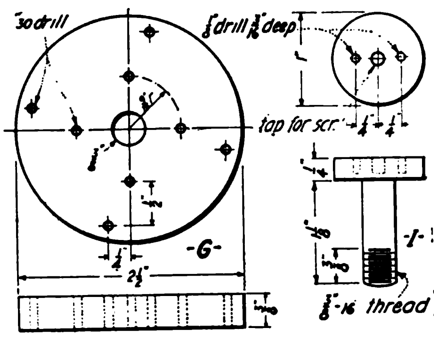
Figure 4—Dimensions of the spokes

of that circuit would be decreased. The inductance would also be decreased, and providing this single turn comprised the greater part of the total inductance in the circuit the coupling between the two circuits would still be of the proper order.

To compensate for the inductance which we have now taken out of the circuit, capacity is added, and that is

what we are after, since at a wavelength of 200 meters it is extremely seldom that one finds even a half kilowatt outfit which is drawing full power.

Sketches are shown herewith, which it is hoped, may be of value to some amateurs—at least by way of suggestion. The assembly figure 1 shows the secondary of the transformer only. The frame of the primary may be made in the same manner as that of the secondary, excepting that only 3 turns of copper need be used. These may be placed opposite turns 3, 4, and 5 of the



Constructional plan of shaft and bearings

secondary, counting from the inside. Neither is a sliding contact so essential in the case of the primary. The wavelengths at which it may be desirable to work may be ascertained by the use of the wavemeter, and clips soldered to the primary turns at the proper points.

The various parts of the assembly drawing and the corresponding details are lettered so that each part may be readily identified. Part A, figure 2, is a brass track for the movable slider figure 3 which is made up of the parts M, B, and C. The coil should be wound with soft-drawn copper strip 1/2″ wide by 1/16″ thick. The spokes, figure 4, are of rectangular dilecto rod 5/8″ by 3/8″. The sketches show the method of slotting for the copper strip. Before the copper is in position it might be well to drill a hole into each slot at the middle with a 1/16″ drill. After being placed in position the copper may then be punched with a small center punch from the back. This will prevent the copper from coming out of the slots.

The main shaft or bearing screw I, figure 5, is made of brass and works in a dilecto bearing, figure 6, provided by parts E and G. The four spokes E, J, K, and L are fastened to the dilecto disc G by eight machine screws. On the front of the shaft I, parts A, N, F, and the knob H are assembled over two brass pins, as shown in assembly. F is a dilecto protecting disc to prevent brushing to the operator's hand while tuning the transmitter. The contact shoe, or slider, is put in place on the arm A and travels along the copper ribbon when the arm is revolved.

Connection to the arm should be soldered to the washer under the nut holding shaft and run along the back of the spoke E and connected to the upper hinge through a flexible braid. Connection to the inside end of the coil should be made and the connecting strip run along back of spoke J and connected to lower hinge in like man-

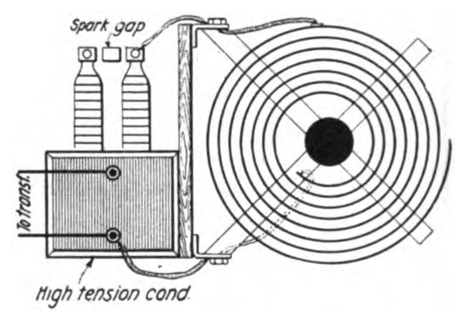


Figure 7—Arrangement of the closed circuit units

ner. The primary connections may be taken care of in the same way. These connections are not shown in sketches.

A good arrangement for the closed circuit units is also shown in figure 7. Here the rotary gap is mounted on top of the high tension condenser which might also serve to support the small panel to which the spirals are fastened.

Second Prize—The Oscillation Transformer for 200 Meters

By Arlyn Rosander

Of all the oscillation transformers ever designed and placed on the market for the amateur none have, in the writer's opinion, ever surpassed the excellent features of the pancake type. The very fact that it is preferred in the most modern Marconi commercial transmitters and by the majority of prominent amateurs should surely be convincing, but the writer will, from a practical point of view, discuss why it is given preference above all other types. Before commencing the details, a few fundamental considerations of the oscillation transformer will not be found amiss. The functions of an oscillation transformer are: (1) to transfer energy from the closed circuit to the open circuit; (2) to vary the wavelength of either of the above circuits; and (3) by varying the coupling, to alter the character of the emitted wave. In order to get maximum efficiency careful consideration should be given to the following essentials. First, the primary and secondary coils should be wound with good conducting wire or ribbon. Second, the coupling should be easily and closely variable. Third, the coils should be well insulated between turns.

The amateur should realize that it is condenser charges in the primary that make for efficiency. Therefore, he should use as large a condenser as possible, leaving only two to three turns for the primary winding. Similarly in the antenna circuit, we should have just enough turns in the secondary for the safe transference of the energy. Five or six turns are sufficient to do this. Amateurs who depart very far from this will not be getting maximum efficiency.

No better oscillation transformer can be found than the pancake type employing copper or brass ribbon and using clips for variation of the inductance. This type presents the following desirable features and advantages over the helix and other types: (1) the coupling may be varied more easily; (2) it is easier to construct; (3) it is preferred for panel sets; (4) it is more compact.

It is obvious that it would be hard to get a proper variation of coupling if one were forced to use the helical type of oscillation transformer on a panel set. Using the pancake type, however, control of coupling is a simple matter.

The oscillation transformer used by the writer is simple and can be duplicated very easily. Although bakelite is the best material to use in the construction, it has been found that well seasoned wood baked in paraffin or shellac will compare favorably with the more expensive insulating materials. Two pieces of wood are placed at right angles to each other for each winding and secured to a base. Strips may be used to hold the ribbon in place, but it may be better to enlarge the cross pieces a little and saw slots into which the ribbon may be forced. For the primary, three turns of 1 1/2″ copper ribbon are used, the turns being spaced 1″. The cross pieces are 13″ long, the inside diameter of the winding being 6″. The secondary consists of six turns of the same material with the same spacing, the cross pieces being 16″ long.

Third Prize—An Oscillation Transformer for 200 Meters

By Howard W. Lewis

IN choosing an oscillation transformer suitable for use at 200 meters wave-length, one grades the various types in accordance with the following points. First, ease with which the self or mutual inductance may be altered; second, convenience and mechanical strength; third, simplicity and ease of construction. These qualities may be easily and economically attained in a type of construction which consists of two similar spirals, one of which is fixed, preferably in a vertical plane, and the other hinged so that the coupling between the two may be altered. The base for supporting each spiral may be merely a hard wood board, or, a better arrangement is a frame consisting of two wooden sticks 1 inch square and 10 or 12 inches long. These are notched together at their centers in such a way that they are at right angles to each other. Upon these crossed sticks is mounted a single row of porcelain insulators. Twelve will be required for each stick and they should be 3/4 inch apart on centers. The conductor passing the inductance proper is 1/4 inch copper tube which may be secured from almost any supply house. Ten feet will be required for each spiral. This will be sufficient for six complete turns. The tube is now wound smoothly on the frame. In most cases it will be found that the natural springiness of the tube will cause it to lie snugly in the grooves of the insulators. Where this is not the case, occasional tie wires may be used. In winding the tube on the knobs take care to avoid kinks and bends, as these are hard to remove and detract greatly from the appearance of the finished article.

When two spirals are thus completed, a base consisting of a rectangular board is provided. One of the spirals is firmly fastened at right angles to the base board using any convenient means. The second spiral is fastened to the base board with small brass hinges in such a way that it can be folded up closely and in a plane parallel to the plane of the first spiral, thus giving a maximum of coupling.

A system of four flexible leads or spring clips is now provided which serves to connect one spiral into the closed oscillatory circuit and the other spiral into the antenna earth circuit. the completed oscillation transformer may then be finished off to match the woodwork on the rest of the radio outfit.

It is apparent that any desired value of inductance for either the primary or secondary circuit may be obtained by shifting the spring clips and also, that the mutual inductance or coupling between the two circuits may be altered by swinging the hinged spiral toward or away from its neighbor. Also, the two spirals may be conductively connected in series in case it is desired to make use of the variometer effect.

WE HOLD OUR BREATH

Suggestion for Prize Contest—DECEMBER Wireless Age

A good transmitting condenser is difficult to build—usually. Yet once built it is the joy of any amateur's heart. How many times has it been said that the amateur always holds his breath while transmitting in expectation of the blow-out under the table or down in the cellar! It always comes sooner or later.

We are holding our breath for the Christmas number. And we have a nice little Christmas present fund. Come across with dope on Transmitting Condensers.

If you have built a good, highly efficient, and thoroughly reliable high tension condenser, you have done something really worth while.

Nothing connected with the game has caused more shut-downs than a faulty transmitting condenser. Every amateur will testify to this from personal experience. And yet, there are those among us who have built their own units and had the satisfaction of seeing them "stand the gaff."

If these ingenious few wish to confer a real benefit upon their fellows they are respectfully requested to submit their "dope."

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject by November 15:

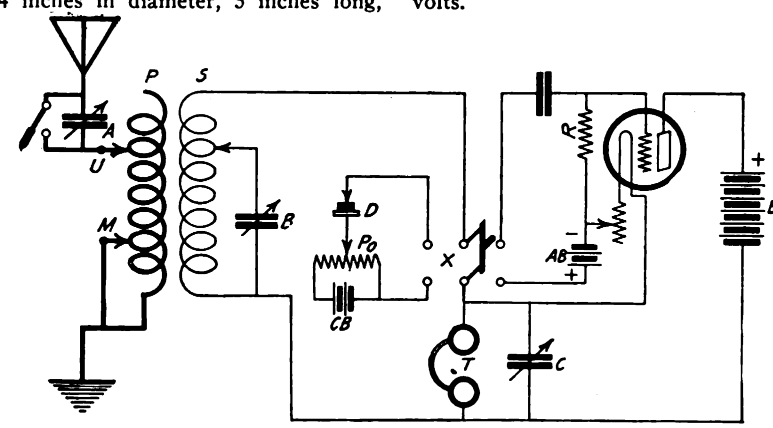
"HOW TO BUILD A RELIABLE TRANSMITTING CONDENSER."

J. M., New York City:

In reply to your request for a diagram of connections and dimensions for a receiver to cover a range of 200 to 1000 meters for use in connection with a bulb or carborundum detector, note circuit diagram and dimensions below.

Receiving transformer dimensions: Primary 4 inches in diameter, 5 inches long, wound with 156 turns No. 24 D. C. C. wire; take off tap from first 12 turns, and tap every twelfth turn thereafter; secondary 3¼ inches in diameter, wound with 220 turns No. 28 D. S. C. wire, 8 taps.

In the circuit diagram A, B, and C are, respectively, the primary, secondary and telephone bridging condensers; U, the single turn primary switch; M, the multiple turns primary switch; D, carborundum detector; Po, 400-ohm potentiometer; T, telephones; R, grid leak resistance of from 4 to 6 megohms; X, a double pole double throw switch for changing over from carborundum to V. T.; AB, filament lighting battery; BB, high voltage plate circuit battery; and CB battery always required for proper operation of a carborundum detector. It should be about 4 volts, or if the resistance of the potentiometer is cut down to 200 ohms, 2 volts.



Circuit diagram for a receiver to cover a range of 200 to 1000 meters with a bulb or carborundum detector

It is to be noted that the switch is so placed in circuit that changing from tube to crystal automatically opens filament circuit. When working with the tube, the telephones are placed common to wing and grid circuit and shunted by a variable condenser, thus providing capacitive coupling between the two circuits for regenerative operation. The three condensers A, B, and C, should have each a maximum value of .001 microfarad approximately.

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

Government Ownership Again

A GREAT many members have written to headquarters to inquire whether a call to action is to be expected, in view of the renewed activity in Congress on the subject of Government control of wireless.

The officers of your Association value highly the spirit which animates these evidences of the alertness of amateurs to protect their rights. We hope and expect members will continue to look to headquarters for guidance and we, in turn, will keep in closest touch with affairs at Washington so no one will be caught napping. The call to action will come, as in the past, if it appears that a crisis is impending, and we know from experience that a 100 per cent protest from individual amateurs will result. When amateur interests are not in danger, though, it is the Association's policy to let members of Congress pretty much alone, saving our letter-of-protest writing for a concentrated effort when actual danger signals are set.

At the present writing there are two bills in the House of Representatives and two documents affecting wireless. Two bills have also been introduced in the Senate, along with the two documents mentioned—letters from the Secretary of the Navy.

The House bills are H. R. 7288 and H. R. 8783. The first, introduced by Congressman Mapes, is concerned only with equipment of all passenger vessels with wireless apparatus. The other bill, introduced by Congressman Curry on August 26th, seeks authority for the handling of commercial radio business by naval stations. This bill and the two documents are of interest to amateurs. Document No. 159 is a letter from Secretary Daniels, dated July 19, containing a proposed bill giving permission to naval stations to handle commercial business. The bill proposed in the letter has not yet been introduced, in either the House or the Senate. The other document, No. 165, a letter written by the Secretary of the Navy, supplements the earlier communication and, in addition, seeks complete control or Government ownership of all radio stations. This proposal is substantially the one which the amateurs united to defeat last December. The hearings will be held, as usual, before the Committee on Merchant Marine and Fisheries, House of Representatives, at some future date. Thus far, no dates have been set and, on reliable information, it may be said that there is no immediate prospect of the bill's consideration by the House Committee.

The Senate Committee on Commerce is to consider a bill introduced by Senator Calder, S. 2523, which deals with the licensing of operators, but action on this relatively unimportant bill has not yet begun. Another bill, S. 1651, introduced by Senator Jones, mentions wireless in one article, although its substance deals with the cable situation. Reference is also made to radio in letters from various Government departments. Hearings will begin on this bill almost immediately, according to information just received. It is a question, however, if the amateurs' status will be in any way affected by this proposed legislation.

The principal matter for consideration, and possible concern, is the activity of the sub-committee of the Senate Committee of Naval Affairs. Senator Poindexter, as Chairman, has been holding hearings on the letters of the Secretary of the Navy already referred to. Up to the time of writing there have been three sessions, the first of which was executive and attended by naval representatives only; the succeeding public hearings have not been concerned with amateur affairs. During the progress of the hearings, however, a Navy-sponsored draft of a bill has been submitted, providing for complete Government ownership.

The heart of the question, so far as your Association is concerned, is that the hearings now being conducted by Senator Poindexter's committee are concerned with the propositions contained in the letters from Secretary Daniels. The Senate sub-committee is therefore only considering the advisability of introducing additional radio legislation, not holding hearings on bills already introduced on the floor of the Senate.

The situation is not one to cause immediate alarm to amateurs. The progress of these bills and proposals will be carefully watched, however, and a campaign be organized instantly, should amateur communication be threatened with measures of extinction. Meanwhile, as in the past, it is the policy of your officers to withhold protests until the issue looks critical. It is hoped that members will not give themselves undue concern over the hysterical outbursts of those poorly informed. Your Association and its organ, this magazine, will keep you reliably informed and sound whatever warnings are needed, knowing that you will rise to the occasion and set Congress straight if our Senators and Representatives get on dangerous ground.

J. ANDREW WHITE,
Acting President, N. A. W. A.

Giving the Editor Facts

THE officers of the Association are anxious to enlist the co-operation of all members in securing proper representation of the amateur's case in the newspapers of the country. It is urged that the local papers be watched closely and when news items are printed giving only the viewpoint of the Navy on the subject of Government ownership, that an appeal be made to the newspapers to include an expression from the experimental side of the art. Specially important are the editorial columns, which should be closely watched. Editorial writers are eminently fair in estimating the merits of questions of public interest, providing both sides of the arguments are before them. Thus if some newspaper editorial looks unfair from the amateur standpoint it is up to members to write immediately to the editor of that newspaper. Such communications will be published, if informative. For the guidance of members the following specimen is given, an item which was sent to the New York Herald from Association headquarters, immediately after Secretary Daniels' letters had been published and editorial comment made thereon.

This is how the communication appeared in that newspaper:

To the Editor of the Herald:

Your editorial of June 7 under the heading "Radio Control" gives some incorrect impressions as to the practical working of wireless. Exception is taken to the statement that government control over radio transmission is justified in peace "by the many difficulties and at times dangers caused previous to the outbreak of hostilities by the inconsiderate or mischievous work of uncontrolled operators."

I view this as an unjustified criticism of amateur wireless men, and one which has no foundation in fact. This whole subject was investigated by the House Committee on Merchant Marine last December, and the navy officials interested in putting through a government ownership bill had to frankly admit the great assistance rendered by amateurs.

Be reminded also that prior to the outbreak of hostilities it was an amateur who detected the unneutral messages from the German owned station at Sayville; also that the man selected as assistant to the Director of Naval Communications during the war was an amateur, and that the chief operator in Washington was a civilian commercial operator.

Your editorial assumes that official control by the navy need not interfere with amateur efforts. The testimony of radio experts and the decision of the Congressional committee gives the exactly opposite view. It is well established in the field of wireless that the short wave-lengths and low powers used in this experimental work insure that interference is practically negligible.

It should be understood also "the official and commercial demands" for message traffic through organized and authorized plants have nothing to do with the technical development of the art or working out "vexing problems that require free air."

J. Andrew White.

Eastern Amateurs, Attention!

By AUTHORITY of the Director Naval Communications, commencing about October 5th, a code broadcast schedule, addressed to all amateurs, will be transmitted by the Naval Radio Station, 44 Whitehall Street, New York, on 1500 meters. This broadcast will be transmitted immediately following the 9:00 P. M. press schedule.

Various items of interest to amateurs, such as the establishment of new stations, changes in wave-lengths of high power stations, etc., will be transmitted in this broadcast.

Copies of the code to be used may be obtained by any amateur by writing a request to the District Communication Superintendent, 44 Whitehall Street, New York City. When writing this request an amateur should give the following information:

1. Name.
2. Address.
3. Age.
4. Data concerning any military service.
5. Commercial experience, if any performed.
6. Class of operator's license, if any.
7. Number of words per minute he can copy.
8. Education.
9. Size and power of transmitting set, if any erected.
10. Type of undamped wave receiver, if one installed.
11. Name of any radio organization or club to which he may belong.

The object of this radio broadcast is to maintain the interest of radio amateurs and to train them in receiving code.

At present there is no medium power undamped wave transmitter in the Third District, but, should one be installed, it is hoped to establish an undamped wave broadcast schedule for amateurs.

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.

N. J. F., Feeding Hills, Mass.:

Inasmuch as your house is 1000 feet from the high tension sub-station you will experience no difficulty due to inductance except at times when circuit breakers discharge, etc., and this is infrequent. If you do not care to purchase apparatus we suggest that you make it for yourself. A great many books giving information which will enable you to construct apparatus have been printed and in addition you will find construction articles in every issue of THE WIRELESS AGE.

* * *

C. P. B., Edgemere, Long Island:

In order to receive signals using the circuit which you show, it is necessary to provide a stopping condenser, which you have done in your second circuit. In the first diagram, your oscillatory circuit has been short circuited by the crystal detector. This stopping condenser should have a value for crystals of about .005 microfarad and may be fixed. You would obtain better results if you tuned your antenna circuit by a variation of your primary inductance or by the use of a condenser either in series or in shunt with the antenna.

With an aerial having a fundamental wave-length of 200 meters the maximum range of your coupler, according to figures which you have given, is approximately 1000m. With this same arrangement coils having an inductance of 1,000,000 centimeters and 2,500,000 would tune up to approximately 1400m and 2100m respectively.

* * *

Wm. Eadie, Franklin, N. Y.:

Instructions for building a radio telephone which would serve your purpose fully, were printed in the June and subsequent issues of The Wireless Age. There is no information available concerning the "tube unit" and the "No. 2 oscillating audions" which you mentioned.

* * *

F. W., Los Angeles:

As far as we are able to gather from what you say concerning your outfit, you should be able to receive time signals with your present loose coupler. The fact that you get a humming noise after the 15th tap on the primary winding very probably indicates that the circuit is open at that point. It is reasonably certain that if your windings are intact you should have no difficulty. For the reception of wave-lengths up to 3000 meters, we would suggest that you provide yourself with an antenna 100 ft. or more in length and 50 ft. or more in height, at least. Your results will not be worth while on the longer wave-lengths with your present antenna. Your circuit diagram appears to be all right. If you wish to try for the longer wave-lengths with your present antenna a loading coil of about the same dimensions as the primary of your coupler would be advisable.

The hook-up which you have shown is suitable for the reception of wireless telephone messages. We do not know of any stations on the Pacific coast which are experimenting with radio phones. The wave-lengths used by aeroplane outfits usually run between 250 and 750 meters.

Inasmuch as you give us no data as to the number of turns on primary and secondary of your spark coil it will be impossible for us to tell you what spark length it should give and what battery you should use in connection with it.

* * *

E. H., Jersey City:

The two tone note of the New York Herald spark which you refer to is in all probability due to an improper adjustment of the transmitter and a faulty spark gap.

As we understand it, all the radio stations in and around New York are controlled from one point. This makes it possible to connect two or more stations so that they are controlled by the same manually operated key. It might be desirable to do this in case all the stations so connected were working on different wave-lengths in order that receiving operators who are tuned to the various standard wave-lengths might be reached without delay.

In answer to your question regarding circuits for the vacuum tube the regenerative circuit is preferred by most amateurs.

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W. J. M., Charleston, S. C.:

We very much regret that, due to lack of information, we are unable to put you in touch with any one who can furnish you with the voice amplifier.

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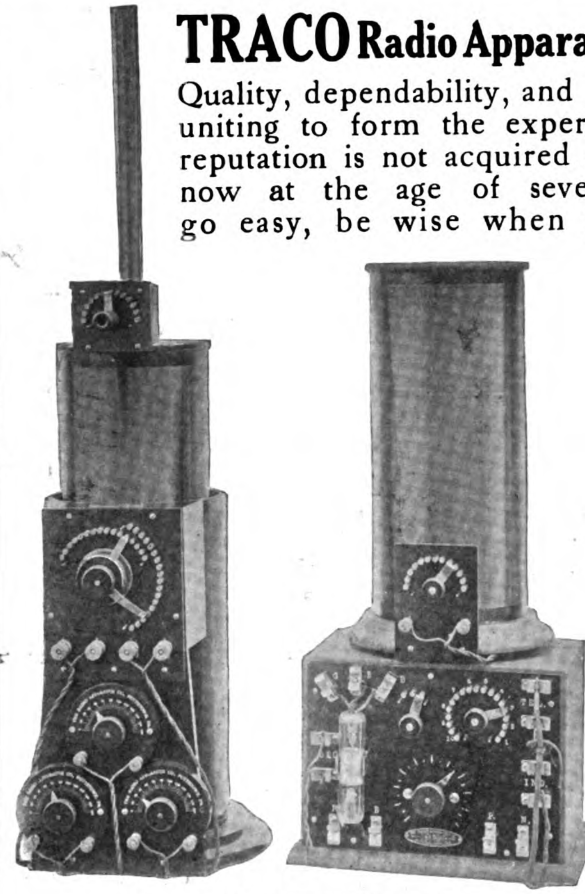
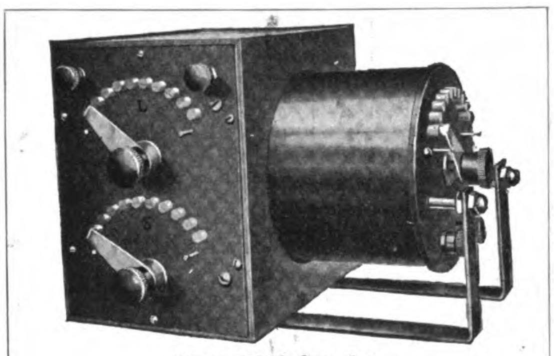
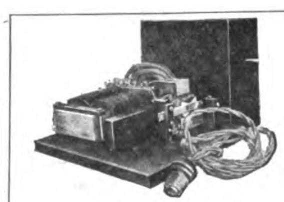
J. M., New York City:
(See page 38 of this issue.)



Type 93 Undamped Wave Set



Type-Y673-Coupler



Rectifier

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(See page 38 of this issue.)

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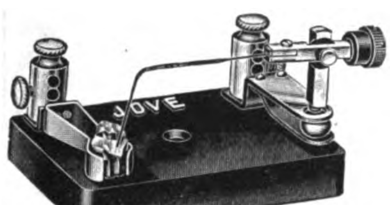

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The day class convenes from 1 p. m. to 5 p. m. The night class from 7.30 p. m. to 9.45 p. m.

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PAN-AMERICAN WIRELESS TELEGRAPH AND TELEPHONE COMPANY

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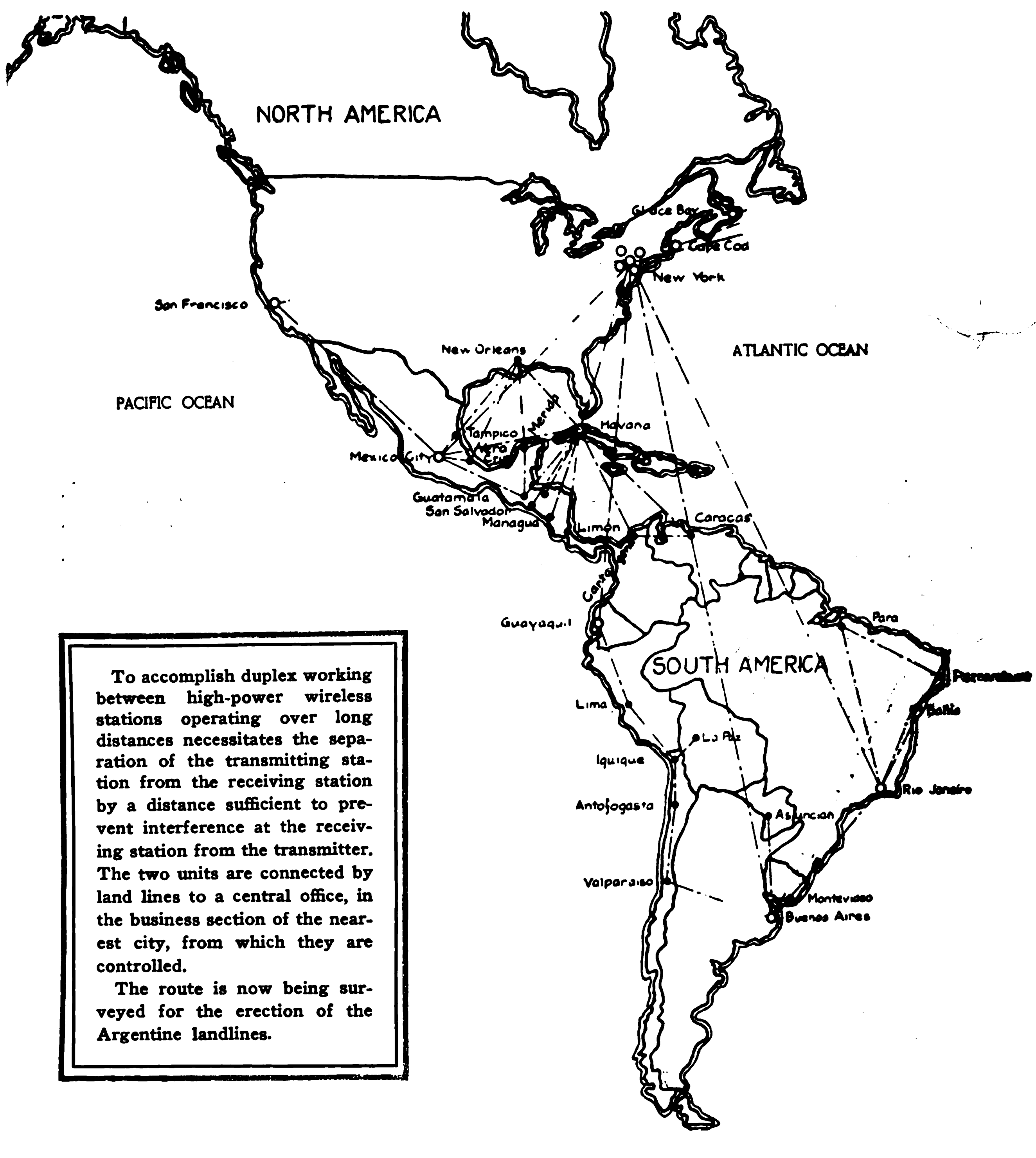


To accomplish duplex working between high-power wireless stations operating over long distances necessitates the separation of the transmitting station from the receiving station by a distance sufficient to prevent interference at the receiving station from the transmitter. The two units are connected by land lines to a central office, in the business section of the nearest city, from which they are controlled.

The route is now being surveyed for the erection of the Argentine landlines.

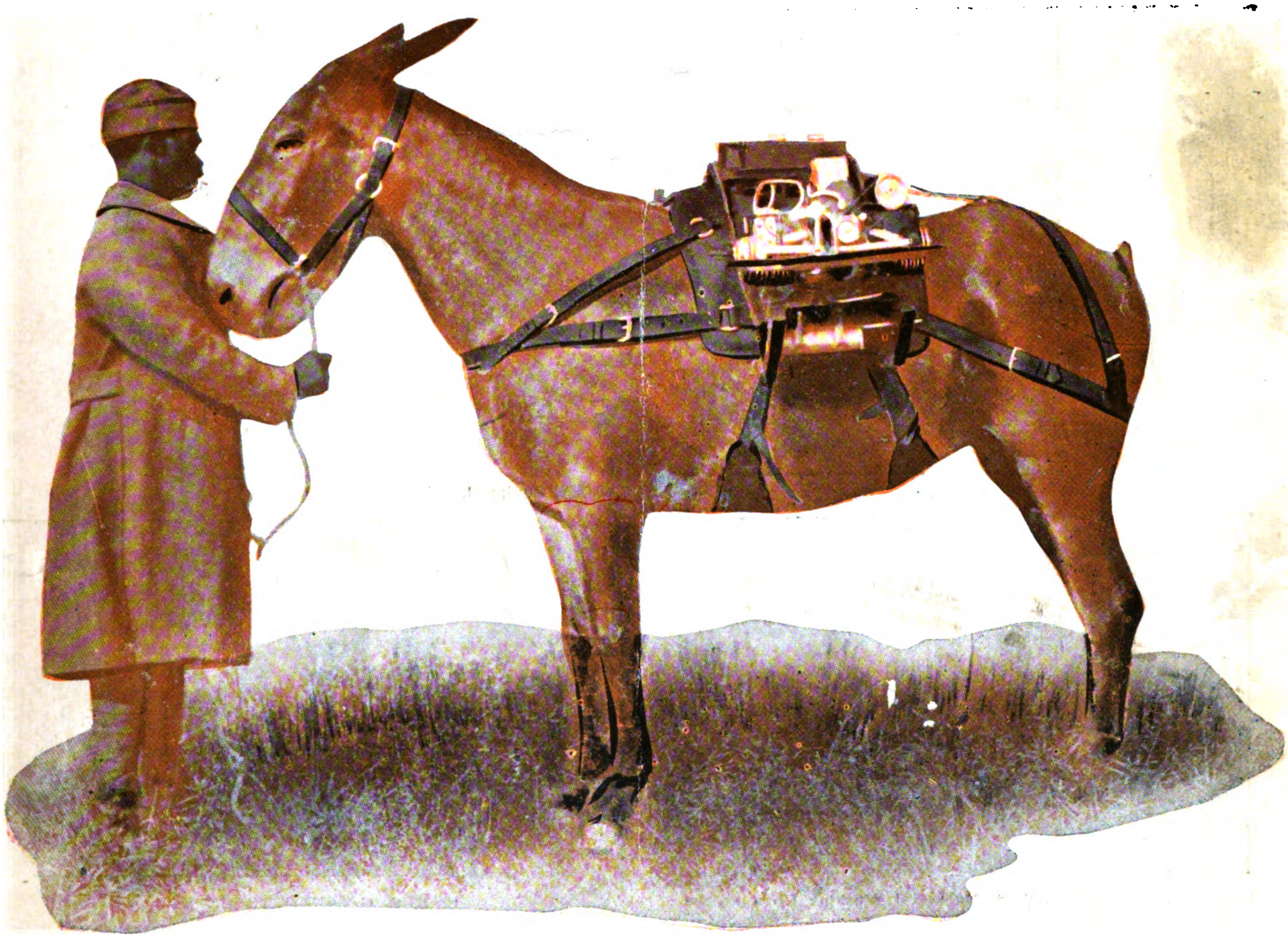
November, 1919

20 Cents

The WIRELESS AGE

Volume 7

Number 2



The power unit of the recently designed wireless pack set for military use

A New and Powerful Wireless Company

Details of its organization

Across the Ocean on the NC-4

By Ensign Herbert C. Rodd

HATS OFF TO THE NAVY

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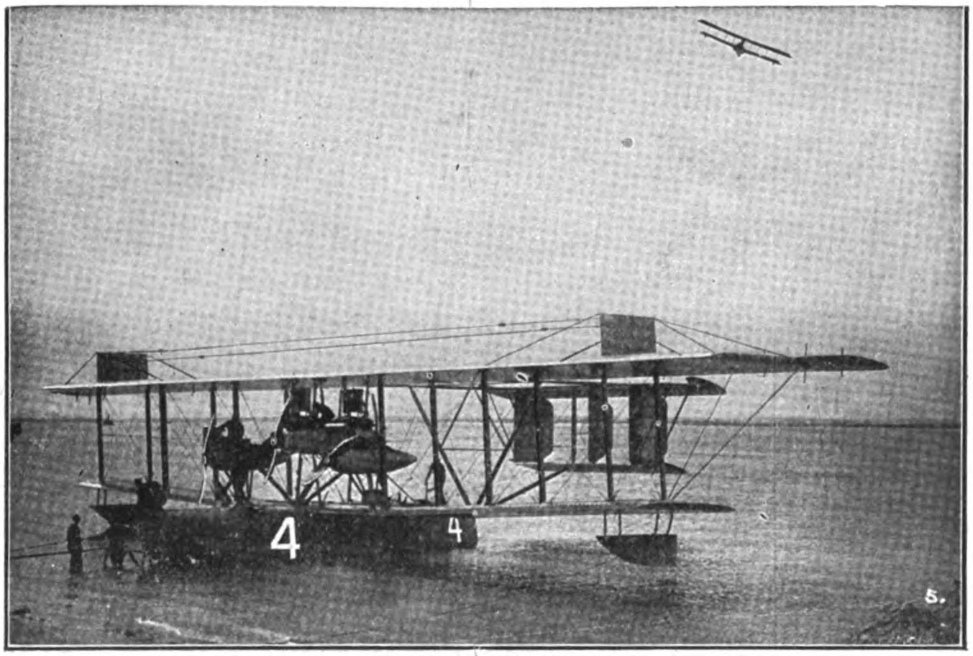
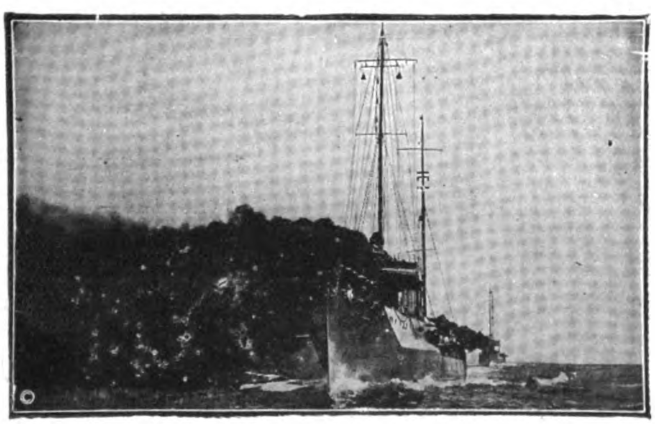
"By courier, coach and sail-boat, it took days for the news of Waterloo to reach London. During Lieut. Commander Read's flight to Halifax, Assistant Secretary Roosevelt in Washington sent a radio message to NC-4, of whose position in air he had no knowledge. In three minutes he had a reply."

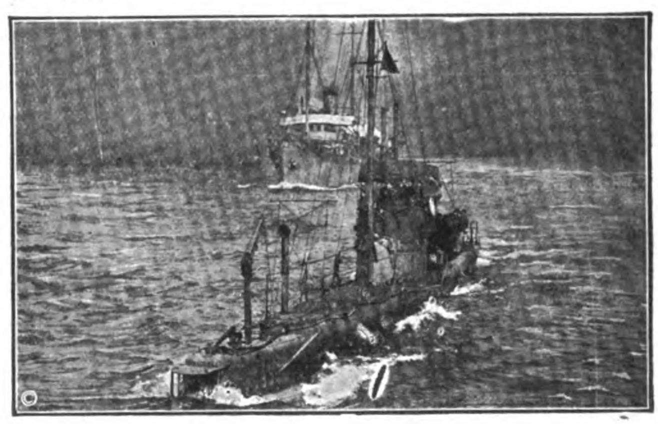
Extract from New York World, June 3, 1919.



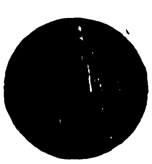
NC-4—ELECTROSE Equipped.



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



U. S. S. G-2—ELECTROSE Equipped.



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

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THE WIRELESS AGE

Edited by J. ANDREW WHITE

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Vol. 7. **No. 2**

Contents for November, 1919

Index of Equipment

RENEWALS—When subscription expires find a renewal blank enclosed. Return with remittance promptly.

CHANGE OF ADDRESS—Notify us of any change in your address, giving both the old and new location.

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David Sarnoff, Secy. George S. De Sousa, Treas.
J. D. Conmee, Business Manager

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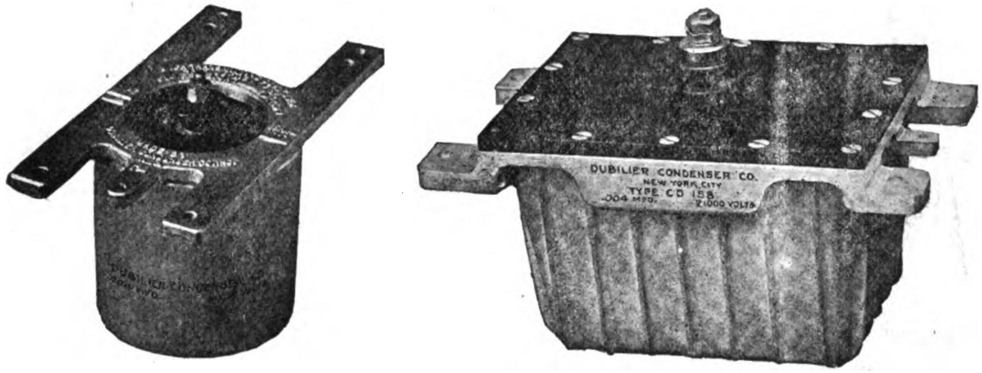
GREAT BRITAIN, Marconi House, Strand, London
AUSTRALIA, 97 Clarence St., Sydney, N. S. W.



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The kind of apparatus you used before the war doubtless answered your purpose nicely, but just consider the tremendous advancement made in the art during the past two years and you will appreciate your modern apparatus must contain several new types of equipment to bring it up to date.

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MICA CONDENSERS

proved their *real worth* in the Navy, the Signal Corps, and as a part of the equipment of the fighting Airplanes both here and abroad since 1916. They made it possible for wireless messages to be sent and received during all kind of weather and under most trying conditions when every message had its own important story to tell and had to reach its destination without fail.

You can now purchase a *genuine* DUBILIER MICA CONDENSER for your new set for any voltage and capacity. They replace Leyden Jars with greater efficiency and without brush discharge and with negligible losses. They are compact and indestructible.

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Vol. 7. No. 2. November, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

South Pole Explorer to Use Wireless

AN AIRPLANE hovering about the south pole may send to London daily wireless advices relative to explorations or scientific researches by the south pole expedition, which is to be led by John L. Cope next summer.

The explorer, who has served as surgeon and biologist on former south polar expeditions, believes the use of airplanes and wireless in probing the solitudes of the icebound antarctic regions will lead to revelations that will make the trip more important, from a scientific point of view than any previous explorations of the earth's "under side."

Although new difficulties will be created by use of aircraft, it is said the advantages to be obtained are so great as to be obvious to any one acquainted with such research.

It is proposed to equip the airplanes with wireless apparatus having a sending range of several hundred miles, insuring communication with the "mother ship" of the expedition. From this ship summaries of the airplane's exploits are to be flashed by more powerful instruments back to the civilized world.

Vienna to Become European Wireless News Station

TO MAKE Vienna the central receiving and distributing station of wireless news for all parts of Europe is the ambitious plan of a combine just founded in Germany.

A powerful radio receiving station has been established in the Hofburg, formerly one of the Hapsburg's favorite castles.

Wireless an Aid to Fishing

NAVAL SEAPLANES have been used to co-operate with fishing schooners in reporting prospective "catches." This co-operation is to be extended by the Bureau of Fisheries, Department of Commerce, in an effort to increase the supply of fish and reduce the cost of living.

War activities against the submarine developed the fact that bodies moving beneath the surface of the ocean were visible from an aeroplane, and this fact is being utilized to increase the fishing facilities of the country.

W. W. Welsh, of the Bureau of Fisheries has just completed his report upon an experimental flight from the United States Naval Air Station at Cape May, in which he co-operated with a fishing fleet.

Wireless telephone apparatus was used to report schools of fish to the fishing vessels below.

"At the time of the flight," the report says, "no schooling fish were breaking on the surface, and none could have been visible from the crow's nest of a vessel at short range.

"At an altitude of 800 feet some schools of menhaden were so near the surface that they appeared as a reddish brown granular mass, ameboid in character and changing in form constantly. Deeper schools had the appearance of large masses of sunken gulfweed."

Graphic News Bureau
The wireless telephone, installed in a Signal Corps truck and communicating with airplanes in the trans-continental flight, was recently exhibited in connection with the recruiting work of the Army

German Wireless System for Newspapers

THE GERMAN GOVERNMENT is experimenting with wireless with a view to extending its use internally. It is proposed to install stations in all the large German cities, and to utilize the wireless as an adjunct to the existing telegraph system. An especial advantage from use of the wireless is seen in its adaptation to newspaper purposes. A single story intended for a number of newspapers throughout the republic could be sent once from a central station and picked up by the substations in various cities. The technical work is just now being undertaken.

Wartime Amateur Wireless Restrictions Removed

WARTIME restriction governing the operation of radio stations and radio equipment by amateurs were removed October 1, by the Navy Department, as announced in the October issue. The removal applies to technical and experimental stations at schools and colleges and to all other stations except those transmitting or receiving commercial traffic.

The restrictions on commercial traffic stations will remain in effect until the President proclaims peace.

Regulation Likely to Be Government's Wireless Policy

WHILE Secretary of the Navy Daniels has by no means abandoned hope of persuading Congress to pass the Radio bill as drafted by the Navy Department, giving the Government a free hand in radio both for national defence purposes and commercial business, there are strong indications that Congress will not yield to any proposal leaning toward Government ownership of this method of communication.

A compromise has been suggested looking to the establishment of radio interests privately owned but controlled for national defence and other purposes by a Federal regulatory board or commission.

At the present writing the plan is tentative and there have been no commitments on the part of the Government and will be none unless Secretary Daniels can be convinced that the legislation desired by his department cannot be had. The Naval Affairs Committee of the Senate is now holding hearings on this bill.

One of the reasons demanding an early decision on policy by the Government is the fact that American business interests are already suffering from the forced use of foreign cables and wireless. Several instances are already known in Washington of American commercial houses engaged in foreign commerce whose messages have been delayed in transmission without explanation, thereby enabling their competitors abroad to get in bids and take other steps to secure business which might have come to the United States.

While it is yet too early to predict the course Secretary Daniels will take with reference to the Radio bill, and no action may result until the committees of Congress are ready to indicate their attitude, the general opposition in both Houses to anything savoring of Government ownership or monopoly now points to a solution of the question through private interests under Government control.

World's Baseball Series Reported by Wireless

AMATEUR wireless operators throughout Long Island, Connecticut and New Jersey had the benefit of the wireless report of the world's baseball series which was sent out each afternoon by the naval radio station at Whitehall street, New York. Word has been received from scores of these operators acknowledging the service.

Ships at sea were supplied with the news of the games at Cincinnati. Included among the vessels receiving the reports were a great many United States naval ships, on board which the interest in baseball is naturally high. Destroyers stationed up the Hudson as far as Yonkers benefited by the service and other war ships of varying kinds, stationed in waters near New York or travelling along the coast, also receiving it.

Far East Wireless News Service Proposed

ESTABLISHMENT of a transpacific news service with tentacles that will reach into the remotest parts of the Far East and daily bring the news of the now little known corners of the entire world to the breakfast table is proposed by V. S. McClatchy, publisher of the Sacramento Bee. He has appealed to the State Department at Washington to assist in this venture for according to his theory, the news service must be under the direction of the National Government during its inception.

Newspaper men who have given thought to the proposed advice agree that the daily interchange of news across the Pacific would probably have a greater effect in maintaining a world peace than any number of leagues organized for that purpose. Strong representations have been made on this matter to the State Department by the United States Ambassadors in the Far East, the acting Governor General in the Philippines and by commercial bodies whose interests lie in that direction.

Cable facilities are considered inadequate for this service and it is to be conducted entirely by wireless.

The communication to the Government urges that such a service be established at once; that service to Manila presents the least difficulties and should not wait for other connections; that while it may be necessary to start with a Government report, it be replaced by an independent report as soon as practicable; that the independent report be free from Government control or censorship, except in war; that where the Government report cannot be self-supporting, for a time at least, which may be true in China, the Government is to make such arrangements to meet the cost of transmission as will enable users of the report to secure it at a price within their means.

British Wireless Export Ban Removed

A CABLEGRAM from Consul General Hollis at London, announced that the British export embargo on wireless telephone and telegraph apparatus and instruments has been removed.

International Cable and Radio Conference

PRESIDENT WILSON has asked Congress if it would authorize the proposed International cable and radio conference in Washington, D. C., next month.

A recent law prohibits the executive from giving or accepting invitations to international conferences without express authority of Congress. The principal allied powers expect to participate.

Under-Water Wireless

COMMUNICATION by both radio telegraph and telephone has been established between a hydroplane and a submerged submarine lying several fathoms under water off Fishers Island, six miles from New London, Conn. The experiment was watched by 250 members of the Edison Society of Electric Engineers.

The engineers were taken on board the destroyer Blakeslee and a Government submarine chaser, where they listened in through wireless sets to the submarine N-6 and a hydroplane which was flying overhead. The destroyer's wireless outfit also established communication between the submersible and the airship.

Mexican Station at Salina Cruz

THE PRESIDENT OF MEXICO has ordered the work of the installation of the wireless station at Salina Cruz to be speeded up and to terminate it as soon as practicable. This station will communicate directly with the Republic of San Salvador. The station will receive messages from other stations that are established in the republic and abroad, but especially so from San Salvador, as this has been the main purpose of its installation agreed to by President Carranza.

Forestry Service Wireless System

THE ESTABLISHMENT of a wireless telephone system on top of the new postoffice building at Portland, Ore., for the use of the forestry department in conducting experiments as to the feasibility of establishing this means of communication throughout the national forest system in the northwest is progressing and the system will soon be ready for trial.

Recently the forest service carried a wireless telephone outfit to the top of Mount Hood and received messages there with perfect success. In carrying out the experiments from the new postoffice building it is probable that other stations will be established at Zig Zag on Mount Hood and at Wind River, north of Carson, Wash.

In Honor of Marconi

THE National Electric Light Association announces the organization of a special committee on the Marconi Fund for Italy at the suggestion of the Italian War Relief Fund of America.

The appeal now being circulated states that the moment is believed to be propitious for honoring the services to mankind of Marconi, and at the same time for showing the appreciation of Italy's great sacrifices and achievements in the war, by raising a special fund in the name of Mr. Marconi for immediate work in relieving the distress of Italian war orphans and blinded and mutilated soldiers and other war victims.

The retirement of the American Red Cross and the Y. M. C. A. from the suffering peninsula makes it vitally imperative that the Italian War Relief Fund be continued through this trying and critical winter and to this end a committee to represent the electrical interests of America in the matter has been formed, composed of Elihu Thomson, John W. Lieb and T. Commerford Martin.

The appeal of the committee to electrical workers contains the following:

"We feel that everything that can be done must be done to give to the Italy that fought for us two weary and bitter years before we entered the war that has saved civilization, a further proof of American friendship and sympathy. She has profound claim on the respect and good will which we electrical engineers and all others engaged in electrical affairs can express through her great son, our friend and colleague. The effect upon Italo-American relations is sure to be salutary on both sides of the Atlantic."

Criminal Captured by State Constabulary Through Wireless

TROOPER E. C. ROBERTS, of the Brewster Station of the New York State Constabulary ordered the arrest by wireless of Nicholas Toleff, charged with murder in Jamesville. When the suspect was four days out at sea on the steamship Pannonia of the Cunard Line. The ship was destined for Piraeus, Greece, and was not due to make a landing for fourteen days.

The defendant is accused of murdering Christo Bozenoff. The trooper traced him from Jamesville to the Cunard dock in New York City, where they established that he sailed with a Serbian passport. This is the first time the State Constabulary has effected an arrest by wireless. The ship officers were asked to return Toleff to the United States.

Graphic News Bureau

The latest of Uncle Sam's super-submarines, the H-2, is equipped with the most modern wireless apparatus which permits the sending and receiving of radio messages while submerged or afloat

The First U. S. Wireless Station in Siberia

THE FIRST United States naval radio station in Russia was opened this year at Vladivostok by naval engineers who went to Siberia in November, 1918. G. K. O'Leary, mechanical engineer in the employment of the navy returned on the army transport Sheridan recently, after the completion of the station. It is one of the finest in all Asia, according to O'Leary.

American Legion Radio Post Formed

GEORGE GUYNEMER, famous French ace, will be honored by a post of the American Legion, which is to bear his name. It is proposed to make this post the "Radio Post," and all New York men who have served in the radio service of the army, the navy or the marine corps are urged to join.

The members of the new post are also planning the erection of a radio receiving and transmitting station at their headquarters in New York. Among the organizers of the post are:—Edgar H. Felix, Will T. Weatherbee, J. E. Howay, Donald D. Way and Harry A. Burgess.

A New and Powerful Wireless Company

Details of the Scope and Purpose of the Radio Corporation of America Which Will Have Behind It the Combined Achievements of the American Marconi Company and the General Electric Company

DURING the war the art of long distance wireless communication progressed to such an extent as to make it clear that this new means of communication is quite as reliable as the cables. The crowded condition of all communication facilities, particularly cables, is such as to make it necessary, from the point of view of the commercial interests of the country, that this new factor in communication should be developed as rapidly as possible. Political, diplomatic and national reasons require that there should be ample radio facilities in the hands of one or more exclusively American concerns.

The Marconi Wireless Telegraph Company of America, which is the largest and strongest wireless company in this country, has the disadvantage of having a substantial percentage of its stock held abroad, and because of patent agreements with the British Marconi Company, of having its operation limited to the United States. The research laboratories and engineering force of the General Electric Company have been working for a number of years on radio matters and radio apparatus of great value has been developed which was used by the Government during the war for important communications. These two factors are basically considered in the formation of a new corporation called the Radio Corporation of America which has taken over the radio rights of the General Electric Company and which has proposed to the American Marconi Company to take over its patents and stations and some other of its assets. The directors of the American Marconi Company have approved this arrangement and have called a meeting of their shareholders on November 20th, to pass upon it finally.

If this proposed arrangement goes through the block of shares in the American Marconi Company held by the British Marconi Company will be acquired by the General Electric Company, and steps will be taken immediately under contracts and concessions already in existence to set up high grade commercial communication with England, France, Norway, Japan, Hawaii, Cuba and South America. It is proposed to extend the communications to China and various other countries as rapidly as possible.

Arrangements will be made that provide for the new company to remain permanently under American control. It will be amply provided with capital; none of its stock is offered on the market. It will enjoy the full technical assistance of the General Electric Company and of its research laboratories and will retain the highly developed staff of the American Marconi Company.

The new company will enjoy exclusively the patent rights of the British Marconi Company for the United States and Cuba and will be entitled to licenses under its patents in various other countries. In addition it will be in a position to enter into traffic arrangements with respect to communication in various important countries.

Mr. Edward J. Nally, who has spent his life in the communication business and for the past six years has been Vice President and General Manager of the Marconi Company, will be the first President of the Radio Corporation, which will have a strong board of directors.

Over the signature of John W. Griggs, as President of the Marconi Wireless Telegraph Company of America, the following circular containing the full proposal has been sent to Marconi stockholders:

The principal aim and purpose of the Marconi Wireless Telegraph Company of America, during all the period of its existence, has been the establishment and maintenance of transoceanic communication. Although the Company has done no inconsiderable business in minor branches of the wireless art, such as the equipping of vessels, the operation of ship to shore traffic, the manufacture and sale of wireless apparatus, and the collection of royalties, yet these have by the management been always considered as incidental to the greater and more profitable business of long distance communication.

When the war came your Company had erected, and nearly ready for operation, long distance stations at New Brunswick and Belmar, New Jersey, for co-operation with similar stations of the British Marconi Company in Great Britain. It had long distance stations on the Pacific Coast, near San Francisco, and on the Hawaiian Islands, for communication with Japan; and it had in the course of construction stations at Marion, Mass., and Chatham, on Cape Cod, for communication with Norway. Your Company has recently purchased the station at Tuckerton, New Jersey, intended for communication with France. At the beginning of the war the British Government, for its own use, took over all the British stations, thus preventing any use of our New Brunswick and Belmar stations; and when the United States entered the war our Government took over the Tuckerton station and all of our stations; thus any use of our stations and all development of the business of transoceanic communication has been absolutely suspended and will remain suspended until the Navy Department, under whose administration wireless affairs have been conducted for the Government, permits us to resume operations. This must happen soon; when it does happen your Company will, except for the objections hereinafter mentioned, be free to complete its preparations for engaging in long distance business. The revenue which will be realized from such operations will be particularly necessary because of the cessation of the extraordinary demand for small wireless outfits created by the war.

As you doubtless know, the American Marconi Company was organized as a co-relative of the parent British Marconi Company, receiving a grant of the Marconi patents and inventions for use in the territory of the United States and Cuba only, and under the expectation that it would, under a traffic agreement between it and the British Company, conduct a wireless service between the United States and Great Britain. The British Company has always held a substantial stock interest in the American Company and the plans and policies of the two have contemplated mutual co-operation and control so far as trans-Atlantic service is concerned. Two of the officers of the British Company have been officers of the American Company, viz: Senatore Marconi, as a director and vice-president, and

Mr. Godfrey C. Isaacs, who is Managing Director of the British Company, as a director.

Owing, no doubt, to the greatly increased use of wireless by the United States Government, especially during the late war, during which all wireless operations, both of commercial stations and naval stations, have been under the control of the Navy Department, our Government has come to regard the subject as one of very vital importance to this country, especially from a military standpoint.

As you have been informed by means of the report of hearings in Congress which have been mailed to each stockholder along with the annual report of the company, the Navy Department has sought to procure the adoption by Congress of legislation to vest solely in that department the right to operate wireless stations and to carry on wireless commercial business.

Congress has so far refused to pass any such legislation and the Committee of the House of Representatives, to which bills for that purpose have been referred, has in each instance refused to report them, clearly evidencing the opinion of Congress that commercial wireless business should be left in the hands of private companies rather than be made a subject of government ownership and operation. Notwithstanding this, we have found that there exists on the part of the officials of the Government a very strong and irremovable objection to your Company because of the stock interest held therein by the British Company. This objection is shared by the members of Congress to a considerable extent. Consequently your Company has found itself greatly embarassed in carrying out its plans for an extensive transoceanic traffic, and unless this British Marconi interest in your Company is eliminated your President and Board of Directors believe it will not be possible to proceed with success to the resumption of its preparations for a worldwide service when its stations shall be returned to it, as they will be in the near future. Even in the minor branches of your Company's work, which branches have been quite profitable during the war, the objections above alluded to have been increasingly effective in limiting your Company's activities. For example, the United States Shipping Board recently awarded to your Company contract for the maintenance of wireless outfits on certain ships which it controlled, but required as a condition certain affidavits that a majority of the shares of your Company were owned by American citizens, which affidavits could not under the present conditions be made.

In a word, we are satisfied and convinced that in order to retain for your Company the proper support and good will of our own Government it is necessary that all participation in its stock, as well as in its operations, on the part of any foreign wireless company must be eliminated. The objections of our Government are founded on such reasons of a patriotic nature as to command our respect and compel our compliance with their wishes.

Having these considerations in mind your officers have lately undertaken to remove the objections of the Government and to do away with the threatened embarrassment of which we have spoken.

Certain long distance and other radio devices and systems have been developed by the General Electric Company, a powerful corporation having assets of nearly $200,000,000, extensive factory facilities and connections with a number of manufacturing companies in foreign countries. Some of these devices and systems promise to be of great value in transoceanic radio communication.

A corporation has been formed called The Radio Corporation of America, which is authorized to issue capital stock as follows:

(a) 5,000,000 shares of preferred stock of the par value of $5.00 per share. This stock is entitled to receive preferred dividends of seven per cent. (7%) per annum and no more. In any distribution of the assets it is entitled to be paid off at par prior to any payment to the common shareholders. The preferred dividends are to be cumulative after the end of the Radio Corporation's fiscal year ending in or with the calendar year 1923.

(b) 5,000,000 shares of common stock without par value.

The preferred stock and the common stock have equal voting power, share for share.

The preferred stock may be retired on any day on which a dividend thereon shall be payable, at the price of $5.50 per share and accrued dividends.

The Radio Corporation has entered into an agreement with the General Electric Company concerning present and future patent rights, the manufacture of patented apparatus and devices exclusively by the General Electric Company for the Radio Corporation and the exclusive right to the Radio Corporation to sell patented radio apparatus and devices of the General Electric Company.

The General Electric Company has appropriated $2,500,000, a portion of which is to be used by the General Electric Company under an arrangement satisfactory to your directors in purchasing the shares of stock in your Company now owned and held by Marconi's Wireless Telegraph Company, Limited, of Great Britain, which shares it will hold, the remaining portion of this sum having been paid in cash to the Radio Corporation or expended or agreed to be expended directly for its benefit.

The General Electric Company has made an agreement with Marconi's Wireless Telegraph Company, Limited, which, if the proposed plan goes through, will enable the Radio Corporation to enter into an agreement with Marconi's Wireless Telegraph Company, Limited, which will greatly increase the powers and privileges of your company outside of the United States and Cuba, and which will provide, among other things, for the formation of a South American company managed and operated by the Radio Corporation, which will own the majority of the stock of various companies which will construct stations in South America for communication with the United States and England, and in due course with other countries.

135,174 shares of the preferred stock and 2,000,000 shares of the common stock of the Radio Corporation have been issued to the General Electric Company The remainder of the shares remain in the treasury.

In addition to the above, the General Electric Company contract with the Radio Corporation to furnish to it certain 200 K. W. High Frequency alternators known as the Alexanderson alternators, with accessories, at an agreed price, to be paid for in preferred stock of the Radio Corporation at par.

In accordance with what is understood to be the wishes of the United States Government, effective means have been used to see to it that the actual control of the Radio Corporation shall at all times be in the hands of loyal American citizens or corporations. It is hoped that it will be possible to accomplish this end and at the same time issue a limited number of shares which can be voted if held by foreigners, the certificates for which are to be known as "foreign share certificates." Efforts will be made with the co-operation of the General Electric Company to supply to your company enough of such foreign share certificates so that all or substantially all of your company's stockholders who are foreigners may receive their stock of the Radio Corporation in such certificates.

It is now proposed to enter into a contract with the Radio Corporation by which your company will sell and convey to the Radio Corporation all its assets and property including cash and securities, except its manufacturing plant at Aldene, New Jersey, and its claims against the United States Government and certain private corporations and firms arising from unlicensed use of the apparatus covered by the patents of the Marconi Company, and will receive two million (2,000,000) shares of the common stock of the Radio Corporation and preferred stock of a par value of $10,000,000 in consideration of the transfer of its assets above set forth and its agreement to transfer to the Radio Corporation the first $500,000 derived by it from the claims above referred to or alternatively to transfer to the Radio Corporation its factory at Aldene, N. J. If the net tangible assets thus transferred, not including the claims or the factory, are not reasonably worth $9,500,000 appraised on a going-concern basis the deficit is to be made up in cash realized on the claims above mentioned as and when the claims are settled, but your Company will not guarantee the claims in any respect and will not be liable for any cash deficit except to the extent indicated.

It is intended (after the proposed plan is approved), to declare a dividend on the shares of your Company of 25c. per share, payable on or about January 2nd, 1920, and a sufficient amount for this purpose will be reserved.

It is also proposed to lease the Aldene factory to the General Electric Company.

This plan, as will be seen, does not involve the sale of the whole assets and property of your Company as an entirety, but does radically change the scope of its operations and transfers the conduct of wireless communication and sale of wireless devices to the new Company. Your directors have thought it wise to call a meeting of the stockholders and take their judgment and advice and obtain their approval of the transaction.

Accordingly, a special meeting of the stockholders of the Marconi Wireless Telegraph Company of America is hereby called to be held at the registered office of the Company, 243 Washington Street, in the City of Jersey City, New Jersey, on the twentieth day of November, 1919, at 12 o'clock noon.

It is contemplated and expected that each stockholder of the Marconi Wireless Telegraph Company of America will have the privilege of exchanging his stock in that Company for an equal amount, par for par, of the preferred stock of the Radio Corporation and in addition shares of the common stock of the new Company equal in number to the number of shares held in the present Company. For illustration, for one share of the par value of $5.00 in the present Company, a shareholder will be entitled to receive preferred stock of the par value of $5.00 in the new Company and one share of common stock in the new Company in addition.

Your directors and officers believe that the carrying out of the plan herein outlined will be of great advantage to the stockholders and will relieve the Company from a seriously embarrassing situation, and they unanimously recommend its approval and adoption. Unless new and unforseen obstacles arise, the New Company under its traffic arrangements with the British Company and others will be enabled shortly after its stations are returned by our Government to start traffic with the British Islands, Norway, France and Japan, and, as soon as the necessary stations are built, to open communication with South America, thus attaining under conditions of financial strength, with a departmental staff of exceptional experience, and ability, the great objective that has always been aimed at, namely, a world-wide system of commercial wireless communication. We believe that such an achievement will not only redound to the advantage of our shareholders, but will be a material and very important benefit to our country.

We, therefore, request stockholders to promptly sign and return to the Secretary in the Woolworth Building, New York City, the accompanying proxy authorizing consent to be given to the sale of the assets of the Company as above outlined and approval of the said plan.

The stock transfer books of your Company will be closed from three P. M. October 31st until ten A. M. December 1st, 1919.

JOHN W. GRIGGS,
President.

233 Broadway, New York, October 22nd, 1919.

A Quenched Spark Gap

THE electrodes of a quenched spark gap usually consist of two plates or rings facing each other in a parallel position and separated a very small distance. Mica discs or rings are inserted between the electrodes in order to keep this distance always constant. It is, however, a very difficult matter to keep the electrodes parallel for a long time, owing to the rise of temperature, which warps them to such an extent that the distance between them is changed in some cases and the quenching effect reduced. If mica rings are inserted between the electrodes the material must be selected with the greatest care, as besides the great electrical stress placed on it, the mica has also to withstand high temperature. In the spark gap shown in figure 1, the electrode surfaces are kept in a position parallel to each other in spite of the rise in temperature. To this end, flanged or cup shaped electrode discs of different diameters are used, the flange of the larger disc encircling the flange of the smaller disc so that the two cylindrical electrode surfaces are separated by a small

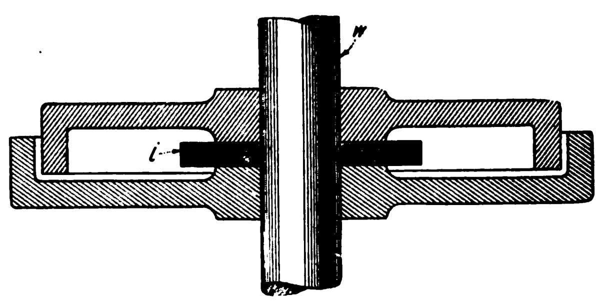


Figure 1—New form of quenched spark gap having the electrode surfaces constantly parallel

annular gap. The distance between two such surfaces can easily be kept unaltered providing they have been carefully turned on the lathe. These two discs are separated by an insulating insert i, and are held on an insulating rod w. Any number of these electrodes may be placed on the insulating rod and a compound spark gap formed thereby.

Across the Ocean on the NC-4

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

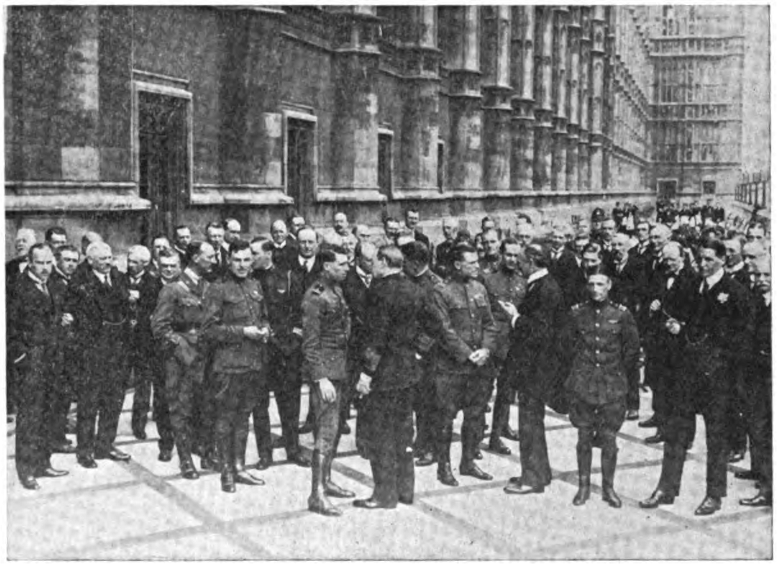
By Ensign Herbert C. Rodd

PART III

(Continued from September Wireless Age.)

THE villagers of Horta, mostly Portuguese peasants, showered flowers and souvenirs upon the crew of the NC-4 when we came ashore; our reception lost nothing in enthusiasm from the fact that ours was the first airship they had ever seen.

But the call of normal things prevailed, and after an appetizing meal served in the captain's cabin aboard the Columbia, we indulged ourselves with about two hours' sleep, to counteract the effects of about thirty-four hours' constant activity from the time we had reached Trepassey. Later, we paid a visit to the village and, as special guests, saw the only "movie" in town.



On the terrace of the House of Commons after the luncheon given to the American aviators by the Prince of Wales. The author is in the left center of the picture with fingers locked. Among the notables to be seen are: the Prince of Wales, Lord Reading, Admiral Wemyss, General Seeley and Winston Churchill

When we entered our box the orchestra greeted us with "The Star Spangled Banner," and I nearly made a bad bull. Deafness, caused by the constant roar of motors for sixteen hours and signals received through a six-step amplifier, prevented me from recognizing it and I nearly sat down. Then, too, none of the NC-4 crew recognized the Portuguese national air played immediately afterward and the officers of the Columbia had to signal us to rise. After that we jumped whenever the fiddler made a move, during a reception which continued until nearly 2 o'clock the next morning.

Although our craft was ready to leave for Ponta Delgada the next day we waited to get word from our Division Commander aboard the NC-3. This was necessary, since the three NC boats had been commissioned regular ships of the Navy before the start at Rockaway.

On Sunday morning the crew of the NC-1 was brought in by the steamer, Ionia. Standing on the unsteady deck of the Columbia we watched this Greek tramp put in, land the men she had rescued, and then proceed on her way to Gibraltar. She seemed to toss about like a cork in the heavy seas and made us realize what the NC-1 crew had gone through while battling the storm, with their plane going to pieces. The men, glad to be alive, were keenly disappointed over the loss of their plane and the termination of their cherished hope of completing the trans-Atlantic flight.

The welfare of the remaining plane, the NC-3, gave us deep concern at this time and we wondered if she could weather the seas that were running. Even the destroyers were having a rough time of it in their search for her. As the hours slipped by, so did our trust that she would live through it. When Monday morning came, and still no news, we concluded that our brother naval adventurers were lost.

That evening, however, we were overjoyed by a report that the NC-3 had arrived at Ponta Delgada under her own power with the entire crew safe. The dispatch did not state that she was damaged so we expected that the NC-3 and the NC-4 would continue the trans-Atlantic flight together. News that Hawker and Grieve had started from Newfoundland in the Sopwith plane also reached us.

On Tuesday morning, May 20, we made ready to leave Horta for Ponta Delgada. There was nothing to do to the wireless apparatus except to charge the storage battery. The high voltage batteries read 69 volts, the same as at Rockaway. The spark transmitter was in fine condition though the sparking disc and stationary electrode insulator were slightly coated with oxide. This was removed with an oily cloth.

All morning we waited to make the hop. Finally, after five rain squalls had blown over we got started. It was 12:35 o'clock when the NC-4 jumped from the water 20 seconds after the motors were given full throttle. We shipped a little water in the take-off and that caused a leak in the skid-fin antenna insulator, so I could not send until we were high enough to use the trailing antenna. At 1,300 feet I sent a broadcast.

Leaving Horta, after five rain squalls had blown over

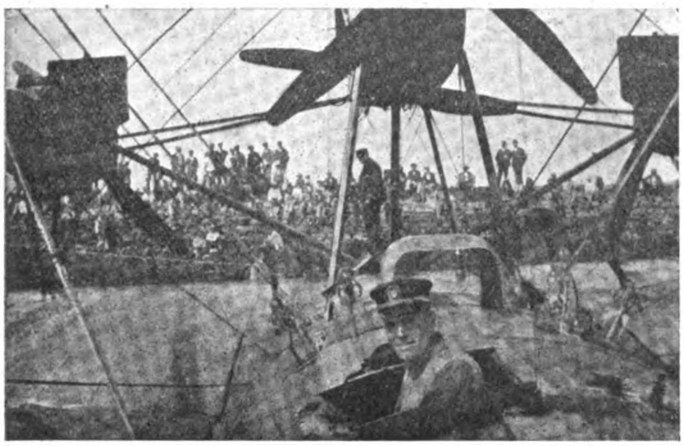
Mt. Pico—Taken from the plane as the storm clouds rolled away

In the harbor at Lisbon where the Order of Tower and Sword was conferred on the crew

Flying high we watched Mt. Pico, the crest of which is 7,000 feet above the sea, and, as though especially for our benefit, the surrounding clouds lifted and we saw for the first time the snow-capped peaks glistening in the sunlight.

A half-hour after the start destroyer No. 24 informed us that she was making heavy black smoke and the Columbia wirelessed that weather conditions were improving along our route. Communication with the Melville at Ponta Delgada was also established a little later and at 1:22 we passed beyond the smoke screen created by destroyer No. 24. A radio compass bearing on destroyer No. 25, fifty miles distant, showed 351 degrees at this time.

Lieutenant Breese created a diversion on the leg to destroyer No. 25 by getting out his shaving kit and shaving himself. The water that he used was badly discolored and I assumed it was hot coffee from a Thermos bottle, and so informed several of the destroyers that were communicating with me. It developed later that the murky mess was hot radiator water.



Waiting for high-tide at Figueira, Portugal, where we were forced to land for repairs and got stuck on a sand bar

When we had been in the air one hour the operator aboard the destroyer Wilkes, which held station No. 4 on the Lisbon leg, informed me that our signals had been fine ever since we left Horta. We passed over station No. 25 soon after this and the station ship Melville at Ponta Delgada came in to inquire what time we expected to arrive. "About 2:20," said our navigator. We were off the harbor at 2:20 and landed at 2:24. As we nosed down, steam could be seen issuing from the whistles of the ships in the harbor, but we could not hear the din until we had landed. It sounded like the celebration of Armistice Day back in the States.

Commander Towers came out in a small boat to greet us and then we learned, for the first time, that the NC-3 was damaged to such an extent that she could not continue the flight. The power plant of the NC-3 was as good as ever. The four Liberty motors operated without any trouble despite the abuse that they had undergone, but the lower wings of the plane had been battered to pieces by the heavy seas when the NC-3 was compelled to descend on account of the fog, and this prevented a continuation of the flight. We learned that these same heavy seas had prevented the plane from rising again and forced them to resort to taxying until they reached Ponta Delgada. It had been no failure of personnel or material, for everything had proceeded according to plan until the fog was encountered. The NC-3 crew looked very haggard and worn, as well they might after their harrowing experience, and we felt a very genuine regret that their misfortune had put them out of the running.

Nearly endless greetings and equally endless photographings awaited us ashore. Admiral Jackson finally came to our rescue and secluded us in his home. We had a week of rain and windy weather at Ponta Delgada but the time passed by rapidly, for the surrounding country was of the greatest interest and there were many receptions and festivities to attend. One very large reception was held at the Governor's Palace, where we met the Mayor, the military authorities and the leading citizens. So generously were the attentions and souvenirs showered upon us that we left there with feelings of awe.

We made a trip of inspection to the plane each morning. Since we were not quartered aboard the station ship Melville I could not supervise the recharging of the batteries for the wireless set, so I sent a message from shore to have it done. When at 5 o'clock the next morning we went aboard the plane I found a new battery which showed a specific gravity of only 1100. A boat was immediately despatched for a new battery which read 1250. Later on I was able to get the old battery back. It registered 1290!

The shelter of the harbor being none too good, we feared some damage to the plane might be caused by a slight change of weather conditions and this gave us so much concern that we had almost decided to attempt to leap the sea wall in order to take off in smooth water in the harbor beyond, when at last a favorable day arrived and we got away in spite of very rough water. The start had been planned for 6 A. M. but because of dirt in the gasoline and carburetor we were delayed about four hours. But as we rose in the air I felt that our troubles were over and the impatience of the past week disappeared.

It was 10:17, Greenwich Mean Time, May 27, when we left Ponta Delgada, on the leg to Lisbon, 786 miles away. The favoring wind was about 23 knots and visibility was good with clouds covering the mountains. Immediately after the start, I inadvertently caused what might have proved a catastrophe to the wireless set, when I made the mistake of plugging in the six-step amplifier tubes on 12 volts and burned them for about a half-hour before discovering it. I felt sure that I had injured them, but upon plugging in 6 volts —the correct voltage—destroyers five stations away were heard loudly. It was evident that the tubes were in good working order so I dispatched some traffic to the destroyer Wilkes for relay to the Melville. A half-hour afterward I sent a message to Admiral Jackson at Ponta Delgada thanking him for his hospitality and stating that we seemed to be on our way. During the next three minutes I requested weather reports and received replies that favorable weather conditions existed along our entire route. Wishes for good luck were extended to us, too, as we passed over No. 1 destroyer on the Lisbon leg. Within the next quarter-hour we passed No. 2 destroyer 10 miles to the southward, sending her a message to that effect, as those on board the vessel did not see us. At this time Destroyer Gamble, No. 6, seemed exceptionally loud for the 200-mile distance between us; destroyer No. 7, 250 miles distant, also called us and advised us that our signals were strong.

We missed station No. 3, the wireless equipment of which did not seem to radiate well on 1,500 meters, so I requested several compass signals from No. 4. At 12:20 he was bearing slightly to the left, ten minutes later he was 20 degrees to the left, and at 12:35, 45 degrees to the left. Commander Read could not figure out what the trouble was, but headed back to our course with the aid of the radio compass, and we passed over Destroyer No. 4 at 12:50, much to the relief of the pilots and the rest of the crew. Later our Navigator discovered that the gimbal rings of our magnetic compass had jumped out of the pivots, probably at the time of our take-off at Ponta Delgada when we bounced on top of several waves. With this trouble rectified the compass functioned properly for the rest of the trip.

At the rate we were flying it appears that radio compass signals were audible at 50 miles, which was the best distance spanned during the trip.

About this time I told Chief Wiseman on the destroyer Wilkes about having worked Cape Race 650 miles. He replied if Cape Race could do it, he could also do it, so we arranged to see how far we could work each other. Since the optimum wave of destroyers is 756 meters, we agreed to use that wave when the 1,500 meter signals became weak. At this time we were flying at an altitude of 1,000 feet and our speed, aided by a westerly wind, was about 88 knots.

At 1:10 Destroyer No. 7 advised that he had heard us when we left Ponta Delgada—a distance of 350 miles. A bearing on No. 6 about this time showed 15 degrees to the left and we passed her at 2:05. Destroyer No. 11 was coming in loud at 300 miles on the run to No. 7, whose radio compass was weak, though we got a bearing from her. It showed 8 degrees to the right, and we passed her at 2:40.

Requests for weather reports were sent to No. 8 and No. 9, to which they replied promptly and at 3 o'clock I exchanged messages between our captain and Captain Simpson of the destroyer Robinson. We passed destroyer No. 8 a little later and I worked No. 4 to test her signals in compliance with Chief Wiseman's wishes.

At 3:30 a weather report was secured from No. 11 in 5 minutes; this time was approximated 15 minutes later when No. 12 replied to a request for a report in 7 minutes. Shortly afterward, 4:18 to be exact, we passed destroyer No. 9. She had been moved 17 miles to the eastward and No. 11 had taken a position 17 miles to the westward of the scheduled points, because destroyer No. 10 was missing, for some unknown reason. At 4:46 I got a weather report from No. 14 and I also worked No. 4 again, both stating that my signals were loud. I called the station ship Shawmut at Lisbon at 5 o'clock, but she did not answer.

Destroyer No. 11 had been audible for 25 minutes on the radio compass, a distance of 40 miles, when we passed her at 5:05. About 15 minutes later I carried out another test with No. 4. She stated she had left her station for Ponta Delgada at 2 o'clock. Her signals were good on 756 meters, but quite weak on 1,500 meters. The Rochester at Lisbon was the next ship to call me with a message from Admiral Plunkett, which read: "Fine work. Come along." Immediately afterward I managed to get a reply from the Shawmut at Lisbon and we exchanged messages. At 6:05 we passed Destroyer No. 12.

The test with Wiseman on the Destroyer Wilkes, No. 4, having lapsed for a time, I worked him again. He said he was only using .4 kw. and that they expected to reach Ponta Delgada about 10 P. M. This indicated that the Wilkes was approximately at station No. 2, making the distance covered by our signals around 520 miles. I promised to call him at 6:30, but being busy with the Rochester for about a half-hour I forgot about the Wilkes and later when I called at 6:47 I heard no reply. I have since learned that Lieut. Sadenwater, using a 950 receiver aboard the Columbia in Horta, copied my messages all the way to Lisbon, and that the chief on Destroyer No. 23, stationed near the Azores, copied us from Trepassey on the Trepassey-Azores leg and also on this leg, Bar Harbor station turned in messages copied from the NC-4 at a distance of 1,400 miles.

The flight thus far exceeded our expectations and now a message came in from the Rochester inquiring as to the time we expected to arrive, to which our navigator answered: "Expect to arrive about 8 o'clock. Please have search-light on water trained into the wind. Shall I land to north or south of Shawmut?" We had passed No. 13 at 6:35 and because No. 14 was bearing to the left about 32 degrees we passed her to the right at about 7:16, shortly afterward sighting the rocky coast of Portugal. Many Portuguese stations were heard, as we approached the coast. Cadiz (EBY) near Gibraltar, especially was very loud and clear.

We approached the Tagus River just as the sun was getting low, and after circling a bit we landed astern of the station ship Shawmut at Lisbon. The time was 8:01 P. M. While landing, I communicated with the Rochester and the Shawmut on the skid-fin antenna without any difficulty. The time for the trip was 9 hours and 42 minutes and the average speed was a little more than 81 knots.

Just after landing at Plymouth. The entire crew at the finish of the epochal flight

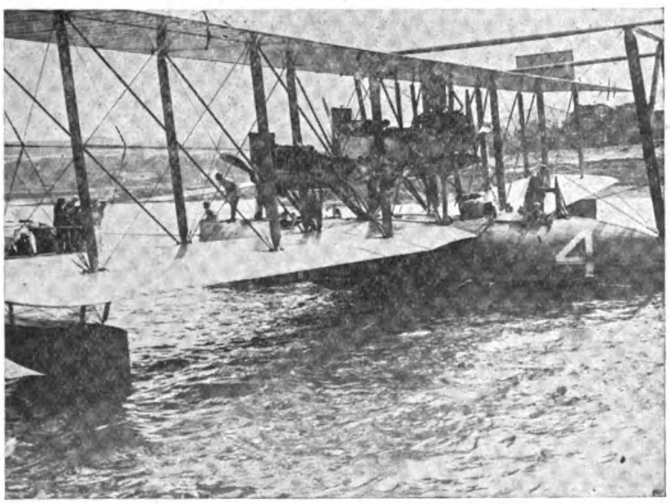
We were taken from the NC-4 immediately and put aboard the Rochester, the flagship of the destroyer force, where we were received by Admiral Plunkett, his officers and men, as well as the American Minister and officials of the Portuguese Government. The Order of the Tower and Sword was conferred upon us on this occasion and we had to pose for "movies" that were taken by searchlight.

At length we were allowed to remove our warm flying clothes and permitted to sit down to a meal. Having taken practically no food since 4 o'clock that morning this part of the reception appealed to us immensely. The crew, a little tired, but in excellent condition, were interested in all the festivities and some went ashore to see the town that night for fear that it would be the only chance, as the NC-4 was in perfect running order and might start the next day. We found Lisbon to be a good-sized city, with many buildings constructed of red and white tile located on an expansive hillside that inspired one with its beauty. If this were not strictly a radio story I might relate many amusing incidents that occurred during our stay. However, it was all very enjoyable and interesting.

No repairs were necessary at Lisbon and on May 30 at 5:29 in the morning we departed. After circling over the harbor we cleared the mainland at 5:55, at which time I let out the trailing antenna. The Shawmut was busy broadcasting until 6:12 when we sent the following message to her: "For American Minister. Request you express to all heartfelt appreciation of Commanding Officer and crew of NC-4 for wonderful welcome (signed) Read."

The destroyers Connor, Rathburne, Woolsey, Yarnell and Tarbell were stationed between Lisbon and Cape Finisterre, using the call letters A, B, C, D and E respectively.

At 6:25, CTV (Monsanto, Portugal) sent this broadcast: "Trans-Atlantic seaplane flight now in progress. Ships are requested to restrict use of radio apparatus to avoid interference with seaplanes." This message did not have the desired effect, for Spanish and Portuguese ships interfered considerably with "QRU?" signals.



NC-4 at Plymouth, showing after cock-pit containing radio equipment. Rodd is hoisting the colors

Weather reports were secured from A, B and C with difficulty and I despatched a message to the Shawmut to request destroyers to listen on 425 meters. Station A was passed at 6:33. Then I was told that a water leak had been discovered in the port motor and it seemed necessary to land for repairs. Shortly afterward I sent B the following: "We may have to land. Stick close on 425 meters for my buzzer modulated set if I send the word 'landing.'" At 7:12 I sent: "We have gas leak on port motor and may land soon." B acknowledged promptly. At 7:15 I reeled in the trailing wire and sent: "Landing, landing, sending on emergency antenna." The NC-4 was headed for the shore near Figueira, Portugal, to find smooth water for the landing, which was made in the Mondego River.

The repairs were quickly made, but in the meantime the tide fell rapidly and small islands appeared here and there, making it unsafe to "take off" until the tide was high again. We went aground on a sand-bar and I called B with the battery set. Hearing no reply I shifted to 756 meters and copied the following, although I missed the call letters: "NC-4 passed station A, but Rathburne (B) has not sighted yet. Sea smooth."

There was nothing to do but wait. Lieut. Stone and Chief Rhoades slept peacefully in the sun on the hull of the plane, while the rest went ashore.

The Shawmut on 756 meters at 8:30 sent the following: "To NC-4. What is your situation? Where are you? Answer via destroyers. Shawmut." Then the following: "Destroyers please listen on 425 meters for message from NC-4." I then called B, but found her sending this message to the Shawmut: "NC-4 not sighted. Am searching to southward of position. Sea smooth, visibility very good." I called B again at the first opening only to hear a destroyer on 756 meters reply: "Proceeding to assistance of NC-4." This reminded me of Chatham when destroyers worked on high wave-lengths and did not listen on 425 meters. The signals were so loud that Commander Read, sitting on a bank 100 feet away, heard them. Ensign Dowd, an aircraft radio officer, divining our situation, sent the following from the Shawmut: "Destroyers please listen on 425 meters for message from NC-4." Destroyer C acknowledged this message, but instead of heeding it called ISW (general call) about two minutes and then sent the Shawmut's message repeating each word and sending very slowly. His intentions were good, but we might have sunk several times during the five minutes he took to do this.

When C finally finished, B called me and asked: "Have you landed?" I answered quickly giving our position, but when I listened A and C were working. Destroyer A said, "NC-4 last seen full speed." B's signals were audible over 100 feet away. He then sent the following to the Shawmut at 9:04: "NC-4 reported leak in gas tank. Would probably land. Am searching to southward of position now. Last signals transmitted by NC-4 were on emergency radio set." This showed that B had heard my message and that the ensuing two hours' delay in rendering assistance could have been avoided if all had been listening instead of sending.

Finally, when things quieted down, I called B again on the battery set and sent: "In Mondego River. Must wait high tide at 2 o'clock. Seaplane O. K. Cannot make Plymouth tonight. Request destroyers keep station. What is best port to north to land within 300 miles? Request report situation Comfran and Plymouth. (signed) Read." B replied that our signals were faint but readable.

It might be noted that the skid-fin antenna was only 70 feet long and stretched about two feet above the top wing. Considering that the telephone set was rated at 5 watts, the distance which this message traveled—about 25 miles—is quite remarkable.

At 10:30 two destroyers arrived, anchoring off the mouth of the Mondego River, and Lieut. Commander Geer phoned that Commander Symington was on his way to us in a boat. When he arrived the details for the remainder of the trip were arranged. It was decided to stop at Ferrol Harbor, Spain, before dark and continue the flight to Plymouth the next day. At 2:14 the following by Commander Read was sent from B to C, having been semaphored to the Rathburne, anchored off the mouth of the river: "To Comfran, Brest and Simsadus, London, from NC-4. Request destroyer of coast division nearest Ferrol Harbor proceed there immediately anchor in position when seaplane can secure astern and act as tender for NC-4. Expect leave Figueira one thirty GMT and stay Ferrol tonight leaving for Plymouth tomorrow morning at eight weather permitting. Read." "Comfran" is the code word for Commander of Naval Forces in France and "Simsadus" stands for Admiral Sims.

We left the water at Figueira at 1:38, getting off very easily and with a slight favoring wind and fine weather set out for Ferrol. A few rain squalls were dodged by hugging the coast where the air was clear and the scenery more enjoyable. The Liberty motors were turning over so good that the estimated time for the trip was beaten by 15 minutes. The wireless apparatus was working fine, as usual, and my head phones were buzzing continually from the increased air talk.

At 2:51 I received the following from station E: "Tarbell will arrive Ferroll Bay 4:30 P. M." Immediately after that a delayed message from station D, relayed from the Rochester, came in. It read: "Best place north Mondego River is Ferrol, and second, Vigo."

Passing station D at 3:10 we told the Tarbell that we would arrive at Ferrol about 5 o'clock. Greetings were exchanged with Spanish stations at Oporto and Cape Finisterre about 4:15 and we also received the following from station No. 1: "Harding will act as mooring ship at Ferrol. Will anchor in inner harbor on arrival unless you wish me to meet you outside." The operator added that he had heard us 450 miles. Station E sent: "Will be outside making big smoke." As we came within range the Spanish station at Ferrol inquired: "Hydroaeroplaniz Norte Americano," to which I replied that we were.

At 4:45 the outskirts of Ferrol were reached and the NC-4 began to spiral to the landing, so I reeled in the trailing wire. The landing was made two minutes later. People flocked by the thousands to the docks and sea-walls to view us.

Immediate attention was required by the many small sail boats that swarmed out; these gave us much concern because of the danger of tearing the fabric of the ailerons, as they insisted on sailing underneath them. We endeavored to wave them off, but it was futile. At last, much to our relief, a Spanish admiral appeared on the scene and, uttering a few excited phrases, got them to disperse a reasonable distance.

The harbor afforded excellent shelter for the plane. The Harding came in from sea about 15 minutes later to act as a mooring ship, but the NC-4 required very little attention. I did not even charge the battery, though it had been used considerably at Figueira. Ferrol boasts of the largest navy yard in Spain and the friendly and courteous welcome by the naval officers was on a scale to comport with it.

We left this Spanish port on the following morning, May 31, at 6:27 o'clock. The NC-4 climbed so rapidly that I was working on the trailing wire within six minutes and heard the Harding sending our time of departure to station No. 2 for relay to Comfran, Brest, and Admiral Plunkett at Plymouth. At 6:37 I heard No. 4 sending the message to the Rochester. Stations Nos. 2, 3 and 4 replied to my requests for weather reports, stating that visibility was very good at No. 2, good at No. 3 and fair at No. 4. Station No. 5 (the Biddle) came in loud on his compass schedule, but was two minutes ahead of time, so I called him and corrected his time. At this stage of the flight rain was encountered and the weather became thick, causing reduced visibility and requiring frequent changes of course.

I asked No. 3 for compass signals. The reply gave a bearing 35 degrees to the left and 17 minutes later it was 49 degrees to the right. Thus it was apparent that we had passed No. 3 without seeing her and that the bearing was reciprocal. We were uncertain as to our course so the Navigator steered from bearings obtained by the radio compass. At 8:30 No. 3 was 45 degrees to the right and getting fainter. No. 4 was 20 degrees to the left, changing to 40 degrees left 18 minutes later. This proved that we were too far to the East for the bearings, or that No. 3 was a stern bearing.

At 9:03 No. 4 said she had sighted us and we flew over her three minutes later, somewhat to the relief of our navigator who was having difficulty in keeping to our course. Up to this time I had heard nothing from Destroyer No. 6, the Stockton, stationed near Plymouth; so I asked No. 5 about her. He had no definite answer, but No. 4 volunteered the information that the Stockton was at her station although possibly she was not sending. The Rochester, 300 miles away, surprised me with her signal intensity from Plymouth. A message from her read: "Desirable NC-4 land inside breakwater near Rochester, then taxi to mooring in Cattewater west of Mount Batten. British plane will probably lead you to mooring. Aroostook boat at mooring." She also sent this weather report: "Weather in Plymouth fine. Light northeasterly breezes, clear overhead, but slightly hazy around horizon. Apparently splendid flying weather. Stockton is in position."

We missed No. 5 station entirely and No. 6 asked for the time of arrival at her station. I replied that we had probably passed No. 5 about 10 A. M. and that we were going to fly over Brest. An attempt to get a time tick from the Eiffel Tower failed, because I just missed the schedule and Nauen, sending at noon on 4,000 meters, was beyond the range of my receiver.

A part of the reception in England which the author terms "a fitting climax to the whole trip"

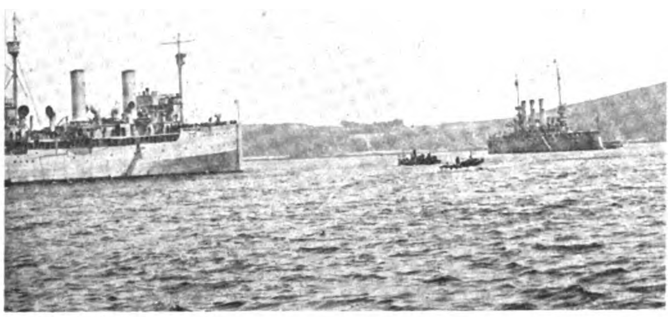
The George Washington at Brest called us about 10:50 and I received on the skid-fin antenna because we were flying low. I surprised the operator by telling him that I had copied his messages when leaving Newfoundland and only convinced him that it was true when I repeated the text.

Brest station came in with a "Bon voyage bon jour." Not knowing much French I had to limit my reply to: "Merci."

When, at 11:15, we sighted a point south of Brest and turned off our course to get a look at the harbor, I sent the following: "To Comfran-Brest: Greetings from NC-4. I am sorry we cannot stop. (signed) Read." Brest replied: "To NC-4: Congratulations on your magnificent feats. Sorry you cannot stop and let us entertain you. Good luck. (signed) Halstead." Brest harbor seemed just full of American ships and was the most typical American sight on our trip. It seemed quite like a port of our own.

Passing over Brest we flew very low to secure better visibility, and leaving France behind, ran into an increasing head wind and thick haze. This cleared slightly when we reached the middle of the Channel but not until we had sighted Plymouth, about an hour later, were we high enough at any time to let out the trailing wire, so communication was maintained through the U. S. S. Hannibal at anchor in Brest Harbor.

About 12 o'clock destroyer No. 6 sent weather reports, saying the sun was shining and visibility was seven miles. I told her that, flying low in fog, we were using the small antenna; she replied that our signals, though faint, were getting louder. A little later No. 6 added that our signals were good and that she was making heavy black smoke so that we could locate her. Her bearing then was 50 degrees to the



The NC-4 beginning the spiral to the waters of Plymouth harbor and the end of the first trans-Atlantic flight

right and three minutes later it was 55 degrees to the right, or reciprocal. Upon inquiring if our signals were louder she replied: "You seem about the same."

I don't know how the Navigator felt at this time but I doubted the correctness of our course to Plymouth and therefore took every opportunity of locating our position by radio. At 12:41 No. 6 transmitted the information that visibility was eight miles and our signals were weaker. I replied that I thought we had passed to the eastward of her. Then, looking out of the hatch, I saw a merchant ship and I hoped we could get our position through her, so I sent the International Abbreviation for "What ship is that?" and "What is your position?" Probably the operator was out on deck watching us, for no answer was received on 600 meters. Destroyer No. 6, however, came in with: "There are two sailing vessels about four miles apart, bearing 150 degrees true, eight miles from Stockton." But we did not see them.

Having visions of missing Plymouth I asked the navigator if it was possible to climb to 400 feet so that I could call Plymouth station for compass signals on the trailing antenna. I thought that shore station bearings, being more accurate, would help us to find the harbor. We began to climb, but had to come down again because of very thick weather at 300 feet. The Rochester at Plymouth then called and said that our signals were getting louder. Her signals were good, but reception on the skid-fin antenna was not as good as on the trailing antenna four hours before, when we were only half way across the Bay of Biscay. Plymouth seemed to be further away than it really was. After being accustomed to the signal strength obtained from the trailing antenna the decrease of signal intensity on the skid-fin antenna was very confusing.

The Aroostook now came in with best wishes and while I was listening in the NC-4 began to climb. This permitted the use of the trailing wire again.

Land was sighted at 1:15.

Destroyer No. 6 called and said that the visibility was ten miles and the sky was clear, to which I replied that we had sighted land and were all right.

We found ourselves headed directly for Plymouth harbor. This was very good navigation on the part of Lieut. Commander Read, for the wind had shifted several times during the flight across the Channel and the pilots, who had frequently been ordered to change the course, did not think that we would land exactly at Plymouth.

We climbed to 3,500 feet and circling for position landed inside the Cattewater at Plymouth at 1:26, thus ending the first trans-Atlantic flight and achieving the hitherto impossible in human endeavor.

Two British planes sent out to meet us came in about ten minutes after we landed, having missed us on account of the fog. They were equipped with 1,600 meter continuous wave transmitters, but since I knew nothing about it at the time I did not tune to receive that wave-length.

The reception by the officials made a fitting climax to the entire trip.

We were again taken aboard the Rochester, where the usual motion pictures were taken, but, unlike our experienc at Lisbon, we were promptly fed, being cautioned to allow for the public banquet to be given at the Grand Hotel by the Royal Air Force. Our stay on shore lasted eight days.

In London we were received splendidly everywhere, one occasion which stands out being a luncheon given by the Prince of Wales at the House of Commons. I sat next to Commander Grieve, the companion of Hawker in his attempted trans-Atlantic flight, and upon inquiry learned that their Sopwith plane had been equipped with a radio set, but the apparatus had failed to work satisfactorily. Admiral Wemyss was intensely interested and questioned me closely on the NC-4's installation. He seemed to have an excellent knowledge of radio. While in London I called at the Marconi House just in time to verify a communication that General Manager Bradfield had received from the Cape Race station concerning the distance the NC-4 had worked.

Paris and the famous Eiffel Tower then received our attention, and shortly before we prepared to leave for the good old U. S. A. we were permitted to visit the Battle-Front in France, spending much time at Chateau Thierry and Belleau Woods. Those two places seem very close to Americans.

Summarizing my observations made during the entire flight the things worthy of note are about as follows:

The health of the crew was better at the finish than at the start of the flight. The performance of the Liberty motors, especially the motor installed at Trepassey without a test, was marvelous. In fact the whole plane was in excellent condition upon our arrival at Plymouth and we regretted to see her torn down for shipment to the United States. We preferred flying to London and Paris instead of traveling by rail and steamer.

The radiation on the skid-fin antenna changed slightly during the flight across the Channel, but it was kept to 3 amperes by adjusting the variometer from time to time. This variation was no doubt caused by the varying quantity of moisture in the air at different times and at different altitudes. Radiation on the trailing wire averaged 3.3 amperes throughout the flight and the transmitter, running 54 hours without oiling, functioned perfectly. Judging by ear, the frequency of the generator was never quite up to 500 cycles, due no doubt to being mounted too near the deck, which prevented the proper rush of air from reaching it except when the center tractor engine was running. An improvement would be to mount the generator on an upper wing, out of the slip stream of the propellers, so that in a glide with dead motors signals could be sent. The present position of the generator propeller is in the path of all traffic over the hull when the plane is at rest, and in flight the propeller is apt to be damaged by things blown against it while traveling at 5,000 revolutions per minute.

No adjustments or repairs of any kind were required on the oil field-switch, sending key and antenna switch. The 6-tube amplifier also worked perfectly. Four extra tubes were never used and the six used were never transposed to secure a better combination even after 12 volts had been applied to the filaments for a half-hour by mistake. The only tendency of the amplifier to oscillate was at slightly above 1,500 meters.

A voltmeter was carried on the flight and readings at Plymouth showed the plate battery up to 68½ volts after nearly 100 hours' usage—a loss of only ½ volt since leaving Rockaway. The value of immersing the cells in paraffine is very evident, for ordinary batteries would not have stood up through the rain and fog encountered during the flight. The cut-down SE-950 receiver gave no trouble. Tight coupling was generally used because interference was seldom experienced. I noticed that maximum inductance and minimum capacity gave the sharpest tuning possible, and also the best audibilities.

It might be stated that the amount of amplification necessary to overcome the mechanical noise of the engines has been reached with the 6-valve amplifier, and although the signal audibility is increased by increasing the pressure of the phones no better readability is obtained.

The induction was much worse when using the compass coils than on the antenna. This, coupled with the fact that the signal intensity without any induction interference is much less than on an antenna, explains why the ratio of audibility on the same destroyer was about one to eight. Many readings were taken on the "A" coil only, because of the great increase in induction experienced when the "B" coil was thrown in. With the single coil it is possible to read within 5 to 10 degrees using the maximum method and taking the mean of the points when signals fade out, after rotating the coil either way from the maximum point.

A remarkable feature was that not a trailing wire or "fish" was lost and the tension of the skid-fin antenna developed no sag during the trip from Rockaway to Plymouth. All the insulators were leak proof except the lead-in from the skid-fin antenna, which, after having all the exposed surfaces rubber-taped at Ponta Delgada, functioned properly when the power transmitter was used.

Mention may be made of the desirability of having the wireless operator located so as to secure outside visibility with relation to the plane or else placed in close proximity to the navigator. It is hoped that the design of future flying boats will include this improvement.

The flight demonstrated the urgent necessity of developing the use of the radio compass to a much higher degree of efficiency and also made apparent the need of an emergency set employing a broad wave in place of the very sharp wave emitted by the continuous wave transmitter.

The use of a telautograph is contemplated for standard equipment in large seaplanes. It has the advantage of being both a communicating and recording device and requires a radio helmet only for the wireless operator instead of one for each of the entire crew.

In conclusion, I want to thank all the destroyer operators who stuck to the job so faithfully and gave us such excellent service. Since our flight, nearly every day has brought information that some ship or station heard us at greater distances than has been recorded in this story.

Weagant "Group Frequency" Circuit

ANOTHER circuit devised by Mr. R. A. Weagant for the detection and amplification of continuous and damped oscillations is shown in figure 1.

The aerial is earthed in the usual manner. Coupled to the aerial either directly or inductively is a secondary circuit which includes an inductance being in series with it, a variable condenser which is connected to the grid of a three-element valve. The plate of the valve is connected to a local circuit, which includes a telephone shunted around which is a variable condenser. In series with the telephone is placed a relatively large resistance shunted by a condenser in series in an inductance. The resistance is connected in series with the high potential battery, which in turn is connected to the negative side of the filament. The filament may or may not be connected to the earth. Connected across the local circuit from the plate to the filament is a second condenser in series with an inductance. Both the condenser and the inductance are adjustable so that they may be varied to secure the best effects. The last mentioned inductance is used when receiving continuous oscillations. It is not essential for damped wave reception except when the damped wave signals are very weak.

The condenser and inductance in shunt to the resistance permit of tuning the telephone circuit, which includes the telephone itself, to the group frequency of the incoming signal so that in the event of the apparatus being used to receive damped oscillations the effects produced by the groups of oscillations are very much magnified.

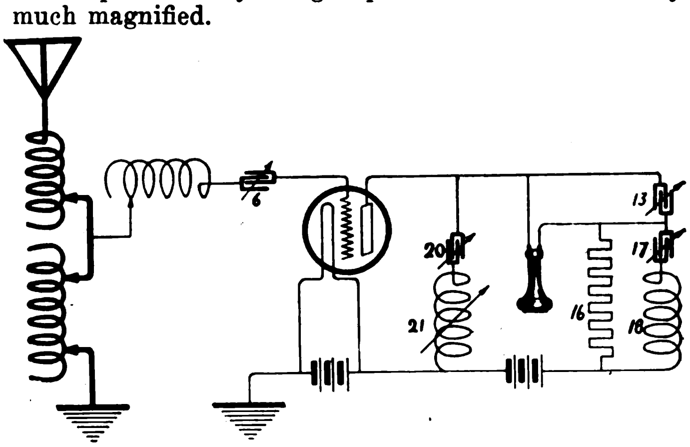


Figure 1—Circuit for detection and amplification of continuous and damped oscillations

In using the apparatus to receive continuous oscillations the inductance in the telephone circuit may be dispensed with.

Figure 2 shows a modification of the arrangement, which consists in using a closed secondary circuit, which includes the inductance 5 and capacity 6 instead

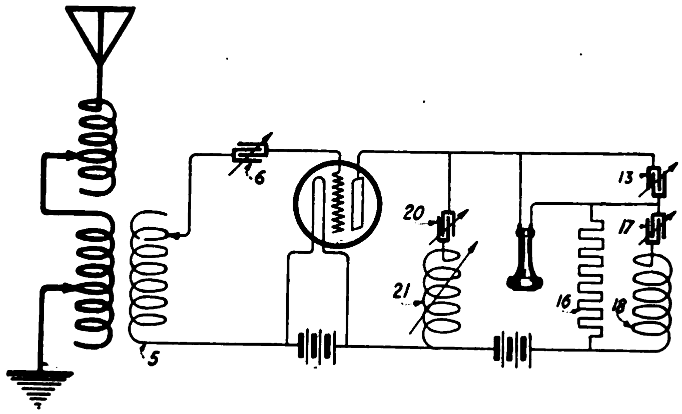


Figure 2—Modified group frequency circuit

of the open circuit shown in figure 1. It is also to be noted that the filament is ungrounded in figure 2. The operation of either arrangement is, however, essentially the same. The method of operation is somewhat as follows. The filament is first adjusted to incandescence. The potential of the high voltage battery is adjusted to a point so that the incoming signals give a maximum response. The resistance 16, the inductance 18, the condenser 17, the condenser 13, the condenser 20, and the inductance 21, are separately varied until the maximum effect of each is obtained. The usual adjustments of the aerial circuit and of the inductance 5 and condenser 6 are made in conjunction with the above mentioned adjustment of the local circuit. The adjustment just described is ordinarily used when damped oscillations are to be received. When continuous oscillations are to be received, it is preferable to adjust the potential of the high voltage battery to such a point that there is heard in the telephone receiver a high pitched note. This adjustment is generally to a higher voltage than that ordinarily employed for receiving damped oscillations with detectors of this type. For example, potentials as high as 100 volts and a resistance of 75,000 ohms has been used in practice. Having obtained this high note in the telephone receiver, the capacity of condenser 13 is reduced until this note is no longer heard or is very slight. The same result may be obtained by the adjustment of condenser 20 instead of condenser 13 or by a combined adjustment of the two.

Stabilizing the Energy Output of Transmitters

GUSTAV REUTHE has worked up a method of stabilizing the energy output of a radio transmitter which utilizes frequency changers by which the fundamental frequency of the primary source of alternating current energy is multiplied to obtain the frequency required for radiation.

The novelty of the means lies in suitably controlling the electrical characteristics of the several circuits of which such transmitter arrangements are composed, and in so far as these circuits constitute oscillating systems, in such a way that they are brought out of resonance with the fundamental frequency of the primary alternating current generator, or an integral multiple thereof, to a certain degree.

When transmitter arrangements of this character are operated, certain difficulties are encountered in maintaining a steady energy output and at certain frequencies and under certain load conditions, the whole system becomes unstable. In such a condition, a very slight variation of operating conditions such as for instance the variation of the speed of the generator or of the generator potential, or of the load, is sufficient to vary the current in the generator circuit in leaps so that it becomes very difficult to maintain a steady output, thus rendering operation difficult and sometimes impossible. Besides, the excess of potential, which might result from such leaps, is apt to endanger the entire installation. This danger is particularly great in case the entire system is in resonance.

In the endeavor to overcome difficulties of this character, Mr. Reuthe detunes the generator circuit with the generator frequency, and the intermediate circuits are detuned with the multiple of the generator frequency supplied to them by their particular frequency changer. He states that especially favorable results are obtained when the tuning means (capacity and inductance) of the generator circuit and of the intermediate circuits are chosen larger than those values corresponding with the exact resonance. Very favorable results are always obtained in connection with the above mentioned scheme when the antenna circuit is somewhat out of resonance with the multiple of the generator frequency supplied to it. In this case, however, the detuning must be such that the constants which determine the resonance of the antenna circuit are smaller than the values corresponding with the resonant condition.

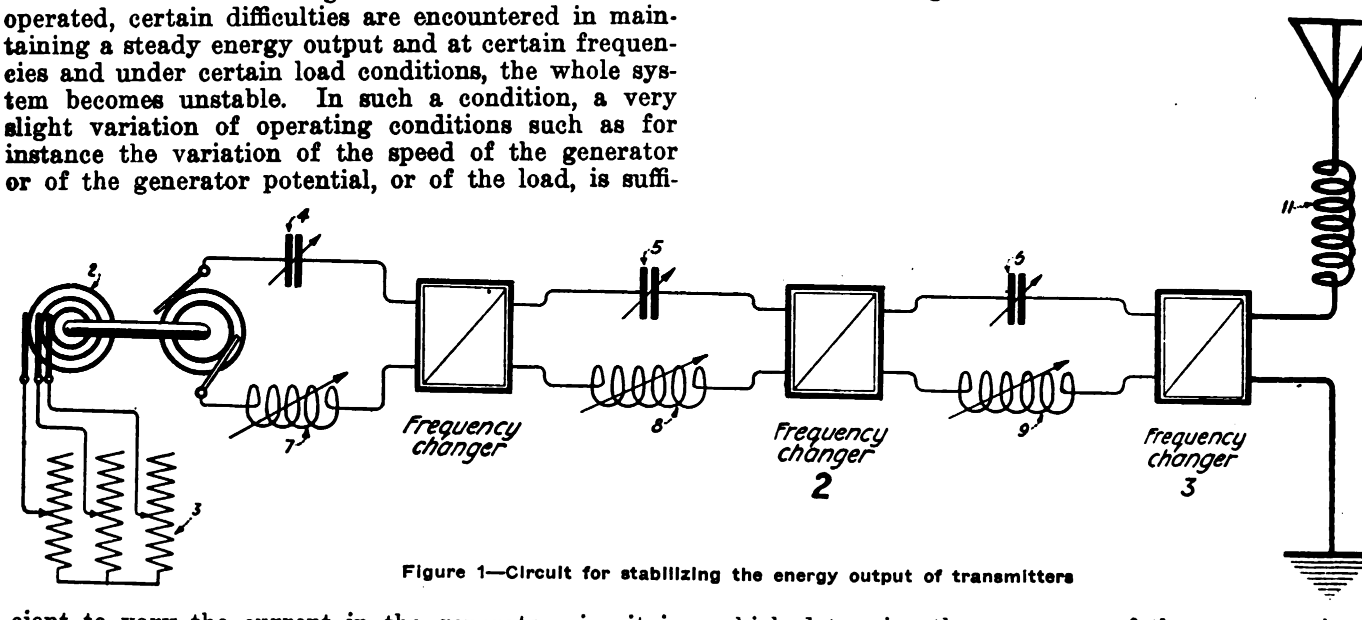


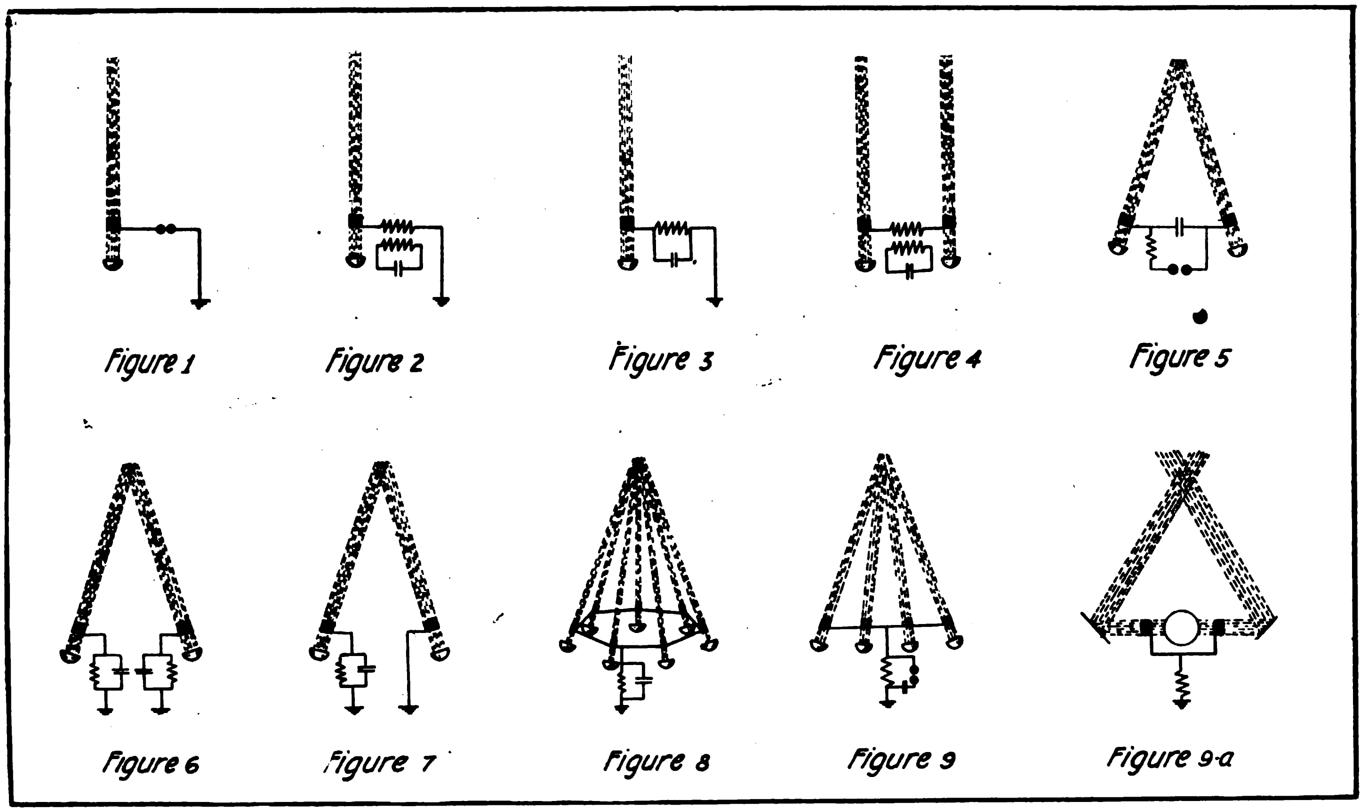
Figure 1—Circuit for stabilizing the energy output of transmitters

In connection with this expedient, a regulator is also provided which regulates the speed of the prime mover so that if the prime mover exceeds a certain speed the output of the engine or motor is decreased.

A High Antenna Without High Masts

RADIO men are more or less familiar with the effects which strong ionization in the upper atmosphere levels has upon the electrical waves used in wireless telegraphy. In studying the spectrum, we find that there is a decided absence of the shorter wavelengths. It has been shown by at least two scientists that the light which reaches the surface of the earth from the sun contains no wavelength shorter than about 2950 Angstrom units. It would be unreasonable to assume, in view of what we know, that no shorter wavelengths leave the sun and stars, and since it has been proven that an upper ionized layer of atmosphere exists, we have come to the belief that the light of the shorter wavelengths is absorbed prior to the time that it reaches the earth. The atmosphere immediately surrounding the earth then is not ionized, or, only very slightly so due perhaps to the radio-active rounding atmosphere in the immediate neighborhood of the beam is also rendered conductive to a less extent.

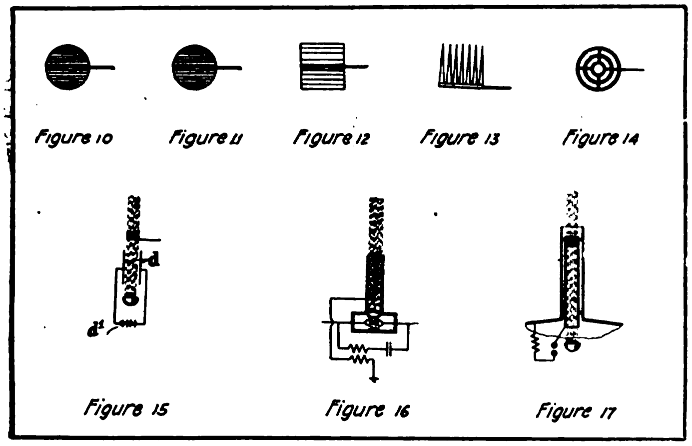
The conductivity decreasing continuously and quickly along circles concentric with the beam and also gradually decreasing from its electrical connection in the direction of the beam facing away from its source. Further, owing to the fact that the air is free to move about, ionized particles of air will be shifted from the position they occupy in the track of the beam so that the actual form of the conductive zone will be altered to a certain extent at various points. The effect of these various conditions is that although ionization is actually maintained along the beam, the beam conductor is not supposed to have the actual form of the beam but a form depending upon circumstances above referred to, the line of comparatively strongest conductivity being in the center of the beam



Various arrangements of aerials

matter in the sea or earth or to photo-electric action on dust particles.

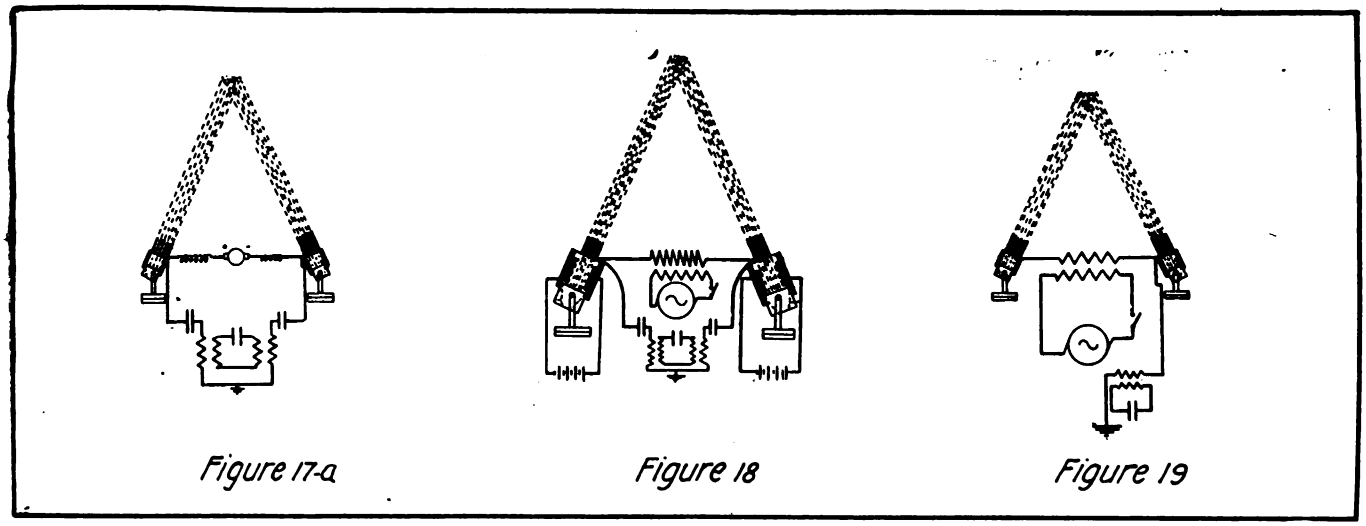
Ionization of gases is proven by the acquisition of electric conductivity on the part of the gas. An un-ionized gas is a perfect non-conductor. Advantage has been taken of this characteristic by John Hettinger of London, who has taken out a patent wherein he proposes to substitute conducting ionized beams, such as a search-light beam of ultra-violet rays produced by means of a suitable electric arc or mercury vapor lamp, for the wires of an antenna for transmission or reception of radio telegraphic and radio telephonic signals. According to the invention, a portion of the atmosphere is continuously ionized along a beam so as to render it more conductive than the remaining portion and a good electrical connection is established between the beam and the metallic portion of the electric circuit in which the beam is substituted for the long conductor. In view of the fact that the air along the beam is not enclosed but is in actual contact with the remaining part of the atmosphere there is a certain amount of diffusion, with the result that the surrounding with small deviations therefrom, as in the case of movements of air. When used for signaling purposes this beam conductor may be compared to an elevated conductor of large surface in electrical connection with a metallic circuit, the other end of which is connected to earth. The potential imparted to the metallic portion of the circuit tries to equalize itself along the beam conductor and the entire system thus absorbs large amounts of energy as compared with the energy that could be imparted to the system without the ionized beam. In the latter case, all the lines of electrical force would be bent toward the earth immediately after leaving the other end of the metallic circuit. Where the beam is used, however, a current will flow along the lines of least resistance, viz: Upward within the beam and immediately around it and more particularly along its center and there will be lines of force which will start bending downward toward the earth at a much higher point than would be the case were the beam not used. While the amount of current actually flowing through the beam may be small and decreasing continuously toward the upper end of the beam it is to be remembered that this is not material in the case of an aerial, it being known that the current flowing through the aerial and more particularly through the upper part thereof may be small as long as the potential is high in the upper part and the current large at the point where it is connected to the earth. The electrical connection of the ionized beam with a point of high potential and the absorption of great energy by such a beam insures the fulfillment of these conditions. The accompanying drawings illustrate diagrammatically various arrangements and details for carrying the invention into effect. Figures 1, 2, 3, 4, 5, 6, 7, 8, 9 and 9A illustrate various arrangements of aerials. Connections to the beam are made with devices as shown diagrammatically in figures 10, 11, 12, 13 and 14.



Various methods of producing beams and the types of connections

It is known that when certain metals are charged, more particularly with negative electricity, they have the property of becoming discharged under the action of light and it has been determined that this discharge is due to ultra-violet and other rays and would be dependent upon the state of the surface of the metal. This property of certain metals is usually referred to as photo-electric effect. Since a small length of the beam lies between the electrical connection and the source of the beam use may be made of the photo-electric property—possessed by certain metals and not by other metals—to prevent a discharge of electricity from the electrical connection toward the source of the beam, or to reduce it as much as possible and at the same time assist the discharge from the electrical connection in a direction away from the source of the beam. With this object in view the photo-electric effect, above referred to, has to be assisted in every respect on the surface of the connection facing away from the source of the beam, while the effect has to be prevented from taking place—or reduced as much as possible—on the surface facing the source of the beam. For instance, the surface of the gauzes or perforated plates facing away from the source may be highly polished while the opposite surface may be covered with a material which is not transparent with respect to ultra-violet rays. The same object may be obtained by using for this connector metal which is not very sensitive with regard to the photo-electric phenomenon, such as copper. This copper is provided, on the surface facing away from the source, with a covering of metal which is very sensitive with respect to the photo-electric phenomenon, such as rubidium or an alloy of potasium or sodium. The discharge of electricity from the metallic connection toward the source of the beam may also be prevented or greatly diminished by removing or greatly reducing the conductivity of the beam between its source and the metallic connection, causing a direct or alternating current to flow across the beam in that part lying between the source and the metallic connection. This flow of current may be produced by means of an electric field as shown in figure 15 and in figure 25. The two plates d of a condenser being connected to the two poles or source of d of constant potential may be replaced by an alternating current supply of low or high frequency which may belong to the transmitting system.

For the production of the beam use may be made of an ordinary searchlight in which an arc lamp or mercury vapor lamp is employed, care being taken to prevent the absorption of the ultra-violet rays by substituting quartz for all transparent parts usually employed in searchlights.



Method of superposing high-frequency currents upon a low alternating electric field or upon a continuous electric field of high potential

The spark or arc producing the oscillations may also be employed for producing the beam. In figure 16, illustrating such an arrangement, a spark gap is enclosed in a cylinder of insulating material having an extension which is open at its outer end to allow the passage of the beam to the exterior of the electrical connection which is effected by a series of pointed metal pieces carried on a support electrically connected with the secondary of an oscillatory transformer which is earthed. Quartz may also be arranged in the back of the beam.

The high frequency currents or impulses supplied to the transmitting beam aerial or collected by the receiving beam aerial may be super-posed upon an alternating electric field of low frequency or upon a continuous electric field of high potential. This is illustrated in figure 17 in connection with a continuous electric field, and in figure 18 and figure 19 in connection with an alternating electric field. Referring to figures 17 and 18, the continuous or alternating field of low frequency is set up by connecting the two poles of a high voltage continuous current machine through inductive resistances, or the two terminals of the secondary of an ordinary transformer (not a high frequency oscillation transformer) to two electrical beam connections, one of which is directly connected to the oscillatory system while the other connection is not directly connected to the oscillatory system, and is placed in an less signals over long distance by means of low horizontal aerials, but such attempts have not led to any practical results. Transmission over long distances may now be accomplished by combining low horizontal aerials with the ionized beam aerial, and leading the free end of the horizontal metallic aerial into the ionized beam by means of a beam connection, the source of the beam receiving its energy from a source of current G or by arranging the metallic aerial in a plane of ultra-violet rays directed upward. See figure 22. The latter arrangement is preferably carried out as shown in figures 23 and 24, by using as the

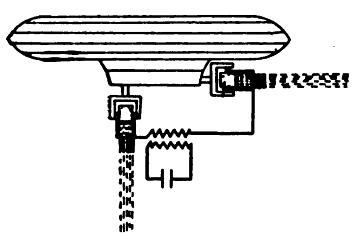


Figure 20

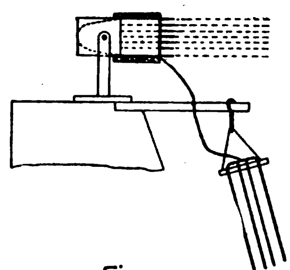


Figure 21

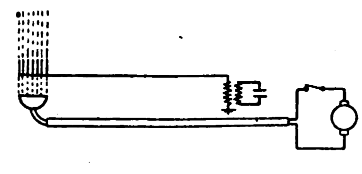


Figure 22

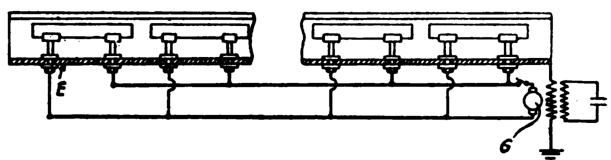


Figure 23

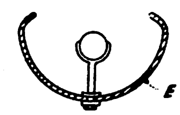


Figure 24

Arrangements to realize the advantages secured through the use of beam aerials

ionized beam arranged to intersect the beam in which the beam connection, first referred to, is placed.

In the application of the invention to wireless signaling to and from aircraft use is preferably made on the aircraft of one ionized beam aerial directed downward so that it may strike the earth, a telegraph wire, a railroad track, or other conductors and of another ionized beam aerial which is substantially parallel to the earth, thereby forming a directive aerial. See figure 20.

The aerial may be used in connection with any wireless aerial of known construction, for example, it may be movably connected with the top end of the usual elevated aerial thereby forming a directive aerial of the horizontal type. Figure 21 illustrates such an arrangement in which the source of the beam together with the electrical beam connection, is mounted on and insulated from the casing of the arc and is electrically connected with the top of the aerial. It is mounted on a high support in the usual manner so that it may be turned in a horizontal plane as well as in a vertical plane.

Attempts have been made heretofore to transmit wire- metallic horizontal aerial, a long strip E of zinc or other metal which is sensitive with regard to the photo-electric phenomenon and is bent to form a trough, the ionized aerial being produced by several mercury vapor lamps of tubular shape supported in the concave part of the metallic trough and being directed upward in a plane containing the metallic aerial, the mercury vapor lamps receiving the current from the source of energy G.

This invention is also well adapted for use on submarines and figure 25 illustrates a transmitting arrangement used in connection therewith. The electrical connection is attached to the upper part of a metal tube which is arranged within a periscope and forms with the latter a condenser included in an oscillatory circuit. The system is earthed through the body of the submarine. The periscope mirror (not shown), which may be used to reflect the beam in any desired direction, must be made of metal or the glass used in ordinary mirrors must be replaced by quartz. The receiving apparatus may be connected up to the beam aerial in a similar manner.

The Effect of Direct Connection of Plate Circuit With the Antenna

THE novel feature of the wireless signaling system devised by W. C. White lies in the means which he takes in getting around certain difficulties encountered in the usual arrangements, by including the plate circuit inductance directly in the antenna circuit and thus impress the alternate component of the plate current upon the antenna, thereby avoiding the necessity of an inductive coupling between the plate circuit and antenna and the use of a separate coil. In his practical application however, it is found that the source of potential used for heating the filament together with the auxiliary apparatus used to control the heating current, instead of being at a fixed low potential with respect to the earth as in the ordinary arrangement, is at a potential which alternately varies at the frequency generated between positive and negative values with respect to the earth and that this potential may rise to such a high value that it becomes inconvenient to insulate from the earth the source which furnishes the heating current. In order to get around the difficulty, the plate circuit inductance has been divided into two parts and the parts arranged in such a way that two parallel paths for the high frequency plate current are provided. One of these inductances is included directly in the antenna circuit and the second

A further object of his device is to provide a simple and effective means for automatically breaking up the oscillations which may be generated by the arrangement so that audio frequency telegraphic signals may be formed. With reference to the diagram, this is accomplished in figure 1 by arranging a buzzer so that inductance 6 is short circuited at regular intervals,

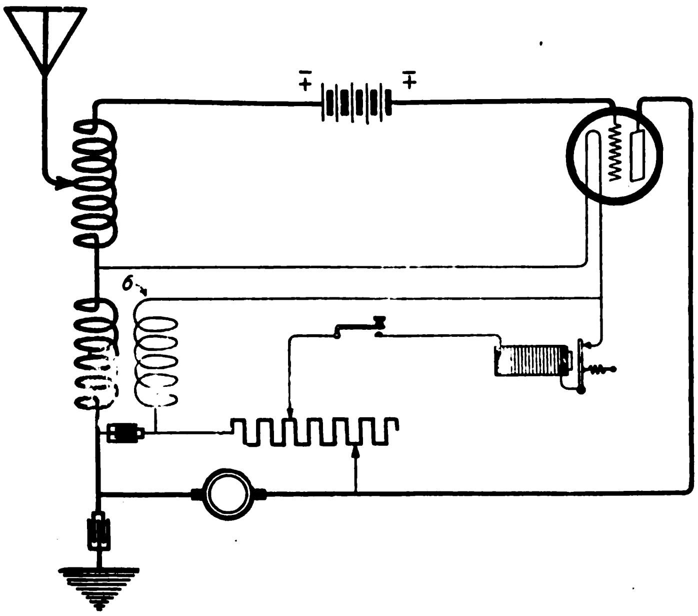


Figure 1—Diagram showing plate circuit hooked up to the antenna

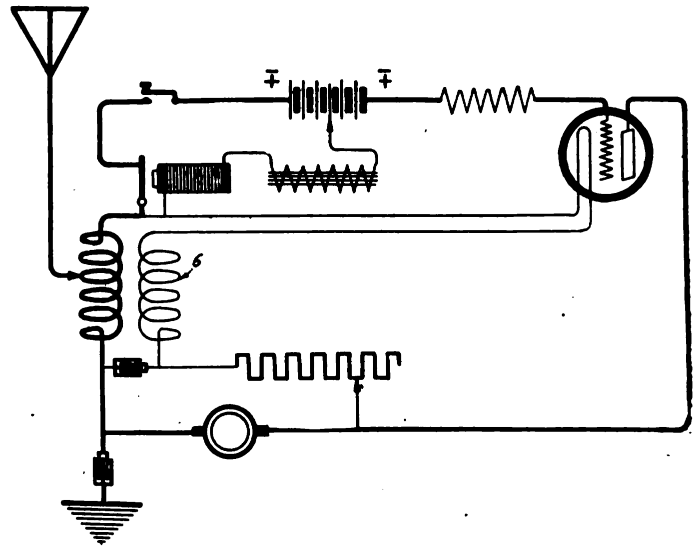


Figure 2—A modification showing the grid circuit arranged to normally prevent operation

inductance is so closely coupled to the first that for all practical purposes, it may be considered as being directly in the antenna circuit. The source of current for heating the filament is connected to the ends of those inductances, which are always at a low potential with respect to the earth, in such a way that the heating current always flows through the two inductances in series. As a result the source which furnishes the heating current, as well as the regulating apparatus, will always be at a low potential with respect to the earth.

thereby interrupting the production of the oscillations. The arrangement shown in figure 2 differs from that shown in figure 1 merely in the arrangement of the auxiliary circuit for controlling the oscillations. In figure 2 the grid circuit is so arranged that the device is normally inoperative for producing oscillations. When the key is depressed the grid circuit is closed through the key and the contact of the buzzer and oscillations are produced. At the same time the buzzer coil is energized and the buzzer contact broken, oscillations thereby being interrupted.

Kolster's Direction Finder

A CIRCUIT diagram of Frederick A. Kolster's direction finder is shown in figure 1. It is comprised of two sets of rectangular coils of several turns, whose planes are at an angle with respect to each other, usually 90 degrees. A pointer or needle rotates with each set of coils over a graduated scale. The two rectangular coils of each set are connected in series with each other and with an adjusting tuning condenser C and C1. Any suitable detector or wave responsive device and a pair of telephone receivers is employed in a circuit in shunt to the condenser C, C1. The Audion detector might best be chosen with several stages of amplification. This arrangement may be used for direction finding, and to a certain extent for interference prevention, where the two pairs of coils are disposed at a distance from each other. The terminals of the condensers C and C1 are connected respectively to the two sets of terminals of a double-pole double-throw switch. Connected to the blades of the switch is the detector and its associated apparatus. With the switch thrown to the left, the circuit including the two left-hand rectangular coils and the condenser C is tuned to the energy transmitted from the station D by a variation of the condenser C. The left hand pair of coils is then shifted to such a position that there is no response in the tele-

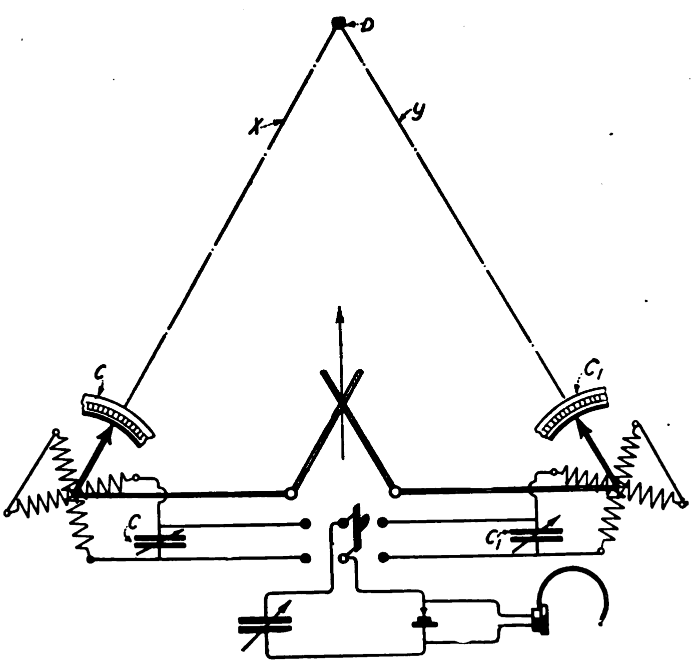


Figure 1—Circuit of Kolster's direction finder

phone in which case the needle will point at the station D. Then throwing the switch over to the right and connecting it to the right hand pair of rectangular coils the circuit, which includes the condenser C1 and the two right hand coils, is similarly tuned and the direction of station D found as before by means of the indicator on the scale.

We then have a triangle whose sides are x, y, and z, the last being the line between the pivotal axes of the two pairs of coils. The length of side z is known and the two angles between z an x and between z and y have been determined by the positions of the pointers and therefore the direction of the station D is not only accurately known but its distance may be readily computed. It will be noted that there is neither an antenna or earth connection to these devices and it is also obvious of course that the ideal arrangement for operation would consist in devising some means of remote control in order that the operator seated at the detector might revolve the rectangular coils at will.

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

Experiments With Fluorescent Substances

By Thos. W. Benson

THE property of fluorescence possessed by certain chemical and mineral compounds always excites wonder and interest even in the mind of the layman or one not given to the study of the sciences. For here we have Dame Nature in one of her more beautiful moods, taking the invisible rays of light and by some mysterious process converting them into every conceivable color. With a few pieces of apparatus anyone can conduct a series of experiments and be more than pleased with the results.

The term Fluorescence was given to the phenomena on account of it being first noticed in a certain variety of fluor spar. The difference between fluorescence and phosphorescence should be clearly understood. The former is that glow emanating from a substance while under the influence of the invisible and highly refrangible rays, the latter, the property certain substances have of storing light energy and later giving it off in the dark, such as calcium and zinc sulphides. Some compounds possess both properties in varying degrees.

Though the phenomena may be viewed with sunlight as the exciting medium it will enhance the beauty of the work if use is made of ultraviolet rays. Immediately there comes to mind an arc lamp or a spark gap as the source of such rays. In consideration of those not having access to power for an arc, let us select the spark gap as the more common and obtainable ultraviolet ray generator.

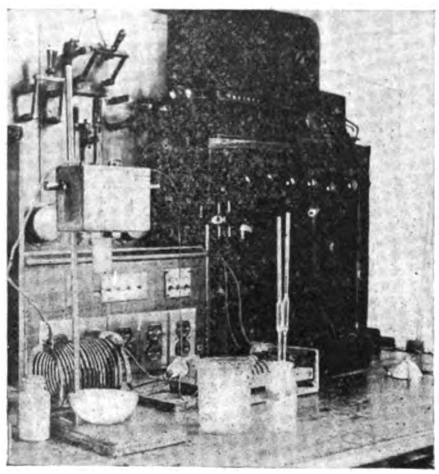
The mechanical details of such devices deserve little consideration.

A box, containing a regular or homemade radio spark gap, with a hole cut in one side is possibly the simplest form. Let those who care to tackle the problem in a more complete manner consider the ultraviolet ray generator pictured in fig. 1. Here we have a device suitable for the study of the various effects of ultra-violet light in addition to its uses as an exciter for fluorescence.

A small wooden box is fitted with binding posts to support two iron electrodes. The electrodes are rounded at the sparking end and extend through the sides of the box to be fitted with insulating handles for the purpose of adjustment. Terminals are arranged on the top of the box to allow of ready connection to the other apparatus.

A one inch hole is cut in the bottom of the box which has fastened below it a tin tube to confine the rays in a downward direction. The tube is soldered to a sheet of tin bent in such a form as to allow the insertion of glass or other substances in the path of the rays.

The generator is supported on a ring stand by means of a universal burrette



Apparatus used in performing the experiments with fluorescent substances

clamp with the outer clips removed and a screw passed through the rear of the box into the body of the clamp. This construction gives a handy form of generator suitable for many experimental uses.

A spark coil, ranging from ½" up will operate the gap nicely, the limit of power with the construction described is about ¼ kw., beyond this the heat and noise is objectionable. The regular radio condenser is used, or in fact any condenser giving a good heavy spark will be suitable. Likewise the helix or tuning inductance of the radio set is utilized. A few turns of heavy stranded wire on a cardboard tube will suffice if a helix is not handy.

Wire the outfit as shown in the diagram, close the primary circuit and adjust the gap to the greatest length giving a steady spark. When adjusted the platform will be flooded with ultra violet light mixed with the visible blue and violet rays.

A few beakers and saucers are all that is required in the line of apparatus. The chemicals needed will be mentioned in their proper place.

Take a breaker, fill it nearly full with clear water and stand it on the platform. Float a strip of horse chestnut bark on the surface and start the gap, extinguishing all the lights in the room.

In a few minutes a stream of bluish gray fluid, asculin, will be visible clinging to the bark like barnacles to a boat. In ordinary light this is not noticeable but the rays of ultra violet light are so altered by this substance that they become visible.

If some of the bark is boiled in water and filtered the solution appears colorless but a tube of it held in the ultra violet light shows a blue glow.

Soak a strip of paper in this solution and allow sunlight to pass through a prism and fall on the strip. It will be found that the length of the spectrum obtained in this manner will be much longer than that obtained without the treated paper, the treated paper making visible the more refrangible ultra violet light beyond the visible violet.

A very beautiful experiment may be performed with the red ink in common use. It will be noticed that when a large blot of this ink dries it has a greenish tinge in spots. We can demonstrate this phenomena in a rather startling way in the following manner.

Take a deep glass vessel with parallel sides, a tall beaker or cylindrical graduate will do, and fill it with water. Stand this on the generator platform and allow the water to become perfectly quiet and settled. Gently deliver a drop of aniline ink to the surface of the water with a pipette while the generator is operating. The drop will begin to contract but at the centre will descend in the form of a tube, the denser coloring matter forming the outer rim. But instantly the tube spreads into a parachute of waving red and green the edge of which breaks up into tubes to go through the same phases of the parent stem. The figure retains its shape for several minutes and is very beautiful with its slowly moving waves of green. By transmitted light it appears pink but viewed at an angle by reflected light it appears a brilliant green. Viewed from above the figure is very peculiar; the edges glowing with a fine golden tinge. By placing a drop of heavier colorless liquid (sulphuric acid will do), on the surface the figure is put into motion and looks like a sea weed disturbed by water current.

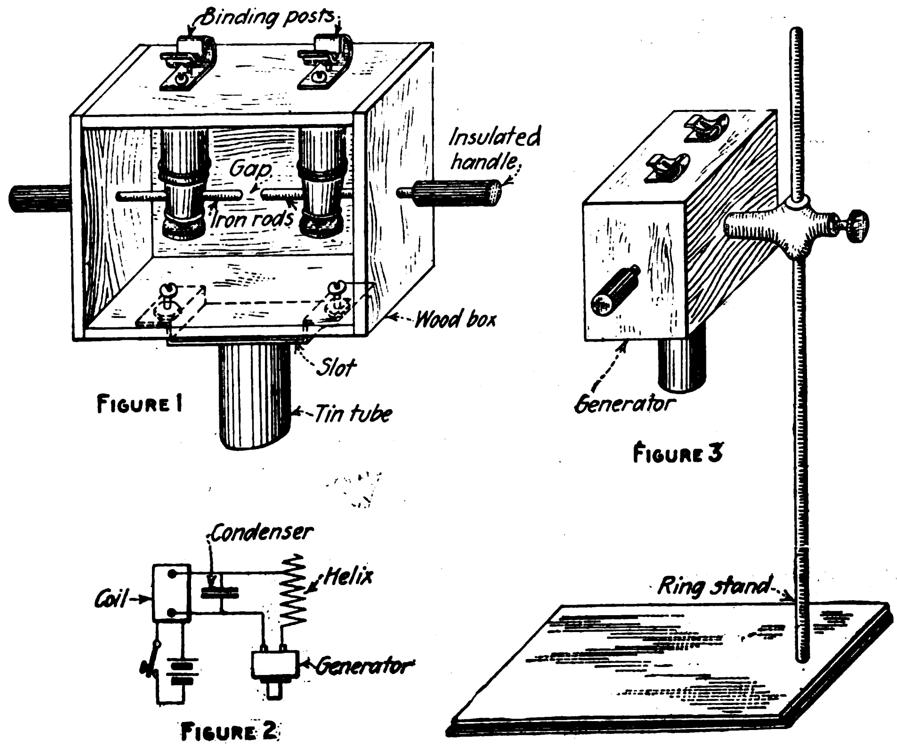
Put a small quantity of crude resin oil on a watch glass and place on the generator base. This oil is nearly opaque but when the spark gap is operating it shows a delicate sky blue fluorescence. The same phenomena is noted when paraffin oil is used. This is quite colorless by transmitted light but glows with a bluish tinge at the edges.

Obtain some nettle leaves and place them in alcohol, bruise them in the solution with a glass rod and allow to soak for an hour. Filter the mixture and pour into a watch glass or beaker. The liquid will appear a bright green. Now take a piece of cardboard with a hole ½" diameter and hold over the solution and start the generator. The path of the rays will be of a blood red hue. Tinctures of other vegetable substances have a similar effect on light. That of stramonium gives a pale green fluorescence, guaiacum, a beautiful violet color, turmeric a greenish tint.

The coal tar colors are very remarkable in their effect on light. If a beaker of water is placed on the generator stand and a few grains of fluorescence gently placed on the surface they will begin to sink slowly to the bottom leaving behind them yellow trains with a brilliant green fluorescence. The experiment succeeds with most artificial dyes that water dissolves slowly, markedly so with eosine and erythrosine. The non-fluorescent dyes such as malachite green, coceine and French red leave behind a train of one color. A very beautiful effect is obtained by mixing together several grains of each substance and placing them simultaneously on the surface of water in the beaker. A truly startling bouquet of colors result, interweaving and mingling to give a wonderful color effect. By arranging a strong light behind the glass vessel and allowing the transmitted light to fall on a wall or white cloth a remarkable color spectacle results.

A weak solution of sulphate of qui-

(Continued on page 29)



Detailed construction of the ultra-violet ray generator

Wireless in the A. E. F.

The strike of the printers in New York forced the withdrawal of the instalment of this remarkable series planned for this issue. The series will be continued in the next number and will appear regularly hereafter under the authorship of

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

A Well Made Grounding Switch

By C. H. Biron

READERS who have used slate base switches as a safety measure for grounding the aerial have invariably traced a fair amount of lost energy to leakage through the slate which often bears such mineral qualities as to make its use prohibitive for high frequency work.

For those who have yet to install such a switch the accompanying design may hold some suggestion. Here a single pole slate base switch

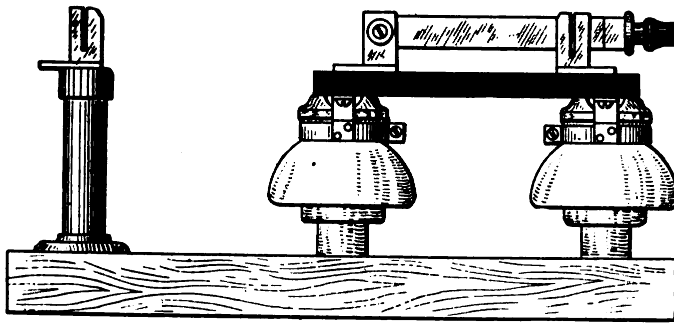


Figure 1—Side view of the grounding switch

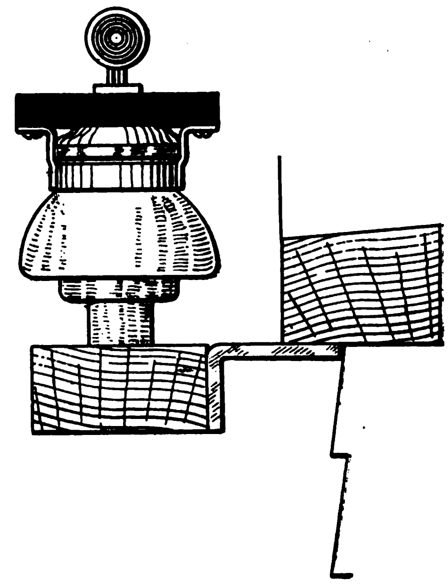


Figure 2—End view, showing method of mounting

is used but under conditions that make its mineral content immaterial. Prototypes of this switch as used in up-to-date power work make use of corrugated porcelain supports known as bus-insulators. However, the petticoat type of standard porcelain pin insulator is more suitable for outdoor service and can be obtained at central stations for a reasonable price.

A size that is commonly used for city service primary lines is four inches high overall and four and a half inches at the widest diameter. The tie wire groove in this size will permit the use of five-eighths by one-eighth strap iron as a clamping strip. To this strip is riveted the bracket pieces that in turn are bolted to the switch base. This construction is clearly shown in the side and end views, figures 1 and 2.

Wood pins form the supports for the insulators. They may be of somewhat smaller diameter than the sockets of the bushings and compounded in with melted rosin or sulphur. They are then forced into holes in the wood base which for symmetrical appearance should have a cross-section of approximately two by four inches. Wedges from the bottom will secure them from any future loosening.

The ground standard need not be insulated and may take any form that suits the builder, but the one shown is in keeping with the design and consists of a suitable length of standard one-inch pipe fitted with a standard floor flange and pipe cap.

This cap should be drilled and the switch jaws mounted before assembling to the pipe.

The end view in figure 2 shows a convenient bracket arrangement for mounting the switch to the window ledge where it is easily reached from the station window.

The lightning switch is one of the exterior fixtures about a radio station, which should have a neat appearance.

EXPERIMENTS WITH FLUORESCENT SUBSTANCES

(Continued from page 27)

nine to which has been added a small quantity of dilute sulphuric acid when placed under the generator has a delicate blue tinge.

The so called "Canary Glass" which is yellow by transmitted light gives off a beautiful green glow when placed on the ultra violet ray generator platform. This is due to uranium salts present which are highly fluorescent.

There are also a number of minerals that have some subtle power over light. Willmite the natural silicate of zinc gives a brilliant green glow when placed on the generator base, and silicate of soda gives a blue glow.

There naturally arises need for an explanation of this phenomena. We can only explain the fluorescence by inductive reasoning. Inasmuch as the rays causing fluorescence are located beyond the violet end of the spectrum the substance absorbs these rays setting the molecules into vibration, these in turn set the ether around them into motion resulting in the emission of visible light. This theory is supported by the fact that should the indicent rays be polarized the resulting fluorescence is not polarized showing the light is re-generated, so to speak, in the sensitive substance.

An Inexpensive Lead-in Bushing

By C. H. Biron

EXCEPTING those procelain tubes used for house wiring, there are few stock articles that improvise well in place of electrose bushings for admitting the aerial lead to the operating room. Even porcelain tubes fall short of the desired ends due to the fact that unglazed porcelain is unsatisfactory for outdoor service.

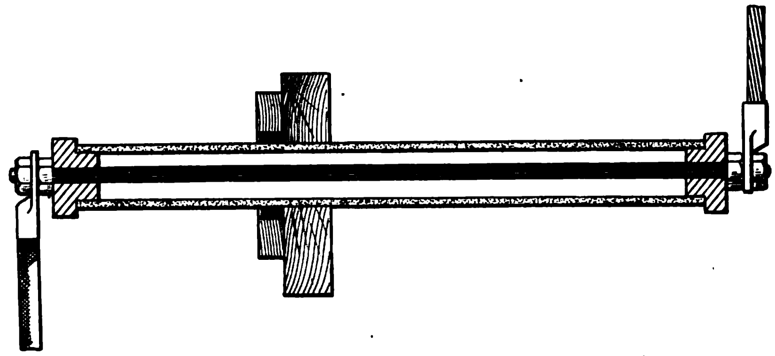


Figure 1—Horizontal section view of the lead-in bushing

A good substitute is found in glass water-gauge tubes which are available at a reasonable price in any steam-fitting shop. These tubes are made with heavy walls to resist mechanical strain and when selected for clearness (freedom from coloring) their insulation value is sufficient for all practical purposes.

There use resolves itself into a question of mounting them and closing the ends to moisture and dirt. In the illustration shown, both ends of the tube are closed by turned maple bushings through which a quarter inch round brass rod passes, fitted with nuts that hold the assembly together and provide fastening for the cable terminals of aerial and instrument leads.

The tube itself is mounted in a sash board similar to those used for ventilating. The reader whose set is located where it is undesirable to drill through the wall or window pane will find this means of overcoming the difficulty entirely satisfactory. This arrangement provides quick and easy access to the lightning switch where it is located on the window ledge outside.

If the tube is a snug fit in the board a little shellac will secure it from loosening or creeping. The writer used an extra piece of board with a somewhat larger hole and filled the space with storage battery "dope."

This piece is shown in section in the drawing. The maple ends should be given a coat of black shellac and a finishing coat of spar varnish before assembling.

The sash board may be painted to match the sash or in harmony with the trimmings of the house.

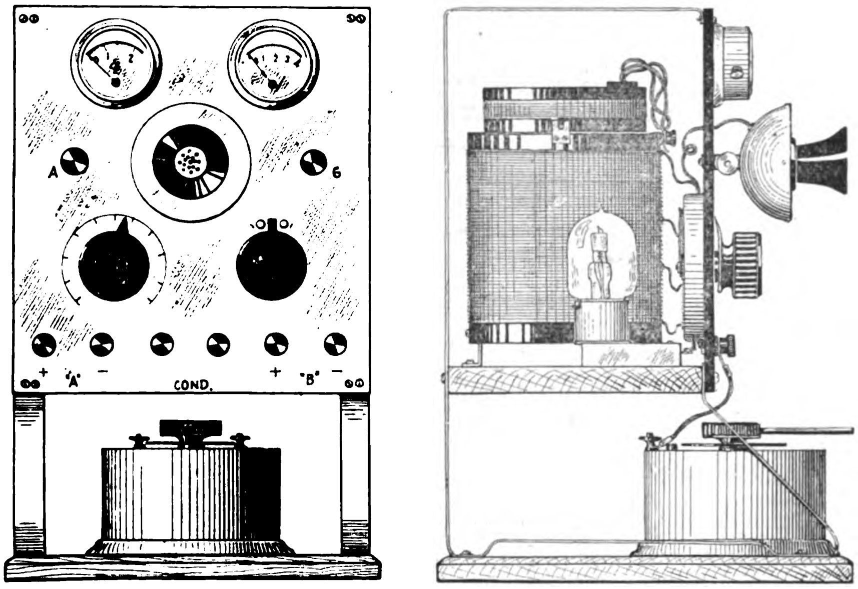
A Laboratory Radiophone

By J. Pignone

As far as the average amateur is concerned radio telephony is in its infancy as yet. The chief causes of this are, the amateur has not had an opportunity to experiment, and the pre-war vacuum tube was not of proper design to withstand a high voltage. However, the modern high vacuum tube presents very favorable prospects for the development of the amateur phone.

New circuits and schemes are constantly coming forth. This places the layman in a confused state, for no sooner would he have a specific set completed than a new circuit would come to his attention.

It is for this reason that I have designed the panel shown. There is nothing fundamentally new and it is comprised of the following: a direct current ammeter and also a high frequency meter, a transmitter, condenser (variable oil), grid condenser and leak, inductance, bulb, and controls.



Figures 1 and 2—Front and side views of the laboratory radiophone

The wiring to the different elements is not soldered directly to the respective binding post, but to a copper terminal, which in turn is connected to the element. This accounts for the adaptability of all circuits. The inductance in this set is interchangeable. The primary is wound on a bakelite tube 6 inches by 6 inches with 20-23 Litz. It is tapped three times. As can be seen in the diagrams (figures 1 and 2) the support bearings for the secondary are slotted. The result is that any sized secondary can replace the one described. It is 4½ inches in diameter by 2 inches, wound with 20-38 on a bakelite tube. Leads from the coil are brought out by flexible wires to binding posts mounted on the primary tube itself. There are three binding posts, the center one being for a tap brought out from the middle of the secondary.

The tube to employ for this set depends upon circumstances—the source of current available, and the pocket book. However, a Marconi V. T. class 2 would readily adapt itself to this work.

If the transmitter employed "sticks," the following can be resorted to. Obtain an empty receiver shell and mount two or three "Skinderviken Buttons" insulated from the diaphragm with mica washers and the buttons connected in series. This will prove a fairly sensitive transmitter capable of withstanding heavy currents.

As accessibility and flexibility were the keynote to the design of this set, it was not found feasible to mount the panel in a cabinet. This and the fact that an oil condenser can only be used in a vertical position, made it necessary to mount the panel on heavy copper strip 1 inch wide. The size of the panel is 11 x 12 inches, the base attached immediately to it is 7 x 11 and the size of the base proper is 12 x 12½ inches.

This will prove a very valuable accessory to the "dabbler's" laboratory and there need be no fear for any circuit as the connections can readily be changed.

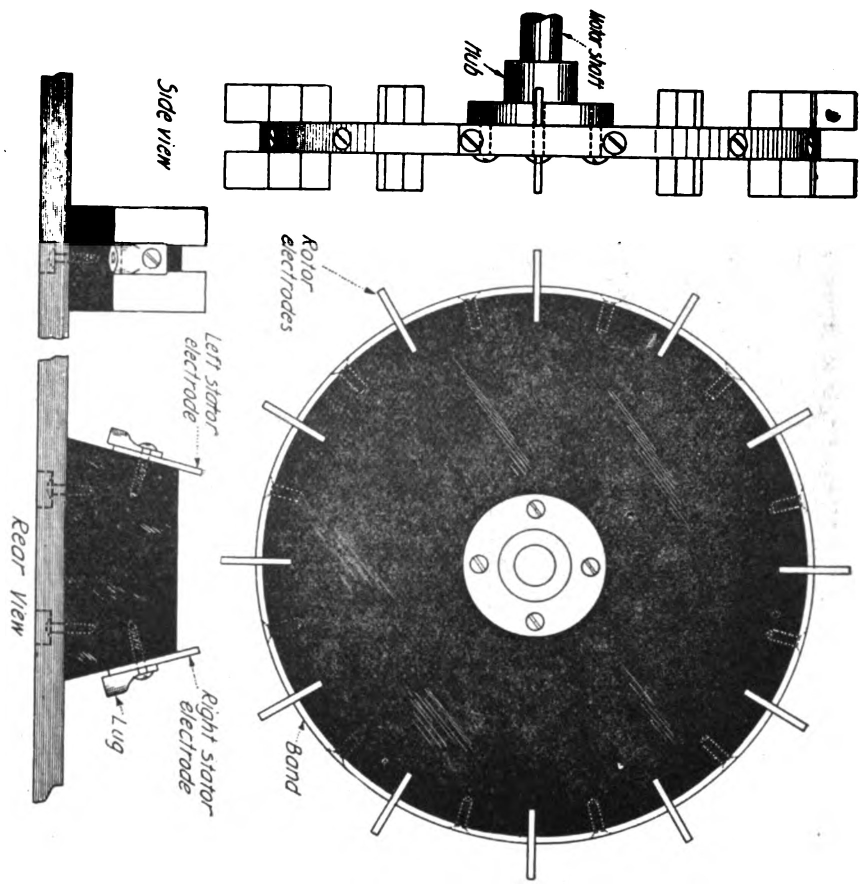
First Prize—Mechanically and Electrically Efficient Rotary Spark Gap

By L. D. Dillenback

THE accompanying drawings show the assembly and details of a very efficient rotary non-synchronous spark gap suitable for stations up to one kilowatt input. The chief advantage of this design arises from the fact that the energy passes into the gap on one tooth of the rotary and out again on a tooth next to the first mentioned. This short path is highly essential in connection with work at 200 meters.

No motor is shown, as the available motor for each particular amateur will vary. This motor should be capable of standing approximately a load of one-sixth horse power at 200 revolutions per minute. A suitable wooden block may have to be constructed to raise the center of the motor shaft 6 1/8 inches above the base.

The main disc is machined from a piece of sheet dilecto 8 inches square. After turning down in a lathe to 6 7/8 inches in diameter, twelve slots 1/16 inch wide and 3-8 inch deep are cut radially from the circumference, each 30 degrees apart. Between the slots are 10-32 tapped holes 5/8 inch deep. Holes are also drilled for the shaft hub as indicated in the drawing. In this connection it will be well to first fasten the finished brass hub to the unfinished disc in accordance with the drawing. The hub can then be placed on a mandrel and the disc turned true in a lathe.



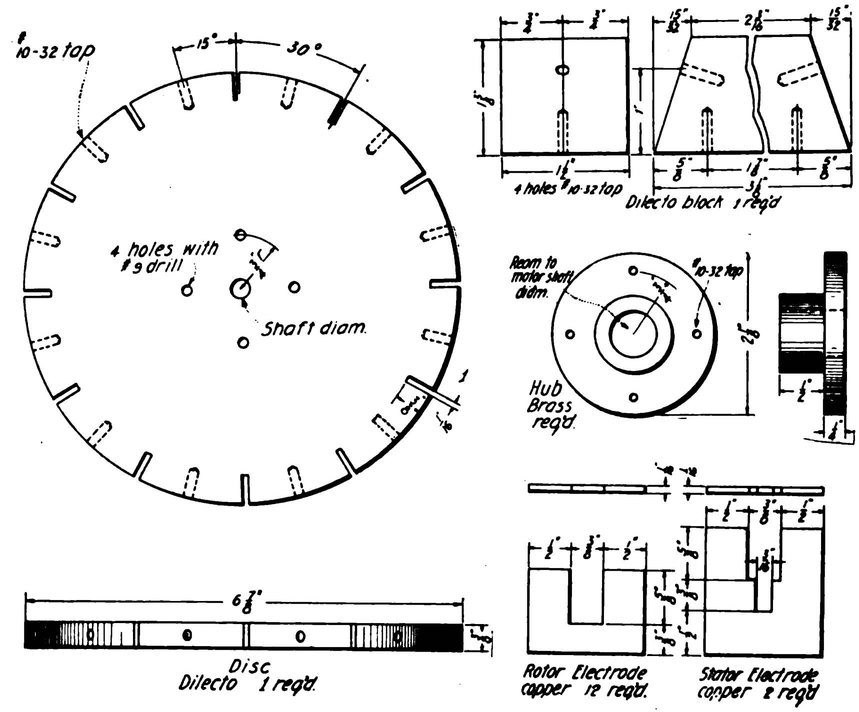
The assembled rotary non-synchronous spark gap

The hub is of brass and should be machined in accordance with the drawing. No dimension of the shaft diameter is given because this will vary with the individual motor. This hub should be made from a piece of brass stock 2 1/8 inches in diameter, a hole being drilled in the center the same size as the shaft diameter. A piece of steel of the diameter of the shaft is then pressed into the hole and the piece finished in a lathe. The disc can then be screwed to the hub and finished in the lathe.

The stator electrodes are filed from sheet copper 1/16 inch thick. Two are required.

The rotor electrodes are also filed from copper sheet in the manner indicated for the stator electrodes. It is recommended that a steel filing jig be made in accordance with the drawing and twelve pieces of copper sheet be clamped to the jig. The copper pieces can then be sawed, drilled and filed to a finish. This is only necessary when no milling machine is available.

A dilecto block drawing is given, showing the method of supporting the stationary electrodes. A copper lug is placed under the electrode clamping screw for connection. It bending in place. This is accomplished by heating the brass to a dull red and plunging it into cold water. The brass should then be stretched around the circumference and cut off to the proper length. Holes should be spotted and drilled, and counter-sunk for 10-32 flat head brass machine screws. After stretching the brass band around the disc and spotting the holes right through the brass into the dilecto disc, the



Detailed construction plans of spark gap

will be noted that the electrodes may be adjusted easily for proper relation to the rotor electrodes, which are non-adjustable.

In the assembly of the disc it will be obvious from the drawings that the rotor electrodes are held in the disc by a brass band 1/8 inch thick by 3/8 inch wide. This piece of brass should be annealed before band can be taken off and tapped holes made in the dilecto disc. The rotor electrodes can then be inserted and the band placed back in exactly the same place, this time screwing in the flat head machine screws. The disc should be mounted on the motor and tested for true running of the electrodes being corrected by filing where necessary.

Second Prize—The Ideal Amateur Rotary Gap

By Arno A. Kluge

In designing the ideal rotary gap for an amateur radio station there are certain conditions which ought to be satisfied, and the closer we can approach these conditions, the more nearly ideal will be our gap. Briefly these conditions are:

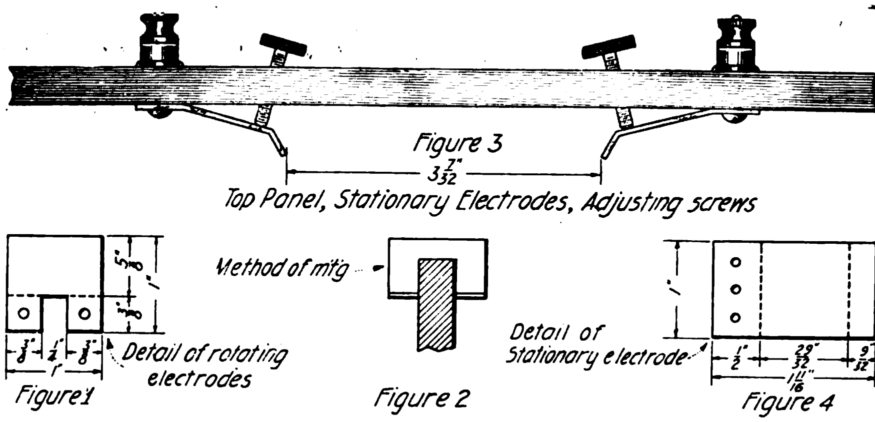
1. A quick break in the circuit, giving good quenching.
2. Ample sparking surfaces, so resistance is low.
3. Accurate adjustment of electrodes.
4. Moderate rate of speed.
5. Reasonable simplicity of construction.

The necessity for opening the primary circuit quickly after a spark has passed across the gap is the primary consideration. Authorities agree that four oscillations in the primary circuit are sufficient to transfer all the energy to the secondary or aerial circuit. The resistance of the gap should then become so high that no energy can be re-transferred from the secondary, which would produce complex oscillations and consequently a broad wave. (See "Practical Wireless Telegraphy," Appendix G, for a further discussion.) If we are to have only four oscillations in the primary circuit, for a 200-meter wave the gap should open in 4/1,500,000 seconds, or 0.00000266 seconds. Practically, of

course, this is impossible of attainment, but by the use of knife edge electrodes, mounted on a fair-sized disc, we can come much closer than with the half-inch plugs used on the old style amateur rotaries.

The rotating member of this gap is a disc of ¼-inch Bakelite, 12 inches in diameter. Twelve slots are cut into the periphery of this disc, at equal distances apart, and along a line running through the center of the disc. These slots are cut with a 1/64-inch hack saw blade, to a depth of ½ inch. Figure 1 shows a detail of the electrodes, which are made from 1/64-inch aluminum sheeting cut to the dimensions shown. The two lugs provided are bent along the dotted line at right angles, and the electrodes are then slipped into the slots as in figure 2, leaving ⅛-inch projecting from the disc. When all are in place, two brass strips 3/8-inch wide and 1/16-inch thick, and having holes drilled at the correct distances, are used to bolt all the lugs of the electrodes together with small machine screws. The nuts should be soldered on these screws to prevent any possibility of loosening. This construction will be clear from figure 5 which shows the rotary disc complete. The hub shown can be any suitable mounting which will fit the motor shaft and to which the disc can be screwed.

The stationary electrodes consist of two copper strips, 1 inch wide and 1/64-inch thick. Figure 3 shows the method of mounting these strips on the top panel of the enclosing box, including binding posts and adjusting screws. If desired, these adjusting screws may be provided with insulated handles, and also lock nuts —a refinement which gives more accurate adjustment. Figure 4 shows the electrodes in detail, which are bent as indicated by the dotted lines.



Details of construction and mounting of the rotary spark gap

The rotary disc is mounted on the shaft of a small series motor, or a 3600-r.p.m.-induction motor. In any case the motor should be about 1/12 h.p., as the very small motors—commonly used—heat up badly on a long run, and tend to vary in speed when excessively loaded.

The rotating disc should be mounted in an air-tight chamber, with the Bakelite panel, already mentioned, for the top. Alcohol vapor may then be introduced into the chamber to aid the quenching of the gap, using

a small oil cup with a cotton plug through which the vapor passes when the gap becomes heated. A safety valve, which may be a bicycle valve reversed, should also be provided to take care of any excess pressure in the chamber, as for example, when starting the spark. The corners of all the electrodes should be slightly rounded to prevent the spark dragging out. A red glass window placed near the top of the chamber will permit observing the spark while it is in operation.

Most spark gaps tend to maintain an arc of the power current after the oscillatory discharge has passed. This will hinder effective quenching, since the low frequency arc keeps the circuit closed. To overcome this the alternator, transformer, and condenser should be adjusted to resonance with the transformer frequency by the use of an external impedance. Then when the condenser is short-circuited by the passage of the spark, the condition of resonance is destroyed and the transformer current is materially reduced, thus preventing arcing. (See discussion of resonance by J. J. Holahan in August Wireless Age.)

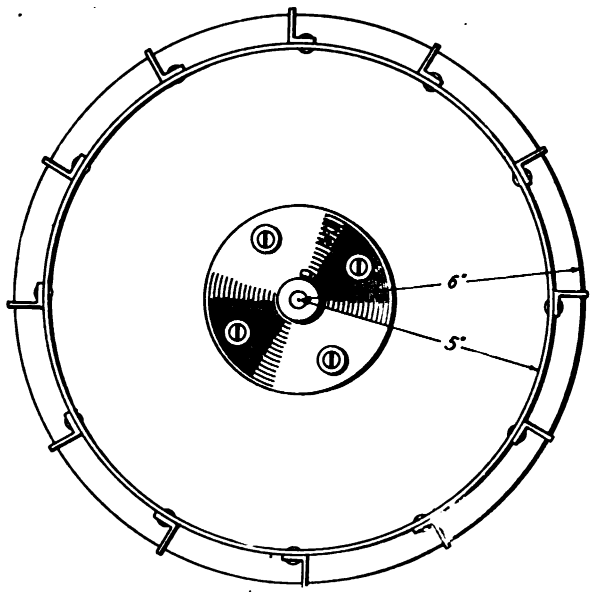


Figure 5—Rotary disc complete

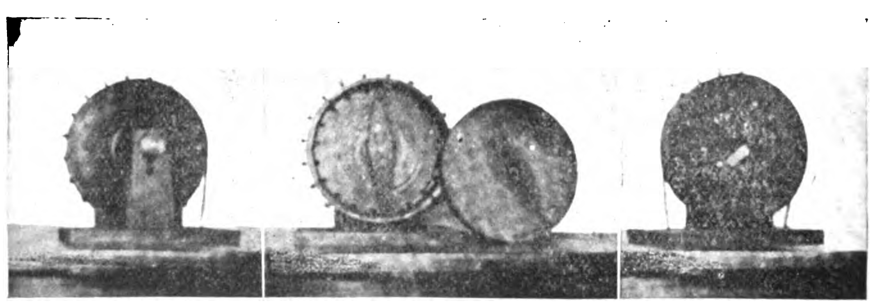
By following the constructional details and technical data given in this article the amateur should be able to produce a highly efficient, almost ideal, rotary spark discharger.

Third Prize—A Good Rotary Spark Gap for the Experimenter

By R. C. Hitchcock

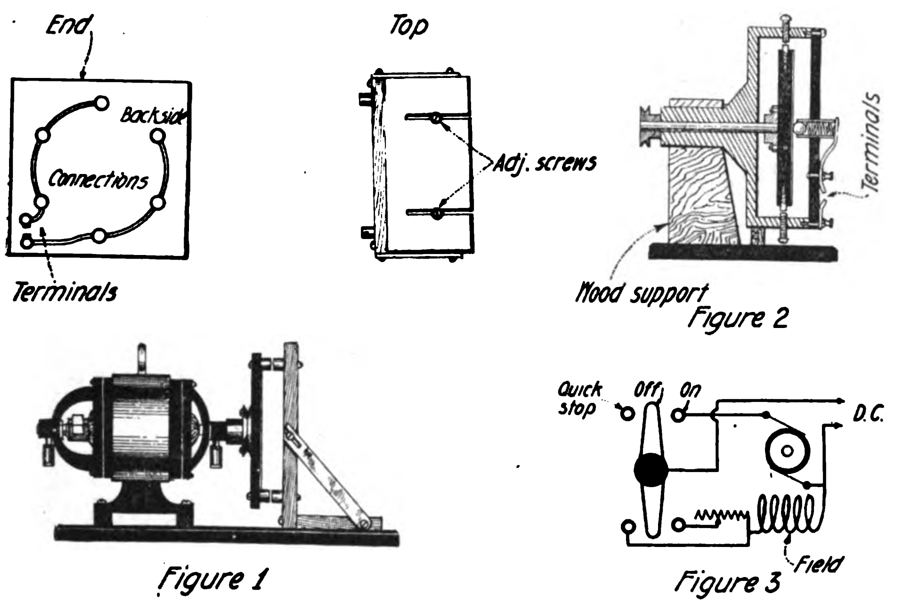
A NON-SYNCHRONOUS rotary spark gap with its musical pitch giving fine reading characteristics should have a place on the instrument table of every radio experimenter. With high frequency work, Tesla coils, and other applications the rotary spark discharger is widely used, for the electrodes, in revolving cool off the sparking surfaces and give greater efficiency than a straight gap.

The ideal gap should gain full speed in ten seconds and come to a stop in a similar length of time. When alternate receiving and transmitting is to be done, a quick starting and stopping gap is very desirable and the best arrangement incorporates a light rotating member.



Enclosed type of rotary gap showing front view with driving pulley and end view with cover removed and in place

The rotating arm carries two electrodes and the stationary electrodes can be of any convenient number, varying with the motor speed and the pitch desired. If an alternating current motor running at 1,800 R.P.M. is used, and 20 electrodes are placed in the stationary disc, a good musical note will be produced about 600 sparks per second. If a higher gap speed is desired with a constant speed induction motor, pulleys may be used to advantage. The speed of a direct current motor may be regulated by a field rheostat, or one directly in series with the current supply.



The open type spark gap in detail and circuit used

The open type gap shown in figure 1 is very easy and inexpensive to construct. The requirements are a battery motor, some electrodes—zinc or brass screws are preferable—and sufficient wood for the frame and base. The stationary plate has its electrodes divided into two equal parts, each set being connected with a wire—the revolving arm always connecting one electrode of each set, completes the circuit. The rotating arm is simply a piece of wood, beveled to cause less air resistance, one electrode on each end connected with a copper strip. The arm is fastened to the motor by bolting to a pulley, or a bushing. The distance between the electrodes is easily varied by moving the stationary plate by means of the adjustable wood screws—this is made clear in the diagram. A gap of this type with a stationary disc 6 inches in diameter and 12 electrodes, connected to a motor operated on a storage battery, has been successfully run at 6,000 R.P.M.

When a direct current motor is used to run a gap it may be stopped as quickly as desired by disconnecting the armature, and permitting the field current to flow. In practice, a series-rheostat is set at the point where the motor can be quickly stopped without appreciable jar. A convenient wiring diagram for this is shown in figure 3. To save battery current the lever should be turned to the "off" position when the motor has stopped.

Where the noise of an open gap is objectionable the enclosed type is of interest. The casing is of cast iron, with brass screws for electrodes which are easily adjusted for any spark length. The rotating member is of wood, on the ends of which are two brass screws which are filed flat after being inserted. The contact is made in the center of the rotating arm by means of a spring ball bearing, the casing being the other connection. The contact construction is plainly shown in the diagram. To guard against the high tension current which is grounded to the gap casing, jumping into the motor windings and causing damage, a belt connection to the motor must be used.

This rotary gap consists of two gaps in parallel, and they may be fixed for distances as small as 1/64 inch. A safety gap of about ⅛ inch placed across the terminals is a wise precaution.

The fixed electrodes will give a snappy break to the spark, if placed ¾ inch or more apart and will also give a clearer tone to the transmitted note. The addition of a rotary spark gap to a station will greatly improve the sending range, and the better musical pitch being more audible through static, will be appreciated at the receiving station. A gap of this type with 20 electrodes has been operated with success at speeds of 4,000 R.P.M.

Suggestion for Prize Contest--January Wireless Age

"The Design and Construction of a Tuned [illegible] Low Power Transmitter for Local Use"

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the above subject by December 31.

Note: It is not at all uncommon in these days of supersensitive receivers for a small spark coil to transmit 25 or 30 miles or even more. A good many amateurs must for various reasons be satisfied with a low power transmitter. The great majority of these use a spark coil with the spark gap in the antenna to their own detriment and to the great inconvenience of all who may be listening for distant stations.

There is a better way. The use of tuned circuits will result in a marked increase in range of any transmitter and the elimination of all unnecessary interference.

For the good of all concerned those of us who have "dope" on an efficient low power transmitter will welcome the opportunity here offered; and those of us who are required to use the smaller outfits will be thankful for information which will surely make for an increased range.

New England Wireless Amateurs Meet

A MEETING of the New England Amateur Wireless Association was held at the Franklin Union, Berkeley Street, Boston, recently with an attendance of about fifty. Mr. G. R. Entwistle presided and a very interesting talk was given by Mr. Henry C. Gawler, First District Radio Inspector, who spoke of the practical use of the amateur stations.

A trans-Atlantic relay is now under development to transmit from the Atlantic Coast to the Azores, or to England direct, in an attempt to improve over the record made just before the war when a message was relayed from New York to San Francisco in one hour and twenty minutes, only passing through five stations each way.

Attention was called to the fact that the radio regulations and laws are the same as in 1917, when amateurs were first silenced, except that the code test is now twelve words a minute.

Advance orders for reservations to the Second Annual Banquet of the Association, to be held in the near future, can be sent to the secretary, Mr. Wallace E. Heckman, 119 Windermere Road, Auburndale, Mass.

The Quenched Gap for Amateur Use

By H. J. Tyzzer

AS a result of the study and improvement of vacuum tubes for both transmitting and receiving, tube amplifiers have been constructed which have increased the range of the receiving station many times. But the tube transmitters, although very effective for local work, are limited in output, and cannot be used to any great advantage for long distance transmission. It is for this reason that the Navy deemed it advisable to adhere to the conventional 500-cycle quenched gap transmitters, equipment which has proven both effective and reliable and which has been standardized by large quantities of sets of this type, manufacured during the war.

It would then seem advisable for the amateur who wishes to transmit long distances and still adhere to government restrictions, to follow as closely as possible the path laid out by the Navy and experienced commercial companies. A method whereby this desirable objective may be attained, will therefore be pointed out.

It is assumed that the amateur has at his disposal a source of 60-cycle alternating current. With such a supply it is customary to employ a step-up transformer, a high potential condenser, some form of gap, and an oscillation transformer, together with such accessories as a key, protective devices, and radiation ammeter. The power of this equipment, however, is limited because of the 200-meter wave restriction. With such a low wave-length it is practically impossible to employ a condenser of more than .01 or .012 mfd. capacity and have allowance for inductance of leads and proper coupling. This means that a much higher voltage must be employed by the amateur than if a supply of higher frequency were available. Such a high voltage often leads to gap difficulties, condenser troubles and low efficiency. It was formerly customary to employ a plain gap which ordinarily gave a note that was anything but pleasing on 60 cycles, and which was noisy in operation. This gap also caused a wave having a very high decrement to be emitted from the transmitting antenna, which tuned broadly at the receiving station and caused a great deal of interference.

The introduction of the non-synchronous rotary gap into the amteur field marked a great improvement in transmitters in general, inasmuch as a clear note with slightly decreased decrement in the antenna circuit was obtained. Even with a rotary gap, however, the conditions are far from ideal as the efficiency is usually quite low and the decrement often exceeds the 0.2 allowed by government regulations. Or in other words, when the coupling is made sufficiently loose to bring the decrement below 0.2 the equipment is not operating with maximum radiation.

Using a quenched gap on a 60-cycle supply, investigations have been made in laboratories at Medford Hillside, Mass., and the following data recorded to show the advantages of the quenched gap.

Tests were first made with a ½ k.w. Blitzen transformer. This type transformer is resonated to a capacity of .01 mfd. on 60 cycles. It was found impossible to work this transformer at its rated capacity with the leakage tongue, which is inserted between the primary and secondary in place. Therefore the tongue was removed and resonance sacrificed for increased output. Three mica condensers of .004 mfd. each were used, totalling a .012 mfd. capacity. The plain gap consisted of two centimeter brass balls, whereas the rotary was of the Murdock type, the quenched gap being a special one manufactured for amateur use.

A Murdock oscillation transformer was used with a phantom antenna consisting of a .00035 mfd. capacity, a loading spiral and 10 ohms inserted resistance. The quenched gap was compared with both the rotary and plain gap referred to above and the following data obtained:

TEST NO. 1

Total antenna resistance—15 ohms

Gap	Input Watts	Wave-length	Watts in antenna	Efficiency
Plain	135	200	41	30.4%
Rotary ...	135	200	43.6	32.4%
Quenched..	135	200	60	44.5%

TEST NO. 2

Gap	Input Watts	Wave-length	Watts in antenna	Efficiency
Plain	250	200	73	29.2%
Rotary ...	250	200	82.5	33 %
Quenched..	250	200	94	37.5%

A ½ k.w Blitzen transformer was then tried and 10 more ohms inserted in the antenna circuit, thus totalling approximately 25 ohms, and the readings below obtained:

TEST NO. 3

Gap	Input Watts	Wave-length	Watts in antenna	Efficiency
Plain	500	200	170	34%
Rotary ...	500	200	190	38%
Quenched..	500	200	225	45%

From these readings it may be seen that a considerable increase in output was obtained—by the use of the quenched gap—and hence better overall efficiency. It was found possible, by selecting the proper number of individual gaps for a given power in the quenched gap unit, and by adjusting a variable reactance in the primary of the transformer, to obtain an exceedingly clear note of double frequency (120 cycles). This means a double discharge per alternation of the 60-cycle wave and gives a pleasing tone resembling that of a rotary gap running at low speed.

The transmitter was then connected to an L type antenna consisting of two wires 60 feet long and approximately 55 feet high. With 200 watts input the maximum antenna current obtainable with the rotary gap was 1.6 amperes. With this setting the decrement as determined with a Kolster decremeter was approximately 0.6. The coupling on the Murdock oscillation transformer was reduced until the primary and secondary coils were nearly at right angles. In this position the antenna current had dropped to 1.1 amperes and the decrement decreased to 0.2 the maximum value permitted by government restriction. It was found, however, that this 1.1 amperes at 0.2 decrement was far more effective than 1.66 amperes at 0.6 decrement. This was determined by observing the deflection of the wattmeter in the decremeter circuit in both cases leaving the coupling conditions between the antenna and the decremeter the same. We have all heard that the reading of an ammeter in the antenna circuit is an untrue indication of effectiveness with a plain or rotary gap, and this is absolute proof of that fact.

The rotary was then replaced by the quenched gap and with the same power input—200 watts—a radiation of 2.1 amperes was obtained. The decrement was only 0.12, which is well within the limit set by the government.

Note the comparison under these practical working conditions. With a 200 watt input, 1.1 amperes radiation with the rotary and 2.1 amperes with the quenched gap; and, as the energy in the antenna is proportional to the square of the current this means a ratio of 1.21 to 4.41 or, in other words, that the quenched gap is over three and one-half times as effective as the rotary.

With the rotary gap considerable difficulty was experienced with kickbacks which punctured the insulation on the transformer and blew fuses, etc. With the quenched gap, however, none of this trouble was noticeable. In operation the quenched gap was almost noiseless, which is an obvious advantage when it is considered that a great deal of amateur long distance transmission is accomplished in the early hours of the morning, when disturbances are not relished by the household or the neighbors.

With a rotary gap very high potentials are built up in the antenna circuit, which tend to strain and even rupture the insulation. With a quenched gap this is not true, as the sparks follow each other regularly and are of uniform potential.

Briefly, then, the advantages of the quenched gap over its nearest competitor, the rotary, may be summed up as follows:

1. Increased efficiency of transmitter.
2. Practically noiseless in operation.
3. Less potential in antenna system.

4. Decrease in decrement of emitted wave.

5. A clear note without the use of moving parts.

6. Less trouble due to kick-backs, etc.

With such an outfit the standard of the amateur will be nearly on a par with the commercial companies operating today, and it is to be expected that with a transmitter of this type and an efficient receiver, far greater distances will be spanned by the amateur than in pre-war times.

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 separte 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.

D. M., Springfield, Mass.

In so far as we know, it will be impossible for you to do any transmitting of any sort on long wave lengths.

There are Government regulations which forbid this.

* * *

R. H., Winnipeg, Manitoba.

We should say that it would be a very easy matter for you to get a position in the Mercantile Marine as radio operator. The present unusual demand is apt to continue for a considerable period of time.

Senior operators draw a salary of $125.00 per month and found; junior operators $100.00 per month and found; and $3.00 per day subsistence in each case when the operator is on shore.

If you seriously consider taking up this sort of work, we suggest that you enroll at once at an accredited radio school.

* * *

C. N. McC., Mountain Home, Idaho.

In reply to your question as to what apparatus you will need to transmit thirty or forty miles or to receive that same distance from a transmitter similar to your own, we assume that you have available alternating current supply. In addition to an antenna about 80 ft. high and 125 ft. long, of the "L" type, having four wires spread 18 in. apart, you will need a good ground connection such as may be had by connecting to the water pipes in the house, or if there is no water system, to a system of earth wires buried underneath the antenna. These earth wires should extend 15 or 20 ft. away from the antenna on all sides. They need not be buried more than 3 or 4 in. An oscillation transformer, a high tension condenser and a high voltage ½ kw. transformer, a rotary spark gap, and a key complete the list of transmitting apparatus required. You will probably be able to build your own rotary gap from directions which are being printed in the November issue of The Wireless Age. Your high tension condenser and your oscillation transformer may also be constructed from directions which have been or will be printed in the Wireless Age. Your high voltage transformer might best be purchased, perhaps, as well as your key, or all of this apparatus may be purchased if you so desire. The receiving apparatus should consist of a short wave regenerative receiver which you may either construct or purchase, a vacuum tube detector, and a pair of telephone receivers, as well as filament lighting and high voltage batteries for the vacuum tube detector. You should be able to obtain all the general information which you require as to construction and operation of the apparatus from the columns of this magazine or books which you will find listed in our advertisements.

* * *

P. M. H., Whitneyville, Conn.

A diagram showing you how to switch from a crystal detector to a vacuum tube detector appeared in these columns recently.

———o———

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

Of The Wireless Age, published monthly at New York, N. Y., for October 1st, 1919.

County of New York, } ss.
State of New York, }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared E. J. Nally, who, having been duly sworn according to law, deposes and says that he is the President of the Wireless Press, Inc., Publisher of The Wireless Age, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations.

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, Wireless Press, Inc., 233 Broadway, New York, N. Y.

Editor, J. Andrew White, 233 Broadway, New York, N. Y.

Managing Editor, None.

Business Manager, J. D. Conmee, 233 Broadway, New York, N. Y.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)

Wireless Press, Inc., 233 Broadway, New York, N. Y.

E. J. Nally (851 shares), 233 Broadway, New York, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)

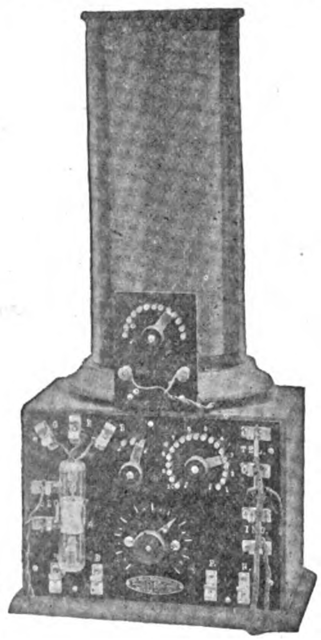
None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

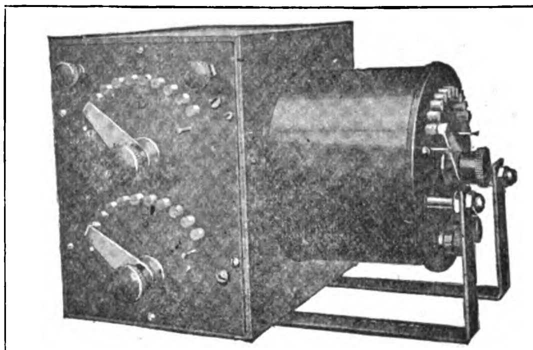
E. J. NALLY,
President.

Sworn to and subscribed before me this 26th day of September, 1919.

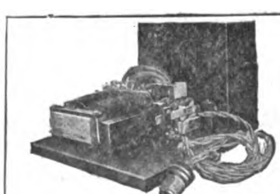
(Seal.) M. H. PAYNE.
(My commission expires March 30, 1920.)

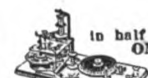
Type 93 Undamped Wave Set

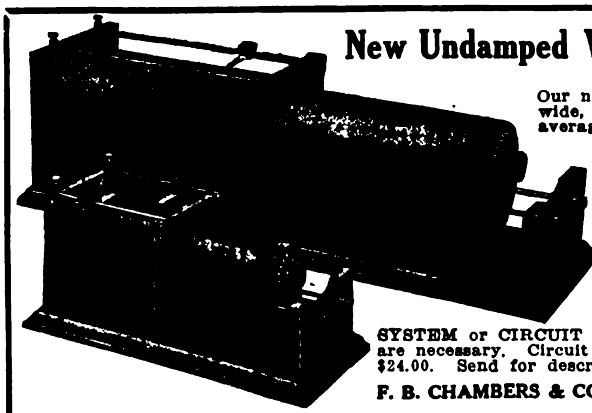


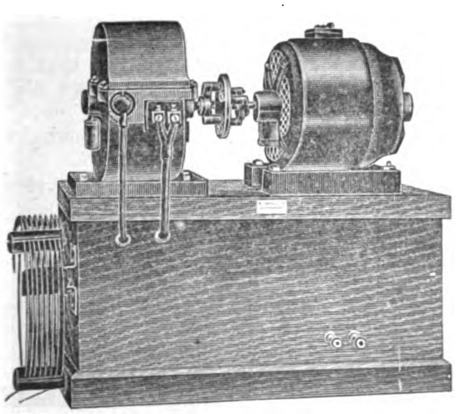
Type-Y678-Coupler



Rectifier







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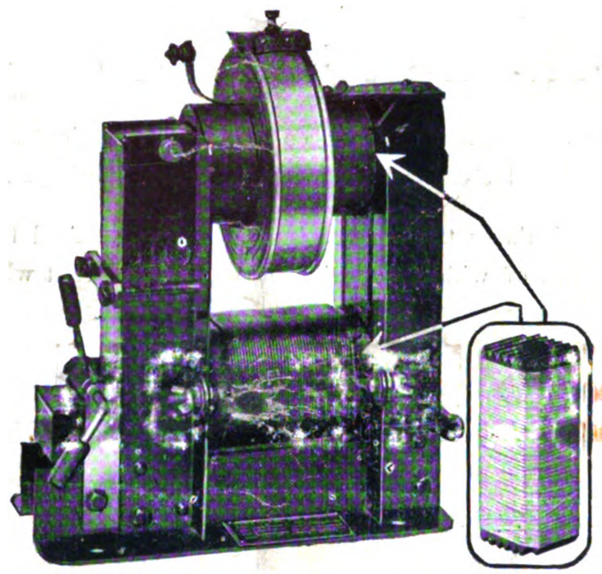

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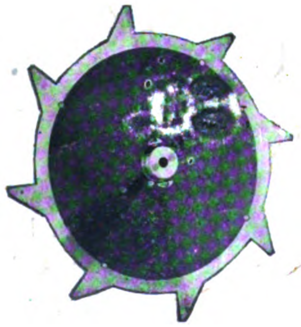

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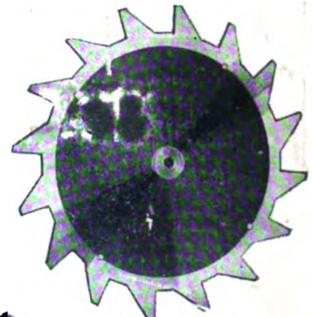


TYPE T-R16

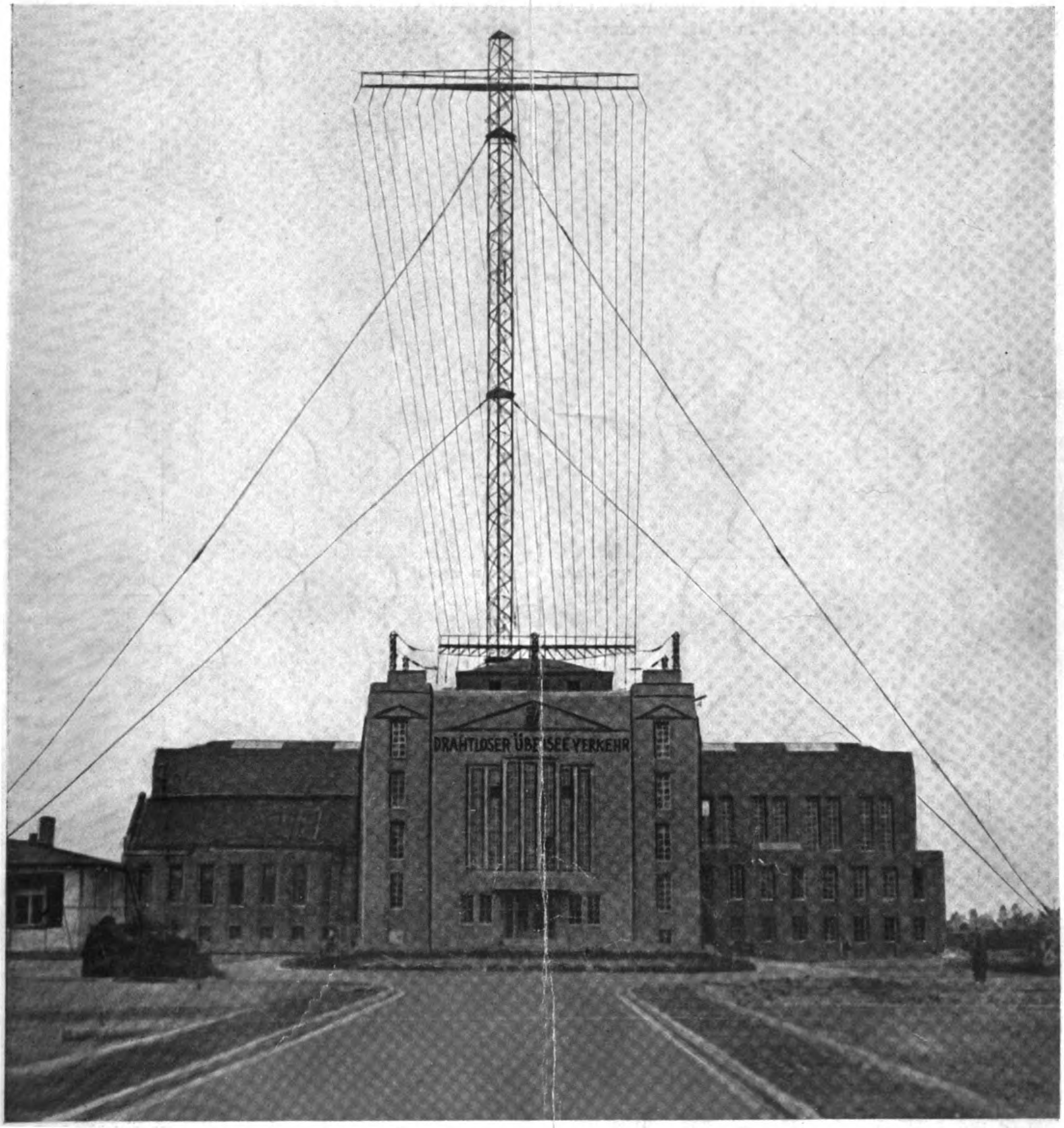
December, 1919

20 Cents

The WIRELESS AGE

Volume 7

Number 3



A close-up of "POZ" the German Station at Nauen

"NSS"—The Annapolis Station

A complete description of the Navy's most powerful wireless plant

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INSULATION
"MADE IN AMERICA"

"By courier, coach and sail-boat, [illegible] took days for the news of Wa[illegible] to reach London. During [illegible] Commander Read's flight to Hali[illegible] Assistant Secretary Roosevelt [illegible] Washington sent a radio message [illegible] NC-4, of whose position in air he had no knowledge. In three minutes he had a reply."

Extract from New York World, June 8, 1919.

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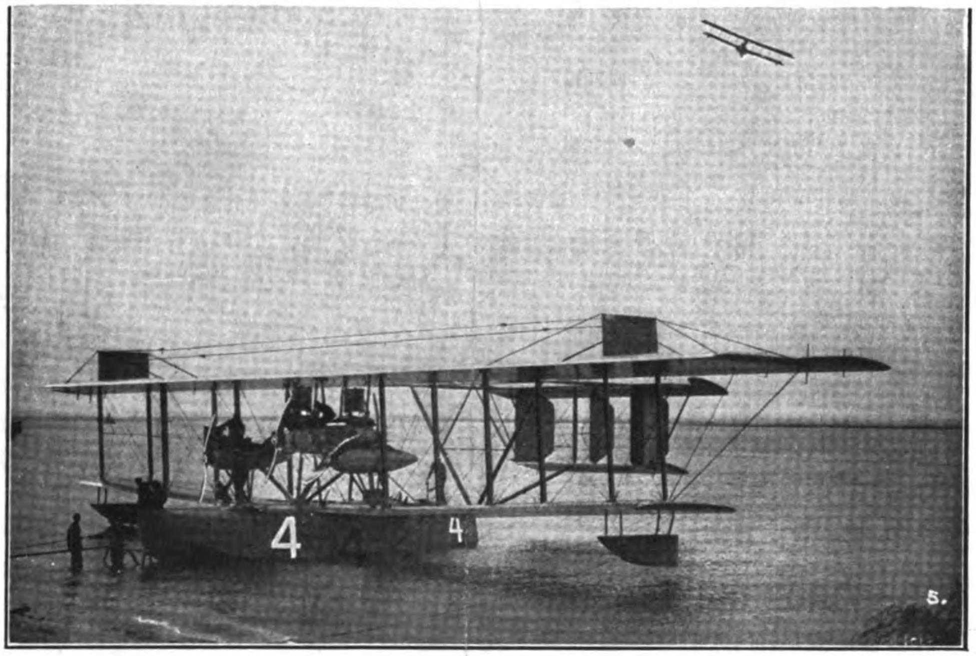
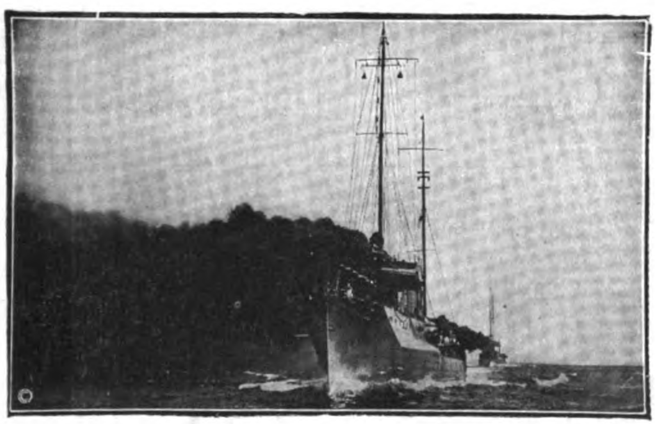
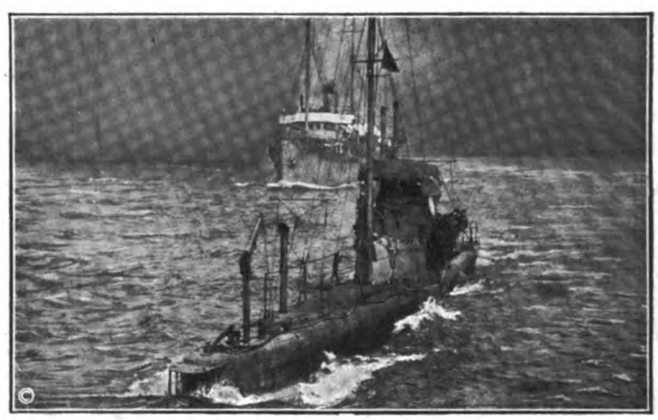


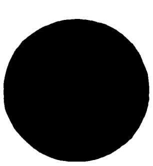
NC-4—ELECTROSE Equipped



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



U. S. S. G-2—ELECTROSE Equipped.



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

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Medal and Diploma received at World's Fair, St. Louis, 1904

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The Wireless Age

Edited by J. ANDREW WHITE

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Vol. 7 — Contents for December, 1919 — No. 3

Contents for December, 1919

Index of Equipment

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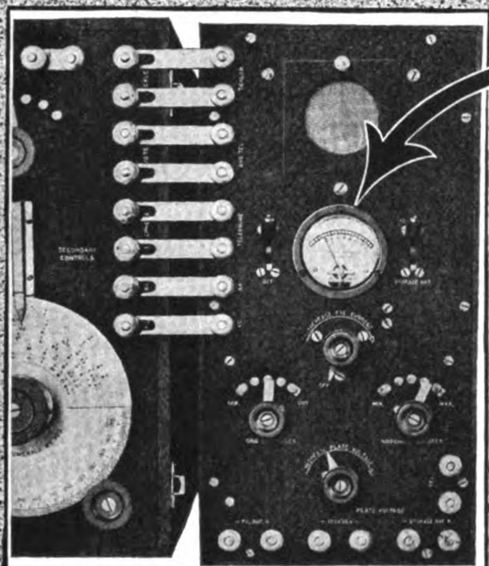
The Universal Instrument For Radio Service



Audion Control Box Showing Type BX Instrument for Measuring Filament Current.

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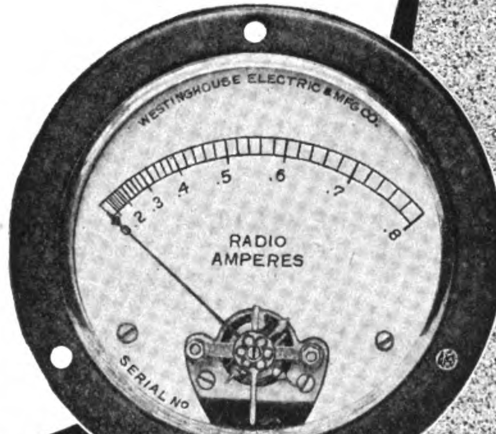

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TYPE WI-114A
Triple Vacuum Tube Base Socket.

TYPE WI-120A
Grid Condenser. Small mica Dielectric condenser. Capacity: 0.0006 Mfd.

TYPE WI-121A
Telephone Condenser. Small Mica dielectric condenser. Capacity: 0.0025 Mfd.

TYPE WI-122A
Grid Leak Resistance. Glass enclosed. Moisture proof.

TYPE WI-126A
Crystal Detector. Dust proof—enclosed type.

TYPE WI-129A
Audion Control Box. Provided with filter system so that in addition to the plate battery of 40 volts, 110 volt supply may be used in the plate circuit.

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. 3. December, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

Wireless to Improve the Aerial Mail Service

THE Aerial Mail Service has developed a most powerful loop radio for communication of mail planes and their guidance through all sorts of weather, even fog. This equipment is now being installed on the new mail planes and landing fields at College Park, Newark, and Bellefonte, Pa.

The radio set has an unusual range for sending. Its possibilities have not been fully determined. Instead of requiring masts from 200 to 500 feet high, the aerial wires are being raised on masts only 23 feet high.

Included in the equipment is a field marking radio device, which enables a pilot to steer exactly for the center of his landing field, although it may be invisible and obscured by clouds, rain, snow or fog.

Fog is the aviator's most dangerous enemy. A majority of crashes and bad landings are caused solely by the inability of the pilot to determine his position and the location of a suitable landing place. A new compass has been devised and put in service on the mail planes, but one of the most important contributions to aviation being worked out by the aerial mail service, with every prospect of success, is a non-magnetic and non-gyroscopic compass which will overcome the unreliability of the magnetic compass caused by vibration and other disturbing features of an airplane in motion.

Greek Ships Equipped With Wireless

GREECE has required radio equipment on all cargo ships of 1,000 or more tons dead weight capacity and on all cargo ships of 1,000 or more tons.

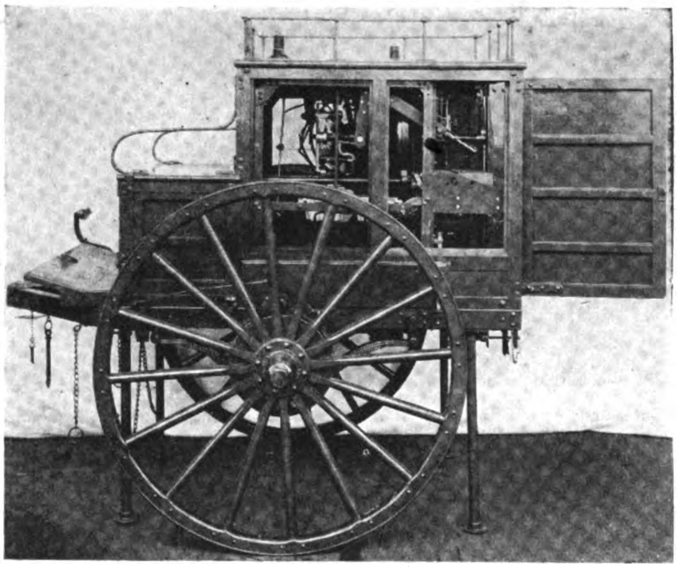
Dr. Alexanderson Reviews Recent Radio Developments

DR. E. F. W. ALEXANDERSON, consulting engineer for the General Electric Company, recently addressed the Schenectady section of the American Institute of Electrical Engineers on radio development.

"As free as the air" is no longer a true simile, Dr. Alexanderson said, because it will soon be as crowded as Fifth Avenue. Only 10,000 to 20,000 meter length wireless waves can be used for inter-oceanic communication. Under present conditions there is room in this range for about 12 stations, of which five are already in use. But, because some of these existing stations have been sending out irregular waves it has been impossible to use the maximum number of stations. By using the new alternator invented by Dr. Alexanderson, it is possible to run seven automobiles, as it were abreast in the space formerly taken by one automobile, because seven messages may be made to keep their own path so that messages can be placed within one per cent of each other, and thus seven times as many stations can be placed within the world as was formerly possible.

It is also possible to send more than one message on the same wave length due to the invention of the "barrage receiver" which cuts out all messages but those from the direction in which one wishes to receive a message. To get these signals pure, a special alternator is driven by a direct alternating current motor, whose speed is kept constant to within 1-10 of 1 per cent by means of special control equipment. The speed with which the messages can be sent has been increased from 20 words a minute to as high as 500, with 100 being a good average.

The result of all of these improvements has been to open up possibilities of communication facilities 125 times greater than those now existing.



Wireless cart of a greatly improved type designed for the Brazilian army by Marconi engineers

Marconi Fund for Italian War Relief

IN connection with the general work of the Italian War Relief Fund of America, a special fund in honor of Marconi is being raised by an electrical committee of which the members are T. C. Martin, chairman, Dr. Elihu Thomson and J. W. Lieb. Considerable success has attended this laudable effort and the Marconi Fund has already reached over $3,500, and a first instalment of $2,500 has been forwarded to Senator Marconi in Rome.

In view of the fact that sore distress in Italy deepens as the winter advances it is believed that many others in the electrical field, as well as outside it, would like to embrace this opportunity presented by the special fund and the Committee therefore renews its plea for aid and co-operation.

Each subscription is accompanied by an autograph card, with the object of assembling all these cards later in a memorial album to be delivered to Mr. Marconi. Such cards can be obtained from the Committee at 29 West 39th street, New York City.

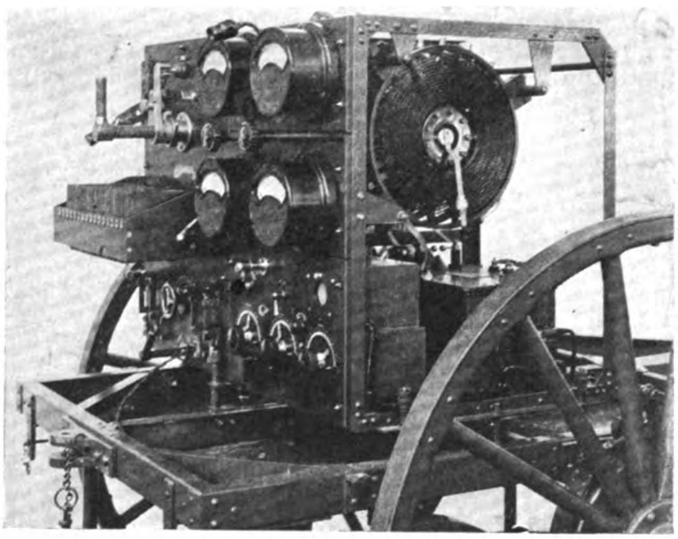
Spanish Station Being Improved to Reach America

IMPROVEMENTS are being made to their important Spanish radio-telegraphic station at Carabanchel, four miles from Madrid, with a view to opening wireless communications with America if possible. This station was used, it is said, to maintain communications with Germany during the war.

Ship Maintains Wireless Communication Across Atlantic

THE distinction of having been the first trans-Atlantic steamship to maintain wireless communication with England during the entire voyage westward has been made by the Cunard Line vessel, Royal George. A long message was received from the Marconi station at Cornwall when the ship was 150 miles from Halifax.

A new valve amplifier, which doubles the distance at which messages can be received, was used on a passenger steamship for the first time. British ships were equipped with the apparatus during the war.



Interior view of the American-made signal corps radio cart equipment designed and built by Marconi for army service in Brazil

Canadian-Japanese Wireless Communication Being Effected

CONSTRUCTION of a high powered wireless station, which when completed will be the most powerful radio depot in the British Empire, is proposed for the vicinity of Vancouver, B. C., by the Canadian Marconi Wireless Company.

The station, which will cost, it is estimated, in the neighborhood of $2,000,000, is designed to handle commercial business between Canada and the Orient, and a station of like power and cost will be built in Japan. Negotiations are being carried on simultaneously with the Governments of Canada and Japan for licenses to construct and operate the two stations necessary to establish direct communication across the Pacific.

Long-Distance Wireless to Ships at Sea

MARCONI'S Wireless Telegraph Company, London, announce that long-distance messages can again be accepted for transmission through their high-power wireless station at Poldhu in Cornwall to ships which are not within range of any other British coast station. The Poldhu station communicates to ships at night only and its range is about 1,500 miles.

American-Japanese Direct Wireless Service to Open

THE new high power Japanese wireless station which will communicate directly with a radio station on the Pacific coast of the United States, will be completed soon. Trial exchange of messages will at once be made with the American station and if satisfactory results are obtained the radio station will be opened to the public for the acceptance of messages.

Construction of the Japanese station was started in 1918 and the total expenditure has been about $360,000. The sending station is located at Tomickamura, a village in the prefecture of Fukushima, about a hundred miles north of Tokio.

Norway's Stavanger High Power Station Opened for Service

THE opening of the high power radio station on the western coast of Norway, near the city of Stavanger has been accomplished and is regarded throughout Norway as marking a new epoch in the communication service between northern Europe and the United States.

The Stavanger radio, which has been ready for business since a short time after the war broke out, but has not been opened until now, is the biggest radio plant in Northern Europe, and was built by the Norwegian Government in co-operation with the Marconi Company. It is expected to handle a great deal of the business correspondence between America and the countries in Northern Europe, as the rate is one-third cheaper than the rates for cables.

Scandinavian commercial interests in the United States have during the war increased to a very large extent, and the radio service is, therefore, greeted with the greatest satisfaction in business circles where correspondence with the United States has been hampered in various ways. The Stavanger station is able to handle unlimited traffic both ways, thereby establishing a new link between the countries of northern Europe and United States.

Consul General of Norway, Christopher Ravn, New York, says: "The long expected and now at last opened action of our wireless will be greeted with joy by all, as the wireless will make Norway's connection with America closer and more reliable, and also forward both countries' business transactions."

Sweden's Karlsborg Station Soon Ready

A STOCKHOLM dispatch received here announces that the Karlsborg radio station, the largest in Sweden, will soon establish regular communication with the United States upon the completion of a test with an American station on the Atlantic coast. The Swedish wireless plant already has established service with many countries, including England and Germany.

England Regulates Aircraft Radio

THE Air Ministry in London makes the following announcement:

The form of license to be granted for the use of wireless to and from aircraft, and the conditions under which such licenses will be granted, are under consideration. In the meantime, pending the issue of the license by the Post Master General, temporary provisional authority for the installation and use of wireless apparatus in aircraft can be obtained, in approved cases, by application to the Secretary of the Post Office.

For the present the wave length suggested for wireless

Telephony is 480 meters. This is the wave length which the existing Air Ministry W/T Stations at present employ for work with aircraft.

For the benefit of designers and others interested it may be said that the Post Master General's license when available, will probably contain provisions to the following effect:

The sending apparatus installed at any aircraft station shall be constructed so as to be capable of using waves of 600 meters interrupted continuous wave, and 900 meters continuous wave; such of the following wave lengths, namely, 220, 300, 450 and 800 meters interrupted continuous wave, and 200-550 meters, 650-950 meters, 200-3000 meters continuous wave may also be used for transmission as are authorized in writing by the Post Master General.

The use of the wave of 600 meters (hereinafter referred to as the "air-craft-ship" wave) shall be confined to the use of the system known as "Interrupted Undamped Wave or Tonic Train," or I.C.W., and the use of 900 meters hereinafter referred to as the "Aircraft Normal Wave," shall be used only for continuous damped waves or wireless telephony.

Should an aircraft station be also fitted with a supplementary installation on long continuous waves, such installation shall be so constructed as to be capable of using the wave length of 2,400 meters.

The range of wave lengths for which the receiving apparatus may be constructed is not limited, but the apparatus must be capable of receiving on 600 meters and 900 meters, and on 2,400 meters when a transmitter working on this latter wave length is installed; it must also be made to embrace any other wave length on which a transmitter installed has been authorized to work.

Australians Plan World Wireless

AN offer has been made to the Australian Government to provide a permanent direct wireless commercial service between Australia and the rest of the world and it is now being negotiated, according to the report submitted by Sir Thomas Hughes, chairman of the Amalgamated Wireless Australasia, Ltd.

Sir Thomas points out that as a result of successful experiments carried out by the managing director of the concern last year, when wireless messages were received in Sydney without relay from the Marconi company's transatlantic station in Wales, a service can be established, including all classes of messages—code, plain language, deferred and press—at one-third less than existing cable rates.

"There has been some delay in this matter," Sir Thomas adds, "because under the wireless telegraphy regulations it is necessary to have a license to erect and operate wireless stations. Negotiations for this license are to be followed up and it is hoped that our Government will decide the matter without undue delay, so that erection of stations can be proceeded with.

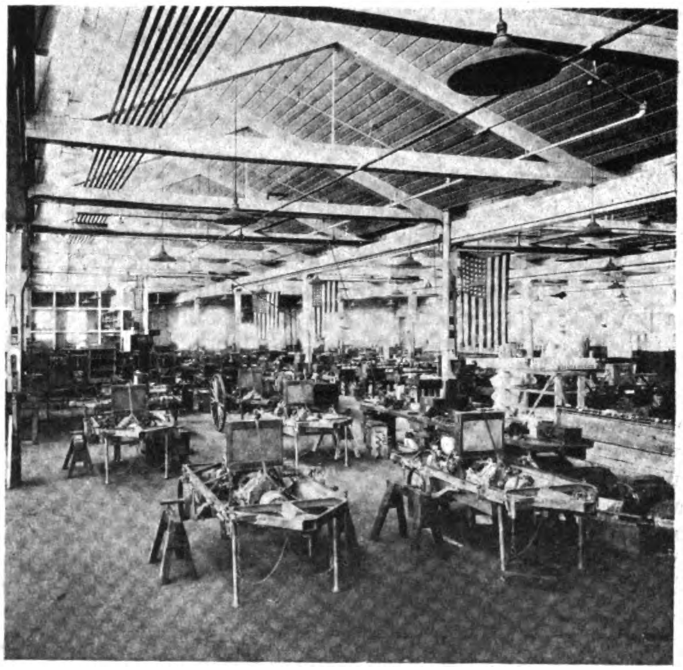
"It would be fatal to attempt to combine a naval service with a commercial service. If a naval service is needed it must be quite distinct, and it should be conducted on purely naval lines. By an attempt to combine the two we would destroy all possibility of efficiency on either side.

"The commercial service will be successful and will be capable of expansion to provide communication with almost every part of the world so long as uniform apparatus and organization are employed at all stations. There is no reason why several stations, if required for different purposes, should not be erected and worked simultaneously in Australia without mutual interference. One great company is reported to have decided to spend about $15,000,000 in improving its connections with Australia."

High Speed Radio Across the Pacific

EXCHANGE of press despatches and commercial messages by radio between California and the Hawaiian Islands, Guam, the Philippines and Japan on a much more extensive scale will become possible when arrangements recently completed by the Government become effective about the first of the year.

Through the use of modern high power, high speed operating equipment it is estimated that it will be possible to transmit and receive more than one hundred thousand words a day between Hawaii and the Philippines; two hundred thousand words a day between San Francisco and San Diego and Hawaii, and about one thousand words a day on a slow speed circuit between Hawaii and Japan. The Hawaii-Japan circuit, operating under an arrangement with the Japanese government, will be available only nine hours a day.



View of the assembly room of the Marconi factory showing the vast quantities of army wireless equipment being manufactured for South America

Rates on press despatches over the new radio circuits will be low, insuring, in the view of officials, a widespread exchange of news between the United States and the Orient and American insular possessions in the Pacific. The rate decided on is six cents a word between California stations and Manila, and three cents a word to Hawaii.

The new arrangement, which will be open to routine commercial business, is expected by officials to aid greatly also in the building up of trade by American interests with Hawaii, Guam and the East.

Mexican Border Patrol Equipped With Wireless

THE Mexican border line within the jurisdiction of the Western Department of the Army is now completely equipped with wireless telephone sending apparatus that will reach an Army airplane at any place along the border.

Colonel J. E. Hemphill, chief signal officer of the Western Department, will inspect the new equipment. Four sending stations were installed, each with a radius of 100 miles. Additional stations and possibly more powerful equipment may be installed as a result of Colonel Hemphill's visit.

NSS—The Annapolis Radio Station

The Arc Radio Transmitter—General Description

(Photos by courtesy of Navy Department)

THE Annapolis radio station is said by the Navy to be the most powerful in the United States. It was constructed by the Navy Department and is one of four high power stations which have been operated under distant control from a main station located in Washington. By means of relay, messages are transmitted through these stations by operators seated at four small tables in the Washington office of the Navy Department. Official messages were handled by Annapolis in large volume during the war, thus relieving the congestion on the trans-oceanic cables.

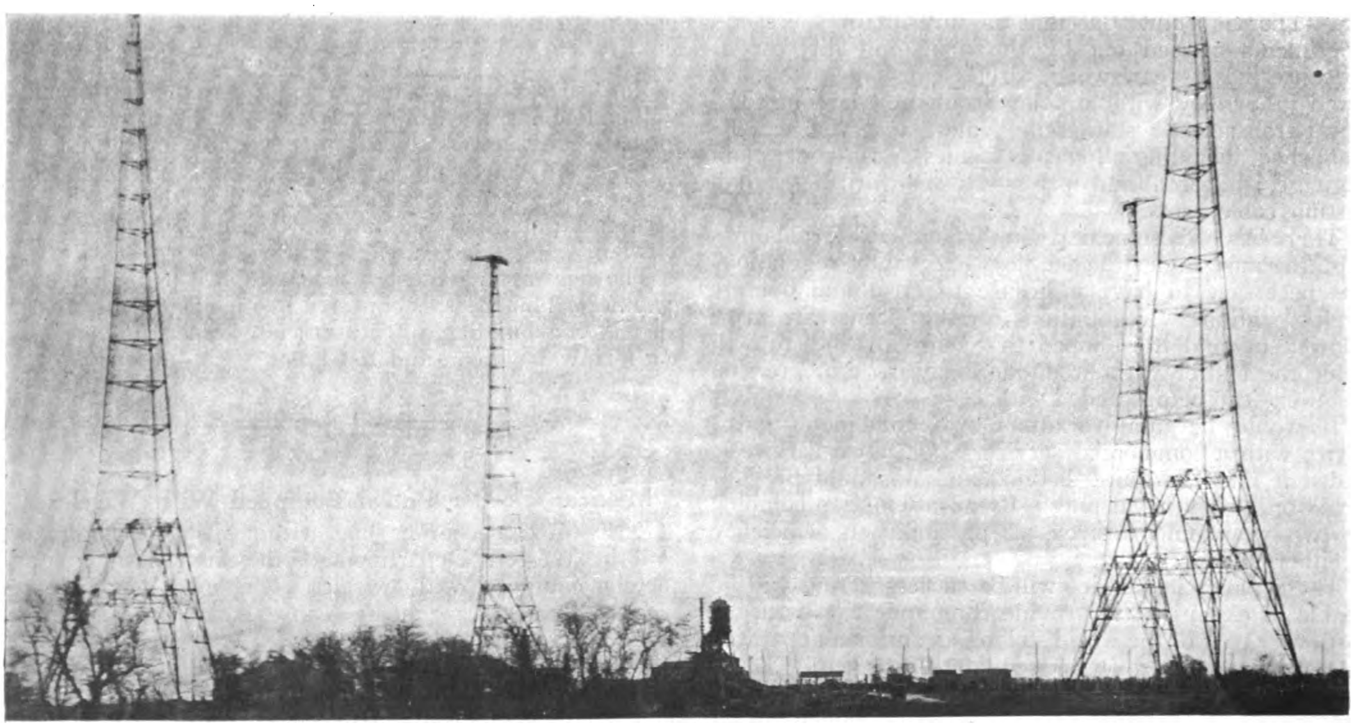
The high power arc transmitter is based upon Poulsen's method of obtaining high frequency oscillations by means of an electric arc burning in an atmosphere containing hydrogen and in a strong transverse magnetic field. The equipment consists of the following main units:

A source of direct current; an arc converter; an antenna loading inductor; an antenna and ground system; a signaling device and auxiliary and control apparatus.

The circuits employed for the set equipped with the coupled compensation method of signaling are outlined in figure 1. The electrodes of the arc converter are enclosed in a water cooled bronze chamber. To this there is supplied either a gas containing hydrogen or a liquid hydrocarbon which decomposes in the intense heat of the arc and releases hydrogen. The arc electrodes are placed between the poles of a strong electromagnet, whose winding is in series in the direct current leads to the arc, and which is therefore energized whenever the arc is in operation. When the arc is started by bringing the electrodes together and then drawing them slowly apart, a direct current arc is formed which burns in an atmosphere containing hydrogen and in a strong transverse magnetic field. This arc is shunted by a circuit containing inductance and capacitance connected in series. The capacitance may be considered as concentrated in the electrostatic capacity of the antenna to earth (the antenna and earth acting as the two plates of a large air condenser). The inductance of the circuit may be considered as concentrated in the antenna loading inductor. Under these conditions there will be superimposed upon the direct current arc a high frequency alternating current which flows in the circuit: arc, loading inductor, antenna, and earth. The arc converts the power supplied by the direct current generator into radio frequency energy with undamped current in the antenna circuit. The choking effect of the arc series field winding prevents the flow of radio frequency current from the arc back into the power machinery.

The frequency of the undamped current in the antenna circuit depends upon the inductance and capacitance of this circuit. The frequency and therefore the wavelength may be altered by changing the value of either the inductance or the capacitance. Since the capacitance is furnished by the antenna and therefore fixed, the inductance is made variable in order to permit changes in wavelength.

When the contacts of the signaling key are closed, the coupled compensation key loop becomes the short-circuited secondary winding of an air core transformer of which the antenna loading inductor is the primary. By virtue of transformer action and mutual inductance between the short-circuited winding and the main loading inductor, the inductance of the antenna circuit is varied and signaling is accomplished by the compensation method. When the signaling key is closed, the emitted wave is of shorter length than it is with the key open. The receiving set is tuned to receive the shorter wave and therefore signals are heard only when the key is closed.



The four towers of Annapolis forming a square within which the aerial wires are strung. A feature of the gigantic antenna is the provision for melting ice from the wires by current supplied from the 400-kw. generators

A general view of the Annapolis station buildings, taken from one of the towers

The Annapolis High Power Radio Station is equipped with duplicate power machinery and duplicate arc converters, permitting practically continuous operation. Power is supplied by a 3-phase, 25-cycle alternating current source at 2,200 volts. The main pieces of equipment may be summarized as follows: Two 400-kw. motor generators, supplying direct current for the arc converters; two oil switches, through which power is supplied to the motor generators; two automatic starting panels for the motor generators; two 3-kw. motor generators supplying 125 v. direct current for operation of control circuits and arc auxiliaries; a switchboard, two arc converters, two benchboards for control of the arc converters, an arc transfer panel, antenna loading inductor, a combined wave changer and send-ground-receive switch, a signaling system and a set of switches for melting ice from the antenna.

Either of the two 400-kw. motor generators may be used to supply direct current to either of the arc converters. When one of these is in use, the other is entirely disconnected. This makes it possible to clean or repair either arc or either motor generator while the other is in operation. The arc transfer panel carries the necessary switches for transferring all the electrical connections from one arc converter to the other. A benchboard located at each arc converter carries all the necessary apparatus for the complete electrical remote control of the station equipment.

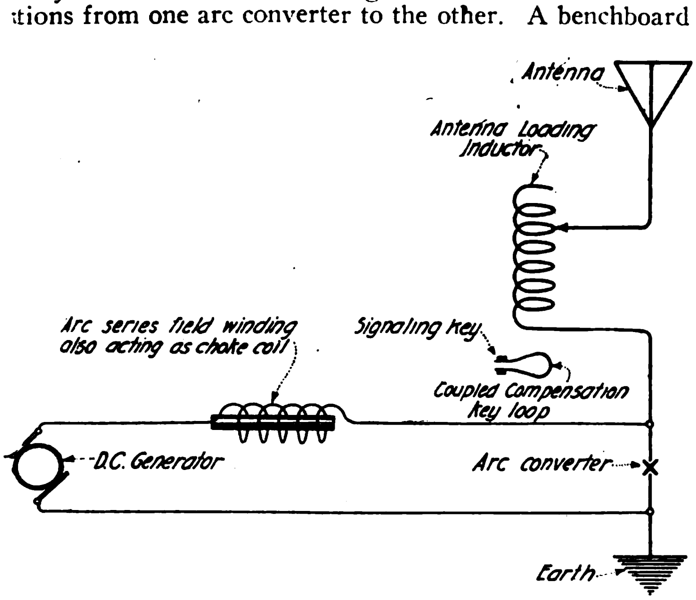
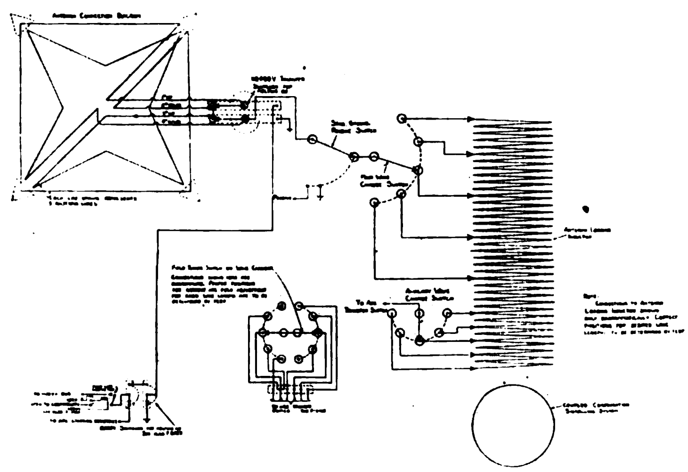


Figure 1—Arc transmitter with coupled compensation method of signaling. The arc flame burns in an atmosphere containing hydrogen and in a transverse magnetic field set up by the arc series field winding



Wiring diagram of the circuits of the Annapolis station

The motors of the 400-kw. motor generators are supplied with power from the 2,200-v., 3-phase, 25-cycle bus through oil switches and automatic starting panels. The oil switches are provided with overload protection and the automatic starting panels have no voltage protection.

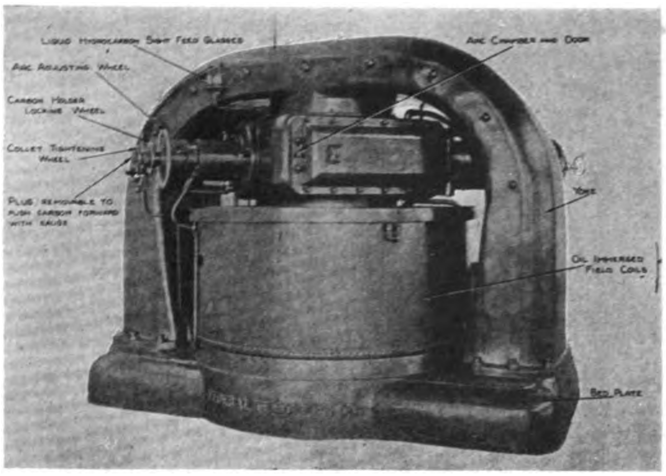
Overload protection for the 400-kw. generators is provided by relays which operate in connection with the contractors through which current is supplied to the arc converters, the contractors serving as circuit breakers between the arc converters and the motor generators.

Either of the 3-kw. motor generators may be used to supply 125-volt direct current for operation of the station control circuits and arc auxiliaries. These machines may be operated in parallel if desired.

For melting ice from the wires of the antenna, the two 400-kw. generators connected in parallel are used. A set of switches is provided for making the necessary connections.

Mounted on the same base with each of the 400-kw., 1,430-volt direct current generators are 600-hp., 2,200-volt, 3-phase, 25-cycle induction motors which drive the power units. Excitation for the generator is provided by a 3-kw., 125-volt overhung exciter. In operation, the voltage of the generator is regulated by an exciter field rheostat upon the arc control benchboard; this rheostat controls the voltage of the exciter, which in turn regulates the voltage of the main generator. Both an exciter field rheostat and a rheostat for the field of the generator itself are provided upon the main switchboard. The induction motor is of the wound rotor type.

Automatic starting panels are provided for the motor generators. These panels have no voltage protection.



The 350-kw. arc converter of the closed magnetic circuit type

Overload protection is provided by relays on the oil switches through which power for the motor generators is supplied. Each starting panel is provided with three push button stations for starting and stopping its motor generator. One push button station is located upon each arc control benchboard, permitting either motor generator to be started or stopped by the arc engineer from his position at either arc. The other push button is located upon the automatic starting panel itself. A transfer switch provides for either local or remote control.

The switchboard for the station consists of ten panels; one for each motor generator oil switch; one for the two 3-kw., 125-volt direct current generators; another is a 6-circuit, 125-volt direct current distribution panel; the fifth is a contactor panel through which current is supplied to the arc converters; then there are two panels for the control of both 400-kw. generators and three panels for the control of the station signaling system.

Each of the panels for the two 400-kw. generators carries two remote manually controlled lever switches through which the generator is connected to the 1430-volt direct-current bus. Each also carries an ammeter and a voltmeter indicating the current and voltage of the generator, an overload relay for opening the proper contactor and disconnecting the generator in case of overload, a generator field rheostat, an exciter field rheostat and an exciter field switch.

The contactor panel carries four contactors for shorting out the arc series starting resistance, and two small contactors for reducing the excitation of the 400-kw. generators whenever either main line contactor is opened by its overload relay. Two high voltage main line contactors are mounted behind the switchboard upon a pipe frame. One of these acts as an arc main line contactor and serves to connect the arc to the positive 1430-volt direct-current bus. The other serves as a bus contactor and connects together the positive switches of the two 400-kw. generators. The positive bus contactor serves to protect either motor generator in case the main line switches of the other are closed when the generator is not running, or in case an attempt is made to connect the two generators in parallel without equalizing their voltage.

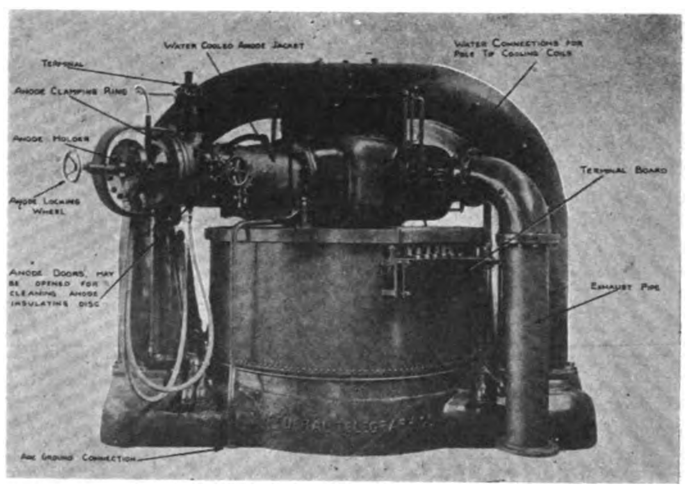
The arc main line contactor and the four arc starting resistance contactors are operated by the arc drum controller upon the benchboard. A switch on the arc transfer panel transfers the control of these contractors to the benchboard of the arc which is in use. In starting the arc, the controller first closes the arc main line contactor and then the four starting resistance contactors one at a time.

The two small contactors for the generator fields are both normally closed at all times and are opened only in case of an overload upon the generator whose fields they supply. When either of these opens, resistance is inserted in the field circuit of the generator, thereby reducing its voltage.

The two arc converters are exactly alike. Each has a normal rating of 350 kilowatts, a maximum rating of 400 amperes radio frequency current in the antenna, and a maximum direct current voltage of 1500.

The 350-kw. arc converter is of the closed magnetic circuit type. The magnetic circuit consists of a bedplate, a yoke, a lower pole, and an upper pole. The field winding is placed around the lower pole and the magnetic circuit is closed through the bedplate and yoke. The pole tips are designed to give maximum flux in the air gap between them.

The field winding consists of 15 flat pancake coils which are wound with copper strip. These are immersed in oil, giving good insulation and facilitating cooling. The six upper coils serve as a choke to prevent the flow of radio frequency current from the arc into the direct current power circuits. The remaining nine coils are used for adjustment of the strength of the magnetic field, and are provided with a series of connections by means of which any or all of them may be short-circuited. When the arc is operating on relatively short waves, a strong magnetic field is required and all of the coils are needed. On the longer waves better operation is obtained with a weaker magnetic field, and a portion of the winding must be short-circuited. A switch is provided on the wave



View of the reverse side of the Annapolis arc converter

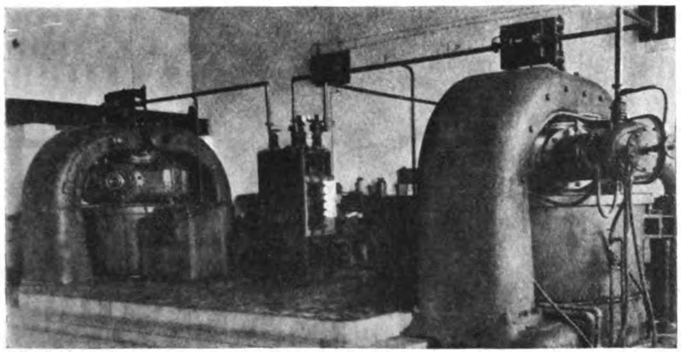
changer for accomplishing this, and after the station is once adjusted for a given set of wave lengths no further adjustments are necessary during ordinary operation. The wave changer automatically tunes or adjusts the magnetic field to the proper strength for the wave length in use.

The field coils are enclosed in a steel tank, which is filled with transformer oil. The cover of this tank is made of brass in order that it may not furnish a return circuit for the flux of the magnet pole.

The heat storage capacity of the coils, oil and tank is sufficient for full load operation of the arc for several hours. For continuous operation, a motor driven pump is provided to circulate the oil through water cooled coils placed in a concrete pit outside the building. The cooling water from the arc runs through this pit. It is still relatively cool when it leaves the arc and serves to remove heat from the oil.

The arc chamber is a water cooled bronze casting provided with a door on one side. This may be unbolted and opened for inspecting and cleaning the interior. The anode and cathode are bolted to opposite sides of the chamber.

The hydrogen content of the atmosphere in the chamber is provided either by city gas or by liquid hydrocarbon



The two arc converter machines installed in Annapolis station, showing the benchboards from which the engineer controls the whole station

fed drop by drop into the arc. Two tanks, one for kerosene and one for alcohol, are connected with a sight feed drip cup mounted on the yoke of the arc above the chamber. From these cups a common feed pipe leads into the chamber through the upper pole tip. The flow is controlled by needle valves mounted on the side of the arc yolk within easy reach of the operator. The hydrocarbon supply is turned on by two small valves operated by the arc drum controller when it is advanced to position 2.

The cathode or negative electrode of the arc consists of a carbon in a holder, a water cooled sheath which surrounds the holder and removes the heat transmitted to it by the carbon, a mechanism for slowly rotating the carbon and its holder and a means of adjusting the length of the arc gap between the carbon and the copper tip of the anode. The carbon is held in the holder by a split taper collet which is tightened by a small hand wheel called the collet tightening wheel. This construction insures good electrical contact between the carbon and the holder and provides an easy means of making the projecting carbon any desired length. The sheath forms a water jacketed bearing surface within which the holder is rotated. The mechanism for rotating and adjusting the carbon are built as parts of the sheath. A sleeve with jaws which engage similar jaws on the carbon holder is rotated by enclosed worm gears. This sleeve is moved axially to adjust the arc gap by a screw and hand wheel, as shown in an accompanying photograph.

Water for cooling the sheath is supplied by a ¾-inch pipe. After being circulated in the sheath, it goes to the water cooled jacket, which acts as an extension of the chamber and helps keep the cathode cool.

The carbon holder is held in position and locked to the sleeve by a locking wheel and is made removable for renewing the carbon. The carbon may be lengthened without removing the holder from the sheath by unscrewing the plug at the end of the holder, loosening the collet and pushing the carbon forward with the gauge rod provided for this purpose. The carbon may be shortened by simply loosening the collet and turning the adjusting wheel to the right, thereby forcing the carbon against the anode tip and pushing it back in the holder.

The carbon is rotated through enclosed double reduction worm gears by a ¼-h.p., 115-volt direct current motor.

The anode or positive electrode of the arc converter consists of a metal tube with a narrow water cooled copper tip which is renewable; the flame of the arc burns between this copper tip and the carbon electrode of the cathode.

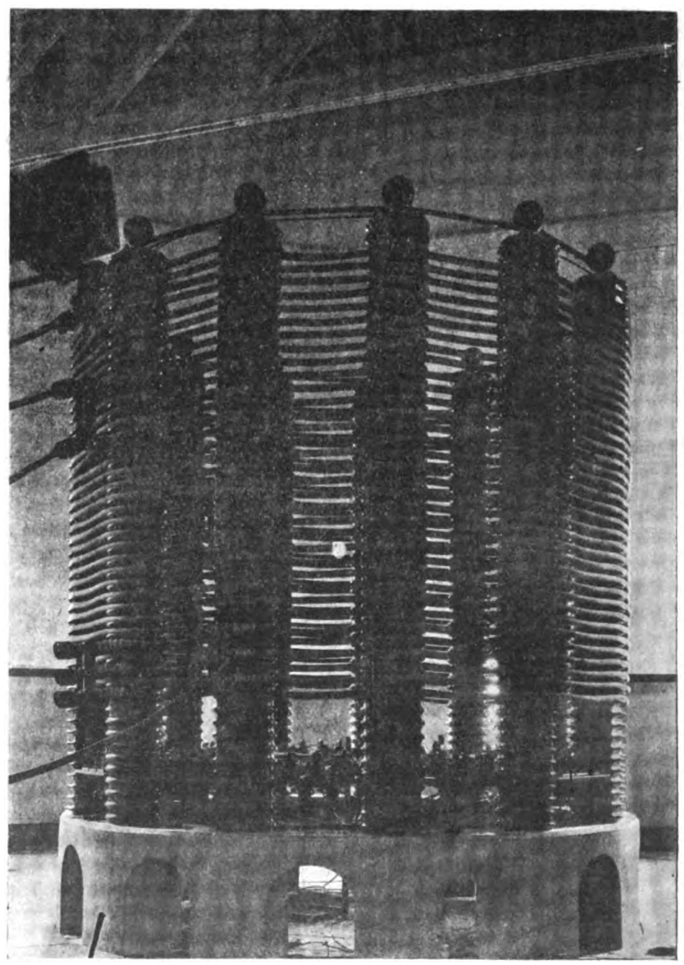
The anode holder is insulated from the frame of the arc converter by a round insulating disc of ebony asbestos. This is placed at the outer end of a water cooled jacket which forms an extension of the chamber. The relatively cool gases in this jacket protect the insulating disc from the heat of the arc flame. The cooling water for the anode is carried to and from it by rubber hose.

It is important that the arc chamber should not be opened after the arc has been in operation until plenty of time has been allowed for the carbon to cool, the chamber is full of combustible gases, which will be ignited by the hot carbon if air is admitted. Two electric Danger signs mounted upon the arc converter which are illuminated whenever the main line contactor is closed and remain lighted after the arc has been shut down until sufficient time has elapsed for the carbon to cool. The lights are controlled by an automatic timing relay.

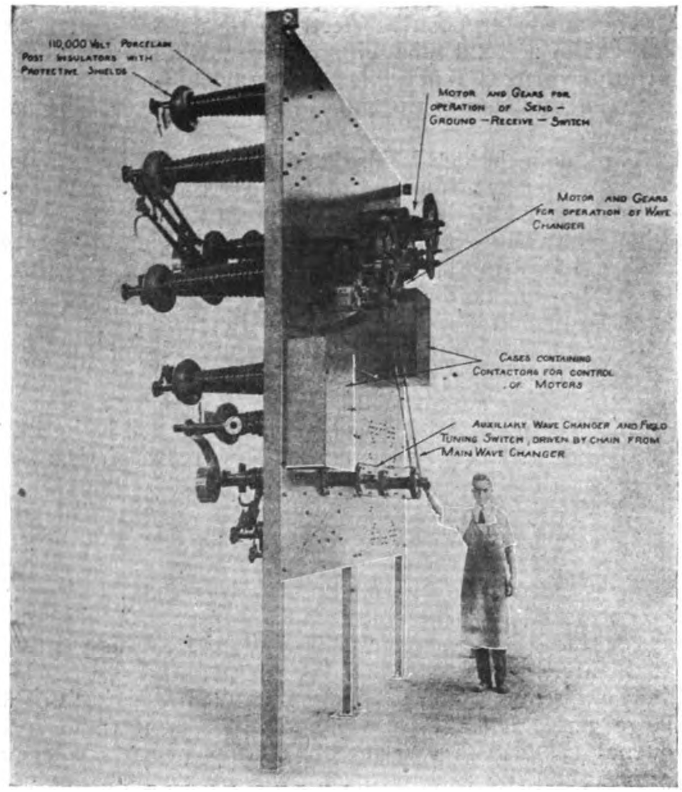
A benchboard located at each arc converter enables the arc engineer to control the whole station from his position at the arc.

The antenna loading inductor is built in the form of a large single layer helix wound with special radio frequency cable upon a series of columns which are made of porcelain rings. Taps are provided for connecting any desired number of turns of this coil in the antenna circuit. Cables connect the proper taps on this loading inductor to the wave changer, which makes the necessary adjustments for five different wavelengths.

The combined wave changer and send-ground-receive switch is a voltage switchboard built with steel panels and



The gigantic helix of the Navy's most powerful wireless station



Combined wave changer and send-receive ground switch with remote electrical control

porcelain post insulators. The send-ground-receive switch occupies one of the four steel panels which compose the board. The main and auxiliary wave changer switches occupy the other three panels. Both the wave changer and the send-ground-receive switch are of the electrical remote control type, and are controlled by drum controllers on the arc benchboard. Each is driven by a ½ H. P., 115-volt, D. C. motor, through double reduction spur gears. Each motor is controlled through contactors by an automatic switch which is inter-connected with the corresponding drum controller.

The wave changer may be set for any one of five wavelengths by turning its controller on the benchboard to the proper position. Similarly, the send-ground-receive switch may be set upon any of its three positions by placing its controller on the desired notch.

For each of its five positions, the wave changer connects in the antenna circuit the proper number of turns of the antenna loading inductor to give the desired wavelength. It also tunes or adjusts the arc magnetic field to give maximum antenna current and steadiest operation of the arc for each of the five wavelengths.

The main switch arm of the wave changer is mounted upon 110,000-volt. porcelain post insulators, and is operated directly by the motor and gears. The auxiliary switch arms are driven by roller chains which connect them with the gear mechanism of the main switch. In operation, the switch arm on the wave changer short-circuits a portion of the arc field winding to give the proper field strength.

In the Annapolis station the coupled compensation method of signaling is employed. A number of relay keys are connected with a loop system which is inductively coupled with the main antenna loading inductor. Two sets of control relays are provided for the operation of the relay keys. One set is used for high speed sending, and the other set for hand sending. For high speed sending, current for the operation of the relay keys is provided by a special 15 kw., 575-volt generator which is driven by a 220-volt induction motor. For hand sending, 125-volt direct current is used. This is furnished by the 3 kw. motor generators which supply current for the station control circuits and arc auxiliaries.

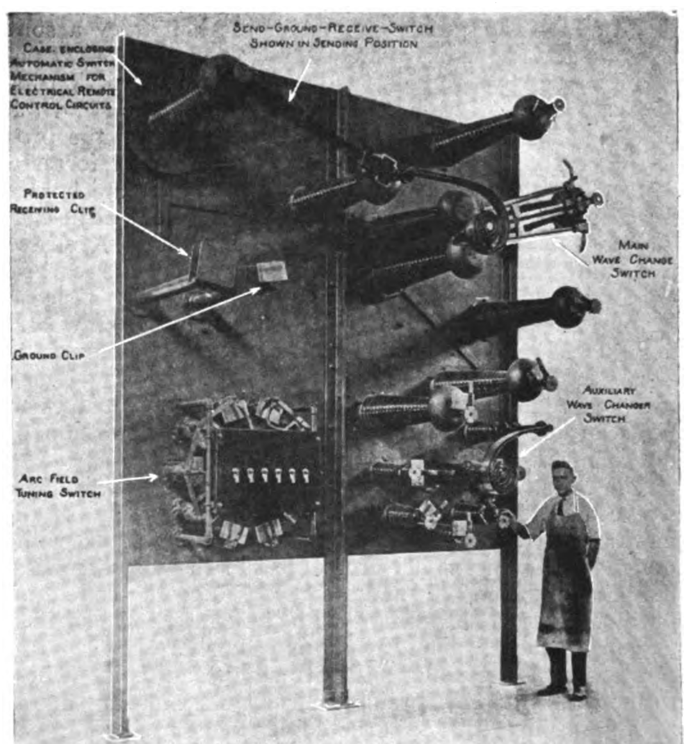
For high speed sending, all of the switches on the transfer panel are thrown toward "high speed sending." The relay keys are then operated in groups of three by 575-volt direct current. Each group of three keys is controlled by one control relay.

The control relays are operated as a group by a master relay using 125-volt direct current. A rheostat behind the switchboard serves to regulate the current which they receive to the value necessary to give the desired speed.

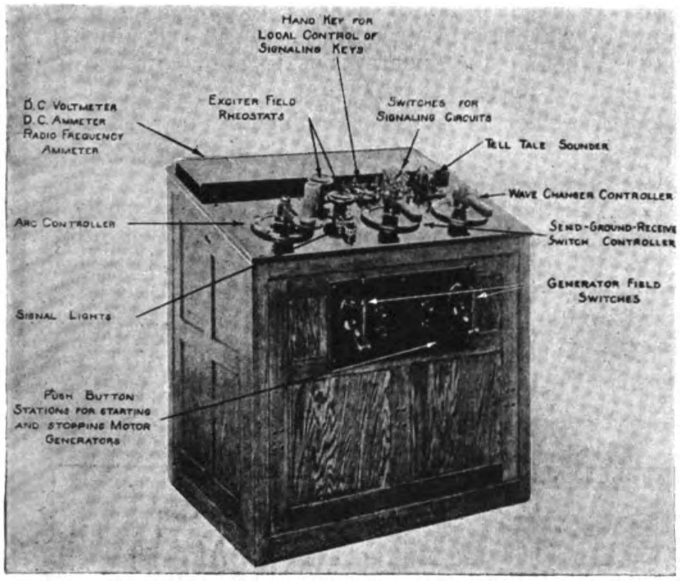
The current which is supplied to the relay keys themselves is regulated by adjusting the spring tension and magnetic air gap of the control relays. A signal light is provided for each control relay, and therefore for each group of three keys. When the keys are operating normally, this signal light burns dimly. In case one of the control relays sticks closed, the signal light burns brightly, indicating that that particular group of three keys is receiving excessive current and its control relay is then adjusted immediately. The signal light goes out in case the control relay sticks open, thereby indicating that that particular group of three keys is not operating.

For hand sending, all of the switches on the relay key transfer panel are thrown toward "hand sending." All the relay keys are then connected in two main groups, each group being operated by one control relay. The relay keys are then operated by 125-volt direct current. This is supplied through a small contactor which closes whenever the main line contactors are closed. This arrangement prevents current being left in the relay key circuits when the arc is not in use. The two control relays used for hand sending are operated by the same master relay which operates the larger group of control relays used for high speed sending.

Cooling water is supplied to the arc converter through a valve operated by the arc drum controller. This valve is opened on the first two notches of the controller and is therefore turned on whenever the controller is advanced for starting the arc.



Send-receive ground switch shown in sending position



Arc control benchboard

The antenna ice melting equipment, by means of which ice may be melted from the wires of the antenna, is operated by a series of switches and utilizes current from the two 400 kw. generators.

During normal operation of the station two switches connect all four of the cables leading down from the antenna loading inductor and thence to the arc. All four of the antenna cables are then connected in parallel, and carry approximately equal amounts of radio frequency current. When it is desired to melt ice from the wires of the antenna, the switches are thrown over to the "ice melting" position, and the four antenna cables are then connected in series. The connections in the antenna itself are such that when the switches are in "ice melting" postion, current will flow through all the various wires of the antenna, heating them and causing the ice to melt.

Circular shields with a large radius of curvature are provided for making connections through the holes in the plate glass antenna entrance windows. The shields furnish charging currents to the glass and prevent corona at high voltage.

The Design of Multi-Stage Vacuum Tube Receiving Circuits

By Lieut. J. Scott-Taggart, M.C.,

Membre de la Société Française des Electriciens

THE present article is intended as an introduction to modern methods of connecting vacuum tubes in cascade for the purpose of receiving wireless signals. Few details regarding such circuits, which are of paramount interest to those engaged in wireless work have been given, and it is proposed to describe some typical practical circuits which have been taken from a complete volume on vacuum tubes by the present author and which will shortly be published by Wireless Press, Ltd., Henrietta Street, London.

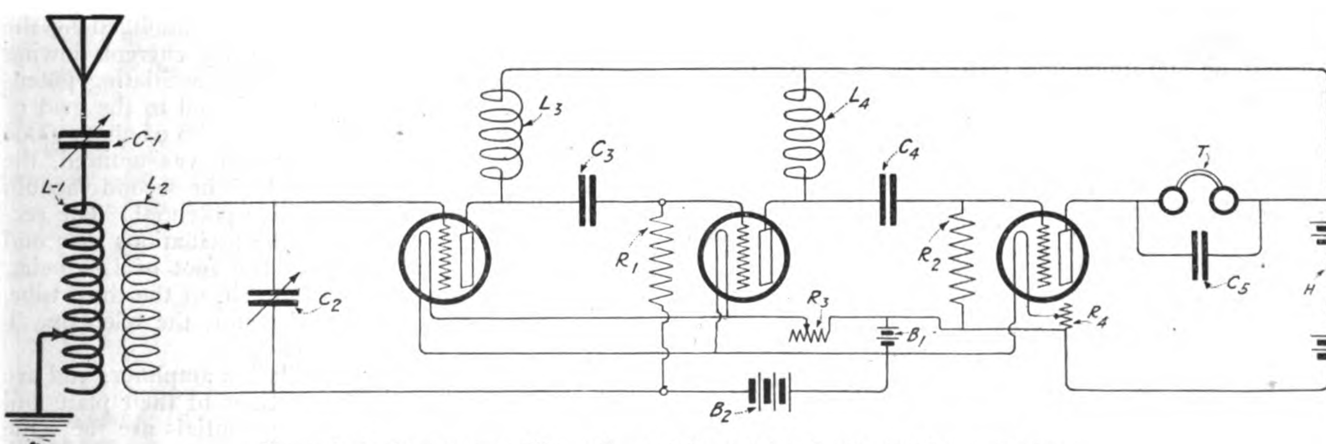


Figure 1—A three-stage amplifier with aperiodic auto-transformer coupling arrangement

All the following circuits possess one common filament battery and one plate battery. A single plate battery may be used provided that its resistance is negligible. The stipulation is that there shall be no resistance common to the plate circuits of several tubes. The voltage applied to the plates of the vacuum tubes is consequently best varied by means of tappings off the battery, and not by means of a variable high resistance in series with the plate battery. Another feature of the amplifier design is that all the vacuum tubes used as amplifiers are adjusted to the same operating point. The plates of all the amplifying tubes are given a fixed voltage which is variable if desired. A single rheostat (of about 5 ohms resistance) serves to adjust the filament currents of all the valves simultaneously. Likewise, since all the tubes are of identical construction and carry out the same functions, a single potentiometer to control simultaneously the grid potentials of all the amplifying vacuum tubes can be used. This potential is preferably negative and in the neighborhood of 2 volts.

Cascade amplifiers may roughly be divided into four classes.

(1) High frequency amplifier-detectors, which use several tubes as oscillation amplifiers and a final tube as a detector.

(2) Amplifiers similar to the above, in which the de-

tector valve is followed by one or more stages of low-frequency amplification.

(3) Amplifiers in which the first vacuum valve acts as a detector, the succeeding tubes operating as low-frequency amplifiers.

(4) Amplifiers in which the oscillations are magnified by a number of tubes and then rectified, the rectified pulses being now led back to one of the preceding tubes and re-amplified by the system at low frequency.

Each of the above four types may be provided with arrangements for producing regenerative amplification or self-oscillation (the latter for continuous-wave reception). Here again the amplifiers may be modified by different methods of obtaining regeneration such as:

(1) The use of magnetic couplings, direct or indirect

(2) The use of capacitative coupling.

(3) Whether it is for general reception on a wide range of wavelengths or only on one wavelength.

(4) Whether the apparatus is to allow of many adjustments or as few as possible.

(5) Whether it is for experimental or commercial work.

(6) The degree of amplification desired.

(7) Whether loud signals or weaker signals with less interference are desired.

(8) Whether the circuit is intended for the reception of weak or strong signals.

(9) Whether the circuit is to be used for the reception of continuous waves or not.

(10) Whether the amplifier is to be used for the reception of short waves or long waves.

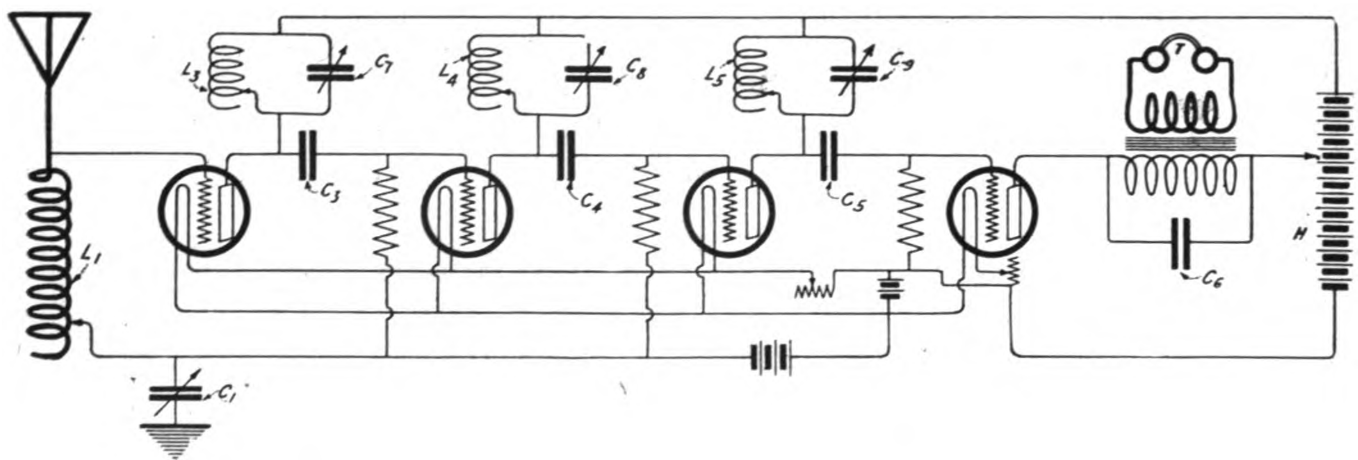


Figure 2—Four-stage amplifier-detector with tuned intermediary auto-transformer

(3) The use of resistance or conductive coupling.

Another matter of utmost importance in the design of multi-stage amplifiers is the means to be adopted for coupling the output circuit of one tube to the input circuit of the next. One or other of the following methods is usually used:

1. (a) Aperiodic air-core auto-transformers.
   (b) Tuned air-core auto-transformers.
   (c) Air-core auto transformers with aperiodic plate circuit and tuned grid circuit (or vice versa).
2. (a) Aperiodic air-core oscillation transformers.
   (b) Oscillation transformers having aperiodic plate circuit and tuned grid circuit (or vice versa).
   (c) Completely tuned air-core oscillation transformers.
3. Use of coupling resistances.
4. Employment of impedance coil couplings.
5. (a) Aperiodic iron-core auto-transformers of fixed ratio.
   (b) Similar transformers with step-up ratio.
   (c) Above transformers resonated to give frequencies.
6. (a) Aperiodic step-up iron core transformers.
   (b) Tuned iron-core transformers for low frequency amplification.
7. Iron-core transformers as described in classes 5 and 6, but designed for high frequencies.

Each of these systems of couplings has its advantages and disadvantages. The complicated circuit, while giving excellent results in the hands of an expert, is obviously unsuitable for use by the average operator. The design of amplifier chosen will depend on the following conditions:

(1) Whether the apparatus is to be handled by an expert or an inexperienced operator.

(2) Whether it is to be portable or not.

These questions must first be answered before commencing the design of a multi-stage vacuum tube receiving circuit. It is now proposed to describe typical amplifiers of each of the seven classes and to show some of the various modifications which are possible. Each of the above ten questions should be applied to the circuit under discussion. By doing this a suitable circuit is evolved having just those characteristics and modifications which are necessary to make it carry out the duties required of it. Figure 1 shows a three-stage amplifier having aperiodic inductances L-3 and L-4 connected as shown. The received oscillations are amplified by the first tube, the magnified high frequency current flowing via L-3 and the plate battery H. The oscillating potentials at the foot of L-3 are communicated to the grid of the second tube through the condenser C-3 of about .0003 mfd. capacity. If the condenser C-3 was omitted, the potential of H would give the grid of the second vacuum tube a high and undesirable positive potential. The second vacuum tube now amplifies the oscillations a second time, the magnified potentials at the foot of L-4 being communicated through C-4 to the grid of the third tube, which is arranged to act as a detector, the telephone T being connected in the plate circuit.

The first two tubes act as oscillation amplifiers and are arranged to work on straight portions of their plate and grid current curves. Their grid potentials are the same and are given a suitable negative value by means of the battery H-2, consisting of one or two cells. The second grid receives its potential through the resistance R-1 of from 2 to 5 megohms. Since the grid is negative there is practically no grid current. Consequently there is no fall in potential across R-1 in spite of its high resistance. This use of the resistance R-1 and battery B-2 is very useful in all amplifiers using auto-transformer, resistance or impedance couplings.

The rheostat R-3 (of about 5 ohms resistance) is used to vary the current supplied by the accumulator B-1 to the filaments of the two amplifying tubes. A separate rheostat R-4 is used to vary the filament current of the detector valve which requires a different adjustment to that of the amplifying tubes. The resistance R-2, having about the same value as R-1, acts in a manner similar to the leak across a leaky grid condenser. It prevents an excessive negative charge from building up on the grid of the third valve. The foot of R-2 might, if desired, be connected to the negative side of B-1. If instead of desiring to use grid current rectification it were desired to work on one of the bends of the plate current curve it would be possible to include a potentiometer between the foot of R-2 and the battery B-1. A suitable operating point on the saturation bend may, however, be most easily obtained in a circuit similar to figure 1 by adjusting R-4. (J. Scott-Taggart "On Valve Characteristic Curves and Their Application in Radiotelegraphy," Wireless World, Sept., 1918).

The inductances L-3 and L-4 should have a natural wavelength less than the wavelength to be received. If the range of wavelengths to be received is wide, tappings may be taken from L-3 and L-4.

Figure 2 shows a modification of the figure 1 circuit. Four vacuum tubes are shown in use. The first three act as amplifiers and the last as a detector. The intermediary inductances L-3, L-4 and L-5 are tuned by the aid of variable condensers C-7, C-8 and C-9. The circuit as it stands is capable of much finer tuning than figure 1, each plate oscillatory circuit requiring to be tuned to the incoming waves, whereas the figure 1 circuit will respond to a wide range of wavelengths without adjustments of the amplifier circuits. In the plate circuit of the last valve is the primary of the step-down telephone transformer. Across this winding is connected a condenser C-6, which, like C-5 of figure 1, allows the passage of the comparatively strong high frequency component of the rectified current in the plate circuit without injuring the windings. Another feature is the use of a separate tapping, which allows the plate voltage of the detector valve to be independently regulated.

(To be continued.)

Some Recent Developments in Radio Transmitters

By Morton W. Sterns

Due to the impetus of the war many and various were the types of transmitters that were developed. Of these many have been described in current periodicals, but nothing at all has been published, to the writer's knowledge, on a very interesting phase of the subject, viz.: the utilization of direct current for transmission without the use of vacuum tubes, Chaffee gaps, arcs, etc.

As is well known, at the outbreak of the war the government asked for samples of transmitters of various kinds, mainly for aeroplane use, giving only very general

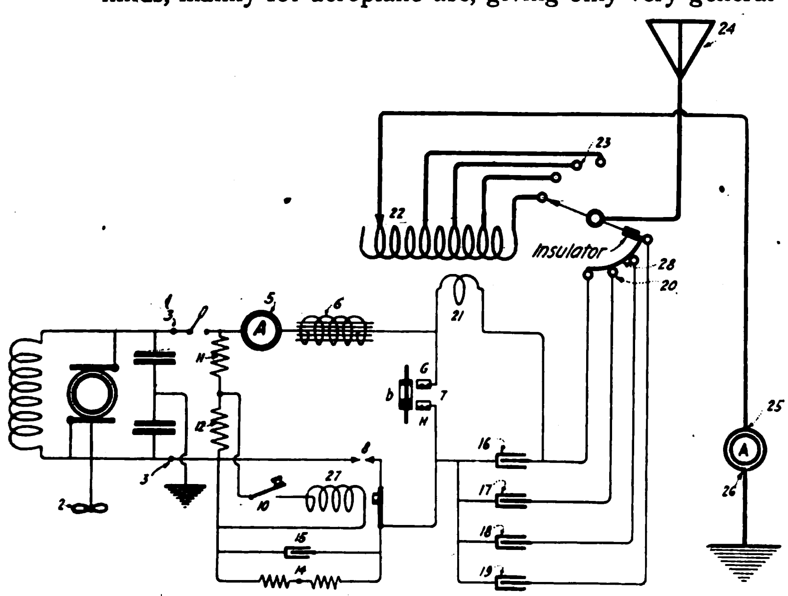


Figure 1—Wiring diagram for airplane radio buzzer set design by Sperry Gyroscope Co.

specifications as to space, weight, antenna capacity, etc., and allowing the various manufacturers to use their own judgment as to type. From the original samples thus produced the present types were developed, which incorporate also the changes found advisable in service.

Among the sets submitted was a direct current buzzer set manufactured by the Sperry Gyroscope Company, illustrated in figure 3. From this original sample a rather complete line of buzzer transmitters of various powers and for various conditions were developed.

It may not be amiss to look into the advantages of the buzzer type transmitter. First, it is very simple in construction and is easy to manipulate; second, it eliminates the use of high potentials, thus simplifying insulation problems; third, it is fairly efficient—ranking quite well with other types of sets; fourth, its extreme simplicity makes it very easy to understand and operate.

A schematic wiring diagram of the buzzer transmitter in its simplest form is shown in figure 2.

To follow its operation imagine the key to be depressed, the current will then flow from the direct current source through the choke coil into the movable spring D, to the stationary contact C and thence back to the source. When current traverses the choke coil winding it becomes a powerful magnet and attracts the iron armature on the movable spring D, which moves over toward the magnet core and opens the circuit at the contacts C, D. Immediately the current ceases to flow in the electro-magnet (choke coil), and, since the magnet

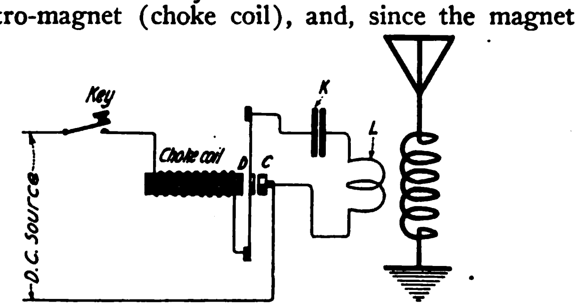


Figure 2—Schematic wiring diagram of the buzzer transmitter

no longer attracts the armature of D, the movable spring D returns to its normal position, due to the bending force it was under. This immediately causes current to flow again in the magnet winding, and the same cycle of operation takes place as long as the key remains depressed.

When the magnet coil causes the circuit to be broken at the contacts C, D, an excessive instantaneous voltage is produced across the gap C, D, due to the inductive kick of the choke coil, and this voltage charges the condenser K in the high frequency circuit CDKL, which in turn discharges across the now open gap and sets up highly damped oscillations in the circuit CDKL and impulses the closely coupled antenna circuit into oscillation at whatever frequency it happens to be tuned to.

If L be the inductance of the coil in henries and I be the current flowing through the coil in amperes, then the voltage across the coil at the instant the current is broken is equal $\frac{1}{2} LI^2$, and this voltage is also effective across the gap CD and tends to charge the condenser K.

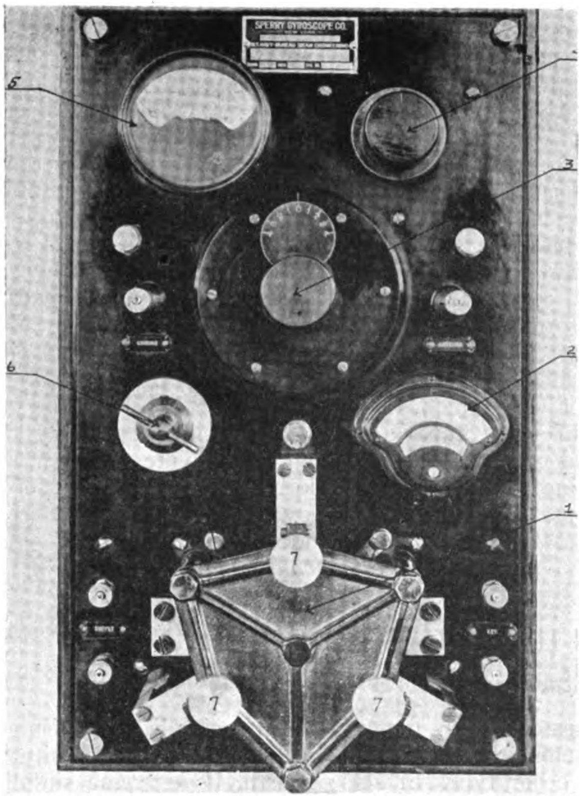


Figure 3—Front view of 500-watt, 500-volt buzzer transmitter

Since the energy stored in the condenser is equal to $\frac{1}{2}CE^2$ it is seen that in order to get maximum output we must use the largest capacity condenser consistent with the wavelength. Using a large capacity condenser fulfills two necessary conditions simultaneously, viz., the elimination of sparking at the contacts C, D and causing a preponderance of capacity with only enough inductance in the high frequency circuit CDKL to efficiently transfer the energy from primary to secondary. This is the ideal condition for an oscillation circuit to rapidly damp out after one or two oscillations and impulse a secondary circuit.

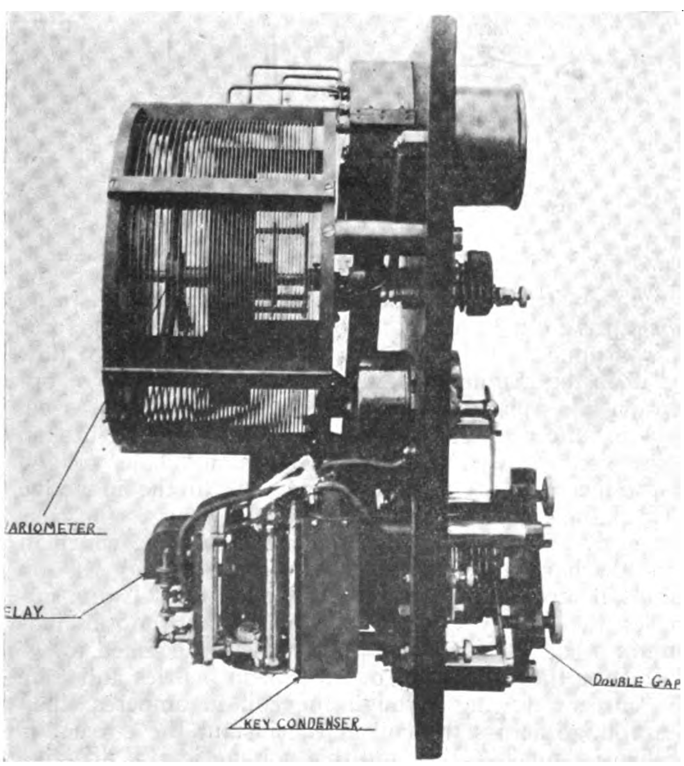


Figure 4—Side view of figure 3, showing arrangement of instruments

The radiation produced by the larger type sets, to be described and illustrated in figure 3, have a rather low note and the wave characteristic is somewhat between a pure undamped wave and a damped wave, so that a receiver of either the usual crystal type or the heterodyne receiver could not get the maximum audibility from its signals. However, since the radiation was good, and since excess of energy existed to work with this slight disadvantage, it was felt it could be overcome. After some experimentation I discovered that by placing a rotary chopper on the antenna circuit I could modulate the emitted envelope and produce notes of absolute purity which, while decreasing the radiation slightly, greatly increased the working range due to its absolute tone characteristics. The note could be varied at the will of the operator by simply changing the speed of the chopper motor, which controlled the rapidity of interruption. It is interesting to note that the use of the chopper was not needed on low power sets.

The oscillations produced by this type of set are almost of the impact excitation type, and to change the wavelength of the emitted wave for ranges of a few hundred meters, the primary may be set at one wave and

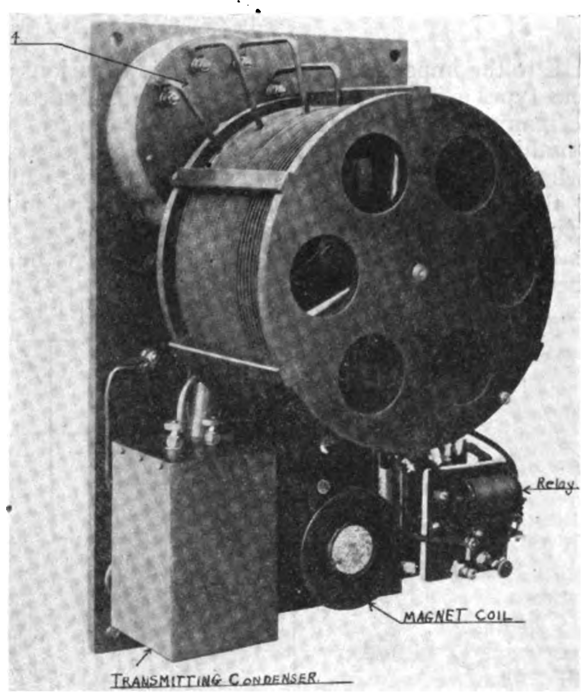


Figure 5—Rear view of figure 3, showing the helix, relay key, coil and condenser

the inductance in the open circuit may be varied. For large ranges of wavelength, such as is shown in figure 10, where seven wavelengths varying from 600 to 2,400 meters are used, it is policy to vary the capacity of the primary condenser for every two or three wavelengths, although the maximum radiation is seldom produced when the primary and secondary circuits are in tune.

A brief description of the three standard type buzzer transmitters manufactured by the Sperry Gyroscope Company will now be given.

Referring to figure 10 we see a very small type 75-watt set which operates on 110 volts D. C. Its dimensions are approximately 7 x 12 x 5 inches, and the whole outfit can be readily held in one hand. It was originally designed for airplane use, but eventually an even more compact set of the same type was developed and these first sets were installed on small boats.

On a submarine chaser antenna these sets give a radiation of about 2 amperes on all wave lengths. On a 250-foot trailing wire from an airplane a radiation of 1.25

amperes was obtained and a very strong signal was obtained at a distance of 18 miles.

Referring to figure 10, the wave changer appears at the top of the panel. This wave changer allows a selection of seven wavelengths between 600 and 2,400 meters to be rapidly made. Under the bakelite button at the switch centre is a fan contact which automatically connects in various values of the primary condenser as explained above. Underneath is the antenna and ground binding posts and the hot wire radiation ammeter. Below the ammeter is the buzzer gap which is constructed somewhat after the fashion described in my article in the July WIRELESS AGE. The arrow points to the vibrating contact. The top of the stationary contact can be seen extending from its casting and shows the method of adjustment. At the bottom of the panel are the terminals for the supply and key. In the rear of the panel behind the wave changer are mounted the pan-cake oscillation transformers wound with large size litzendraht and tapped for the various wavelengths. The primary consists of about three turns. The key and oscillation condensers are mounted in one case behind the ammeter and naturally the magnet coil is mounted behind the gap casting.

The front view of the original type of buzzer transmitter submitted to the government at the outbreak of war is shown in figure 3. This type of equipment was manufactured in large quantities and furnished to both the Navy and Signal Corps. It is a 500-watt 500-volt set and furnishes a radiation of 4.5 to 5 amperes on a 300-foot trailing antenna as used on airplanes.

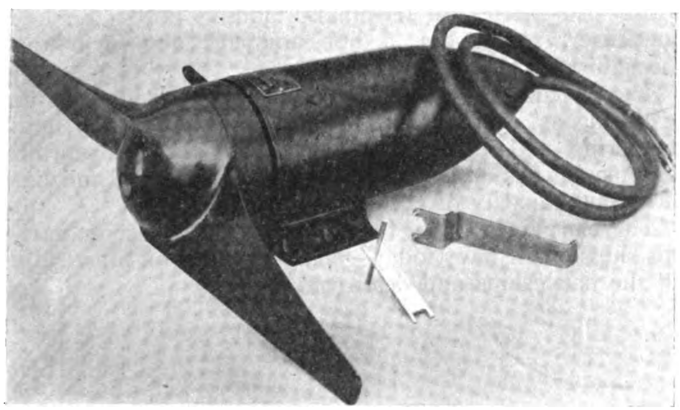


Figure 6—Wind driven generator equipped with self-regulating propeller blades

While these sets were designed primarily for airplane use they were eventually used for ground telegraphy and on training planes, being superseded by more compact types for airplane use.

Referring to figure 3, the hot wire radiation is shown at 5, while 4 shows the wave changer which has the four standard navy waves, namely, 300-378-476-600 meters. Number 3 indicates the antenna variometer adjustment, which allows the wave to be corrected for changes in antenna capacity due to flying low or having part of the antenna reeled in. The scale above the adjustment knob shows the number of turns added or subtracted from the antenna circuit. A total variation of 25 meters is possible with the variometer. Another view of the variometer and a side view of the set is shown in figure 4.

On either side of the variometer handle are mounted the insulated binding posts for antenna and ground.

The main switch which turns the power on or off is shown at 6, while number 2 represents the direct current ammeter in the power circuit.

Number one is the gap, showing the adjusting screws 7. On either side of the gap are the supply and key terminals.

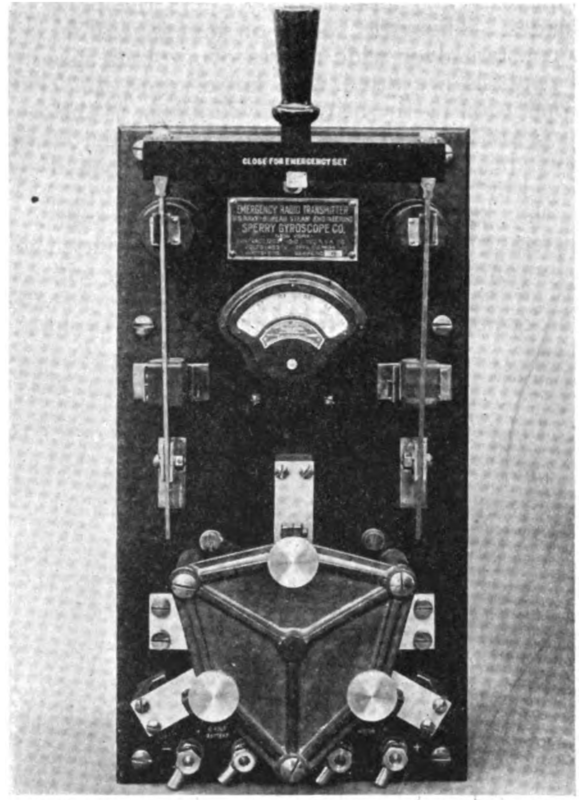


Figure 7—Front view of the emergency radio transmitter

Figures 4 and 5 show a side and three quarter view of the set and give details of the various condensers, helix and relay key.

Figure 6 shows the 500-watt 500-volt wind driven generator furnished with the set, also the necessary wrenches for dissembling the generator. This illustration shows the original type fan with a manually operated brake to approximate constant speed regardless of the maneuvers of the airplane. As is well known, if the plane takes a nose dive the generator speeds up and develops such an excessive potential that damage may ensue. For this reason most of the sets are equipped with self-regulating fans. When the speed of the airplane increases and consequently the speed of the generator, a centrifugal regu-

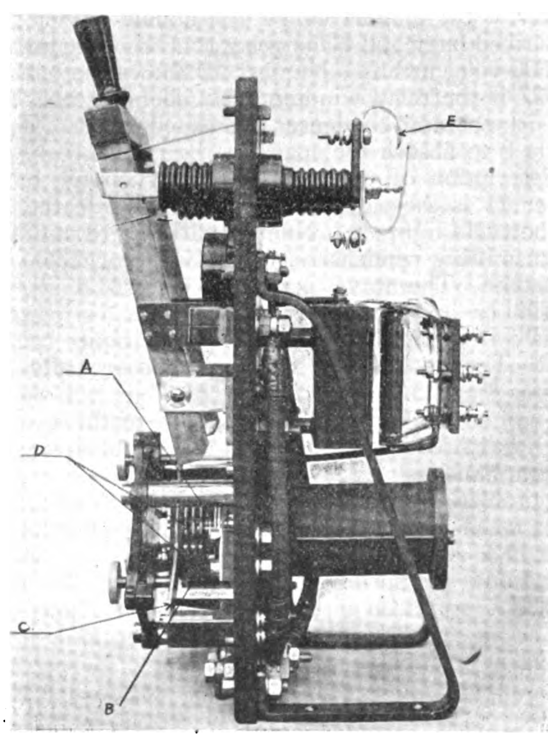


Figure 8—Side view of the emergency set designed for use on shipboard

lator flies out and automatically alters the pitch of the fan blades. Thus the speed of the generator is kept fairly constant over wide ranges of airplane speed.

All controls are fitted with large knobs to permit of their operation by the heavy-gloved hands of the aviator. All parts are fastened so as not to loosen under vibration. The switches must all be pulled out to turn and cannot be moved by vibration.

The key, mounted on an insulated piece with a strap for fastening on the leg of the operator, is fitted with a large button to allow the operator to work it with gloves on.

In order not to put the full potential of 500 volts on the leg of the operator two resistances Nos. 11 and 12 are connected across the line and the fall of potential across resistance 12 in diagram B, which is equal to about 100 volts, operates the relay. Thus if the insulation of the key should break down there would never be more than 100 volts near the operator and his glove would protect him from that.

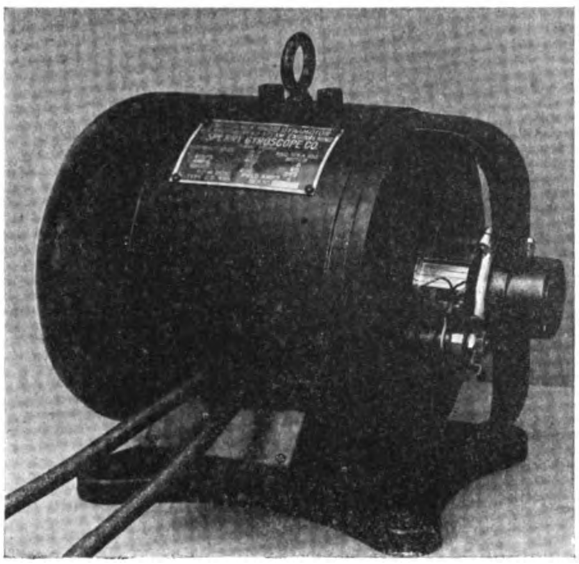


Figure 9—Two-pole semi-enclosed dynamotor which operates on a 6-volt storage battery

Referring to figure 1, No. 2 represents the air driven shunt wound generator. No. 3 shows the kick-back preventer condensers, 4 the main switch, 5 the D.C. ammeter, 6 the magnet coil, 7 the double buzzer gap to be described later and 8 the relay contacts that break the main 500-volt current. Number 10 shows the hand key, while 27 is the relay winding. Numbers 14 and 15 are the resistance and condenser connected across the relay contacts 8 to absorb the spark at the relay break.

A description of the high frequency circuit follows: Number 21 is the single turn primary inside the helix. It is shown in figure 4. Numbers 16, 17, 18 and 19 are the transmitting condensers, with a value of .12 M.F. on 600 meters. The wave changer is shown at 28 where the primary and secondary circuits are varied simultaneously from the one knob, the two circuits being insulated. The taps in the secondary circuit are fully shown in figures 4 and 5.

We will now take up the construction of the spark gap 7 which is in reality two gaps in series but arranged to open simultaneously.

The oscillating member of the gap consists of a copper disc 7b faced heavily with silver. This copper block is carried in a recess of the cooling block. The whole is mounted on a flat spring which is actuated by the electro magnet. A soft iron disc serves the double purpose of acting as an armature for the magnet and as a nut for clamping in position the oscillating gap.

The stationary gap is divided, forming two insulated electrodes, 7g and 7h. The current thus enters through terminal 7g, passes across the gap toward the panel, then down through the vibrating electrode, back across the gap in the opposite direction, and out of the terminal 7h.

One of the essential requirements of this type of gap is that the surfaces be parallel, and in order to make this parallelism a matter of easy adjustment the construction shown was used.

The stationary gaps are mounted on and insulated from an inverted Y spring carried on high standards. Now on each prong of the Y, midway between the centre and the supports, an adjusting screw, 7, figure 3, bears. By turning down any one of these screws, the face of the stationary gap will be tilted down in that direction. By turning down all the screws equally, the entire stationary gap may be moved into contact with the vibrating gap. The pressure of this contact determines the power input. This construction is fairly well shown in figure 8.

Here A is the vibrating contact 7b, B is the vibrating spring. D shows the stationary gaps 7g and 7h. C is the inverted Y spring.

The size of this airplane set is 12 inches wide, 20 inches high and 10¼ inches deep. Its weight is approximately 50 pounds.

The Sperry Type CS 494 Emergency Radio Transmitter is designed for use on shipboard, as an emergency set, when power from the main supply is cut off.

It operates on a 6-volt storage battery through the medium of the dynamotor which delivers 400 volts D. C. to the transmitter. Figures 7 and 8 show the transmitter, while figure 9 shows the dynamotor.

The transmitter is of the vibrating gap type with a capacity of 200 watts continuous sending. It is mounted on a bakelite panel 9½ inches wide by 20 inches high. The panel also carries all terminals, binding posts, the key condenser, resistances, a line ammeter and switching mechanism.

The dynamotor is a two pole, semi-enclosed machine operating as a motor from a 6-volt storage battery, and delivering 400 volts direct current to the transmitter. The machine is entirely fitted with ball-bearings and has an output capacity of 200 watts.

There are over 250 of these transmitters in use on various ships of the navy today—being installed on practically all the battleships and destroyers.

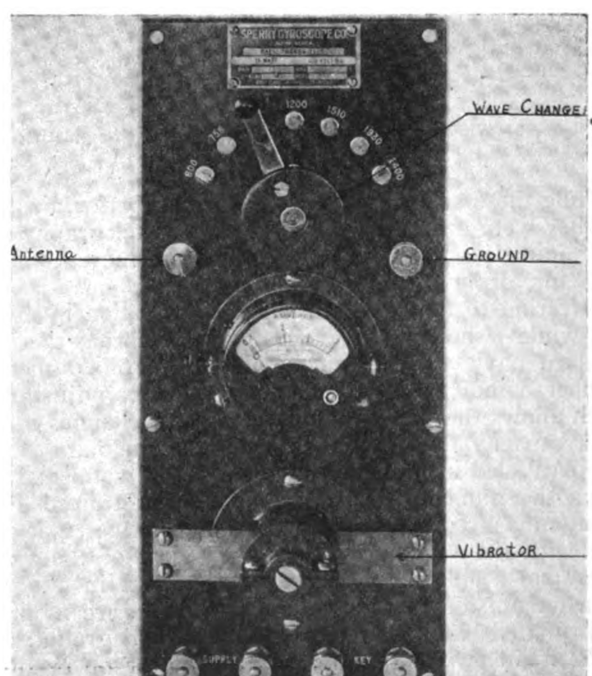


Figure 10—Small type 75-watt buzzer transmitter

This transmitter is intended for emergency use and operates in conjunction with the standard wave-changer of the main radio set and its condenser.

Radio Frequency Interference Balance

THE effect of static disturbances upon a receiving system may be likened to that of a blow upon a tuning fork. Characteristic damped oscillations of the natural frequency of the system are set up therein and these cannot be tuned out as can persistent or sustained oscillations of a definite periodicity from a foreign station. In the present arrangement no attempt is made to tune out the interference known as "static" but an auxiliary system is provided whose function is, in co-operation with the receiving system, to balance out or neutralize static disturbance with respect to the receiving device. The auxiliary system is tuned and is therefore unresponsive to the continuous waves it is desired to receive. The natural oscillations excited by static disturbance in the receiving and auxiliary systems are therefore of different frequencies. For this reason a frequency converting device is provided to convert the frequency of the oscillations in the auxiliary system to the same frequency as that of the oscillations in the receiving system and differentially combine the resultant oscillations with respect to the receiving device. A further feature of the idea consists in providing an auxiliary system whose characteristic damping factor is the same as that of the receiving system. The arrangement is best understood by reference to figures 1, 2 and 3, which are diagrams illustrative of three forms of wireless receiving systems embodying the invention. Referring to figure 1, a pair of receiving antennae are provided, antenna 1 being tuned to the receiving frequency and antenna 2 being tuned to a frequency differing sufficiently therefrom to render it unresponsive to the receiving frequency. Coupled to antenna 1 by a transformer is an oscillation circuit tuned to the receiving frequency and working into the input side of a vacuum tube amplifier of the usual construction. Similarly, antenna 2 is connected by means of a transformer to an oscillation circuit tuned to the same frequency as its antenna and working into the input side of a second vacuum tube amplifier. A frequency transformer 9, of the Goldschmidt type is provided, this transformer comprising a rotor winding 10, and stator and field windings 11 and 12, winding 11 being included in the output circuit of amplifier 8. The rotor winding is connected to the input side of a modulator whose output circuit works through a transformer into an oscillation circuit connected to the input side of a vacuum tube detector in the output circuit of which is a receiving telephone.

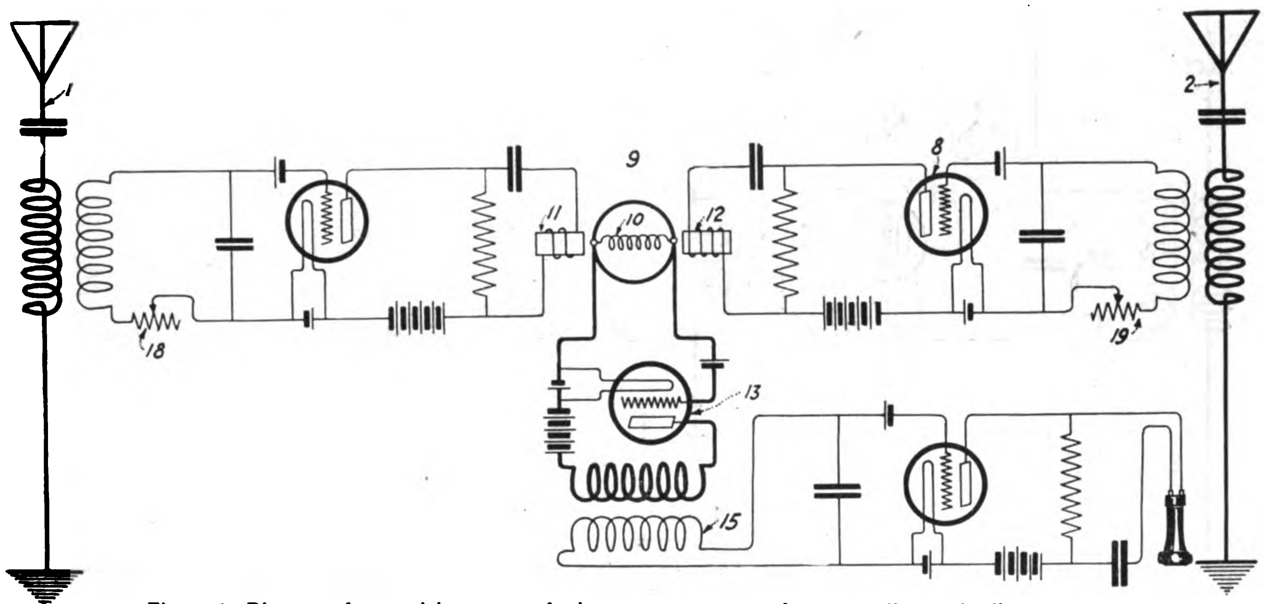


Figure 1—Diagram of a receiving system having two antennae used to neutralize static disturbances

The frequency transformer above referred to is so constructed that its rotor winding may be rotated at a speed such as to give an alternating frequency n. If then, a frequency N be impressed upon its stationary winding 11, it may be shown that two frequencies $N+n$ and $N-n$ will appear in the rotor circuit while if a frequency N_1 be impressed on winding 12, frequency N_1+n and N_1-n will appear in the rotor circuit.

Suppose a static disturbance affects both antennae and that these antennae are resonant to frequencies N and N_1 respectively. Antenna 1 will oscillate at frequency N and impress oscillations of the same frequency upon its oscillation circuit, these oscillations being amplified by the amplifier and impressed in the field winding 11. At the same time antenna 2 oscillates at frequency N_1 and impresses this frequency upon its oscillation circuit, these oscillations being amplified by the connected amplifier and impressed upon the field winding 12. If now the rotor be rotated at an alternating frequency n, so chosen as to be equal to ½ (N—N) three frequencies will appear in the output circuit, namely $N+n$, $N-n=N_1+n$ and N_1-n. These frequencies are amplified by amplifier 13 and impressed upon oscillation circuit 15 which is tuned to frequency $N-n=N_1+n$ so that this frequency is brought out and frequencies $N+n$ and N_1-n are suppressed. The circuits may be so adjusted that the oscillations from both antennae are impressed upon their respective stator windings in such a manner as to appear in the rotor circuit in opposite phase relation, while by suitable adjustment of their respective amplifiers the oscillations may be given the same amplitude, and by means of variable resistances, the same decrement. Being converted to the same frequency by the frequency transformer it is obvious that the two sets of oscillations will then neutralize each other and that no oscillations will appear in the oscillation circuit and no effect will be produced on the detector or the receiving instrument. If, however, signals of a frequency N are received the antenna 2 is substantially unaffected while the antenna 1 being resonant to this frequency impresses said frequency through the amplifier upon field winding 11. As a result, frequencies $N+n$ and $N-n$ appear in the rotor circuit and are amplified by amplifier 13. The oscillation circuit suppresses the frequency $N+n$ while frequency $N-n$ is impressed on the detector and gives a signal in the receiving instrument. It is obvious that the rotor circuit may be tuned to the desired frequency $N-n=N_1+n$ so that the undesired frequencies N+*n* and N_1—*n* are suppressed before amplification by amplifier 13, in which case the oscillation circuit 15 would be unnecessary. It will further be noted that by the provision of resistances 18 and 19, the auxiliary circuits, including antenna 2 and associated circuit may be adjusted so as to have the same damping factor as the receiving circuits so that static disturbances produce oscillations of the same damping in both sets of circuits.

Another arrangement is illustrated in figure 2 in which an antenna is provided having two branches, branch 21 being resonant to receiving frequency N and branch 22 being resonant to a different frequency N. Branch 21 is coupled through a transformer 23 to an oscillation circuit tuned to frequency

N+*n* and N—*n* are suppressed and only frequency N—*n*=N_1+*n* is impressed on detector 37. As the circuits are adjusted so that oscillations of frequency N—*n* and N_1+*n* are impressed upon oscillation circuit 36 in opposite phase relation and with equal amplitude, no effect is produced upon the detector or receiving instrument. If, however, signals of frequency N are impressed upon the antenna system, only branch 21 resonates and oscillations of frequency N+*n* and N—*n* are impressed on the oscillation circuit, the former being suppressed and the latter acting through the detector to produce a signal in the receiving instrument.

A still further modification is illustrated in figure 3, in which an antenna is provided with two branches

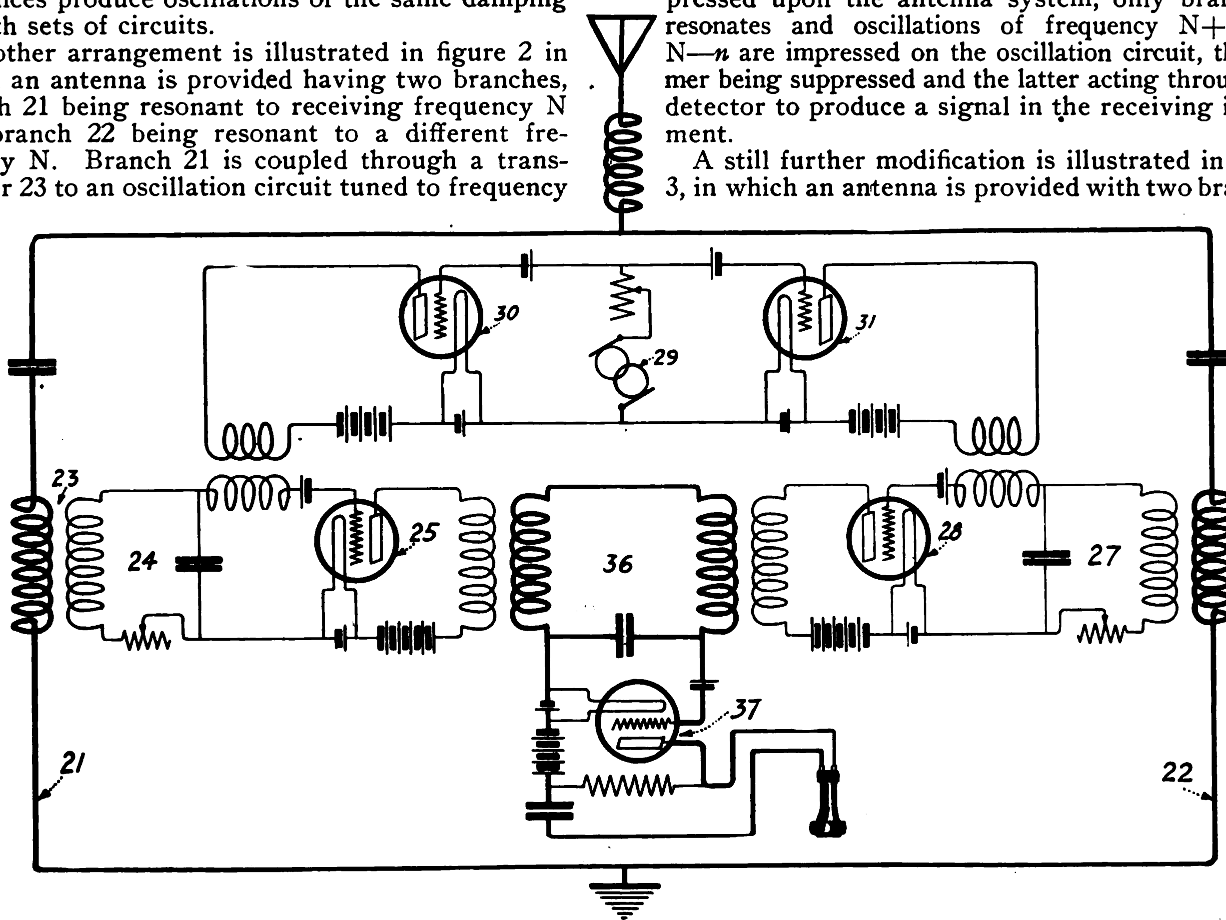


Figure 2—Diagram of a system having one antenna with two branches resonant to different frequencies

N and connected to the input side of a vacuum tube modulator. Similarly branch 22 is coupled through a transformer to an oscillation circuit tuned to frequency N_1 and working into the input side of a vacuum tube modulator. A generator 29 of frequency *n* is connected to the input side of vacuum tubes 30 and 21, whose output circuits are connected through transformers to the input circuits of modulators 25 and 28 respectively. These vacuum tubes prevent any reaction from the input of the modulators back into the generator. The output circuits of modulators 25 and 28 work through transformers into an oscillation circuit 36 tuned to frequency N—*n*=N_1+*n*, said circuit being connected to the input circuit of a detector in the output circuit of which is a receiving instrument.

When a static disturbance occurs the antenna branches resonate at frequencies N and N_1 respectively so that a frequency N is impressed on the modulator from the oscillation circuit 24 and a frequency *n* is also impressed thereon by the generator and consequently frequencies N+*n* and N—*n* appear in the output circuit of the modulator. At the same time a frequency N, is impressed on the modulator from oscillation circuit 27 while a frequency *n* is impressed thereon from the generator 29, so that frequencies N_1+*n* and N_1—*n* appear in the output circuit of the modulator. These several frequencies are impressed upon oscillation circuit 36 through transformers and if, as in figure 1, N—*n* is equal to N_1+*n* and oscillation circuit 36 is tuned to this frequency, frequencies

resonant to frequency N and N_1 respectively, branch 40 being coupled through a transformer to an oscillation circuit tuned to frequency N, and branch 44 being coupled through a transformer to an oscillation circuit 45 having a natural frequency N. Circuit 43 is connected to the input side of an amplifier whose output circuit is coupled through a transformer to the input circuit of a modulator while circuit 45 is connected to the input side of an amplifier whose output circuit is coupled through a transformer to circuit 48. A generator comprising a vacuum tube having an oscillation circuit has its circuit arranged in a manner so as to generate oscillations of frequency *n* in the oscillating circuit 53, which is coupled through a transformer to circuit 48. Frequencies N, N_1 and *n* being impressed upon this circuit, it may be shown that frequencies N+*n*, N—*n*, N_1+*n* and N_1—*n* will appear in the output cricuit of the modulator, said circuit being coupled through a transformer to oscillation circuit 56 resonant to a frequency N—*n*=N_1+*n*. The input side of a detector is connected to an oscillation circuit and a receiving instrument is included in the output circuit of the detector.

If, now, a static disturbance occurs, branches 40 and 44 resonate at frequencies N and N_1 respectively, these frequencies being amplified by amplifiers and impressed on circuit 48 together with frequency *n* from the generator so that frequencies N+*n* and N_1+*n* will be of the same amplitude and in opposite phase relation. Oscillation circuit 56 suppresses frequencies $N+n$ and N_1+n and as the oscillations of frequency $N-n$ and N_1+n are of the same frequency and amplitude but opposite in sign, these frequencies neutralize each other in the oscillation circuit so that no effect is produced on the detector or receiving instrument. If, however, a signal of frequency N is impressed on the antenna systems, branch 40 resonates while substantially no effect is produced on branch 44. Frequency N is therefore amplified by amplifier 16 and impressed on circuit 48 together with frequency n from the generator so that frequencies $N+n$ and $N-n$ appear in the output circuit of the modulator, the former being suppressed by the oscillation circuit and the latter being impressed on the detector to produce a signal in the receiving instrument.

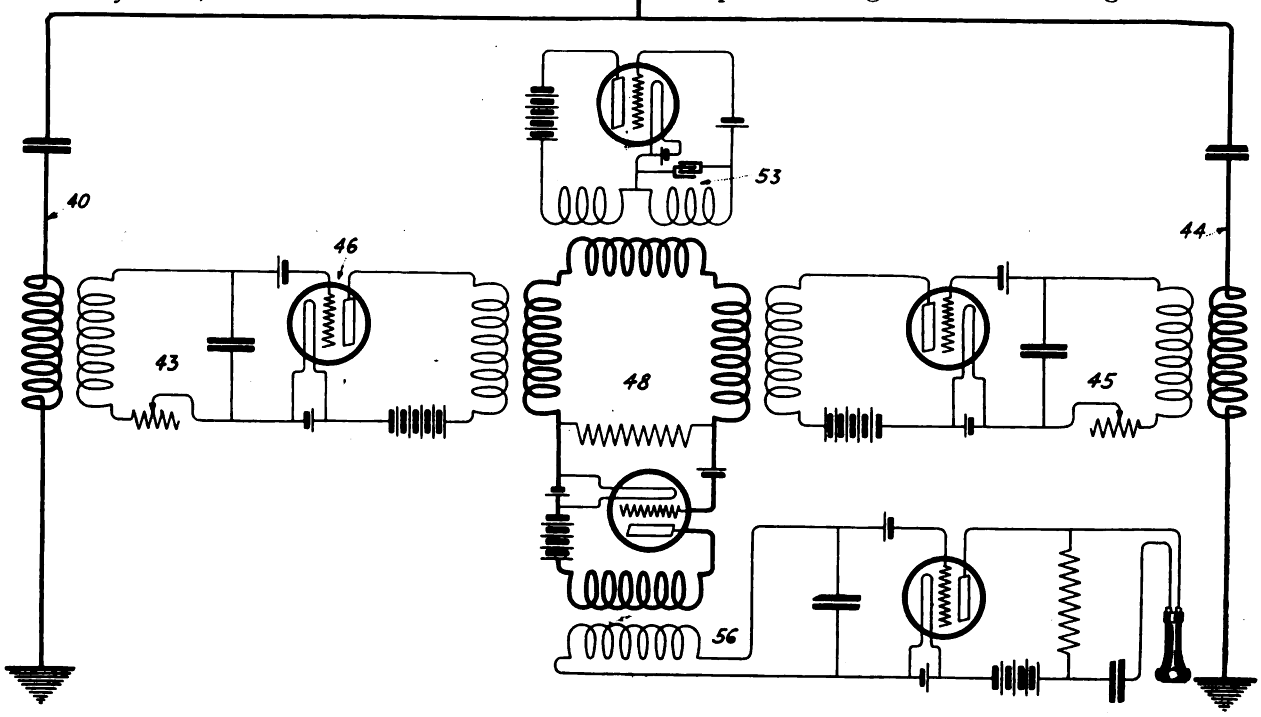


Figure 3—Another circuit used to secure radio frequency interference balance

Radiophone Modulator

LEE DE FOREST has devised a means of modulating radio frequency currents in accordance with the sound vibrations produced by the voice, these currents being of a greater order of magnitude than it would be possible to modulate with the ordinary telephone microphone. He has discovered that if a portion of the inductance which is in the antenna circuit is shunted by a microphone and the microphone actuated by the sound vibration produced by the voice, that the wave-length of the transmitted energy will be varied in accordance with the variations of the voice vibrations and that the energy received at a receiving station will therefore vary in accordance with the variation of the voice vibrations. Figure 1 shows several microphones actuated in phase, each microphone being in shunt to a portion of the inductance in the antenna circuit. It is apparent with reference to the figure that a considerable effect upon the wave-length of the transmitted energy may be produced in this manner.

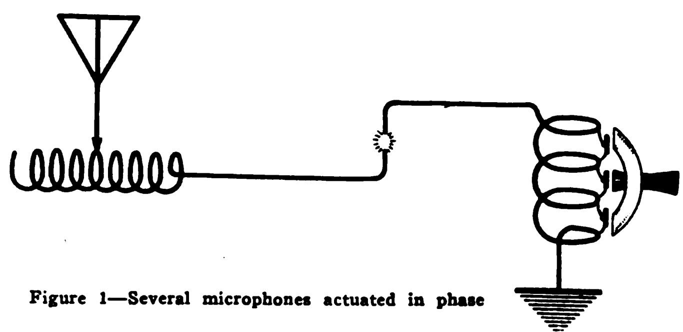


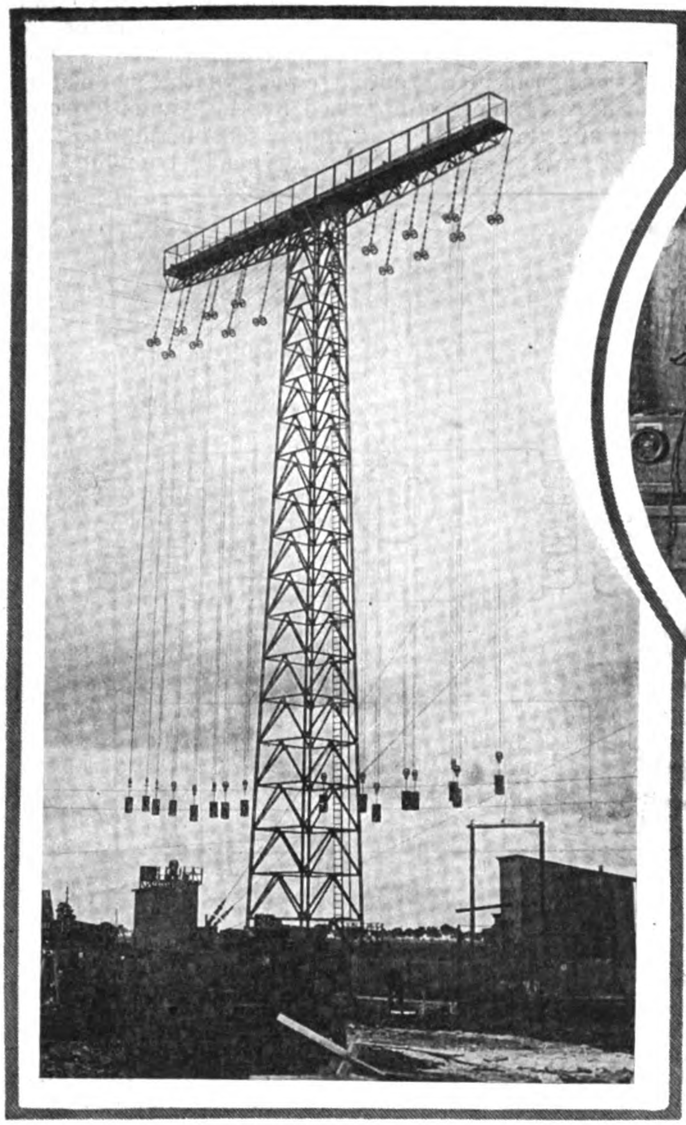
Figure 1—Several microphones actuated in phase

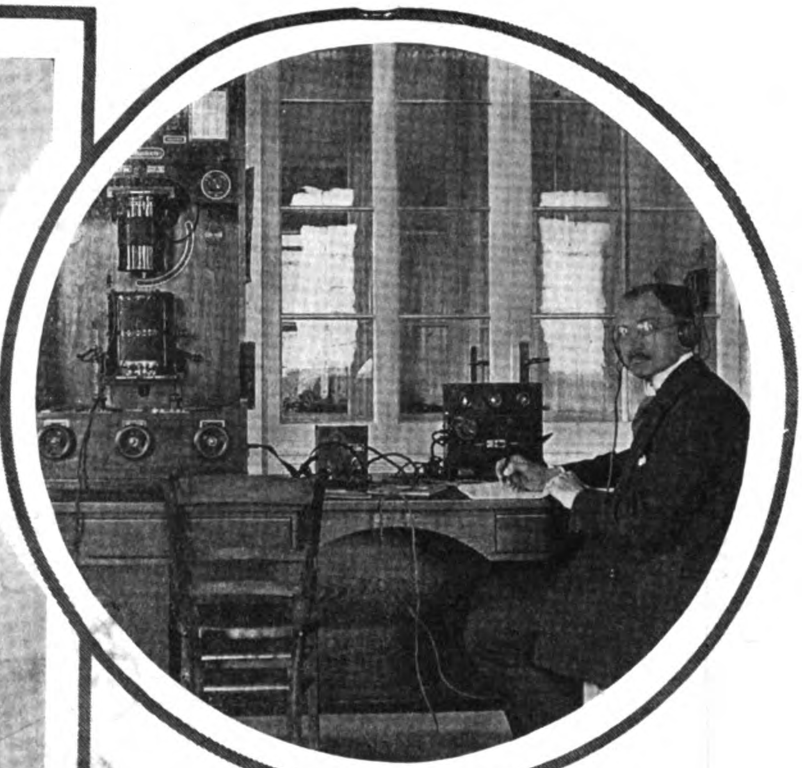
He has also devised means whereby several microphones may be actuated in phase electromagnetically.

The Radio Review

A HIGHLY technical publication, which appears under the title "The Radio Review," has recently been launched in London. Examination of the first issue makes it apparent that this carefully edited magazine will be of great assistance to radio engineers, for its mission is to report scientific progress in the art in a broad international way, and to shed special illumination on the radio conceptions and inventions of British scientists. This publication promises to occupy a niche corresponding to the enviable one attained in America by the "Proceedings of the Institute of Radio Engineers."

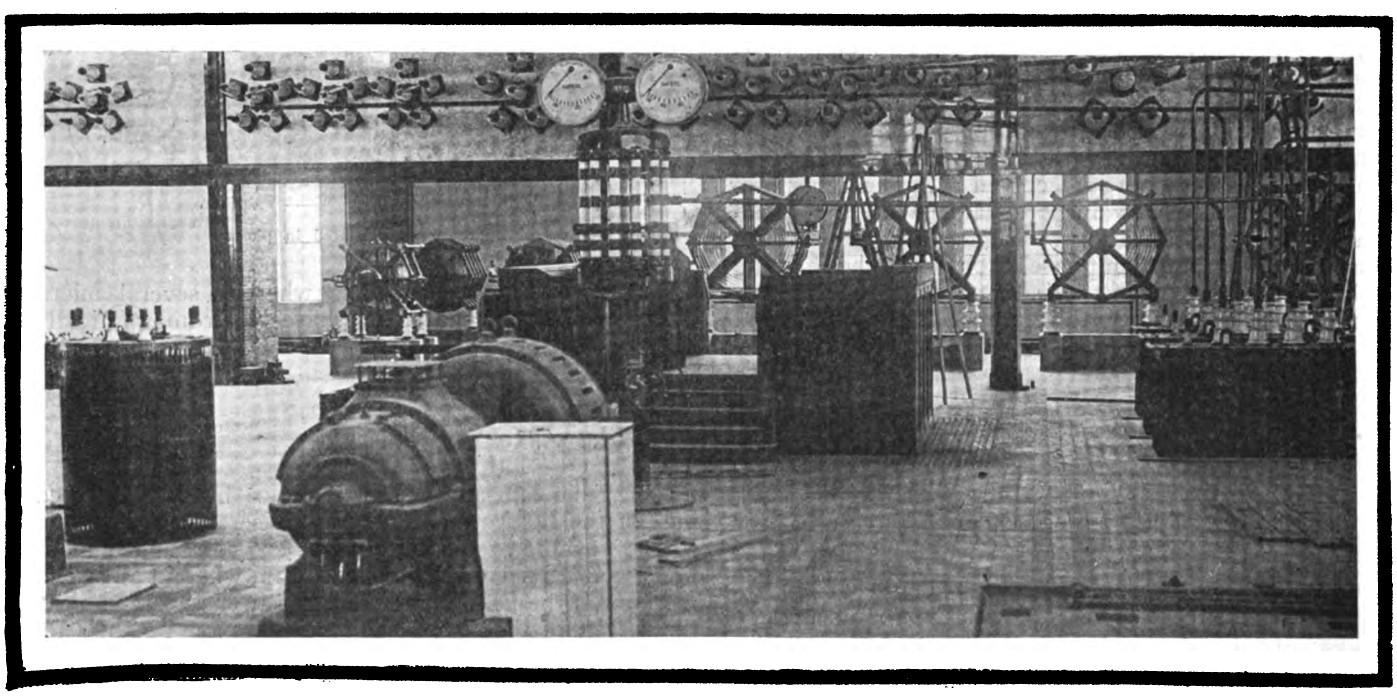
The keynote of the editorial policy, as sounded in the first issue, calls for a wide open forum wherein all science workers in the field of radiotelegraphy may communicate the results of their work and their opinions to their fellow workers. The scope of the articles will cover a broad range, comprising the treatment of subjects theoretical and practical, physical and mathematical, electrical and mechanical.





"Poz"—Nauen

Three views of the German station which acquired fame through the many historical messages sent from it during the war. At the left is seen one of the high towers which support the antenna; above, the receiving room, and below, the generating room, showing a motor generator, transformers and helices as part of the equipment that transmits signals overseas from a power source rated at 600 kilowatts



EXPERIMENTERS' WORLD

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

A Medium Wave Regenerative Receiver

By Ernest G. Underwood

THE following is a description of a medium wave receiver — shown in the accompanying photographs — designed and constructed by myself for use on an antenna of about two hundred meters natural period. Using an antenna of this capacity, the range of the receiver is from two hundred meters up to and including thirty-five hundred meters without an external primary loading inductance. By insertion of additional inductance at the binding posts directly above the primary inductance switch, the effective range of the receiver may be increased to fifty-four hundred meters, which is the capacity of the secondary circuit.

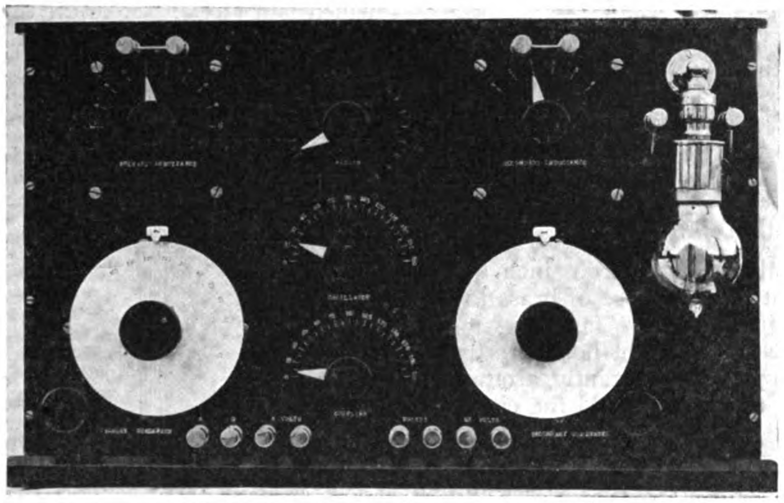


Figure 1—Front view of the medium wave regenerative receiver

This receiver is of the regenerative type, using the standard Navy regenerative hook-up, which has been found to be very efficient. Strong amplification of spark signals is obtained when the receiver is used for six hundred meter work. The receiver is also an excellent undamped wave receiver.

The cabinet containing the receiver is made of birch with a dark mahogany piano finish. The size of the cabinet is 11x19x10 in. The bakelite panel is 11x19x3/8 in., the front of which is finished in a dull gloss. All parts of the receiver are fastened directly to the back of the bakelite panel.

The antenna circuit consists of a movable primary coupling coil, primary loading coil, and a variable series condenser. The primary coupling coil is used for varying the coupling between the primary and secondary circuits and is wound with 37 turns of No. 22 D.S.C. wire on a tube 2 in. wide by 4¼ in. in diameter. The coupling is varied by rotating the knob marked "coupling." The loading coil is wound in two sections on a composition tube 6 in. long by 4¼ in. in diameter. The first section contains 168 turns of No. 22 D.S.C. wire and the second section contains 162 turns of the same size wire. Each section is bank wound in two layers. The loading coils are disconnected from the coupling coil when not in use by two dead-end switches operated by a small cam attached to the shaft of the primary inductance switch. The primary condenser is of the balanced plate type. The fixed and movable plate systems are in two sections arranged 180 degrees apart and are thus balanced. The maximum capacity of the condenser is .0013 mf. The condenser has a maximum capacity of .0013 mf. and a dial on the front of the panel made from a piece of aluminum and having a scale engraved on it is fastened to the shaft. A fixed pointer indicates the capacity being used. A knob mounted on the receiver panel at the left below the condenser knob permits the condenser to be adjusted very closely by means of gears connected to the movable plates. The taps for varying the primary inductance are mounted on the back of the panel and a scale engraved on the front of the panel indicates the tap being used.

The secondary circuit consists of the secondary coupling coil, loading coils, oscillator coil (tickler), secondary condenser, grid and bridging condensers and the audion control rheostat. The secondary coupling coil contains 56 turns of No. 22 D.S.C. wire bank wound in two layers on a tube 4¼ in. in diameter by 5 in. in length. Two sections of the secondary loading coil are also wound in the same tube and contain 74 and 87 turns of No. 22 D.S.C. wire respectively, bank wound in two layers. The loading coils are disconnected from the coupling coil by means of two dead-end switches. Taps for varying the secondary inductance are mounted on the back of the panel, the scale indicating the tap being used. The oscillator coil (tickler) is placed inside the secondary tube and consists of 90 turns of No. 22 D.S.C. wire wound on a composition ring 3½ in. in diameter. It is moved from a vertical to horizontal position by means of

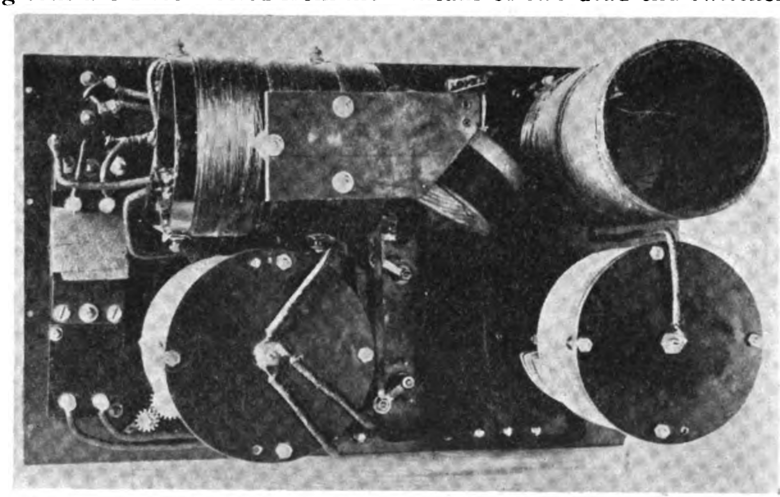


Figure 2—Back view showing secondary fine adjustment gears, and link motion for operating coupling coil

a lever motion which is worked by rotating the knob marked "Oscillator." The secondary condenser is the same size as the primary condenser with a maximum capacity of .0013 mf. and has a fine adjustment knob placed to the right and below the condenser knob. The grid condenser has a fixed capacity of approximately .00074 mf. The bridging condenser is variable by steps and has a maximum capacity of approximately .0025 mf. A standard 10-ohm battery rheostat, used for controlling the filament current, is mounted on the rear of the panel and is operated by the knob marked Audion. The socket for mounting the audion is at the extreme right of the panel.

Binding posts are provided for the connection of the antenna ground, filament battery, plate battery and phones.

This receiver has been in operation since July, 1919, and has given excellent results. The binding posts, audion socket and a small mica condenser, were the only complete parts purchased, all other parts, including the condensers, being home-made.

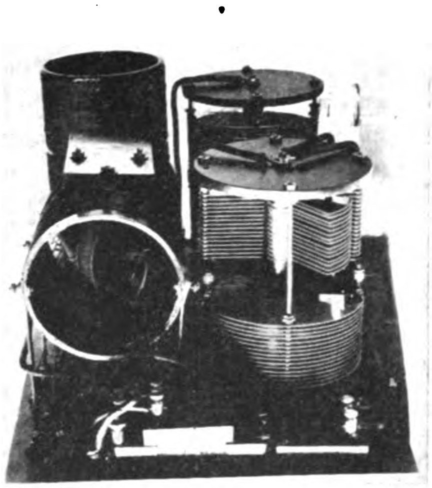


Figure 3—End view, showing method of mounting tickler coil

A Simple and Efficient Rotary Gap

By Wm. D. Reynolds, D.D.S.

THE gap here described has a marked quenching effect and is undoubtedly the easiest to construct of all rotaries I have ever made or seen.

A bakelite ring with ⅝-inch face, ¾ inch deep and 8 inches inside diameter and about 2 feet of ⅝-inch brass ribbon are the essential requirements.

Eight 2-inch pieces of the brass ribbon are first cut and bent in the manner shown in the accompanying diagram. After properly annealing, one inch of the brass ribbon is placed in a small vise. The protruding inch is grasped firmly with flat headed pliers and rotated a quarter turn, so that the ends are in planes at right angles to each other. A quarter inch slot is then cut in each piece of brass to permit adjustment and fastening to the bakelite ring. Eight holes are drilled and tapped equi-distantly around the face of the ring to hold the eight stationary electrodes.

The rotary electrodes are made of a single piece of the same kind of brass ribbon. One inch from each end the strip is twisted in opposite directions, making a fan-shaped rotating electrode. This is centered and bolted to a piece of bakelite and thus insulated from the motor shaft.

The stationary electrodes should be so adjusted as to just clear the revolving member. The spark in this gap has practically no lead and does not jump until opposite the stationary electrodes. The peculiar shape of the revolving electrodes produces a blast of air which quickly quenches the spark and cools the gap.

This gap is easily constructed and correctly designed. The spark occurs between "knife edges" and is therefore almost instantaneous. The superiority of this gap over the slow starting heavy electrode gap is unquestionable.

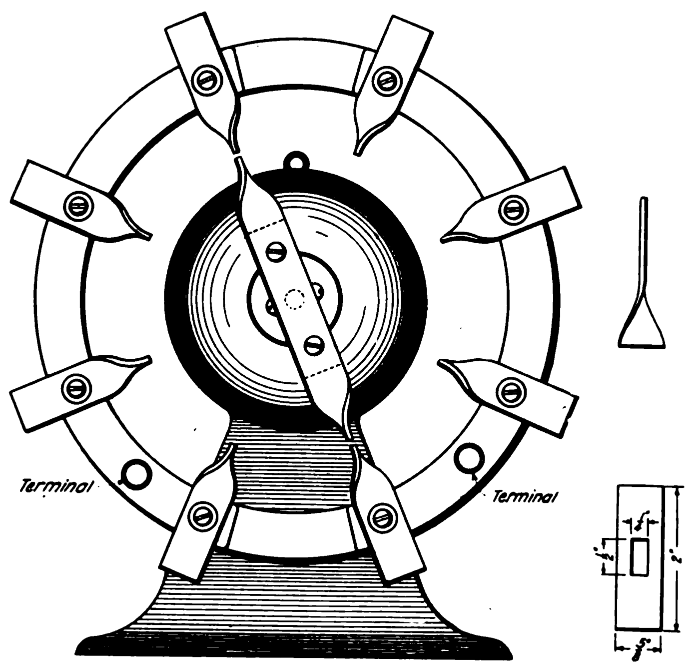


Figure 1—Assembled design of rotary gap and detail of stationary electrodes

An Economical "B" Battery

By E. L. Long

TO make an economical "B" battery secure one new dry cell which has a carbon element the cross section of which is a circle. Take off the outer covering of zinc in one piece. This may be easily done by making a cut lengthwise of the cell with a hacksaw. Remove the center carbon and with a hacksaw cut into pieces about ¼ inch thick. Now from the zinc cut out discs having a diameter equal to the carbon discs. These form the elements for the "B" battery cells which may be put together in the following manner. Bore a hole in a ½ inch piece of wood a trifle larger in diameter than the elements of the cells. Place this form on a smooth surface and put a carbon element flat in the bottom of the hole. Next place a thin layer of the black mixture from the cell in the hole, cover with a couple of discs of the blotting paper which should be remoistened. After having formed a small projection on the zinc disc with a center punch to serve to make the connection between cells more perfectly, place the zinc disc with the projection upward over the blotting paper and press the whole together tightly. Remove from the form and seal by using melted paraffin applied by means of a small brush or rag on the end of a stick. Twenty or more cells may be made in this way for the cost of a single dry cell, and they will serve very well as a "B" battery. They may be used by placing them in groups between springs fastened to a board or other support.

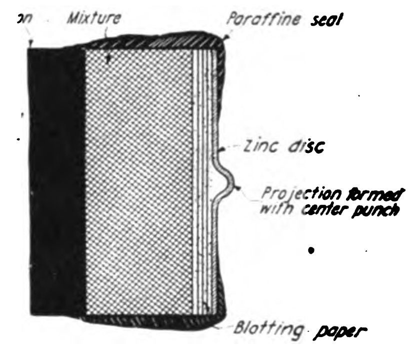
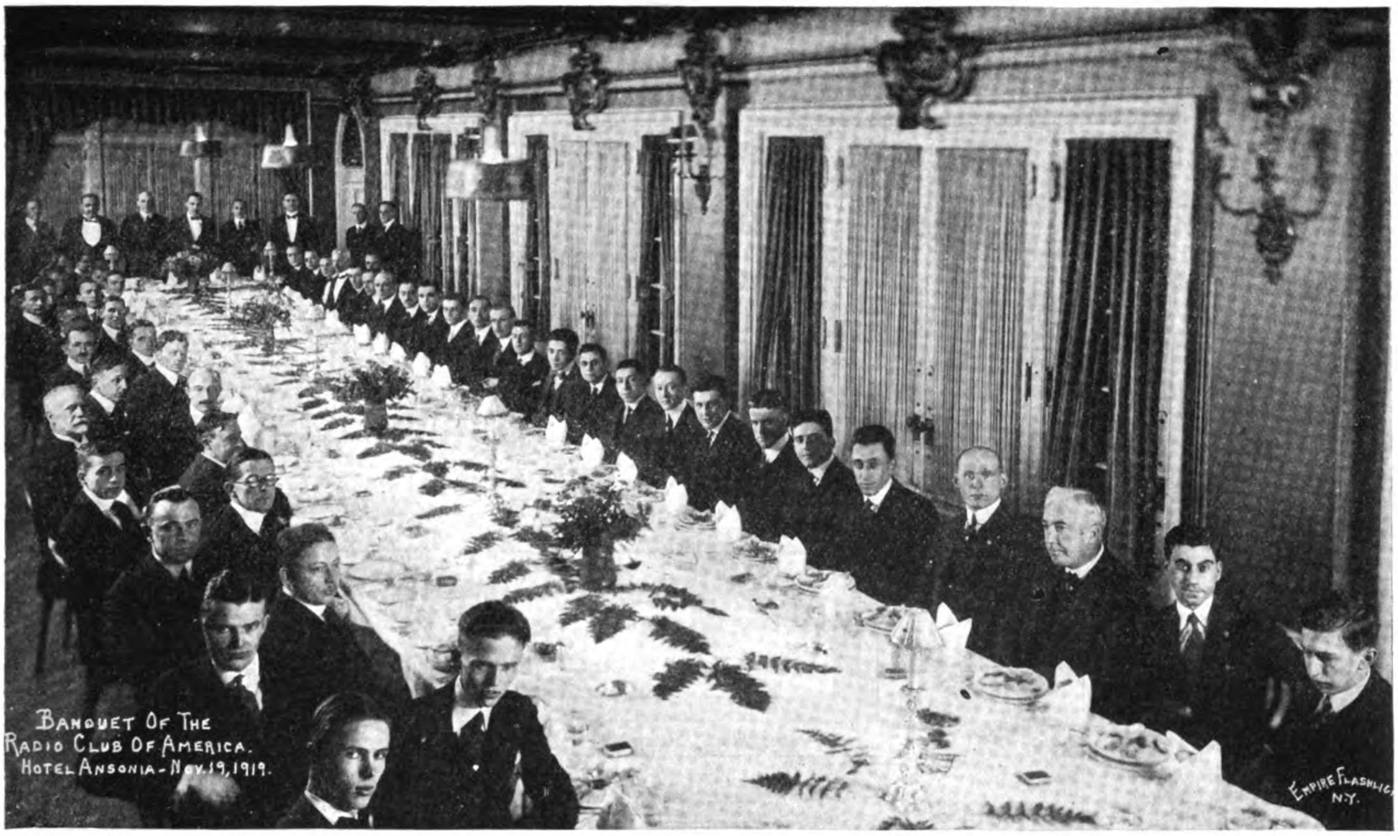


Figure 1—Showing constructional detail of the "B" battery



The three-score enthusiasts gathered to pay tribute to Major Armstrong. Those at the speakers' table in the rear, standing (from left to right), are: W. H. Davis, Prof. M. I. Pupin, Major Armstrong, T. Johnson, Jr., John V. L. Hogan, Dr. Alfred N. Goldsmith, George H. Clark and J. Andrew White

A Dinner to Armstrong

THE firm foundation in which amateur wireless rests in this country was clearly reflected in the testimonial banquet given in honor of Major Edwin H. Armstrong by the Radio Club of American on November 19, 1919. Sixty-four persons were present at the Hotel Ansonia, New York, to pay their respects to the returned president of the club, among whom were those who for ten years have held the leadership in directing the experiments in the New York district, and many men of distinguished scientific achievement who have inspired and encouraged the youthful workers in the art.

During the evening the guest of honor was acknowledged as the amateur who had set up new standards for the unpaid enthusiasts of wireless, established the work on a high plane and secured recognition for amateur radio. The debt to Armstrong, it was conceded, lay principally in the great merit of his invention of the regenerative circuit through which the sensitiveness of the vacuum tube receiver had been increased five thousand times. His work had been acknowledged by the conferring upon him of the medal of honor of the Institute of Radio Engineers, but it is a safe assumption that no tribute could have been more pleasing than the banquet given him by his original associates of amateur days. In the midst of this company it was recalled how he has remained an amateur at heart ever since the day seven years ago when, as a twenty-two year old college student, he perfected the invention which silenced the arguments of those that held amateurs to be meddlesome young men who accomplished no beneficial results in science.

T. Johnson, Jr., a director of the club and toastmaster for the evening, looked upon the club's activity in retrospect, fondly recalling its organization as a neighborhood proposition ten years ago and carrying its work through to the present day when it still retained its original usefulness and had the added prestige of accomplishment by many members. Prof. Michael I. Pupin responded with a sterling tribute to Armstrong's earnestness when a student at Columbia and gave many personal reminiscences of how the young inventor had challenged the admiration of men of great achievement, notably in the recent war; when French and British communication officers had been astonished at his feats in radio engineering.

Dr. Alfred N. Goldsmith responded with an appreciation of amateur workers as a whole, emphasizing the peculiar character of the hobby in that its converts always remained loyal — that they never recovered from the disease. He noted the significant fact that Armstrong had started with the most rudimentary apparatus, out of which he had erected a great structure of achievement and he looked hopefully to an immediate future holding great possibilities for other epochal inventions. The inspirational factor, he maintained, lay in the simple character of the apparatus itself, instancing the vacuum tube as virtually a three-element electric light; yet light at best could be thrown but a few miles, whereas radio signals spanned thousands and gave promise of circling the globe.

George H. Clark, former naval expert, told how at first the navy did not understand that the regenerative circuit was credited to Armstrong, stating that the principal reason for this was the modesty of the inventor. He gave an insider's view of the confidential inventions and developments made during the war and added a strong appreciation of the hard, conscientious and successful work of Major Armstrong as an officer abroad. Mr. Clark then, in lighter vein, effectively scored those of lesser accomplishment but greater pretensions, and with many witticisms drew a word picture of the results if all inventors were to adopt a like attitude.

Other speakers were John V. L. Hogan, Emil J. Simon, Capt. Willis H. Taylor, Jr., W. A. Davis and Prof.

(Continued on page 36)

First Prize—An Efficient Amateur Transmitting Condenser

By Norman A. Nyquist

THERE are so many different types of condensers being used for amateur radio work and so very little information available in regard to the types that are giving most satisfaction, that it is quite a problem for the average amateur to decide upon the proper type to build for his station.

A review of the various forms of transmitting condensers may be in order. Their advantages and disadvantages, in so far as amateurs are concerned, will be itemized accordingly:

No.	Type Dielectric	Advantages	Disadvantages
1	Compressed Air	Low losses Self healing Not fragile	Bulky Expensive Unreliable
2	Oil	Low losses Self healing	Bulky Sloppy
3	Glass & Oil	Fairly low losses	Bulky Fragile
4	Glass in wax	Fairly low losses	Bulky Fragile
5	Leyden Jar	Fairly low losses	Bulky Fragile
6	Mica	Low losses Very compact Not fragile	Initial expense

An analysis of the above data shows that for the ideal condenser, mica should be chosen for the dielectric. Mica is standard now in the Army and Navy.

In the average amateur transmitter arrangement of apparatus, the inductance of the leads are of such lengths that a capacity over .001 microfarads cannot be used on a wavelength of 200 meters.

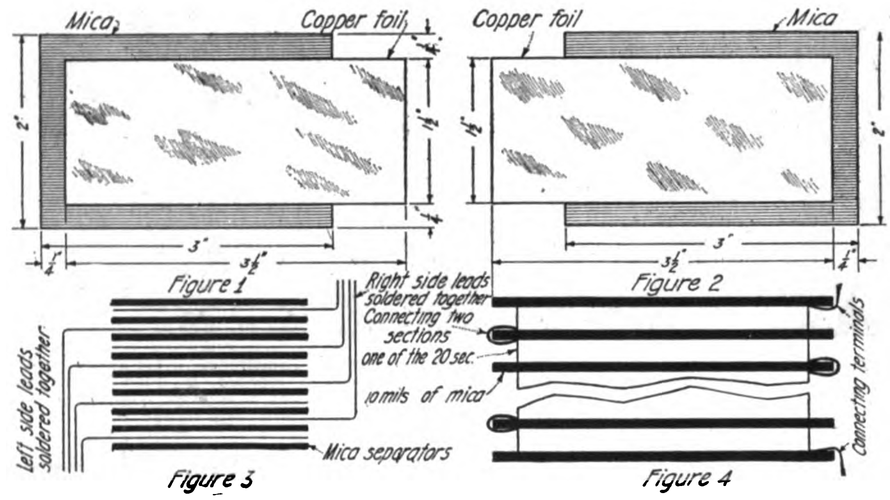
Condensers have electrical losses which summed up are referred to as the "power losses" of a condenser. A large portion of this power loss is in the dielectric between the metallic coatings. This loss is present in practically all insulators. This particular loss is due to "hysteresis" in the dielectric.

Experiments have been made to overcome the defects along this line, the results of which show that the energy absorbed per cycle in the condenser is proportional to the total energy in the condenser during the period, regardless of the frequency of the oscillations.

Therefore, that portion of the total decrement due to dielectric hysteresis is independent of the frequency of the oscillations or the physical size and capacity of the condenser and is wholly determined by the chemical composition of the dielectric and its temperature. There is also a small loss due to "eddy currents" in the metallic coatings.

During recent years much time and money has been spent by different radio investigators on research work with mica dielectric condensers and much valuable information has been obtained.

There is only one grade of mica which gives complete satisfaction, namely, Clear Ruby Mica, which is obtainable from the Mica Products



Diagrams showing detailed plan of constructing the transmitting condenser

Co., New York City. The cost of mica is rather high, but will not total the manufacturer's price on glass or moulded condensers.

When purchasing the mica, sheets two inches by three inches should be specified, as this is a standard and convenient size. The thicknesses should be from two to three and one-half thousandths of an inch. The number of sheets required will depend upon the desired capacity of the condenser designed and the secondary potential which it will have to work on.

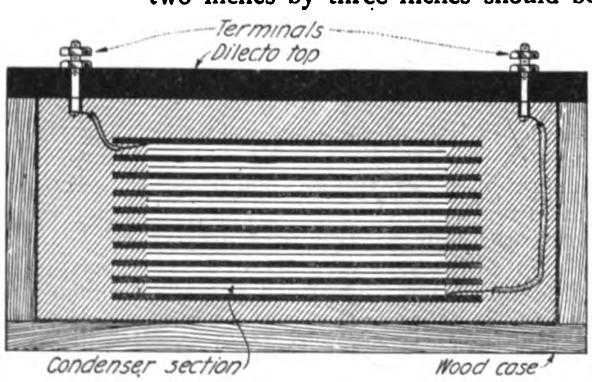


Figure 5—The finished condenser mounted in a case

Let us assume that a capacity of .001 microfarads is desired and that the secondary transformer voltage will be twelve thousand volts.

The particular grade of mica mentioned above will stand about 1,500 volts per one thousandth of an inch without puncturing, but the mica sheets should be tested before assembling. A convenient way of testing the mica is to use the transmitting transformer. A needle spark gap is set across the secondary terminals, separated one-tenth of an inch. Reactance is then inserted in the transformer primary circuit until the secondary voltage has been reduced to the point where it will only jump one-tenth of an inch, and no more, even if the gap is lengthened. Each piece of mica is now placed between two metal sheets slightly smaller than the mica sheets and connected across the secondary terminals of the transformer. All pieces of mica that puncture should be discarded.

Knowing that this mica will stand 1500 volts per mil, a safety factor of five is generally used, which means that each mil of mica is worked at one-fifth its tested voltage or 300 volts. As each mil is worked at 300 volts per mil and the mica is two to three and one-half mils thick, and a secondary voltage of twelve thousand is to be used, it figures out that we must have twenty sections in series.

If there are to be twenty sections in series and we want a resulting capacity of .001, the capacity of each section must be twenty times the desired capacity, or .020 microfarads.

The capacity may be calculated nearly enough by use of the following formula, and the proper number of plates per section can be determined roughly. The capacity need not be exact, as the capacity of the twenty sections in series is finally adjusted by taking off or adding a few plates to one of the end sections.

$$\text{Capacity} = \frac{2248 \text{x} A \text{x} K}{d \text{x} 10^{10}}$$

A = Total area of coatings
d = Dielectric thickness
K = Dielectric constant, 4 for the above grade.

The metallic coating for the mica should be dead soft annealed copper foil one-thousandth of an inch thick and one and one-half inches wide. It may be purchased in rolls of this size. About one-half pound will be required.

The copper foil is cut into pieces three and one-half inches long and assembled on the mica as shown in figures 1 and 2. About eight of these plates placed together will give a capacity of .020 microfarads. After the proper number of plates are assembled to give this capacity, the rest of the sections are made and the twenty sections assembled as shown in figure 3.

All the sections are now held in between two blocks of wood and clamped tightly in a steel clamp, such as is used by machinists, or in a hand vise. This whole arrangement is then placed in an oven and baked at a temperature of 250 degress F. for at least twelve hours, if possible the clamps should be tightened about every three hours.

During the last hour of baking, a compound consisting of one part beeswax and three parts rosin should be prepared, melted, and brought to a temperature of 250 degrees. After twelve hours of baking all moisture has been removed from the condenser. It is then placed in the boiling compound and left there one hour, the temperature being kept at 250 degrees F. during this time.

The unit is next taken out and left to cool. When cold the surplus compound is scraped off and the clamps removed.

The finished condenser is mounted in a case as shown in figure 5, and the case is filled with the remaining liquid compound before it cools.

When soldering the copper lugs together as shown in the drawings, use the only soldering flux that will give complete satisfaction, which is equal parts of alcohol and rosin. The section should be tilted up-side-down when soldering so that the flux will not run into the mica.

The construction of this condenser entails considerable work and the various materials are quite expensive. It is, however, a real condenser,—worth all the time and effort required, and a unit of which any amateur may be proud. The substitution of a mica condenser for a glass and oil condenser will result in a 50 per cent. to 100 per cent. increase in radiation for a given input.

Second Prize—An Efficient Amateur Transmitting Condenser

By H. L. Stanley

THE amateur high tension condenser is usually the weak link in the chain of transmitting apparatus and the condenser described below was developed in an attempt to provide one that would be efficient, rugged, permanent, not too expensive, and capable of being built by an amateur himself with the assurance of success.

Glass plates were selected as being the simplest form of dielectric, having a suitable efficiency and for the ease of attaching the conducting medium. These plates were of plate glass 8x10 in. and varied from 1/4 in. to 5/16 in. in thickness, and were obtained at a nominal price from a jobber in glass from pieces which would otherwise become scrap. Plates of this description have an average dielectric constant of 7.5 to 8 and are not affected by voltages up to 30,000.

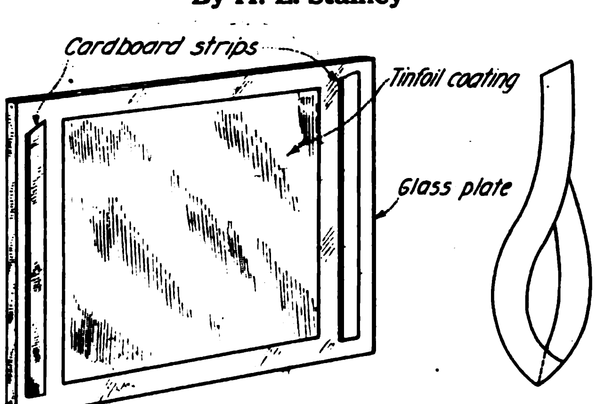


Figure 1 Figure 2

Design of plates with separating strips attached and the connectors made of brass

Commercial tin foil 6x8 in. was selected for the conducting coating, as it was easy to obtain, cheap, and filled all the requirements better than any other coating obtainable. This foil was purchased in the form of a roll of the proper width to require cutting for one dimension only, and of a thickness which would be sufficient to carry the full capacity of the usual transformer without heating.

After trial of several mediums for attaching the foil to the plates, it was decided to use pure beeswax, as this material lends itself readily to the operation, has a very high dielectric value, does not form bubbles of gas under the foil and solidifies at once after being applied.

The glass plates were first washed in warm soapsuds and wiped with a cloth wet with alcohol to remove all grease, etc. The foil was then cut and the corners rounded off.

To apply the foil to the glass the plates were first heated to a temperature somewhat higher than necessary to melt the wax, and while they were hot the wax was applied in a thin coating all over the part of the plate to be covered with foil, the foil laid on in position, rubbed down with a soft rag on both sides of the plate and the whole thing run through the family clothes wringer.

If this operation is properly carried out while the plate is still hot the foil on both sides will be squeezed absolutely flat and into intimate contact with the glass, and the film of beeswax between the foil and the plates will be so thin as not to be noticeable.

The plates and the foil were then washed with a soft rag wet with gasoline and all traces of surplus was removed. After the plates were dry the foil was examined for possible pin holes and these were covered with shellac wherever found and a heavy coat of shellac was flowed around the edges of the foil. The shellac was used to prevent the oil in which the plates were to be immersed from coming into contact with the wax under the foil, thus dissolving it and allowing the foil to fall from the plates.

A rack was then built of dry wood to hold the plates in an upright position and an oil tight metal container built which would hold the assembly. This container was sufficiently deep to allow the plates to be covered when the case was filled to within one inch of the top with transil oil.

When the plates were assembled in the rack they were separated 1/16 in. by means of cardboard strips which were pasted across the ends of the plates with shellac. (See figure 1.) This separation is necessary for the connecting strips to be placed between the plates. The connecting strips were made of 1x.005 in. half hard brass of the shape shown in figure 2, and are long enough to meet over the center of the condenser when placed in position between the various plates. When the connecting strip in this form was pressed between the plates it made a good and sufficient contact with the foil on the opposed sides of two plates. The connectors were placed on opposite sides of each plate connected in one multiple unit.

A condenser constructed according to the foregoing manner has a capacity of approximately .01 mf. when thirty-five plates are included. This is the proper capacity required for use with the ordinary amateur transformer on a wavelength of 200 meters.

Condensers of this type have been in use for some time in several of the best amateur stations and they have given very satisfactory service, being characterized by the absence of the usual losses present in the amateur transmitting condenser.

Third Prize—Transmitting Oil Condenser Suitable for 200 Meter Amateur Sets

By George T. Droste

A TRANSMITTING oil condenser suitable for 200-meter sets and for powers up to 1 kw. is described.

The material is easily obtainable and the condenser is easily constructed and highly efficient. I have been using one for over two and one-half years and there has never been a sign of a breakdown while under severe strain and using 1 kw. output. There is not the slightest sign of corona or brush discharge.

Following is given a list of material and sketches of the construction with all the essential parts being shown.

From a photographic supply house, obtain a composition Hypo fixing tank for 8x10 in. plates. This is a vertical black tank which looks like rubber. It is about 5¾ in. wide, 10¾ in. long and about 10 in. deep. The inside is scored or grooved at the sides for holding the plates vertically and raised baffle walls at the bottom are provided to keep the plates from touching the bottom of tank. The spacing of these grooves keep the plates about ⅝ in. from center to center and the tank holds eight 8x10 in. plates. (See figure 1).

Obtain eight 8x10 in. used photo plates. These may be had at the same photo supply house. Clean off the gelatin by soaking the plate in hot water and scrape off with a knife.

At a hardware supply house obtain sufficient copper foil to coat both sides of these eight plates with sheets 6x8 in. in size. Sixteen are required. This material comes about 12 in. wide, therefore, a piece 64 in. long is required, allowing enough extra for waste in cutting. This copper foil is recommended in preference to tin foil no matter how heavy the tin foil be, as it has tensile strength and does not tear in handling. No tabs for terminals are used. (See figures 1 and 5.)

Obtain from some hardware supply house enough stock for two pieces of brass 1/16 in. thick, ⅝ in. wide and long enough to fit the width of the tank. (See figure 2.) These pieces are bent down at the ends about ¾ in. and drilled and tapped for 12/24 screws for fastening to the tank and forming the terminals. On the long flat portion clear holes are drilled to

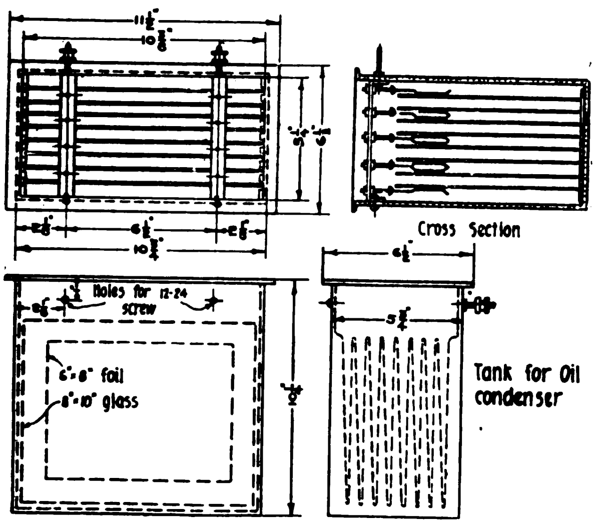


Figure 1

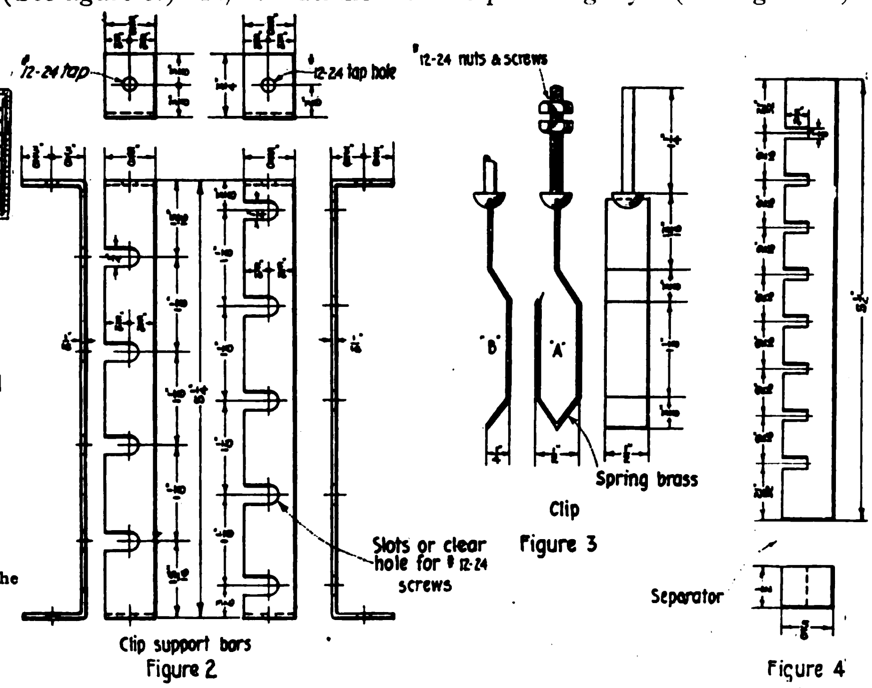
Detailed constructional plan and arrangement of plates of the oil condenser

take 12/24 machine screws. These holes may be slotted if the experimenter desires to allow easy removal of the clips. One piece is drilled with four holes and the other with five.

A dozen 12/24x1¾ in. brass round head machine screws and 24 hex nuts are obtained. Nine screws and eighteen nuts are used for the plate terminals, two screws and two nuts for condenser terminals. (See figures 3 and 5.) Next obtain enough spring brass ribbon 1/32 in. thick and ½ in. wide to form nine pieces as shown—see figure 3. This brass is bent as shown and soldered into the slots of the screw heads. The spring brass clips make rubbing contact with the foil plates at the upper edge and are all alike. Contact adjustment is easily accomplished by bending the lower part of the clip so that it will apply spring pressure between the foil plates or, by raising or lowering, which is accomplished by adjusting the lock nuts. (See figure 5.) 14/24 machine screws placed through holes drilled in the sides of the composition tank will support the horizontal bars. These holes in the tank must be near the top edge so as to be above the oil line, which has to cover the plates. The support bars are drilled and tapped in the turned down ends to take the screws. At one side these screws are long enough to take nuts for locking in position, and also form the binding posts of the condenser.

Two pieces of hardwood ½x⅝ in. and long enough to fit snugly between the walls of the tank are slotted with a hacksaw and the slot spaced the same as the plates. (See figure 4.) This separator is placed at both ends of the tank and holds the upper edges of the plates rigidly. (See figure 5.) The vertical grooves in the tank are tapered, being wider at the top.

The oil used is a standard transformer oil. Two gallons are needed. This will cost about 50 cents a gallon and may be purchased at any oil supply house. It is a vegetable oil and not a mineral oil and is poured into



Constructional plans of the clip support bars, clips and separator

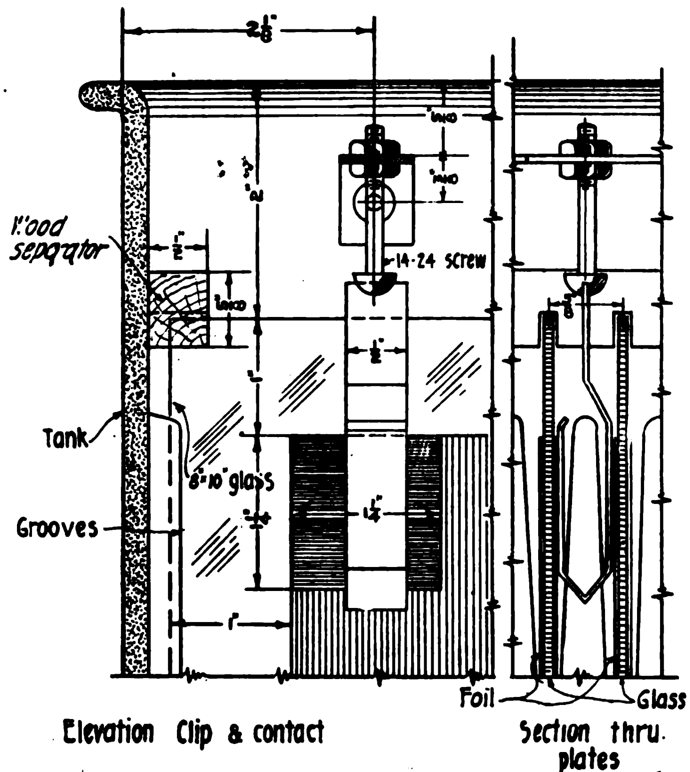


Figure. 5
Showing assembly of parts by means of a sectional and an elevation view

the container after plates have been installed and connections made. The entire unit may be placed near the transformer and oscillation transformer. A sheet of glass placed on top of the container will act as a cover. The foil is applied to the glass with orange shellac. Smooth it out with a squeege roller, or by hard pressure with a cloth pad. Do not use metal, as this will produce a curl to the foil, which makes it difficult to keep the edges down. After the foil is attached and the shellac dry, coat the entire surface of the foil and glass with shellac. Later clean the upper corner of the foil plate for the connections to the plates.

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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AMATEUR wireless suffered a distinct loss with the death of Horace A. J. Upham, prominent lawyer of Milwaukee and an active member of the N. A. W. A. Mr. Upham, who was 66 years of age, died of apoplexy while motoring near his summer home. He took a great interest in amateur affairs and was the leading spirit in the organization of the Milwaukee Club.

A. T. Hovey of Boston has announced the inauguration of a new method of doing business in the wireless field. He is arranging to receive orders for all standard makes of apparatus by radio and will have the station in operation so amateurs may communicate with him either direct or relay on Monday, Wednesday, Friday and Saturday evening from 7 to 9 P. M.

A Radio Club has been formed at New Mexico College which will have for its object the advancement of its members in technical, general and practical information concerning radio telegraphy. The club will have the use of the college radio house and a tower 140 feet high will be built, with an umbrella aerial.

Following is a list of the officers elected: Louis Eddleman, president; Mortimer Beaty, vice-president; Clarance Fite, secretary-treasurer; Professor Goddard, faculty adviser.

The newly formed Philadelphia Radio Amateur Association announces that its initial meeting proved very successful and the regular program will call for meetings to take place the second and fourth Monday nights each month at 1611 Columbia Avenue, Philadelphia.

A course in the elementary principles of wireless will be conducted and there will be an address on technical topics and also on general topics.

The employment of the V. T. in amateur radio was taken up at the initial meeting and will continue to be a lively subject for debate.

The officers of the club are making arrangements to have demonstrations of apparatus and displays of meritorious equipment a regular feature of the meetings.

A prepared program is followed. Lectures and papers which have been thus far presented include: "Elements of Direct Current," by S. S. Harris; "Decrement," by Malcom Ferris; "Elements of Alternating Currents," by S. S. Harris; "Hook-ups for Honeycomb Coils," by P. J. Gallagher; "Poles and Aerials for the Amateur," by Elwood Casey.

At the initial meeting the following officers were elected: Gordon M. Christine, President; W. F. Wunder, Vice President; H. Paul Holz, Secretary and Treasurer.

The president is authorized to call an international communication conference to consider rates, cable and other questions, under a public bill passed by the Senate and sent to President Wilson. No date is fixed for the conference, which was conceived by representatives of the allies and the United States at the Paris Conference and is expected to deal with disposition of the German cables.

Bronze Victory buttons will be issued by the Navy Department to all persons who served in the reserve or regular Navy in the war. Recruiting stations have been authorized to issue them to all eligible persons now discharged or on inactive duty, and a supplementary distribution will be made from the Bureau of Navigation in Washington. Silver buttons of the same design, it was said, will be issued to those who received wounds during the war.

The Victory button, it was explained, is awarded in addition to the Victory medal, distribution of which is expected to begin shortly.

wild man who talked of making one was promptly dubbed as crazy. His aerial switch, if he used one, was once the switch of an auto coil, with slight changes. Since the "set," as it was always reverently termed, was usually in the shed (the family wouldn't let the thing in the house) a lightning switch was unknown and unnecessary.

For receiving purposes he always began with an 80 ohm phone and a single slide tuning coil wound with bare wire on a rolling pin, with string to space the wire. For detector, silicon was the favorite, though occasionally one would find perikon, perikon-electra, pyron, electrolytic, or galena. Soon he would graduate and build himself a loose-coupler, and buy a single 1000-ohm phone, in which case he was of the elite, and had the "best set in town."

But it was by the aerial that the true ham was really known. It invariably had one pole (of bent eucalyptus) in the backyard for one spreader, with the other attached in some weird manner to the house. It was insulated with everything, from old pop bottles to porcelain cleats salvaged from somewhere, and its wires were anything from the 18 telephone already mentioned to 14 galvanized iron. The spreaders were always at least 16 feet long—sometimes longer, for the ham had been told he could receive farther that way—and held from two to four wires. On such an aerial a true ham could copy NAA during the daytime half way across the continent, and with his Ford coil transmitter would work fifty miles through the worst 99 imaginable. I don't know why a true ham could always work farther than a mere commercial operator, but I suppose it is because he is a ham—for no one else could do it.

The ham's code was never to buy anything under any circumstances. This may have been why his publicly expressed opinion was always against such "trappings" as an Audion. "Such things ain't for us. Look at all the junk you gotta have. A bunch o' batteries, rheostats, and the darn things don't work half the time anyhow. No siree—no such junk in *my* station," he would remark when it was mentioned. Probably if an Audion could be made by him in his own workshop he would have had a seven-step amplifier, if he knew that such a thing existed, but he would absolutely refuse to allow any instrument with the taint of commercialism upon it to enter his station.

I have endeavored to set down the chief characteristics of the famous ham as he was in days gone by, and I have tried to do this in a friendly spirit, for I was a ham myself, and used to jam the ether at four words per by the hour, using about 2 k. w. talking to a fellow in the next block, perfectly oblivious to the BK's from nearby commercial stations. About 90 per cent of the 2 K.W. was used up in heating the interrupter. It was a wonderful life, but the day of the ham is past, and specimens now are few and far between. The place of the ham has been taken by a young, smart Alec who prates wisely of heterodynes, logarithmic decrement, vacuum tube transmitters, the relative efficiency of tuning by capacity and tuning by inductance, and other such things unknown to the simple ham of yesterday. We do not mean to unduly rebuke the present generation of radioists, but the ham was dear to our hearts, and we hated to see him go.

The King is dead—long live the King!

Suggestion for Prize Contest—February Wireless Age

An Original Design for an Antenna Switch

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the above subject by January 31.

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. L., St. Anthony, Iowa:

In connection with your query concerning the four-stage amplifier described on page 33 of the April WIRELESS AGE, we suggest that before you spend any money in making up an amplifier incorporating this circuit, you set up one of the circuits to familiarize yourself with its action. Having done this, it will also be possible for you to make comparisons and draw your own conclusions. We regret that we are not in a position to do this for you.

* * *

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

With reference to the four-stage amplifier described on page 33 of the April issue, your inability to get oscillations on the three stages is due to the fact that the phase displacement or the "timing" of the third valve with reference to the first valve is not as it should be. It will be necessary for you to add a fourth tube, and if it should be desired to add more, it will be necessary to add them in pairs. Any tubes which have approximately the same characteristics are suitable for the hook-up above mentioned, that is, the tubes you select for this work should all operate on the same plate potential and approximately the same filament current. The amount of energy passed in the plate circuit of these tubes is very small and the resistances are sufficiently low to supply the required energy to the plate. It will be possible for you to use a three-stage radio frequency amplifier, but if you do so, it will be necessary for you to supply the oscillations to heterodyne incoming signals in some other way than that described. It might be done, for example, by the use of a fourth tube as an external oscillator.

No matter how many tubes are used, providing they have all been selected with regard to similarity of characteristics, the plate battery required will be the same. In connecting up three-element tubes, it is the custom to join the negative side of the high potential battery to the positive side of the filament battery as has been indicated in the diagram on page 33, April WIRELESS AGE.

The idea in supplying a local grid battery is to enable one to charge the grid negatively, in which case the negative terminal of the battery, of course, would be connected to the grid and the positive terminal to the filament.

We regret that we are unable to give you any comparisons which would be of more value to you than the comparisons between the various circuits which you are able to make for yourself. Using four tubes instead of three with the circuit, however, should increase your range considerably.

The Rogers underground antenna has no merits which would appeal to the amateur in particular. As we understand it, it has been originated in the belief that it aids materially at times in securing a better signal to static ratio. The energy picked up by such an arrangement, however, is very small in comparison to the energy picked up by an overhead antenna, and generally speaking, is not apt to become popular with the experimenter.

* * *

W. R. R., Pelham, N. Y.:

With reference to the fourth prize article in the July, 1917, issue we regret that we are unable to tell you where to get gem salts or Peeble's powder. It may be that Mr. McIlvaine will see this query and supply you with the information. We are unable to find his present address. We presume that white wood or bass wood would take the finish described fully as well as, if not better than, cypress.

* * *

A. R., Scottville, Mich.:

Approximate fundamental wavelength of an antenna may be obtained by multiplying the length of the antenna plus lead-in, plus ground connection, in feet, by 4, which will give the wavelength in feet. For reduction to meters, the result should be divided by 3.3.

The fundamental wavelength of a four-wire aerial spaced 32 inches, which is 80 ft. in length and having a 30 ft. lead-in and a 15 ft. ground, is approximately 150 meters.

* * *

A. T. S., Betheny, Nebr.:

The condensers C-4 shown in the circuit on page 33 of the April Wireless Age have a value of .005 mf. each. The ordinary stopping condenser, as sold for use in crystal detector circuits, will serve the purpose admirably, or you may make one by cutting two strips of tin foil 2 inches in width and about 14 inches in length, the two to be separated by paraffin paper 2½ mils in thickness, and wound up until the whole forms a unit about 2½ inches in length by 1¼ inches in width.

With reference to the multi-layered receiving transformer described on page 34 of the September issue, this type of transformer will probably prove more efficient on the longer wavelengths than the usual single-layered solenoid.

* * *

A. C. C., Oneida, N. Y.:

The Armstrong receiving set described on page 39 of the February Wireless Age, was designed for 200 to 600-meter work. The 50 turns of wire need not necessarily have a tap taken off every turn, but if it is desired to do this, it may be accomplished by making a loop of wire long enough to reach the switch for every turn and tying the loop together tightly at the point where it leaves the coil with thread. After the coil has been wound, under these circumstances, it should be carefuly varnished.

It would not make a great deal of differ-

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ence whether you used a 100 ft. aerial or an 80 ft. aerial in connection with a short wave receiver. It would only be necessary in the case of the longer one to compensate for its additional length by the use of a smaller value of series tuning condenser.

With reference to the article on page 41 of the April issue, it will be all right for you to substitute single silk covered wire for the double silk covered wire called for.

This also applies to your question concerning the article in the May issue. You would probably get best results by using either of the receivers described in the February and May issues.

* * *

H. W. S., Binghamton, N. Y.:

We see no reason why you are unable to get results with the cabinet set when working with your antenna. It would be better if you used solid copper wire instead of copper clad, but this should not entirely prevent your getting some results. Look for loose connections, or it may be that the dimensions of the aerial on which the set was tested are entirely different from the dimensions of your own aerial which might, depending upon the set itself, make considerable difference. The wavelength of your aerial is approximately 170 meters. The manufacturers of the receiver should be willing to help you out.

* * *

A. B., Hartford, Conn.:

We have noted your diagram and find nothing wrong with it providing you leave out your 15,000 meter loading coil. It will not be possible for you to tune to 15,000 meters by the use of a loading coil in conjunction with the loose coupler which you describe. In order to reach this wavelength and to receive undamped waves, you should provide yourself with coils similar to those described in recent issues of the Wireless Age, and a Marconi vacuum tube.

"Practical Wireless Telegraphy" by E. E. Bucher, will thoroughly explain damped and undamped waves, and tuning. This will be supplied to you upon application to the Wireless Press, Inc., 64 Broad Street, New York City.

With the outfit which you now have, you should be able to receive upwards of 100 miles. We cannot tell you exactly because you have told us nothing concerning the dimensions of your aerial.

* * *

R. D. W., Plainfield, N. J.:

With reference to your query on page 44 of the July Wireless Age, Mr. Allen C. Rockwood, of the Iowa State University, advises that radiosite consists of specially selected crystals of iron pyrites. We are also informed that lenzite is generally known as iron faced galena.

C. H. McS., Pittsburgh, Pa.:
The honeycomb coils seem to be very popular with amateurs generally. They can be purchased separately, we believe, and refer you to the advertisements.

The only vacuum tube on the market is the Marconi vacuum tube. Vacuum tubes of the types used by the Navy and Army cannot be purchased.

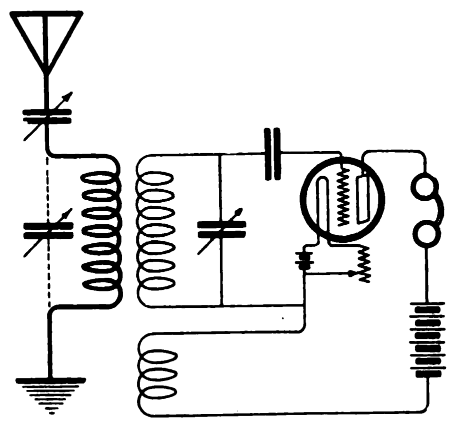
No special hook-up is required for the reception of wireless telephone speech, and vernier condensers are not necessary in order to tune in radio telephone signals.

In reply to your fourth question, we again refer you to the advertisements.

* * *

R. R., Wapinitia, Ore.:
In addition to the vacuum tube and the honeycomb coils you will need two variable condensers, having a capacity each of approximately .001 mfd. A storage battery for lighting the vacuum tube, a battery of dry cells giving you about 30 volts for feeding the plate circuit, a ten ohm rheostat for adjusting the filament temperature, and a pair of telephones.

A diagram of connections is shown below:



H. H., Atlantic City, N. J.:
Most spark coils give a scratchy note because of the fact that the vibrator either is not or cannot be properly adjusted. Best results are obtained from a spark coil when the note emitted is smooth and musical. The pitch of it does not matter so much, but usually best results are had with medium low pitch. This can only be obtained by experiment.

The single wire aerial, 300 ft. long and 40 ft. in height, may be used for transmitting with a 1½ in. spark coil. It is, however, too large for best results, and in addition to this, the wavelength would be in the neighborhood of 500 meters. The natural wavelength of the aerial is about 450 meters.

* * *

E. H. K., Detroit, Mich.:
Arlington sends out time signals at 9 P. M. Detroit time.

The natural wavelength of a four-wire antenna, 55 ft. long, and 35 ft. in height, with a 7 ft. lead-in, would be approximately 135 meters.

* * *

R. Y., Toronto, Ont.:
The hook-up which you have forwarded us is not a particularly good one for your purpose. In case you wish to use it, the bridging condenser around the telephones is not absolutely essential, although the range over which oscillations are available with your hook-up should be materially increased by its use.

The tickler coil design which you ask about is not suitable for long wave work. For data on the construction of long wave receivers we suggest that you read carefully the prize articles printed in the September WIRELESS AGE.

The grid leak may be connected in shunt to the grid condenser, provided the lower terminal of the secondary of the coupler is connected to the negative terminal of the lighting battery, or it may be connected direct from the grid to the negative terminal of the lighting battery.

If your vacuum tube functions properly, the fact that the plate is a little out of line will not in any way affect your results.

* * *

W. G., Burlington, Iowa:

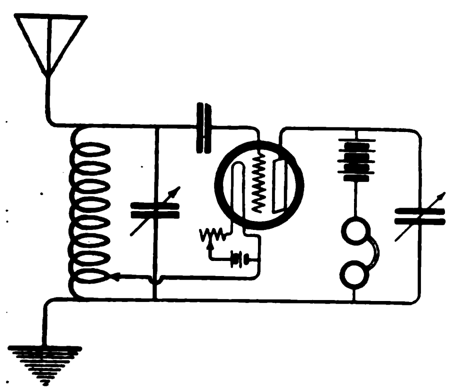
We regret that we are unable to give you the address of anyone who makes the double filament auto headlight bulbs. Such a bulb could, no doubt, be used for the rectification of alternating current at voltages depending upon the insulation between the two filaments, but we are inclined to believe that electrodes so small as these would necessarily be, would not work at all efficiently. An electrolytic rectifier would in all probability give trouble at 400 volts, particularly if an effort were made to draw any considerable amount of current through it. We regret that we have had no experience with electrolytic rectifiers at voltages higher than 100.

* * *

C. R. U., Rutherford, N. J.:

The diagram which you show would not be an efficient receiver for undamped long wave stations. If you desire to use a single coil, connect your apparatus as per diagram herewith.

The vacuum tube which you mention as being 3" in diameter and having plates ¾" by about 1 5-16" could be used as a rectifier on 60 cycles, 110 volts, connected as per hook-up shown below.



A. R., Scottville, Mich.:

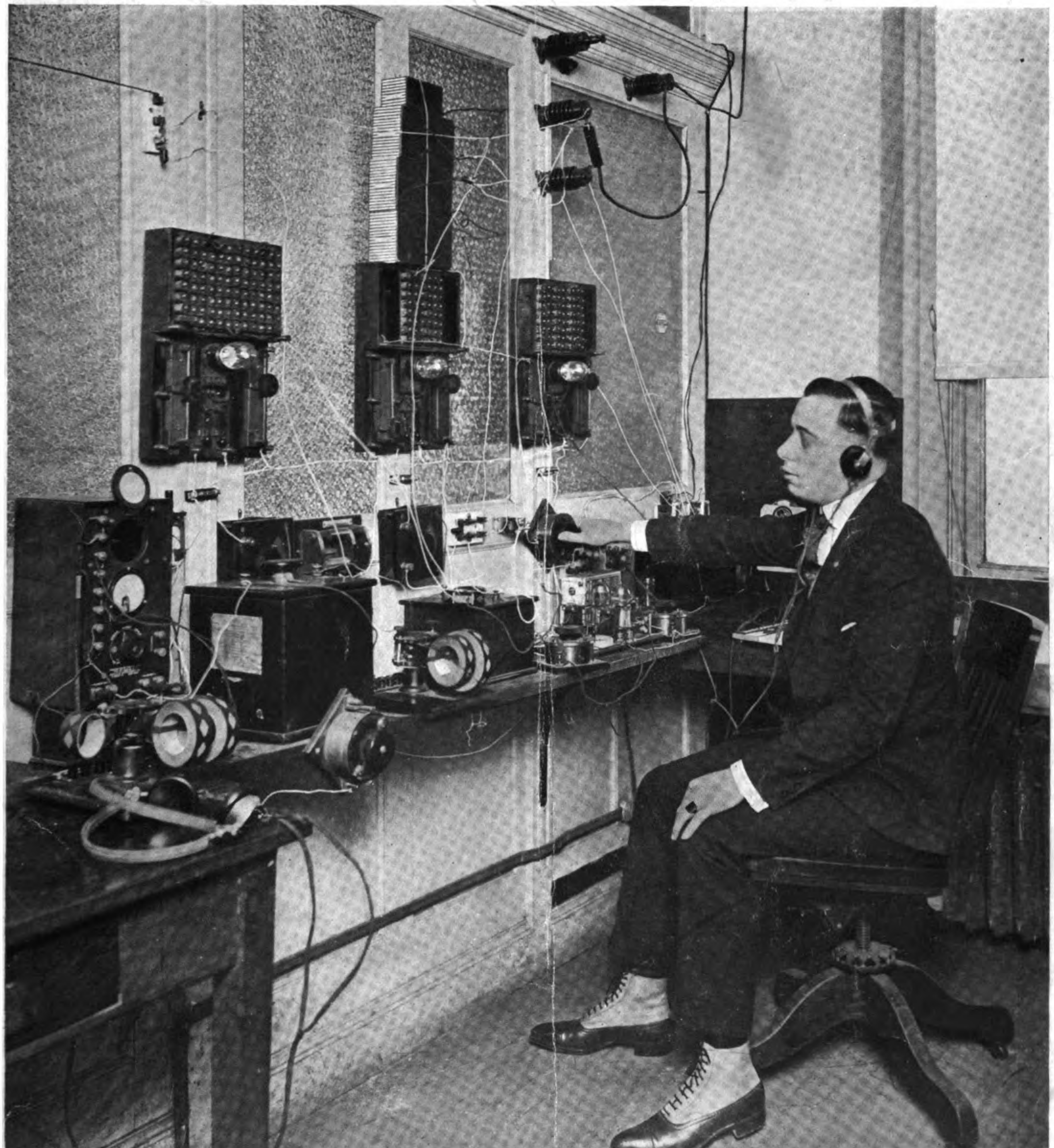
Question 1—The charges on all radiograms are collected at the office of origin, in U. S. currency. The charges will depend upon who controls the radio station on the ship that relays the message. As an illustration: On a ship equipped with Marconi apparatus and controlled by the Marconi Company, the ship tax will be four cents a word; relayed through a ship not equipped and controlled by the Marconi Company, there is a relay charge equal to the ship tax of the relaying ship, generally four cents a word. There is then the coast tax at the New York station controlled by the U. S. Navy, six cents a word. To this must be added a Western Union forwarding charge from the Naval station in New York to the point of destination. Should the relaying ship be controlled by the same company as the office of origin, there would be no charge for relaying the message.

Question 2—A message is seldom relayed through a number of ships as the operator at the office of origin must route his message to shore before sending, in order to be able to compute the charges. If a message must be relayed and it cannot be done in one relay, the message is usually not accepted from the public until the ship can establish better communication. In this case, question one answers number two.

January, 1920 20 Cents

The WIRELESS AGE

Volume 7 Number 4



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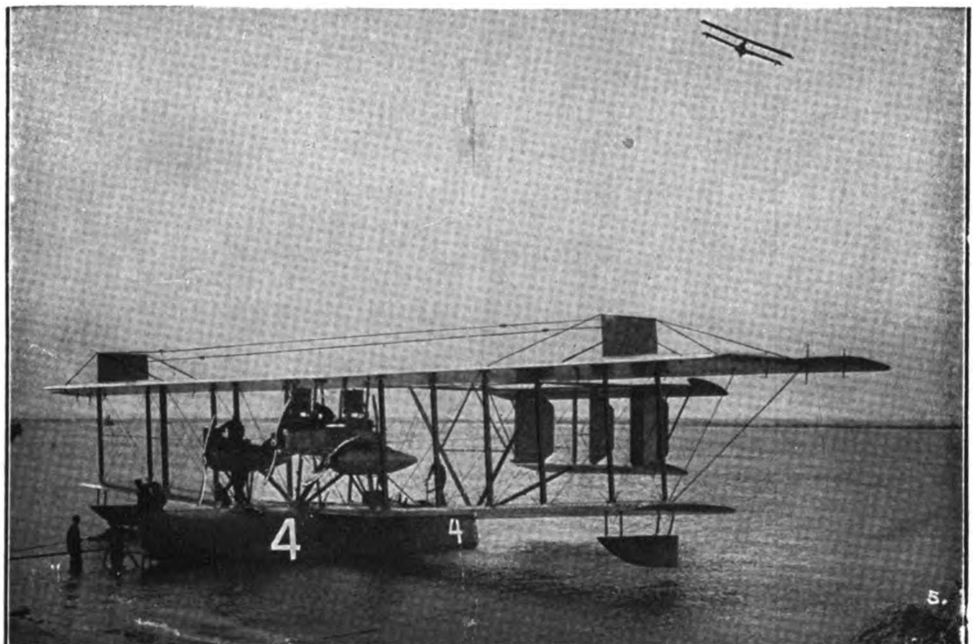
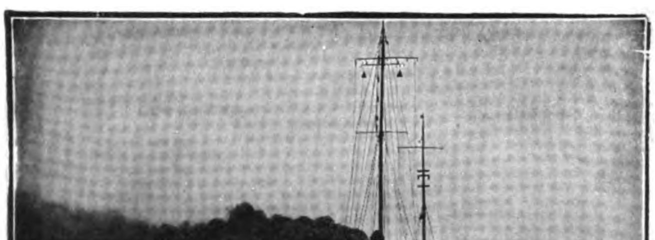
Extract from New York World, June 3, 1919.



NC-4—ELECTROSE Equipped



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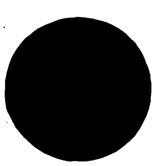
U. S. S. G-2—ELECTROSE Equipped.



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The Wireless Age

Edited by J. ANDREW WHITE

Vol. 7 — No. 4

Contents for January, 1920

Index of Equipment

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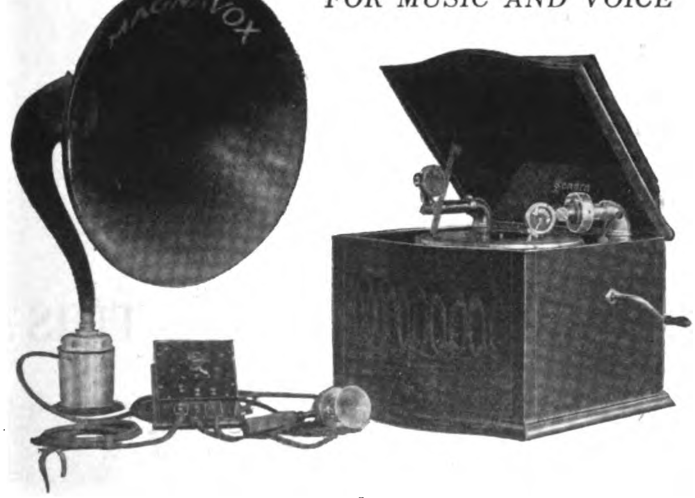

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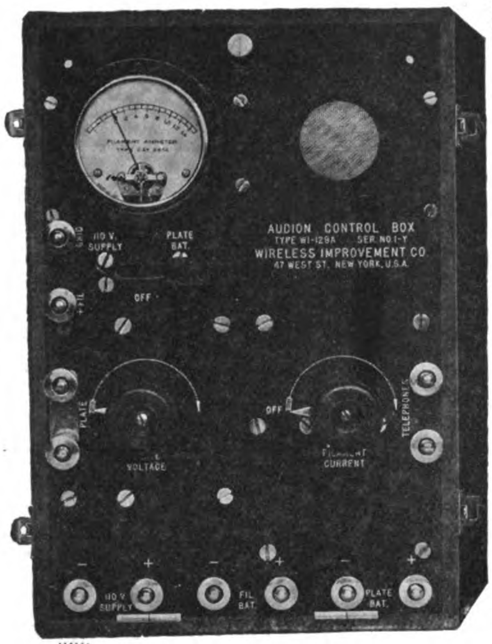

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TYPE WI-112A
Double Vacuum Tube Base Socket.

TYPE WI-114A
Triple Vacuum Tube Base Socket.

TYPE WI-120A
Grid Condenser. Small mica Dielectric condenser. Capacity: 0.0006 Mfd.

TYPE WI-121A
Telephone Condenser. Small Mica dielectric condenser. Capacity: 0.0025 Mfd.

TYPE WI-122A
Grid Leak Resistance. Glass enclosed. Moisture proof.

TYPE WI-126A
Crystal Detector. Dust proof—enclosed type.

TYPE WI-129A
Audion Control Box. Provided with filter system so that in addition to the plate battery of 40 volts, 110 volt supply may be used in the plate circuit.

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.

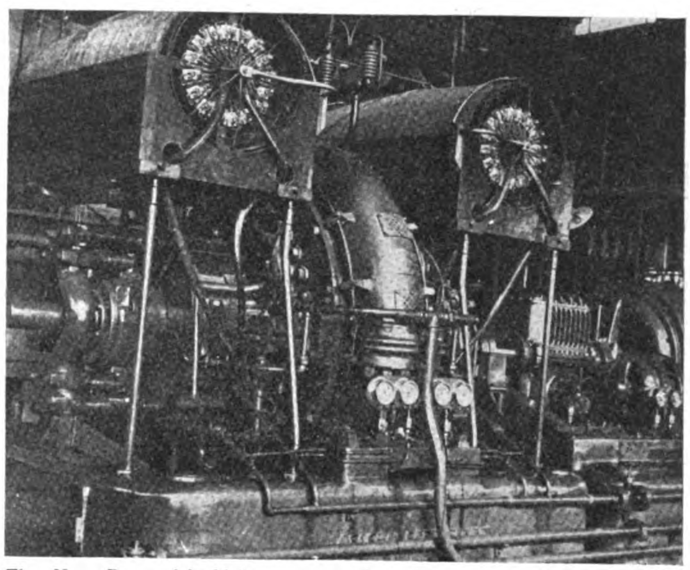
Edward J. Nally, who has devoted his life to communication service and who for a number of years has been vice-president and general manager of the Marconi Wireless Telegraph Company of America, has been elected president of the Radio Corporation.

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 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.



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

"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.

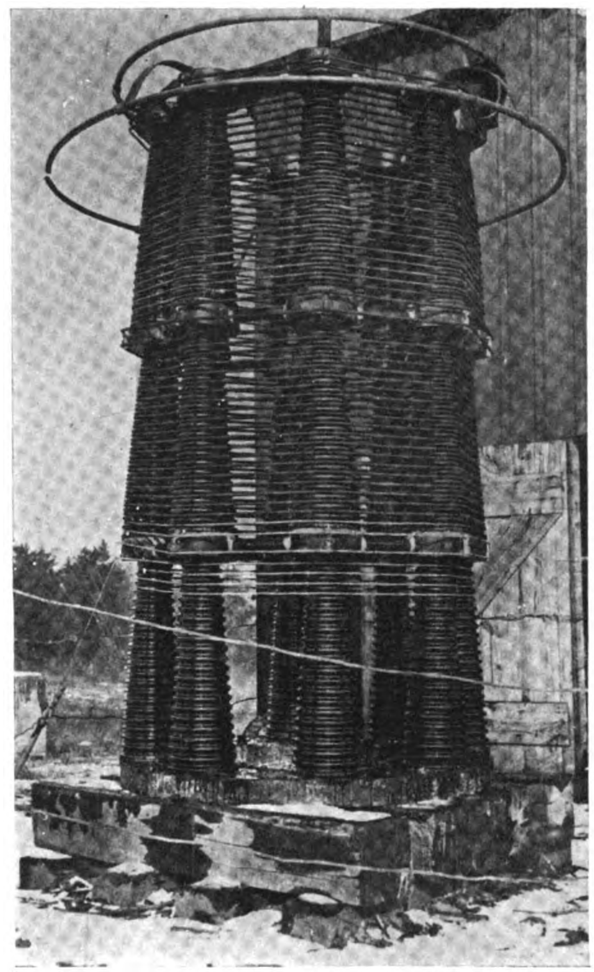
The colony will get one penny on each shilling of local business. The rate to Halifax will be one shilling a word.

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."

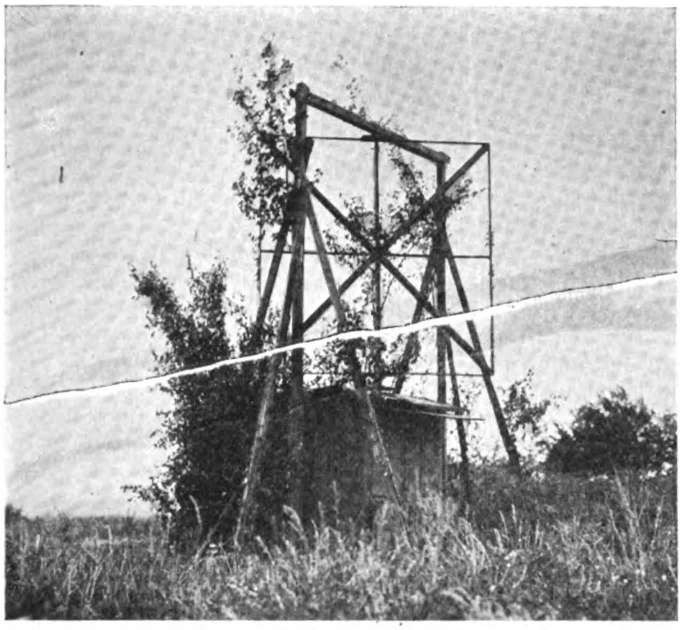
Unceasing vigilance was required of the officers and men of the Radio Section, together with the ability to meet the myriad ever-changing conditions. Too much credit cannot be given to the enlisted personnel. The trying conditions under which they labored, and the important results achieved by them were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

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

Staff) to follow the movements of the German stations with precision and certainty. These movements often disclosed the intentions of the enemy.

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.

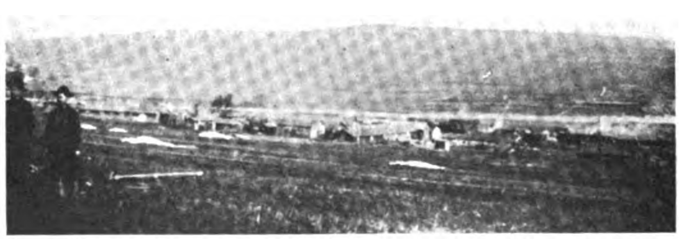
The first American radio intercept station was established at Souilly in December, 1917, at the Headquarters of the Second French Army, which was defending the Verdun sector. Due to the inexperience of the men it was difficult, at first, to obtain satisfactory results, but after a few weeks they became 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



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

gave excellent results. The French equipment was known by the following names:

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

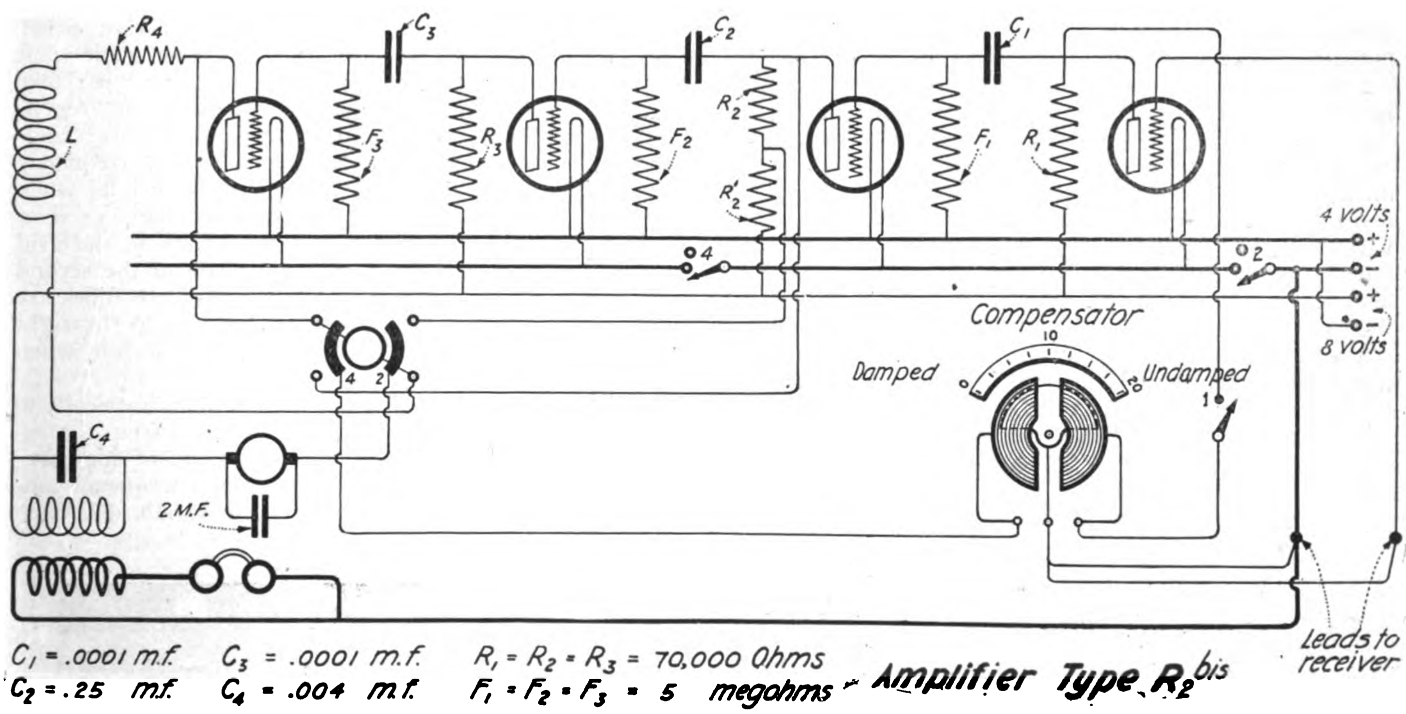
Radio goniometric stations on Toul front provided with small loops of American design

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 number 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.

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.

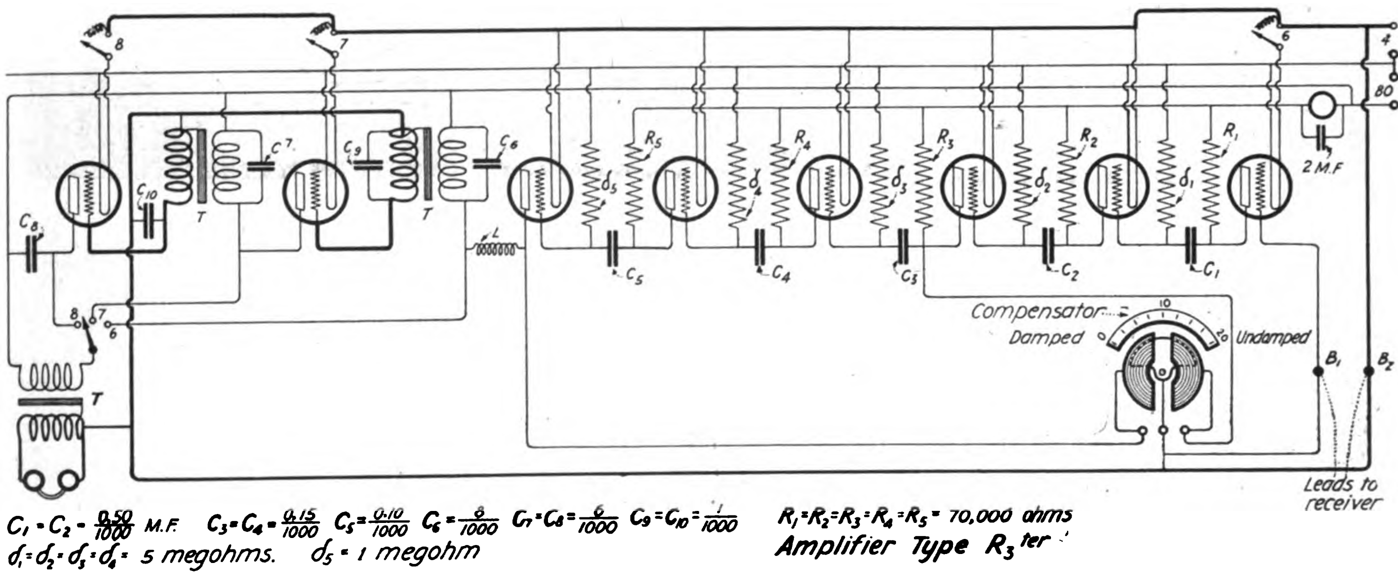
Both the Receiver Type A-1 and the Amplifier Type 3-ter have been described in a previous article.

The Amplifier Type L-3 was used principally for receiving on loops; a description of this instrument will be given hereafter in connection with the radio goniometric station equipment.



Circuit diagram of Amplifier Type R-2 bis

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 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 frequency 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

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.

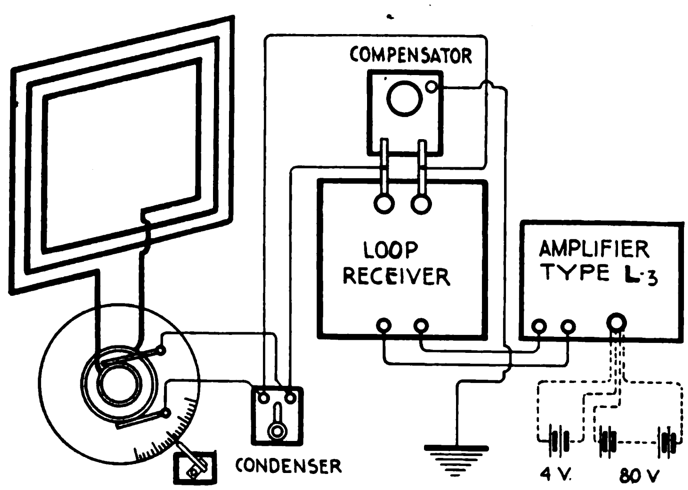
The Amplifier Type R-3 ter is very similar electrically to Amplifier Type R-2 bis, as will be observed from the accompanying diagram, but it has six steps of high-frequency amplification and two steps of low frequency amplification. This makes a total of eight standard French

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.

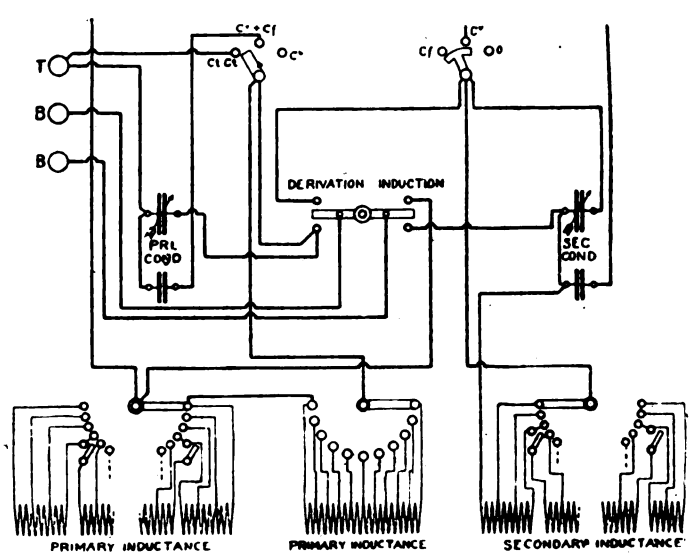
Provision is also made in Amplifier Type R-3 ter to utilize a variable number of vacuum tubes. A switch is provided whereby six, seven or eight lamps may be utilized, which means that no low-frequency amplification may be provided or that one or two steps may be used in accordance with the desires of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



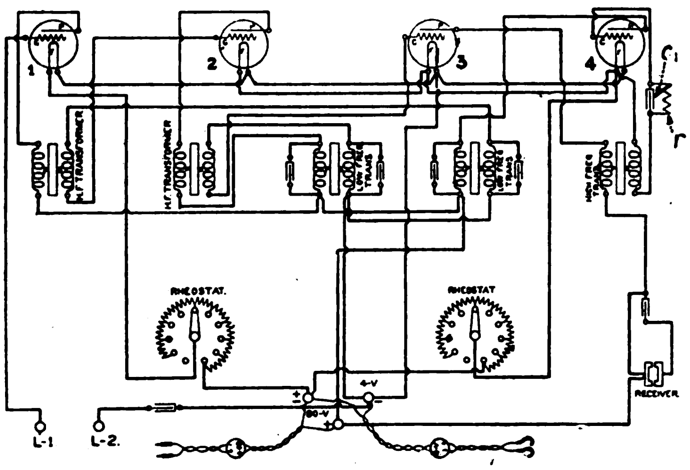
Circuit diagram of Receiver Type No. 2

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 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.



Circuit diagram of Amplifier Type L-3

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."

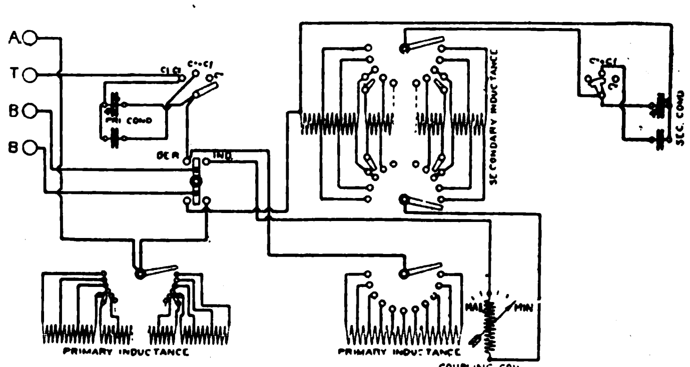
The three radio goniometric tractors moved from the Toul sector to the Verdun sector were stationed at Ville-sur-Taube, Avecourt and Verdun. In co-operation with three French radio goniometric tractors they covered the advancing front extending from the western edge of the Argonne to the right of the 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.

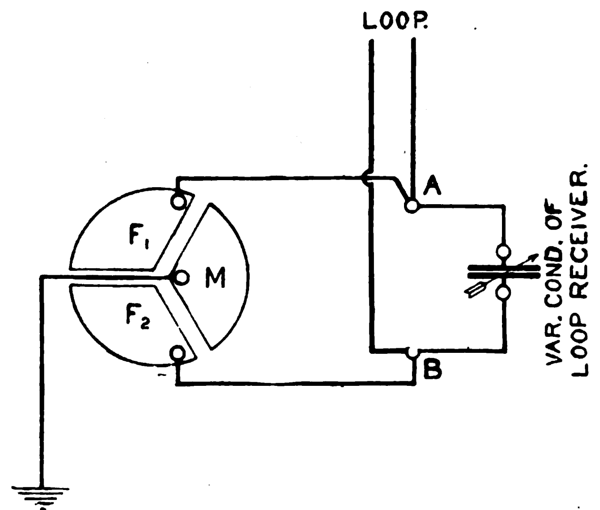
The Loop Receivers Types No. 2 and 3 comprised only variable condensers, together with either one or two fixed condensers; in the circuit diagram herewith they are illustrated in conjunction with the loop compensator. The loop compensator was used to correct the inequality of the capacities of the two 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 adjustment 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.



Circuit diagram of Receiver Type No. 3

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.

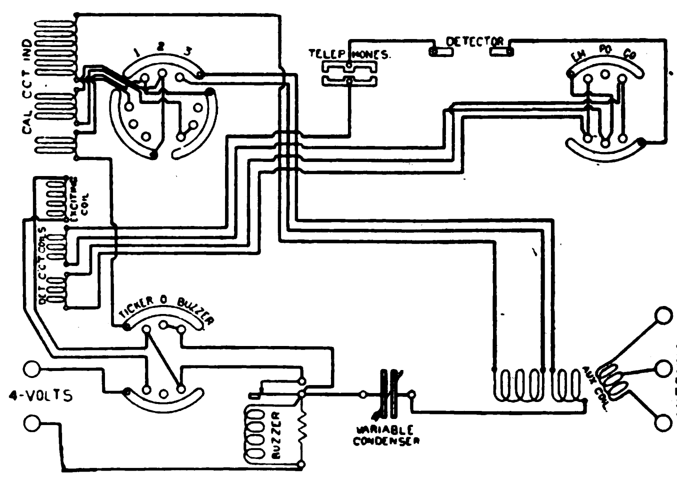
The number of messages sent in "clear" English—uncoded—and other violations of the radio regulations of the A. E. F., demonstrated the need for stations which specialized in copying messages transmitted by American field stations. Two control intercept stations of this character were established at Toul 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



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

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.

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

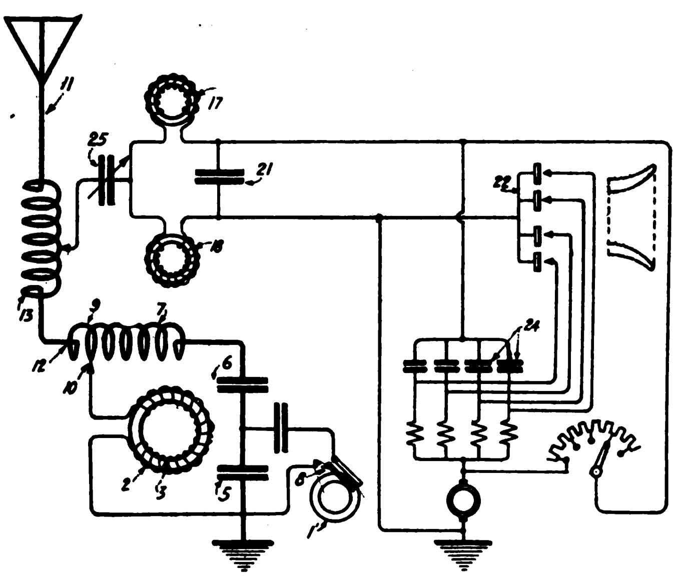


Figure 1—Circuit of the Alexanderson method of transforming the frequency of alternating currents for radio signaling

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

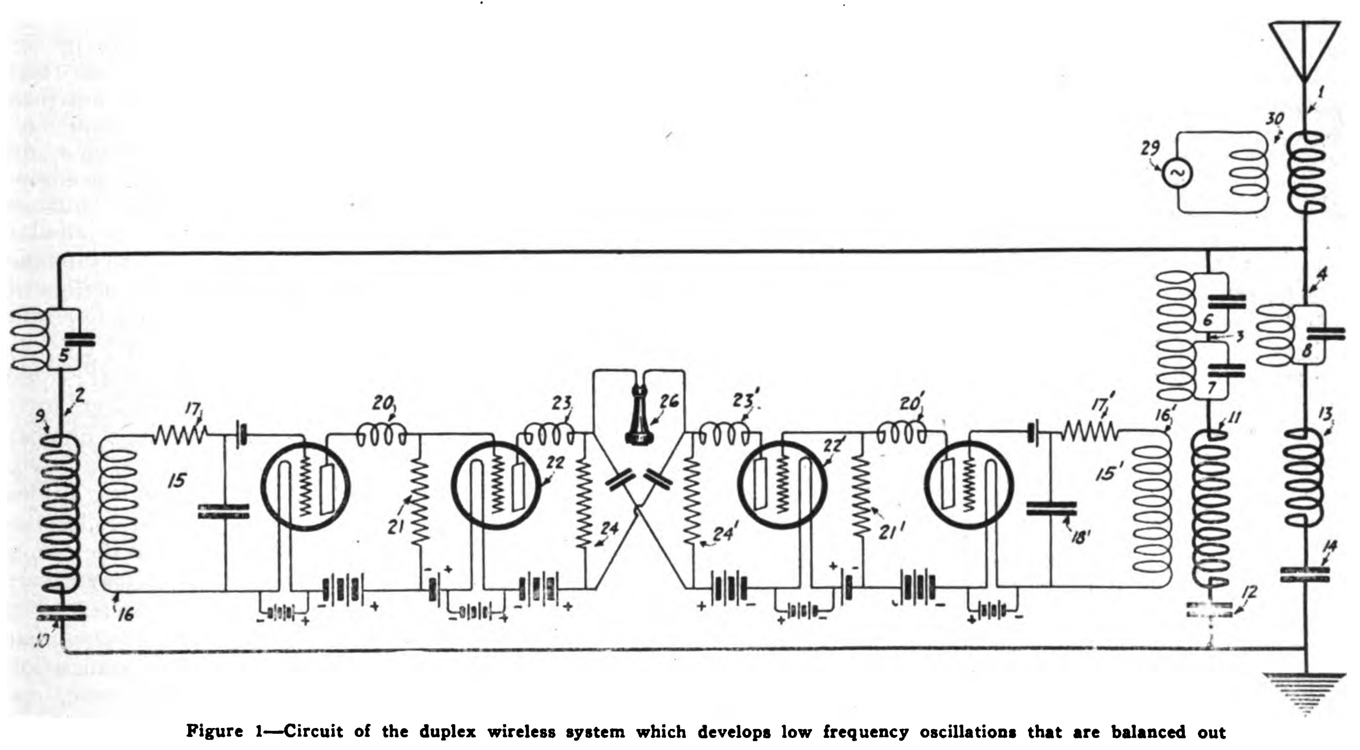


Figure 1—Circuit of the duplex wireless system which develops low frequency oscillations that are balanced out

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 reignited, 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-

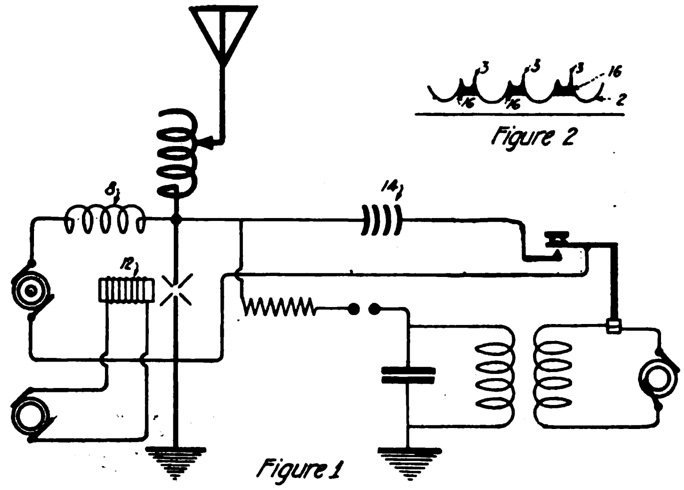


Figure 1—Circuit used in the arc method of signaling. Figure 2—Potential curve across the arc

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-

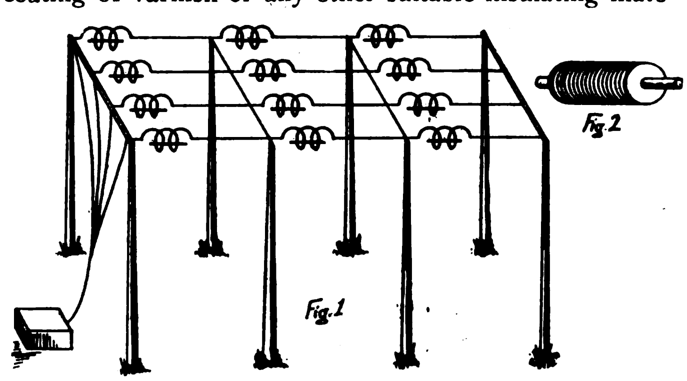


Figure 1—Antenna with inductance coils in place. Figure 2—Construction of the coils

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.

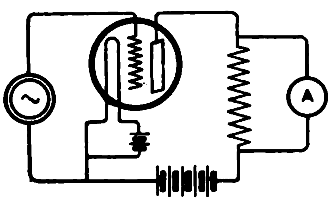


Figure 1

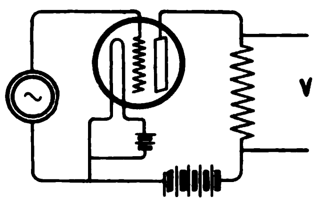


Figure 2

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.

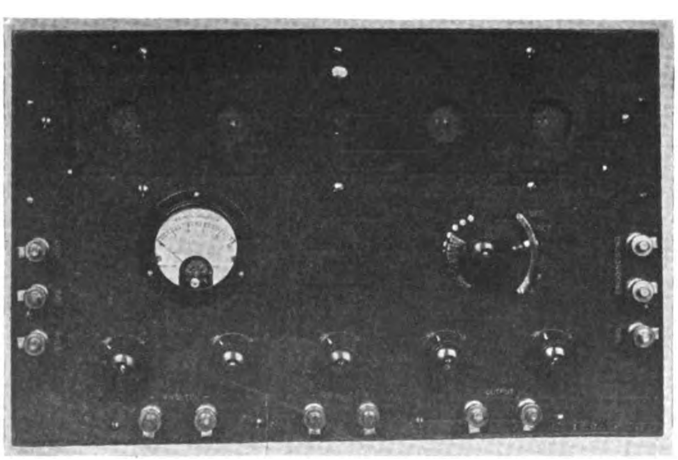


Figure 3—Complete amplifier and detector panel set

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.

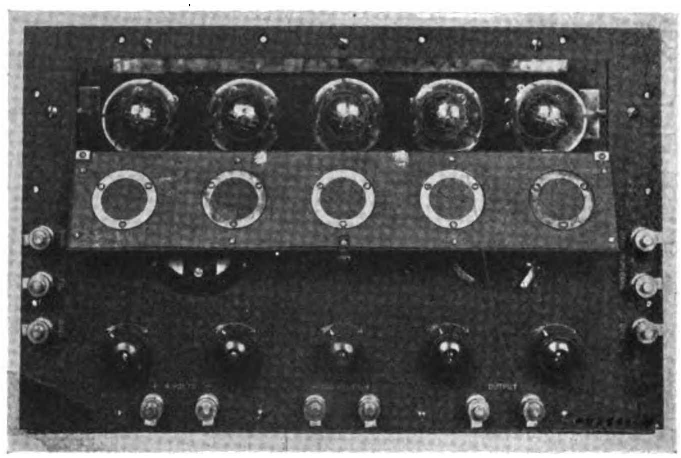


Figure 4—Showing the window panel with copper gauze windows opened to permit removal of V. T's.

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.

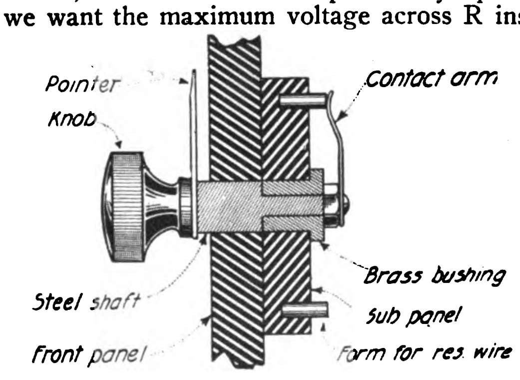


Figure 5—Showing the construction of the filament rheostat

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.

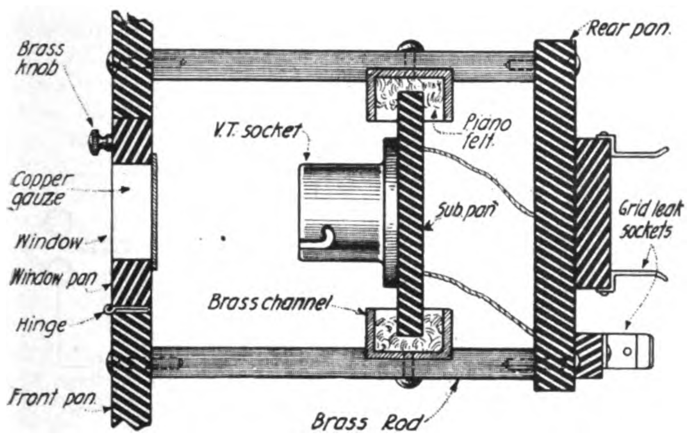


Figure 6—Section showing V. T. holder and shock proof construction

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.

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.

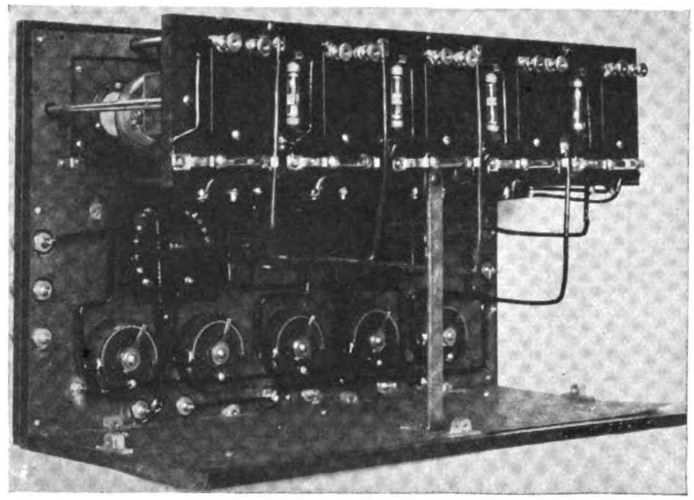


Figure 7—Showing the grid leaks in vertical and horizontal positions

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.

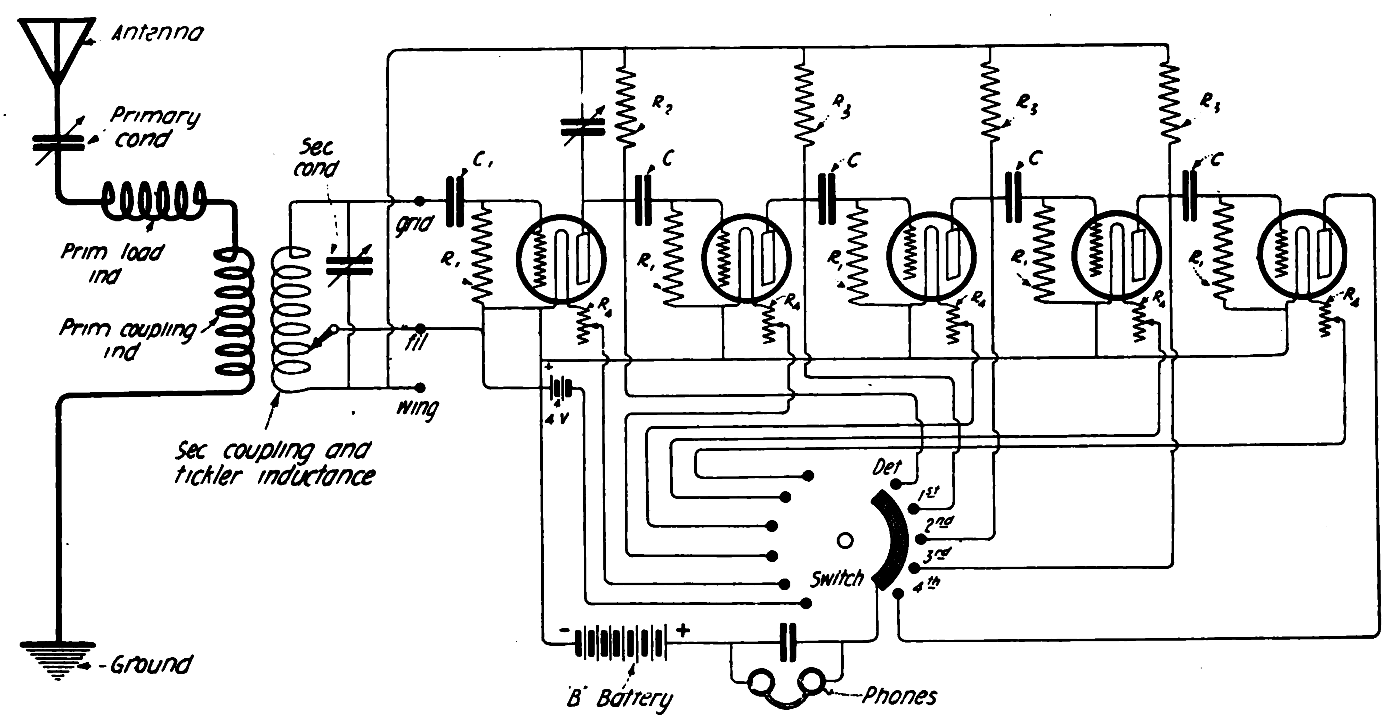


Figure 8—Schematic wiring diagram of V. T. detector and resistance coupled amplifier—four stages—with regenerative feature

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).

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.

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.

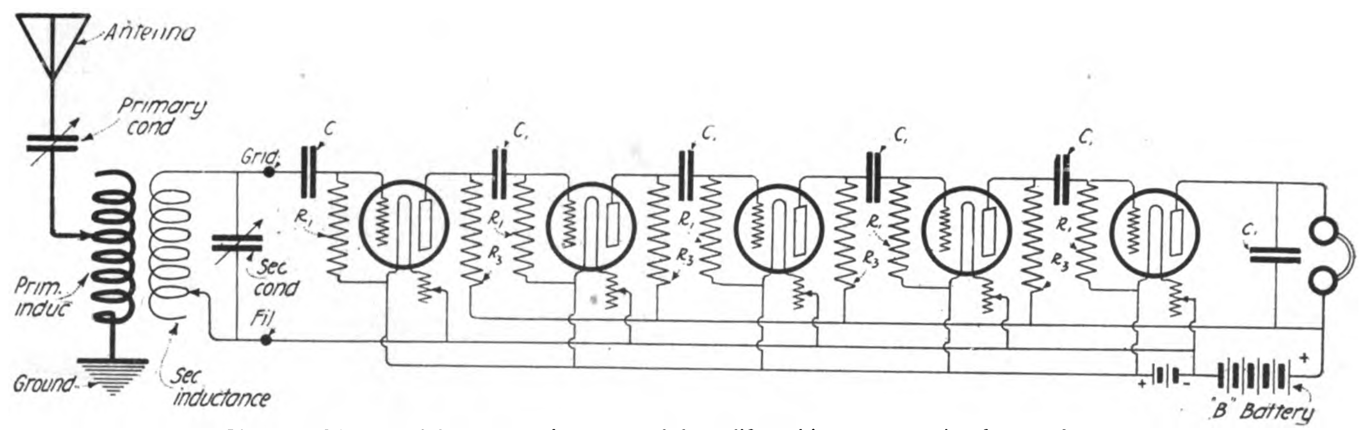


Figure 9—Diagram of five-stage resistance coupled amplifier without regenerative detector feature

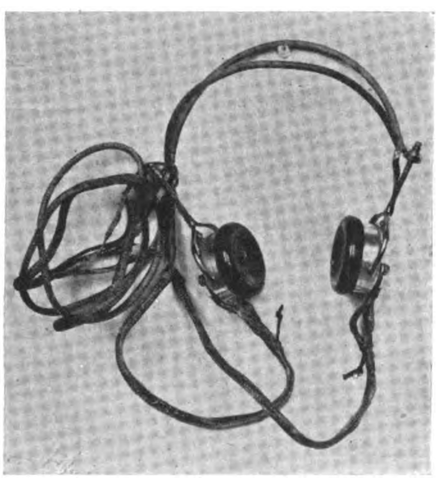


Figure 10—Shielded telephone head set with flexible Belden braid wire cord

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.

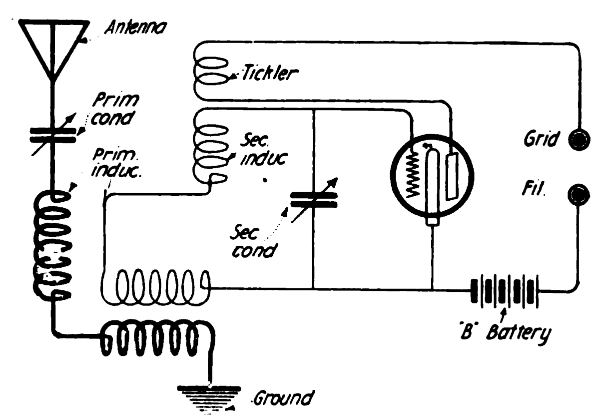


Figure 11—Regenerative receiver circuit which is connected to the plain five-stage amplifier circuit

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

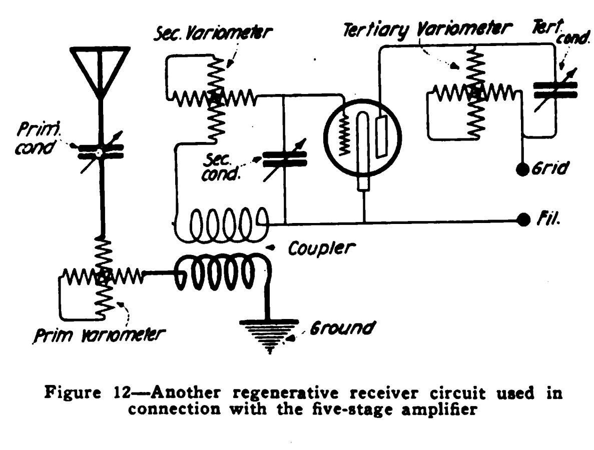


Figure 12—Another regenerative receiver circuit used in connection with the five-stage amplifier

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 ¾ inch thick and 2 to 2½ inches in diameter. On a circle concentric with the face of the cylinder and out ¼ 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 ½ 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.

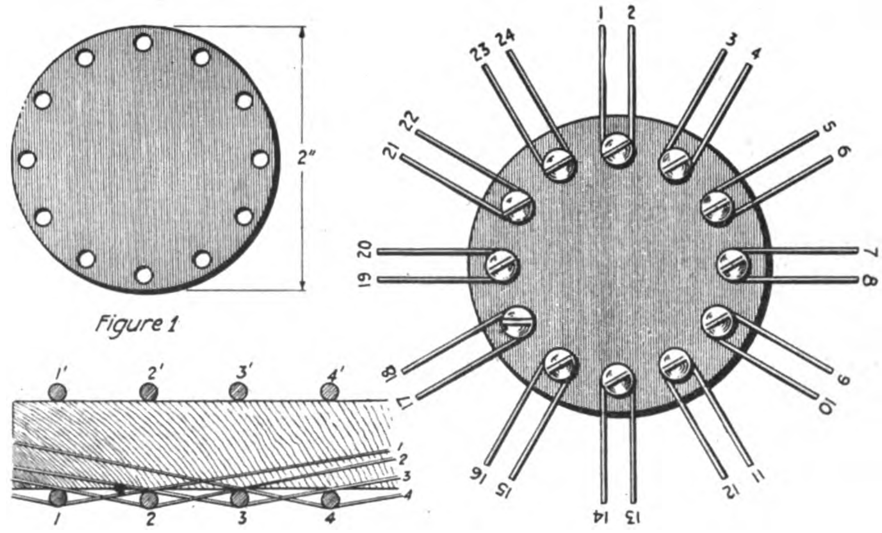


Figure 3 Figure 2

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.

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.

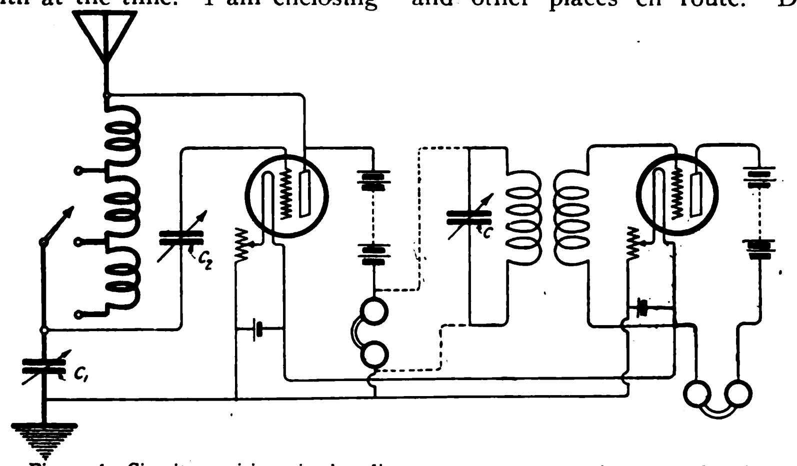


Figure 1—Circuit requiring simple adjustment to tune to various wave lengths

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.

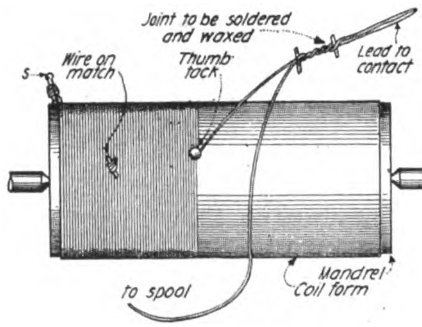
Winding and Tapping Radio Coils

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 ap-



Method of winding

plied 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.

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.

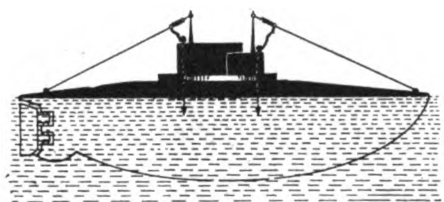
If the leads are to be carried through the inside of the coil form, small holes are made at the exact location of the joint and the leads passed through, numbering each one so it may be identified when wiring to the multiple switch. A hot knife will facilitate getting the soldered and waxed joint home 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.

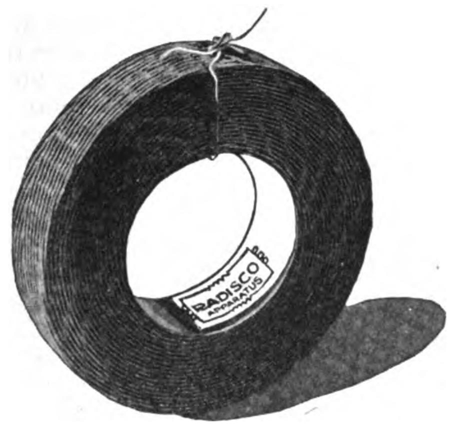
A large amount of research work done by the Bureau of Standards ex-



Submarine with loop antenna in place

tending 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.

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



CONTRARY to RUMORS

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The Radio Distributing Co. is still manufacturing their unmounted universal wound Inductances, and will continue to supply their agents these very efficient coils.

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The RADIO DISTRIBUTING COMPANY will assure all purchasers that they will experience no inconvenience by reason of any action now pending or to be started by reason of patent on coils purchased. These coils are in stock at all RADISCO AGENTS.

RADISCO AGENTS carry only apparatus of proven merit. Look for the RADISCO trademark on all coils you buy and be sure of getting efficient apparatus.

Below are listed a few of the reliable firms who carry the Universal Wound Inductances and are our Agents for all standard radio apparatus of merit, including our now famous BETTER "B" BATTERY.

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ATLANTIC CITY, N. J.
Independent Radio Supply,
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Canadian Radio Mfg. Co.

BOSTON, MASS.
Atlantic Radio Co.,
34 Batterymarch St.

BROOKLYN, N. Y.
Kelly & Phillips Electric Co.,
312 Flatbush Ave.

BRONX, NEW YORK CITY.
Amateur Wireless Equipment Co.,
1390 Prospect Ave.

CHICAGO, ILL.
Chicago Radio Laboratories,
1316 Carmen Ave.

HAMPTON, N. H.
DeLancey Felch & Co.,

LOS ANGELES, CALIF.
The Wireless Shop,
511 W. Washington St.

McKEESPORT, PA.
K. & L. Electric Co.,
427 Olive Street.

NEW ORLEANS, LA.
L. A. Rose,
4323 Magnolia Street.

NEWARK, N. J.
A. H. Corwin & Co.,
4 West Park Street.

NEWCASTLE, PA.
Pennsylvania Wireless Mfg. Co.,
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PHILADELPHIA, PA.
Philadelphia School of Wireless Telegraphy,
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PROVIDENCE, R. I.
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PITTSBURG, PA.
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4614 Henry Street.

SCRANTON, PA.
Shotton Radio Mfg. Co.,
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Also 8 Kingsbury St.,
Jamestown, N. Y.

SPRINGFIELD, MASS.
Electric Service Co.,
585 Armory Street.

TORONTO, ONT., CAN.
The Vimy Supply Co.,
585 College Street.

WASHINGTON, D. C.
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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

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 meet-

ing, 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.

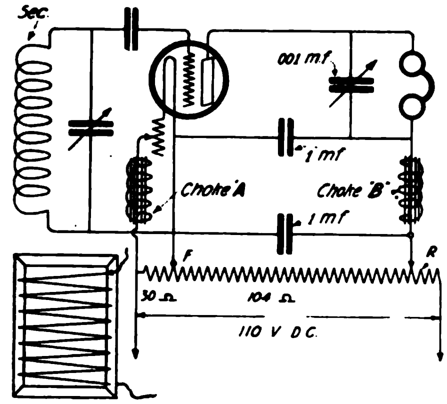
* * *

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.

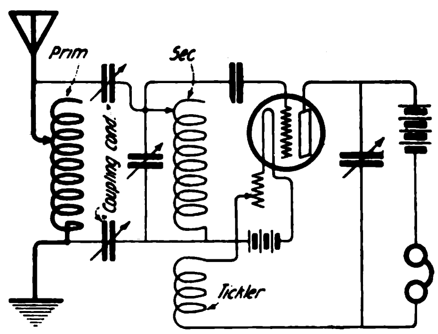
* * *

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.

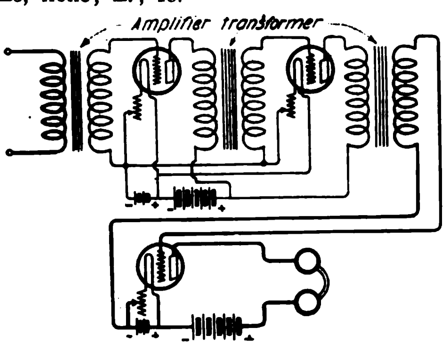
It is possible to rewind a 500 volt generator so that it will give 1,500 volts. The output will be decreased somewhat.

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 unicontrol 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.

* * *

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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.
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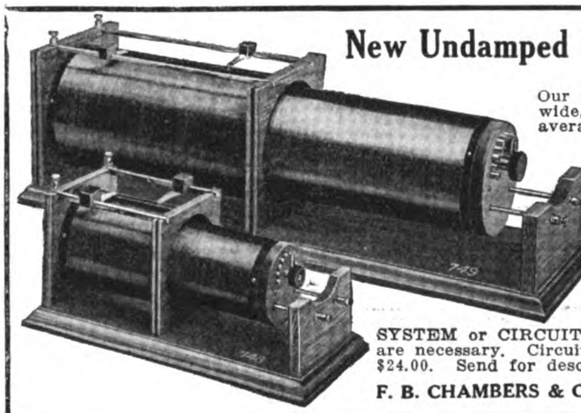

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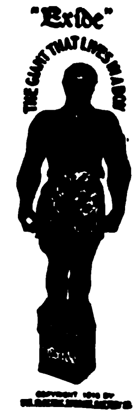

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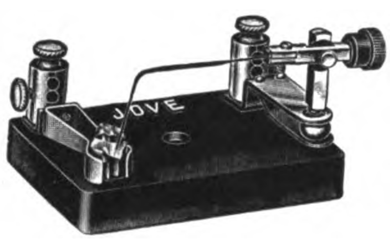

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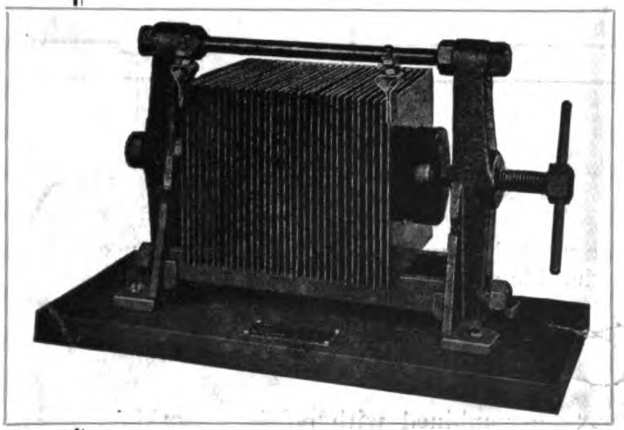

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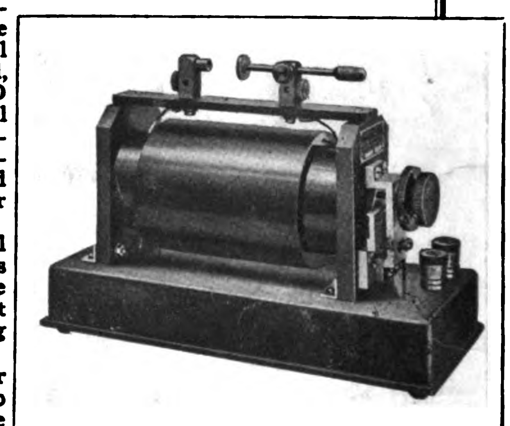

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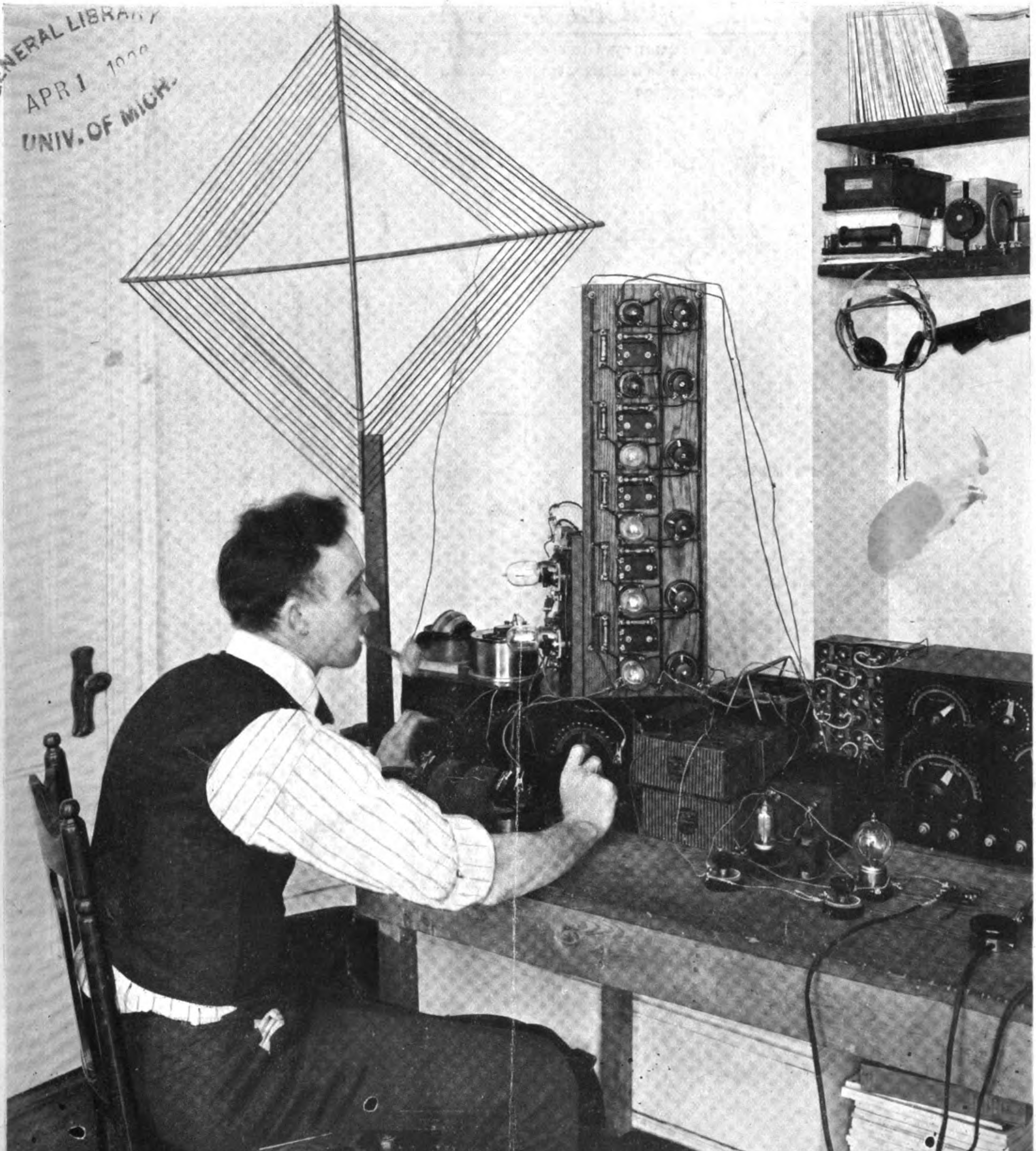
The WIRELESS AGE

Volume 7

Number 5



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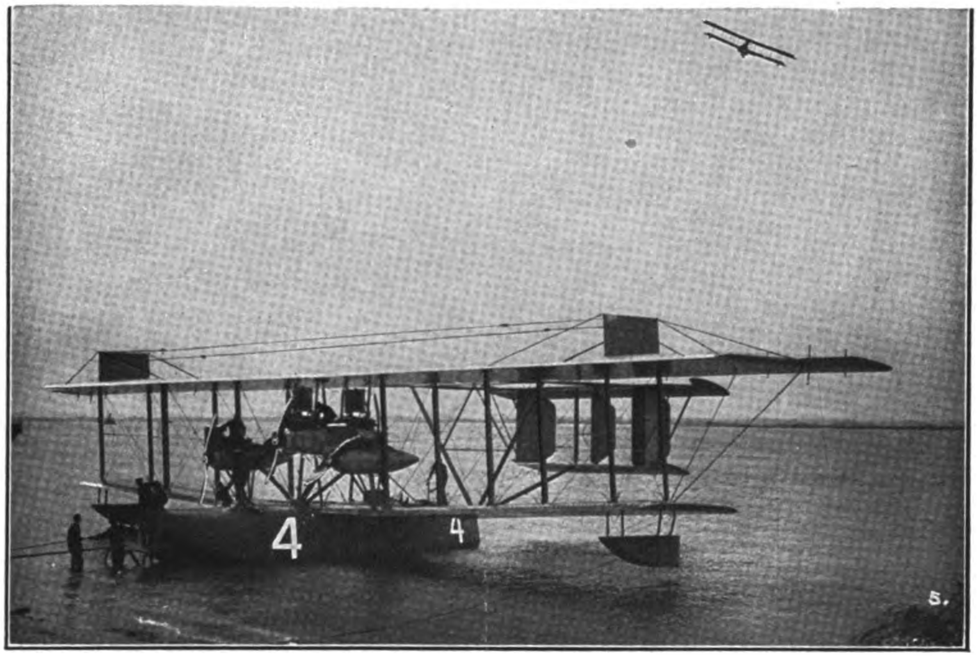
Extract from New York World, June 3, 1919.



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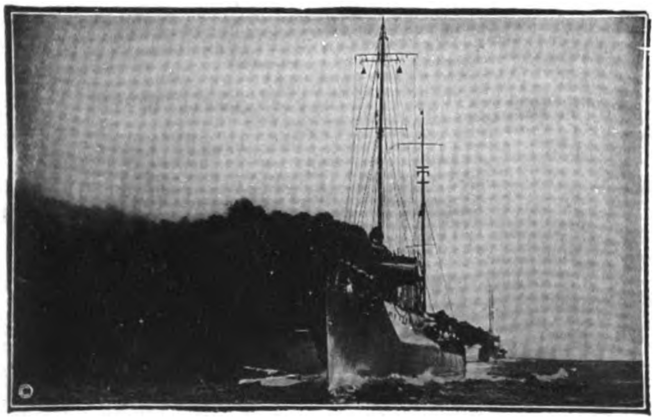

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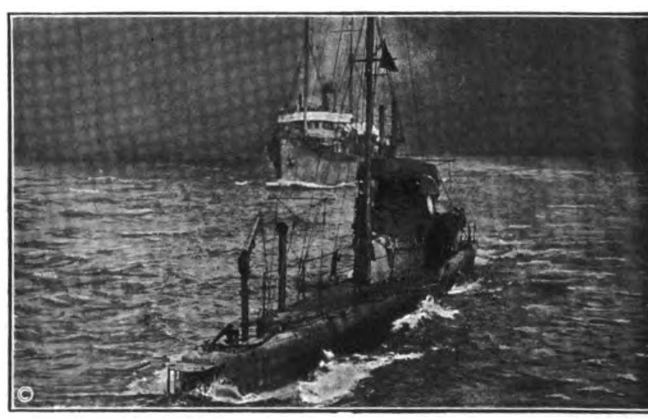

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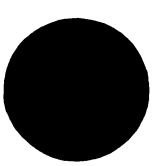

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The Wireless Age

Edited by J. ANDREW WHITE

Vol. 7 — Contents for February, 1920 — No. 5

Index of Equipment

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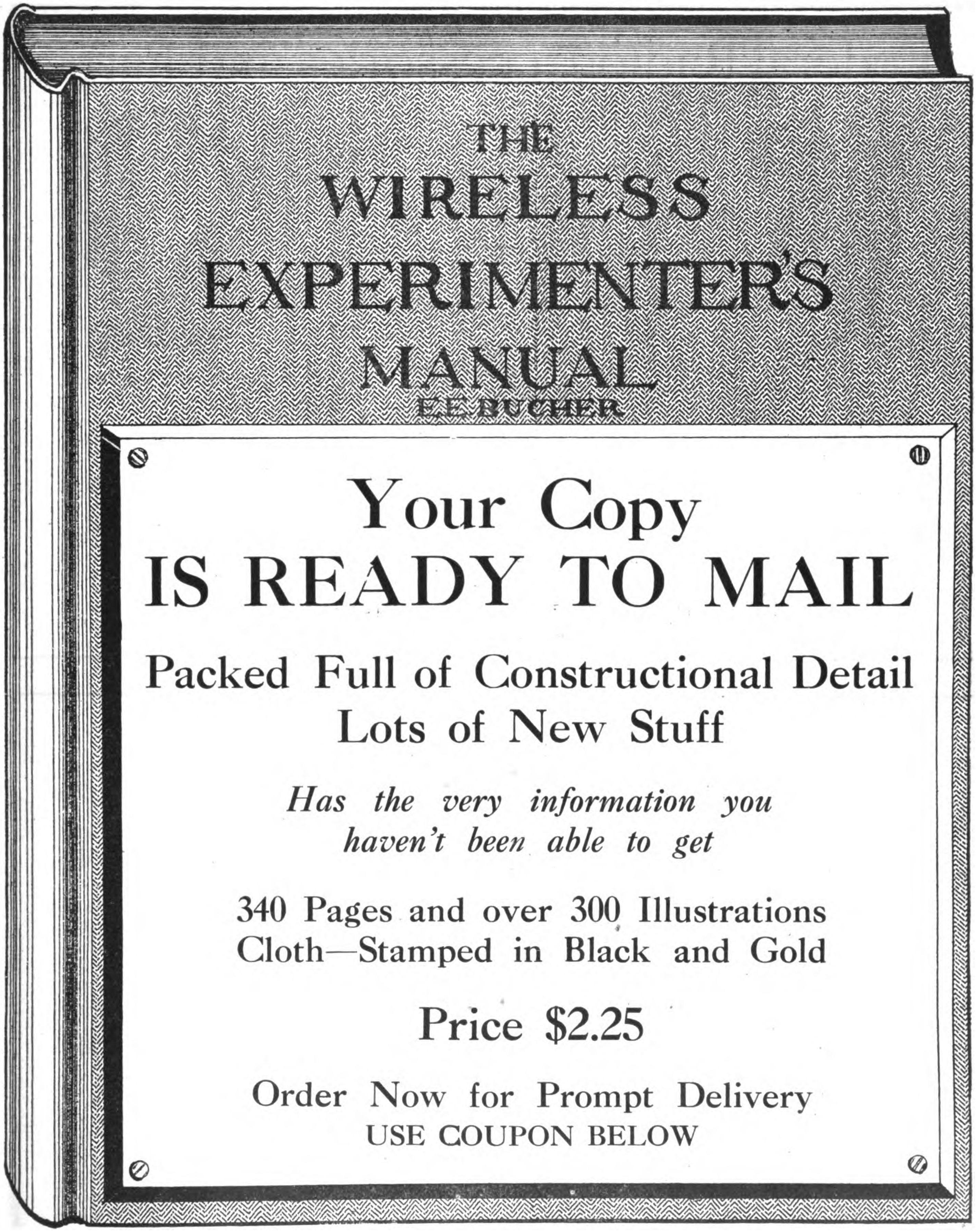
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If this page is cut out and appended to the same page cut from the editions to follow, a complete file of very interesting information will soon be available. (No. 2)

Vol. 7. No. 5. FEBRUARY, 1920

THE WIRELESS AGE

WORLD WIDE WIRELESS

Navy Ordered to Release Radio Stations, Seized in War

NAVAL operation or control of all private radio stations, assumed during the war emergency, will be relinquished at midnight February 29, under an executive order made public by Secretary Daniels.

All stations taken over by the Government at the outbreak of the war are to be returned to their owners and all new stations built during the war by private concerns and which could not be operated because of the wartime restrictions, can be operated after February 29.

Under the order wireless communication reverts to prewar conditions, and is subject to regulations of the act approved August 13, 1912.

Nine high-powered stations controlled by the Radio Corporation of America were taken over at the outbreak of the war. They are at Marion and Chatham, Mass.; New Brunswick, Belmar and Tuckerton, N. J.; Bolinas and Marshall, Cal., and Kahuku and Koko Head, Hawaiian Islands.

Transoceanic Radiophone in the Near Future

MARCONI prophesies that in the immediate future conversations between Great Britain and the United States will be carried on by wireless telephones and that the cost will be not more than 24 cents for one minute.

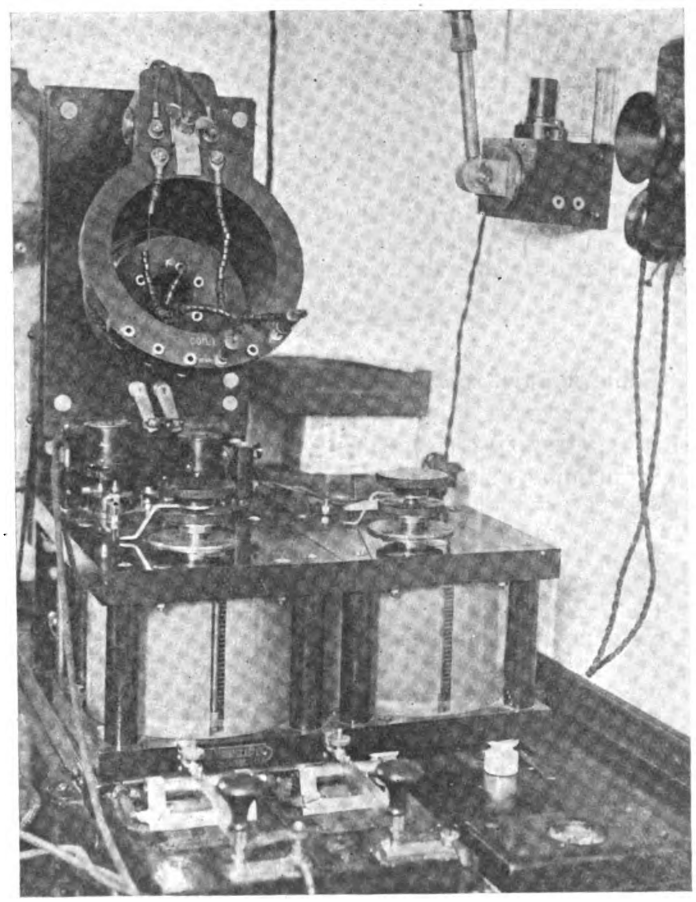
The inventor states that he has spoken directly to Canada from London, and adds: "It is only a matter of time when we shall be able to speak to New York from London. Already we have carried out many successful experiments between London and the Continent and we hope that we shall be able soon to announce the installation of a worldwide wireless telephone system in all countries interested. Our plans are developing rapidly."

Transoceanic conversations will be carried on through an ordinary telephone, the sending exchange being connected with the wireless station; at the receiving end the same method will be followed. Marconi already has applied for permission to erect a station in Norway to demonstrate his ability to talk across large expanses of water.

The cabled interview with Signor Marconi in London, in which the inventor of wireless was reported as saying that wireless telephone communication with New York would be shortly established, was shown to officers of the Radio Corporation of America.

"Every station in the country is under government operation," said David Sarnoff, commercial manager. "Until the stations are returned to us there can be no commercial arrangements made. I think the rate will be much higher than 24 cents a minute, as it will require a tremendous amount of power to send the voice across the Atlantic."

He said that the experiments referred to by Mr. Marconi were being made between the British and Canadian stations, which were no longer under government operation. Extensive plans have been made for some time for the establishment of transatlantic wireless telephone communication to be inaugurated as soon as possible after the great transatlantic wireless stations are returned to the private companies. These plans include radio exchanges which will transfer the voice from the ordinary land line telephone to the wireless telephone automatically. Under this arrangement it will be possible for a subscriber in New York to converse with a subscriber in London while using the ordinary telephone in the home or office.



The wireless set of the S. S. Alban, which accomplished unusual results in long distance receiving recently

Marconi's statement has provoked considerable discussion in London. A prominent official of the Central Telegraph Office pointed out that the Central Telegraph Office was handling on an average 12,000 messages more daily than in 1919. "All I can say beyond that," he added, "is that we have not yet ordered a hearse for the funeral."

The managing director of a cable company, mentioning that statements similar to Marconi's cropped up from time to time, said, "all we can do is to wait and see."

British Wireless Device Has Varied Uses

A REMARKABLE series of wireless experiments, just completed at Chelmsford, England, is the basis of an assertion that by a new wireless device big guns or hidden stores of explosives can be fired or exploded at long distance.

The original purpose of the Chelmsford test was to demonstrate a new device for giving aid to ships in distress at sea. The apparatus in its simpler form is intended to ring bells on board every ship within the wireless radius of the vessel sending out the distress call. It is with the extension of this idea, however, that an official of Marconi's Wireless Telegraph Company declared that such an apparatus in Paris could cause an explosion in Berlin. Also, it was asserted that an apparatus in an airplane could hover over an approaching enemy until his troops were over a previously hidden store of explosives and then destroy them.

It was stated that the instrument was used in experimental ways during the latter part of the war when fog guns some fifteen miles from shore were fired in the Channel by wireless rather than by a party of men despatched to the scene.

However, the principal use to which the device will be put is in merchant shipping, and the experiments at Chelmsford centered about such application.

Cable Delays to Be Relieved by Wireless Service on Pacific Coast

IMPORTERS and exporters in San Francisco are complaining that delay in transmission of their cables is costing a tremendous financial loss.

It is contended that cables to Honolulu are delayed from four to six days; to the Orient sixteen to eighteen days, and twelve to sixteen days to Australia. Some of the foreign traders here overlook the fact that radio service is now available to the Orient.

Importing and exporting firms have been advised to use radio instead of cable wherever possible. Arthur A. Isbell, division superintendent of the Radio Corporation of America, calls attention to the fact that the Japanese government station is open only ten hours a day for commercial business and that causes much of the congestion from that end.

Using radio instead of the cable would expedite messages; besides, radio is less costly.

Spanish Steamer Guided to Port by Wireless

GUIDED only by positions furnished from wireless stations ashore, the Spanish Royal Mail liner Leon XIII. arrived in New York, the first of a fleet of twenty-six vessels held up by a storm to get through quarantine.

When off the danger zone in the vicinity of Cape Hatteras the storm obscured the sun so that Capt. Francesco Murot, commander of the vessel, was unable to get his location. Grouping blindly along the treacherous coast the vessel was in constant danger of piling up on the rocks until the captain took advantage of the facilities for getting his position from the shore wireless stations.

Communication once established, the officers had no further difficulty in determining the whereabouts of the steamer.

Wireless Phone Talks Held Between Spain and England

SUCCESSFUL wireless telephonic tests have been made between the station at Arancuz, near Madrid, and Chelmsford, England, a distance of 700 miles. Conversations were carried on without difficulty.

New Orleans to Get Three Compass Stations

THREE compass stations are being built at the mouth of the Mississippi River. These will direct ships through raging hurricanes and fogs to New Orleans, the second port of America.

The installation of this apparatus will add millions of dollars to the shipping facilities of this port. It will revolutionize the handling of ships. Above all, the lives of men, who go down to the sea in ships, will be safeguarded more thoroughly than ever before.

Wireless Brings Aid to U. S. Navy Tug

A THRILLING tale of a battle with mountainous seas and 70-mile-an-hour gales, in which the Mexpet Company's giant oil tanker, George E. Paddleford, Capt. G. Duncan, turned to and went to the assistance of the disabled United States navy tug Undaunted, which was floundering around 20 miles east of Cape Hatteras, was learned on the arrival of the tanker at Providence.

Darkness added to the dangers in the attempt to rescue the helpless tug, which had lost its propeller. Twice, a steel hawser was gotten aboard the tug by means of floating a smaller line with the aid of a barrel.

Each time the heavy hawser was snapped by the plunging of the buffeted vessels. Only after a wireless message was received that the United States revenue cutter Yamacraw was coming to assist the disabled craft, did the tanker turn and proceed on her voyage to Providence.

Capt. Duncan received a radiogram from Capt. Tarbell of the Undaunted, expressing warm appreciation for his assistance about an hour after the attempt to rescue had been made and the tanker had proceeded on her way.

Navy Adopts Inter-Allied Wireless Procedure

A BULLETIN from the office of the Director of U. S. Naval Communications, Washington, D. C., announces that there will soon be placed into effect a new operating procedure. As a result of an inter-Allied conference, the Navy Department has decided to adopt as a basis for its radio procedure the so-called Inter-Allied W/T Procedure, which is indicated in M. P. L. Document No. 2, entitled "Inter-Allied W/T Instructions." The Fleet is using this procedure now.

The assignment of wave lengths for all stations, in accordance with the Inter-Allied Radio Conference, is being made. It is expected, in the future, that merchant ships and other commercial radio interests will have more wave lengths at their disposal. This can only be accomplished by reducing the navy's. However, it is believed that it will be some time before these wave lengths for shore stations will be effective, because it will mean doing away with the compensating wave on the arc, and adoption of a more selective transmitting apparatus than the spark.

The changes will be incorporated in a revision of the Communication Regulations.

Naval Stations Out of Commission

OWING to the continued shortage of radio personnel at Arlington Station (NAA) its radio activities these days is hardly worthy of mention. Naval men state, however, that they are trying to do their best under the circumstances to keep from being entirely forgotten by those who have been in the habit of listening-in and working with NAA, and hope that the proposed increases in pay will have the desired effect of bringing many of the old radio operators back to the service.

It will be noted that this station's work has been reduced to a point which is next door to going out of commission. The operators have not been standing watch for the reception of signals.

On account of the recent storm, Arlington has suffered the loss of all antennae. The reconstruction, it is said, may cover a period of at least two weeks.

Three of the four high-power naval radio stations on the Atlantic coast were out of commission as the result of the recent storm. The Radio Corporation of America's New Brunswick station was the only one in operation, it was said at the Navy Department, the Arlington, Annapolis and Sayville stations all being "down" as a result of ice forming on the antennae and the dislocating effect of the winds.

Repair of the Sayville station is going ahead. Considerable damage to ship and small shore radio stations also was reported. The damage was not sufficiently widespread to in any way threaten the safety of ships at sea.

British Marconi Companies Declare Dividends

AT a meeting of the directors of Marconi's Wireless Telegraph Company, Ltd., held on December 17th last, a dividend of 7 per cent., less income tax, was declared upon the cumulative participating preference shares, on account of the year ending December 31st, 1919. An interim dividend of 10 per cent., less income tax, was also declared upon the ordinary shares.

These dividends were payable on February 2, 1920, to the shareholders registered on the books of the company on December 17, 1919.

With a view to the more equal distribution of the dividend on the ordinary shares, the Board decided to increase the interim dividend from 5 per cent. to 10 per cent.

On the same date the Directors of the Marconi International Marine Communication Company, Ltd., London, declared an interim dividend of 5 per cent., equal to one shilling per share, less income tax, upon the capital now issued and paid up. This dividend was made payable on January 15, 1920, to the shareholders registered on the books of the company on December 17, 1919.

Ship Message Covers 6,339 Miles

A FAR-FLUNG radio message has been received by the Goat Island wireless station from the Pacific Mail liner Ecuador.

According to the message, the Ingleside station, near Los Angeles, picked up a message from the Ecuador giving her position as a few miles from Woo Sung, China, 6,339 miles from San Francisco.

Rivalry between ships of the Pacific Mail line for wireless supremacy has recently resulted in the Venezuela sending a message from a point 600 miles from Kobe, Japan, or a little less than 6,000 miles from San Francisco.

Hawaiian Station Picks Up Nauen Ten Thousand Miles Away

THE wireless station of the Radio Corporation of America at Koko Head, H. T., recently picked up and distinctly heard the station at Nauen, Germany, about twenty miles outside of Berlin, a distance of some 10,000 miles from Oahu. At the time a message in German signed "Ludwig" was being transmitted.

In addition to improvements which have been made in the receiving apparatus, the Weagant static arrester has been installed enabling the station to operate in practically any condition of weather. It will also do away completely with any intereference from Pearl Harbor or Kahuku. Equipment whereby Kahuku station will hereafter be operated by a land line from Koko Head is also being installed.

"Hullo, Hank! How's yer wireless workin'? Get any flashes this mornin'?"
"Sure did, Patsy! Got one from three planets."
"What'd they say?"
"Wanted ta know what was good for the flu."

Armstrong Sues De Forest

THE suit entered against the De Forest Radio Telephone & Telegraph Company by Edwin H. Armstrong, originator of the regenerative circuit, promises to be the most interesting and important radio litigation since the Fleming valve case was decided by Judge Mayer. The complaint charges the De Forest Company with infringement of the regenerative circuit patent.

Major Armstrong, a former student under Prof. Pupin at Columbia University, served in the A. E. F. as Chief of the Radio Laboratories of the Signal Corps and was awarded the Legion of Honor in recognition of his distinguished services. His invention was used, under licenses, at the German radio station at Sayville before the war to receive trans-Atlantic messages from Nauen, Germany, and also by the Marconi Wireless Telegraph Company of America, now the Radio Corporation of America, which company is a licensee under the regenerative or feed back circuit patent. The invention was very widely used during the war by the U. S. Army and Navy.

French Station to Work 12,500 Miles

A GREAT wireless station five times the strength of the Eiffel Tower station, with a sending radius of 12,500 miles, or half way around the world, is to be built at Croix d'Hins, near Bordeaux, France. Its sending capacity will be 72,000 words a day.

Suits Begun on Vacuum Tube Infringements

ALLEGING that the Fleming patent covering vacuum tubes used in wireless telegraphy has been infringed upon, the Radio Corporation of America has filed a bill of complaint and order to show cause why a preliminary injunction should not be granted restraining Rudolph Schmidt & Company, Inc., of Rochester, from manufacturing the tube. The case will be heard in equity in United States District Court in Buffalo.

Several cases in which the right to the patent by the Marconi Company is affirmed by the courts are attached to the bill of complaint.

Two Buffalo firms, the Bison Electrical Co., Inc., and McCarthy Bros. & Ford, Inc., are defendants in action for alleged infringement on a wireless apparatus patent. Papers have been filed in the office of the federal court clerk here by the Radio Corporation of America.

The bill of complaint charge the defendants with "making, using, offering for sale and selling apparatus" which in part, it is alleged, are copies of the patent.

Portuguese Government to Buy British Radio Station

THE Portuguese Government is planning to buy from the British navy the wireless installation at Madeira for Porto Santo and procuring more powerful apparatus for Madeira.

Sweden Wants Powerful Wireless Station

A MESSAGE from American Minister I. N. Morris at Stockholm states that Sweden wants a wireless station powerful enough to communicate with the world at large, and with the United States particularly.

The Swedish High Commissioner, Axel Robert Nordvall, who was in Washington at the time of the war, is at the head of the movement. The details have been worked out and the whole matter handed to the Government of Sweden, which it is understood will present a request to Parliament for $2,500,000 to erect this wireless station.

The promoters are anxious to have from the United States asurances that definite hours every day will be assigned to the Swedish wireless stations for sending and receiving messages from stations in America.

Wireless Press Service to Rome

A SPECIAL wireless service between England and Italy for the use of the newspaper press was opened on January 6th by the English Marconi Company. This service, authorized by the Italian Government and the British Post Office, was instituted particularly to assist the Italian press in obtaining prompt reports of the Italian Prime Minister's visit to London. The Marconi high-powered station at Carnarvon is being used for the purpose and three hours daily have been allotted for this particular traffic.

German Wireless Messages Barred

ANNOUNCEMENT is made from Berlin that radio press dispatches to the United States can no longer be forwarded through the radio stations at Nauen and Elsenore on the ground that provisions of Article 197 of the Peace Treaty prohibit the forwarding of political, military or naval news. It is stated that the Interallied Naval Commission which recently arrived in Germany notified the German Government that the article was effective. As a result press dispatches to America have been returned and notice given that others dealing with the specified subjects will not be accepted.

The ruling creates a unique situation, so far as the United States is concerned, in view of a recent Washington report that relations between the United States and Germany will still be governed by the conditions of the armistice, under which the wireless stations were at the disposal of Americans.

While it is stated at the Foreign Office that Americans will be permitted to wireless commercial news, this will first be subjected to a careful scrutiny, which will involve long delays. The German Government's daily wireless report has also been abandoned.

Radio Compass Stations Along Pacific Coast

EIGHT radio compass stations are in course of construction along the coast from San Diego to Alaska.

The radio compass station on the Farralone Islands is practically completed and will be in operation in the near future.

Stations are under construction at Pt. Reyes, Bird Island, Pt. Montara, Pt. Hueneme, Avalon, Pt. Firmin and Imperial Beach.

Colombia to Have Two Radio Stations

THE Colombian Government has contracted for two powerful radio stations and a submarine cable from Colon to its north coast.

12,500 Ships to Report Daily by Wireless

THROUGH an arrangement made by the Navy Department with the State Department, United States Consuls at the various ports throughout the world will send by radio or cable daily a report on various matters relating to ships. The Government agents will pay particular attention to the entrance and clearance of American ships in foreign ports and will expedite news of marine casualties and other items of interest to the shipping world. The information will be forwarded to New York and embodied in the daily shipping bulletin which is published by the United States Naval Communication Service.

At the present time the Navy Department is trying to keep track of 12,500 ships, flying the flags of all nations. Of this number 3,991 are American vessels. Under the new arrangement the American consuls will use the radio and cables to keep the shippers informed as to the operation of all vessels, so that it will be possible to tell at any time where any ship is located, whether she be discharging her cargo at Karachi or is on the high seas bound for some remote port.

A communication has been sent out to the various steamship companies asking them to assist by having each master report by wireless to the nearest station the position of his vessel once a day.

No charge will be made for either the radio or land wire service. At various intervals during the day, the naval radio stations send by direct land wire the positions of the ships, and all of these reports are incorporated in the bulletin, which is available to all shippers.

High Amplification at Short Wave Lengths

A Complete Description of Armstrong's Latest Contribution to the Radio Art, the Short Wave Amplifier

By Paul F. Godley

REGENERATIVE circuits, as adapted for amateur use, have gained wide and unusual popularity among amateurs, but there can be no question of the equal or greater attractiveness of the latest invention of Edwin H. Armstrong. He has developed a very effective means of amplifying short-wave signals and thereby opened up new fields of communication to amateurs who are in a position to supply themselves with the materials necessary to place the scheme into operation.

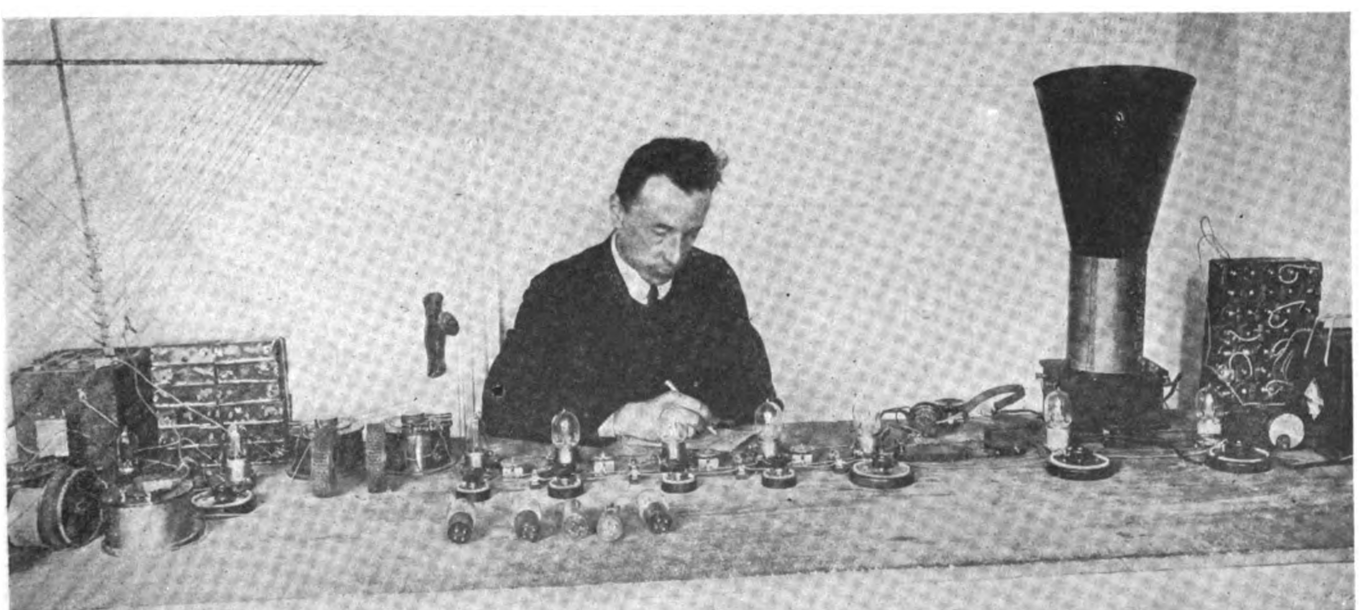
A great deal of progress was made in the various branches of radio during the war. Yet we now find, months after the lifting of the ban on transmission, that amateurs are still employing the circuits which were in use during 1915. These circuits are contained in a popular short wave regenerative receiver and a two-stage amplifier. It is well known that many attempts were made to further increase the sensitivity of amateur receiving equipment secured with this combination, and some very remarkable results were obtained by the use of three short-wave regenerative receivers in cascade, followed by two stages of audio-frequency amplification. But this arrangement, although extremely sensitive, was an impractical one, due to the complexity of adjustments. Even so, it is a fact that an eighth district station was consistently copied in the second district during the daytime.

More than two stages of audio-frequency amplification were not used because difficulties were encountered in getting more than two to function normally. When the third stage was added, tube noises and induced currents from local supply lines reached a volume which made it impossible to read weak radio signals.

The spirit of progress ever stirs uneasily within the amateur and developments made by the Allied Armies during the war were not overlooked; as a result, stories came into circulation some time prior to the armistice, that the British were using 19-, 29- and 36-stage amplifiers! It was reported that it had been found possible to copy, at London, the deck buzzers of the German fleet that lay in the Kiel Canal. Subsequently it was learned that this amplifier had been consummated at the 19th stage.

Since hostilities ended a great deal has been written about multi-stage amplifiers having resistance and transformer coupling for amplification at audio and radio frequencies, several different combinations and arrangements being possible. It was argued that the usable number of stages of audio frequency amplification was limited, for the reasons which have been mentioned, and the construction of a radio-frequency, transformer-coupled amplifier was also rendered difficult because the interactions which took place between the various tubes set up undesirable oscillations at both audio and radio frequencies. A seven or eight stage amplifier, therefore, became a very complicated affair, involving the use of four or five stages of transformer-coupled, radio-frequency amplification, a rectifying tube, and two or three stages of transformer-coupled, audio-frequency amplification. The construction of the tubes was an exacting task, as was also the construction of the transformers and the set as a whole. For this reason considerable attention was given to a resistance-coupled amplifier which had been developed.

This type of coupling, it appeared, could be easily adapted to the high capacity tubes that were being supplied from the United States, since by the use of these small coupling resistances stray electromagnetic and electrostatic fields of any great strength were elimin-



Complete arrangement of apparatus used in the Armstrong short wave amplifier, showing nine VT'S, one used as a detector, one as an oscillator, five as radio-frequency amplifiers and two as audio-frequency amplifiers

ated. It also made possible a material reduction in the physical dimensions of the amplifier unit. Unfortunately, however, resistance-coupled amplifiers were not adaptable to radio-frequency amplification at the higher frequencies.

It was at this point that Major Armstrong developed the idea of changing the frequency of the incoming os-

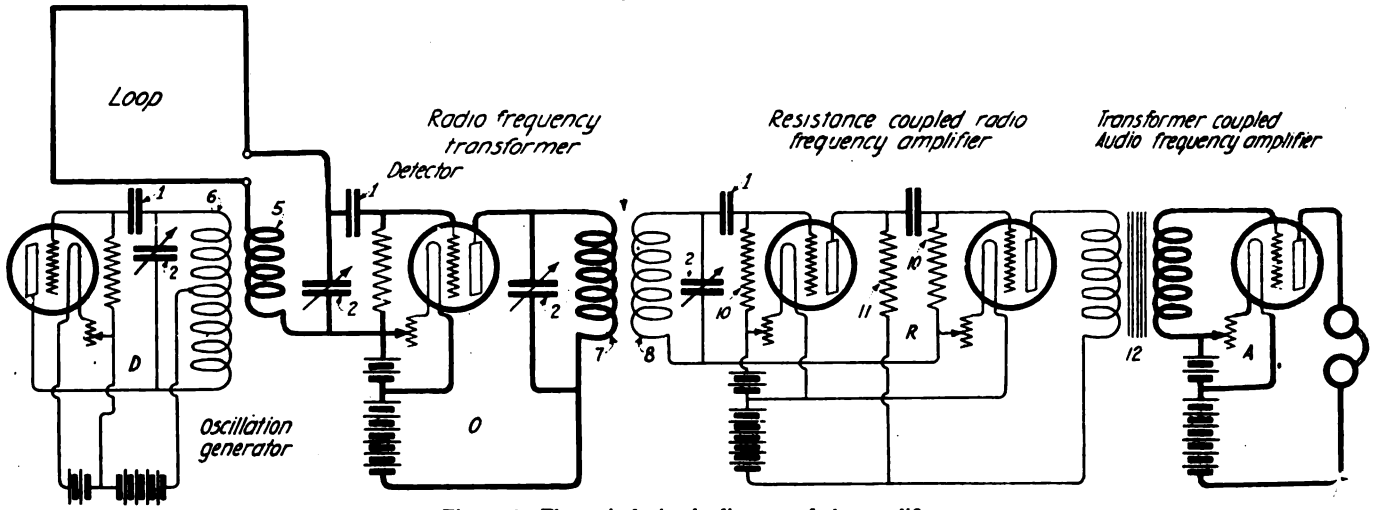


Figure 1—Theoretical circuit diagram of the amplifier

cillations so that they could be satisfactorily handled by a resistance-coupled amplifier. This was accomplished by the use of a radio-frequency oscillator, so arranged with reference to the receiver circuit that oscillations were set up in the receiver circuit by the oscillator. These oscillations were of such frequency as to produce, in conjunction with the incoming oscillations, *radio*-frequency beats of an order that insured satisfactory passage through the resistance-coupled amplifier. This resulting frequency was then fed into the amplifier, and

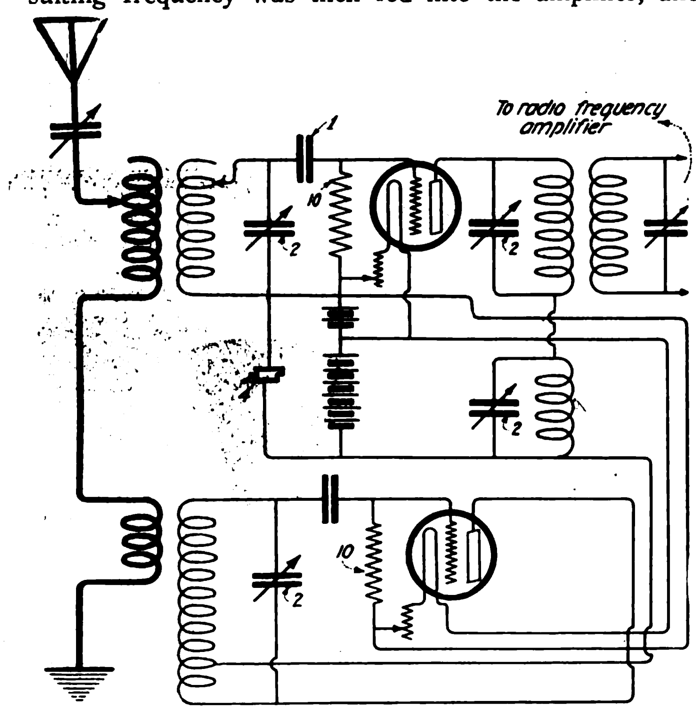


Figure 3—Scheme of connections for use with an antenna

upon passing through several stages and reaching a sufficient strength, was automatically rectified and finally passed as an audio-frequency signal into two or more stages of an audio-frequency amplifier.

At first glance, one might be apt to conclude that the use of this external heterodyne for the production of beats would annul the natural spark tone of the transmitter. This is not the case. The beats produced take place at a radio-frequency rate, and are thus inaudible, the beat-frequency current being, for all practical purposes, identical in form with that of the original incoming impulse. Thus, the outfit works equally well on spark and radio-telephone signals and is something which will be employed with wonderful success by the foremost amateurs.

The scheme makes it possible to amplify at high frequencies to an extent hitherto unthought of. This is evidenced by the fact that in the vicinity of New York City, on an eleven-turn loop about three feet square, stations in the fifth, eighth and ninth district may be picked up at the same strength as obtained by the use of an antenna, a short-wave regenerative receiver and a two-stage audio-frequency amplifier. It can be shown that the EMF generated in the three-foot loop is only about one per cent of that generated in the average amateur antenna. This makes apparent the possibilities of the scheme, when used in conjunction with an antenna.

Figure 1 shows a theoretical circuit diagram of the amplifier, where D is the detector tube, O the oscillator or external heterodyne, R the radio-frequency amplifiers, and A the audio-frequency amplifiers. In general,

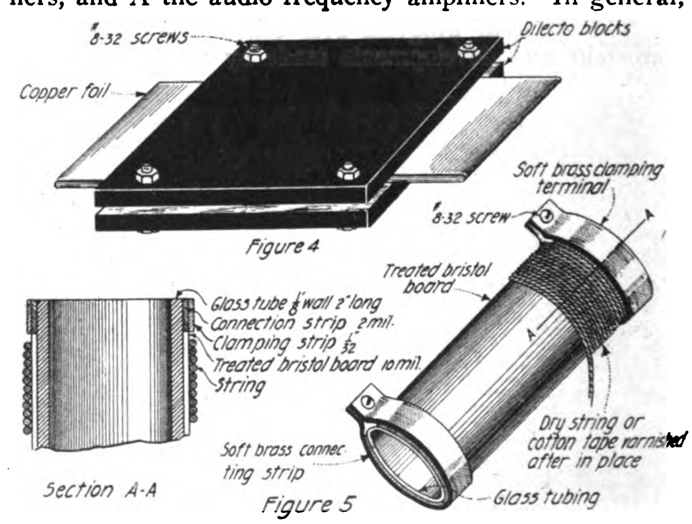


Figure 4—Grid condensers. Figure 5—Construction and assembly of the grid leak

the action is somewhat as follows: The heterodyne O is so adjusted that beats between the incoming oscillation and the local oscillation take place at, say, a 50,000-cycle rate. The primary and secondary of the oscillation transformer 7, 8, are tuned to 50,000 cycles, and the impulses are passed to, and amplified by the radio-frequency amplifier. After sufficient amplification the potentials of the signal impulse reach a value so that one

ARMSTRONG'S SHORT WAVE AMPLIFIER

Wiring diagram showing only two sets of batteries; the detector and oscillator tubes operating from one set and the amplifiers from the second.

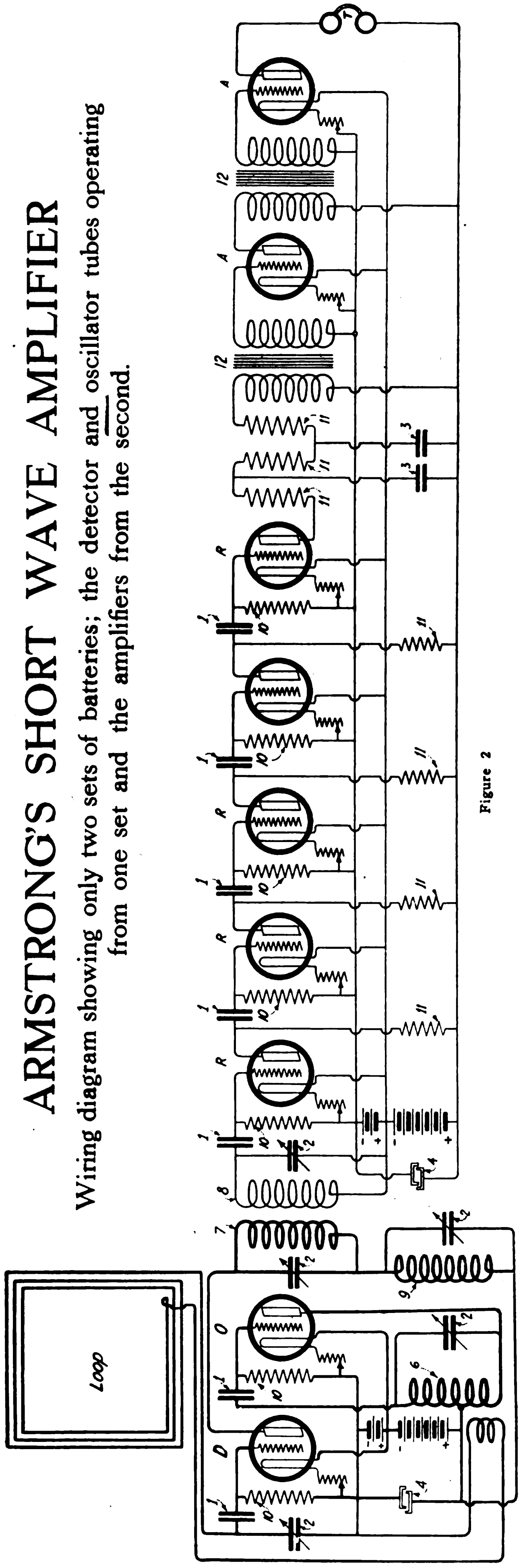


Figure 2

of the amplifier tubes acts efficiently as a rectifier. If the initial impulse is sufficiently strong this rectifying action may commence in the first tube of the amplifier, the succeeding tubes acting as both audio and radio-frequency amplifiers, or, as would be the case with weak signals, no rectifying action takes place until the last tube of the radio frequency bank is reached, whereupon the impulse is passed to the audio-frequency amplifier through an iron core transformer.

Figure 2 shows a schematic circuit diagram where only two sets of batteries are required for the whole system, the detector and oscillator tubes working from one set and the amplifiers from a second. As in figure 1, D, O, R, and A represent respectively the detector, the oscillator, the radio and audio-frequency amplifier tubes. Grid condensers (1) have a capacity of .00025 mfd. Figure 4 gives a suggestion for their construction. The use of 2-mil mica, two-foil plates 0.7 inch square will give approximately this capacity. Variable tuning condensers 2, as used by the writer, had a maximum capacity of .00075 mfd. Condensers in the filter circuit 3 are of the paraffin paper type and have a capacity of .005 mfd. By-passing condensers 4 have a capacity of 2 or 3 mfd. They are shunted around the battery and offer a low resistance path for the high frequency currents. Any resistance in the common battery will, in the case of several stages, result in self-oscillation in the amplifier.

Suggestions for the construction of the coupling inductance 5, and the oscillator inductance 6, have been given in figure 6. The former may consist of 10 turns of No. 18 DCC wire wound on a 3-inch tube 1½ inches in length. No taps need be taken off. The oscillator inductance consists of 40 turns No. 18 DCC wire, wound on a tube 4 inches in diameter and 3 inches in length. The tap is taken off 25 turns from the grid end of the coil.

The primary 7, and secondary 8, of the oscillation transformer may consist most economically of a 500-turn "honeycomb" coil arranged in each case so that coupling is variable.

The inductance 9, in the plate circuit of the detector, may be made by winding 30 turns on a 3-inch tube. Three or four taps, equally spaced, should be taken off. This inductance, with its condenser, is used for getting regenerative action—at the frequency of the incoming signal—in the detector tube. This regenerative action increases the signal strength to a very great degree and also makes the system considerably more selective. The inductance with its condenser may be replaced by a variometer.

Resistances 10 and 11 have values of 2,000,000 and 100,000 ohms respectively. Figure 5 gives suggestions for the assembly of the latter. Coat a strip of bristol board 2 inches wide with a solution made up by mixing six parts Higgins India ink with one part powdered graphite shaved from a grade H pencil. The mixture should be put on with a camels-hair brush, the brush being passed across the strip from side to side—not from end to end. After coating one side the strip is placed in a warm oven until dry, whereupon the remaining side is coated in the same manner. When thoroughly dry, a piece 1½ inches long is cut from the 2-inch strip and carefully wrapped around a glass tube ½ inch in diameter and 2 inches long on the ends of which two strips of thin, soft brass ⅜ inch wide, have already been placed (see figure 5). The paper is now clamped in position with a second strip of soft brass about 1/64 inch in thickness and ⅜ inch wide, as shown in figure 5. The space between the connector clamps is then covered with two layers of cotton or silk tape, varnished with Sterling or Ajax insulating varnish, and again baked until dry. The inner and outer connector strips are connected together. A strip of this same paper, coated only on one side and ⅛ inch wide by 1½ inches long, will serve for the grid leak 10. It should be so mounted as to be protected from moisture.

The two .005 mfd. condensers 3, and the three resistances 11, form a barrier beyond which the radio-frequency currents will not pass. Such a barrier is necessary in the case of many stages in the amplifier. Without it, self-oscillation due to inter-linkage of electrostatic and electro-magnetic fields of the radio and audio-frequency amplifiers respectively, will very likely take place, particularly when the operator wears the telephones and attempts adjustments of the apparatus.

The amplifier transformers 12 may be any of the types on the market. Although as many as eight stages of radio frequency may be used successfully, depending upon the class of tube employed, more than two stages of audio frequency cannot be used with success. In each case the limit is reached when tube noises, or noise due to induction from power lines, has reached a point where it is louder than the signal which one is after.

Figure 7 suggests a layout for the radio-frequency amplifier. As stated above, it need not be limited to five tubes, although in general five tubes of the kind that it is possible to procure on the market are all that can be conveniently used in connection with an antenna. The various units should be mounted in such a way that there is no leakage one to the other. In other words, the insulation resistance of the mounting should be high. This may be insured by the use of a dilecto panel, or if this is not possible, by mounting each unit on a small dilecto base of its own, and the various units on a hardwood board. Leaks, faulty batteries, faulty resistances and poor connections will give rise to noises which will rapidly multiply. Some tubes will be found to be noisy, too, and best results will be had only after tubes have been carefully selected or located where they will cause the least disturbance.

So much has already been published concerning loop construction that nothing will be said here as to details. For wave lengths between 200 and 600 meters, a flat spiral of 11 turns, whose outside turn is three feet square and whose turns are spaced ¾ inch will fill the bill. No. 18 lamp cord may be used.

Figure 3 shows a scheme of connections for use with an antenna. Here the oscillator is coupled to the system through the antenna circuit. To one who is not familiar with the operation of the outfit it may be well to start out with the antenna connection. The telephones may be inserted in the plate circuit of the detector tube until it is certain that the detector tube and the regenerative feature (if used), as well as the oscillator, are operating properly, or the primary of the first audio-frequency amplifier transformer may be connected in the detector plate circuit. The operation of the oscillator will be evidenced by a change in the spark tone of any incoming signals when the oscillator circuit is in resonance with the detector circuit. If no signals are available the system may be excited by a wavemeter. When the detector and oscillator have been brought into operation the radio frequency amplifier is placed into action. Very close coupling is used between 7 and 8 and the oscillator wavelength is varied for the best reception of signals. When signals become audible by means of this adjustment coupling at 7 and 8 is reduced and the two circuits are tuned. The oscillator is now readjusted for maximum signal, and the coupling between the oscillator and the system is varied for the best value; filament temperatures of tubes are adjusted, and the usual details looked after. Once a good value of coupling and adjustment for 7 and 8 has been found no change will be necessary over quite a wide range of wavelengths, and when once the signal is coming in on any wavelength it may be brought up to a remarkable degree by the use of the regenerative circuit (inductance 9).

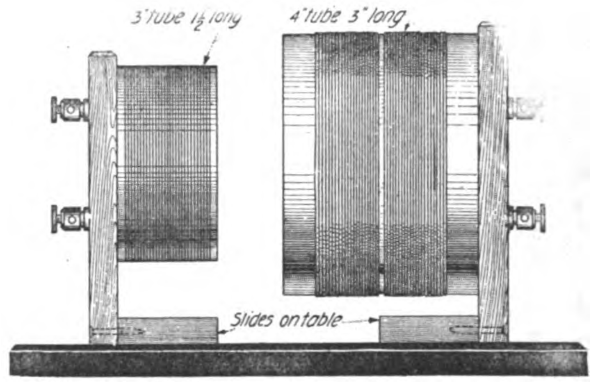


Figure 6—Showing method of mounting the coupling and oscillator inductances

While none of the Chinese amateurs have as yet been heard in New York City with this set-up, C. R. Runyon, Jr., and Minton Cronkhite, in suburban New York, report that eighth and ninth district stations are about "ten times as loud" as with a regenerative receiver and a 2-stage amplifier, while on "good" nights the writer, in Montclair, N. J., has been able to get fifth and ninth district stations on the loop with the same strength as was possible on an antenna and a regenerative receiver and 2-stage amplifier. When conditions are such that the last mentioned system brings in no distant stations, the connection of the antenna to the Armstrong amplifier system can be depended upon to bring them in numbers.

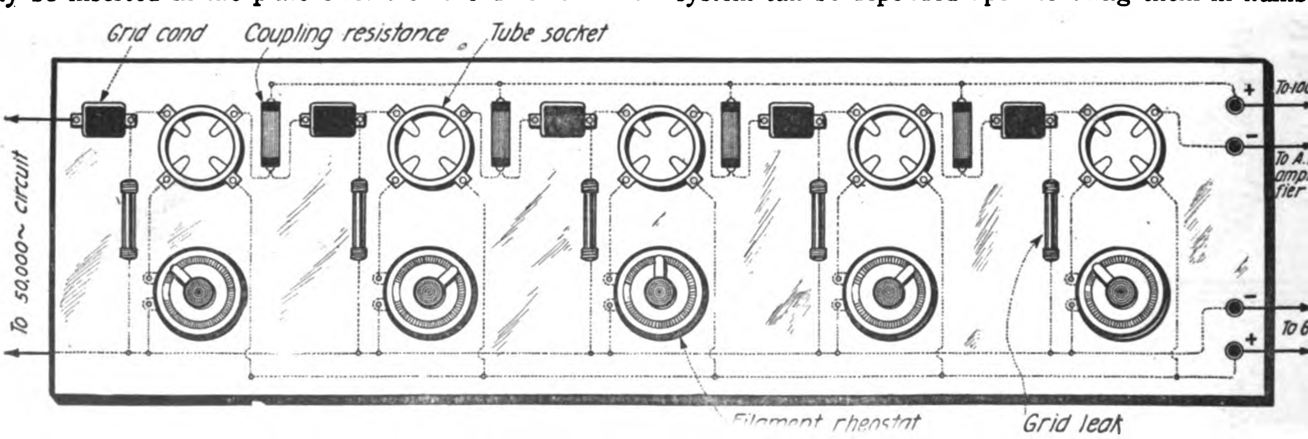


Figure 7—Panel layout for the radio frequency amplifier

Prior to the war we had one case of direct communication between amateurs from coast to coast. It is to be hoped, and expected, that coast to coast communication will now become the rule. It will not be at all surprising if we are soon conversing with fellow amateurs in Holland and the British Isles.

Heterodyne Wavemeter

By R. W. Goddard

Dept. Physics & Elec. Engineering New Mexico College Agriculture & Mechanical Arts

THE wavemeter and high frequency ammeter are the principal measuring instruments used in radio work. The former is by far of greater importance and wider application. In principle this instrument is a simple radio or oscillatory circuit of known dimensions with some current indicating device inserted, attached, or coupled to it. Various designs of wavemeters, their theory and operation are shown in paragraph 30 of "Radio Instruments and Measurements," published by the Wireless Press, New York City, and will not be taken up here. With the recent introduction of vacuum tube oscillator and beat receiver systems these wave-meters fail to function as a universal instrument, being useless on sustained high frequency waves. A new type of instrument has to be used.

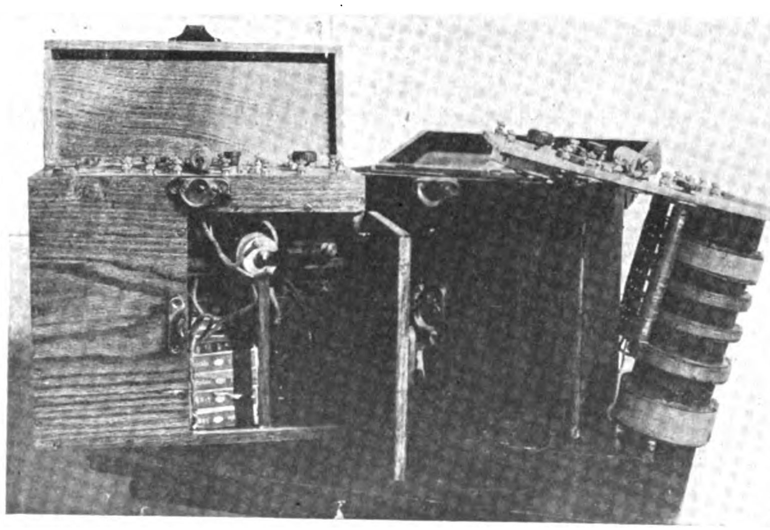
It was during the war while training soldiers for radio work that the attention of the writer was directed to this fact. As a result after three months of experimental work, a wavemeter was developed that fills the requirements of this new field and performs all the functions of the older type. The ideas and principles made use of are not new and the writer wishes to take no credit for any discovery. The aim of this article is rather to give to the amateur and experimenter a practical design of a new and necessary instrument, thus saving many the cost and labor of duplicating the experimental development work.

In principle this instrument is a vacuum tube oscillatory circuit of standardized dimensions. Oscillations of known frequency or wavelength are set up in the circuit by the tube. By placing the inductance of the meter in inductive relation with any other oscillating circuit, oscillations from it are induced setting up beat currents which within the range of audibility may be heard in the telephones of the meter. As the frequency of the meter oscillations is brought nearer to that of the unknown induced oscillations, the beat note lowers in pitch and finally disappears when the two oscillations are of the same frequency or wavelength. If the meter oscillation frequency is varied beyond this point, the beat note appears again and rises in pitch. As wavelength measurements are made by the nil method rather than the maximum as formerly, this instrument gives an accuracy impossible to obtain with the older type even with an experienced operator. By setting the meter to oscillate at any desired wavelength and reversing the procedure above, any oscillating receiver set or transmitter may be tuned in.

Not only does this instrument function as a meter, but it may be used as a beat receiver set or undamped transmitter. To illustrate the possibilities along these lines it might be mentioned that with a single wire antenna, 100 feet long and 20 feet high, connected to one end of the meter inductance, the other being grounded, YN (Lyons, France) and IDO (Rome, Italy) have been heard at State College, N. M., in the daytime, while all of the high power stations in this country are heard at any time. Using a 325-foot two-wire antenna 95 feet high connected with a ground wire across the inductance and tube, with a B battery pressure of 110 volts, signals were regularly sent a distance of two miles with a received audibility of 350. The receiving set used for this was of the static coupled regenerative type without amplifiers.

The material for the construction of the meter is given below:

One piece clear lumber 6 ft. long, 12 in. wide, ½ in. thick, preferably of oak; six 1x1 in. brass hinges with screws; 2 brass sash locks; 1 brass sash handle; 4 dozen 1 in. No. 7 brass flat head screws; Bakelite, hard rubber or fiber: one piece 13 x 5 x ¼ inches; one piece ¾ in, diam. 8 in. long; one piece 6½ x 2 x ¼ inches; one tube 3/16 in. hole, 1½ in. long; one 11-ohm, 2-ampere, back mounting, miniature rheostat; 1 potentiometer switch arm, graphite sector, and clips or instrument switch arm and 9 switch points; 1 vacuum tube; 1 vacuum tube adapter, holder or base; 1 piece 3 in. orangeburg fiber conduit 1¼ in. long; one 31-plate variable condenser in metal case; 1 piece spring brass or phosphor bronze, 2⅛x 2½ in.; 1 piece sheet copper 1½x8½ in.; 3 dozen 1 in. No. 8x32 round head brass machine screws; two 1½ in. No. 8x32 round head brass machine screws; 4 Hex nuts No. 8x32; 2 lbs. No. 24 B&S D.C.C. magnet wire; 1 pint orange shellac; ½ yard oiled linen or empire cloth; 12 No. 531 3-cell flash light batteries; 1 Exide or similar type 3 ZA 5 motorcycle storage battery; 1 pair 2000-ohm radio phones; 1 piece fiber sheet ⅛ in. thick 4x2⅜ in.



The heterodyne wavemeter, which may also be used as a beat receiver set or undamped transmitter

Figure 1 shows the construction of the case with compartments for the meter, telephones, B battery and A battery. Figure 2 indicates the location of the various parts of the meter. All apparatus is attached to the panel and forms a unit easily removed from the case for inspection or repair. The tube and holder shown is an Audiotron. The Western Electric V.T.1, DeForest V.T.21, and the new Marconi V.T. tube have all been used in these meters with negligible change in calibration. If the latter tubes are to be used, the four binding posts and holder shown may be omitted and a standard base mounted on the rear of the panel with the barrel projecting through. The cover of the case must then be made 2¼ in. deeper to accommodate the tube. The A battery rheostat is the ordinary 11-ohm, 2-ampere, miniature rheostat. The B battery potentiometer is a 5000-ohm graphite sector such as is supplied by all dealers of wireless goods. If desired, a circle of switch points can be used instead of this, with every other point connecting with battery taps. The binding posts may be of any variety, but a double post with a hole to receive the tip of a telephone cord is to be preferred.

The tuning condenser is of standard make, having thirty-one plates; fifteen 2½ in. diameter semi-circular movable plates, and sixteen 3 in. diameter semi-circular stationary plates. The bearings are mounted on hard rubber blocks bolted to the outside stationary plates. As purchased, these condensers have circular hard rubber panels to which the condenser body and stamped copper container are fastened by screws. By dissembling and using the condenser panel as a template, holes can be drilled and tapped in the meter panel to hold the condenser and metal container. A knob constructed of material cut from the drum switch body is utilized in place of that supplied.

The inductance is wound upon a piece of 3 in. orangeburg fiber conduit such as is used by electric light and power companies for underground conduit work. Any electrical supply house can furnish this. Having obtained a proper length, place it in a lathe and turn out one end to a taper fit with the condenser container as shown. Holes should be drilled and tapped to bolt the drum switch to it so that the whole assembles together on the panel firmly and squarely. Then place the fiber conduit in a vise and start winding at the bottom. Using No. 24 D.C.C. wire, put on 50 turns, shellac it and cover with a piece of empire cloth, passing the wire through the lap and then put on 50 more turns in the same direction, but progressing from the upper end to the bottom. Shellac this and cover with another layer of empire cloth. Continue until eleven layers have been built up. Then proceed to the next coil of 18 turns, eleven layers, and then to the middle coil of 10 turns, eleven layers. From this coil a tap should be taken out at the end of the sixth layer. From the end of this coil proceed on to the others as shown. A good way to secure the ends of the coils to prevent them from unwinding is to place about the wire a piece of linen or friction tape about 1½ in. long, doubling it back on itself forming a tab. The winding is then started, each turn passing over the ends of the tab and holding it in place. At the end of a coil place the tape loop in position fifteen to twenty turns before the last with plenty of length and the tape ends protruding. Then wind over the tape as before, passing the last turn through the loop. Pull the loop up tight by the

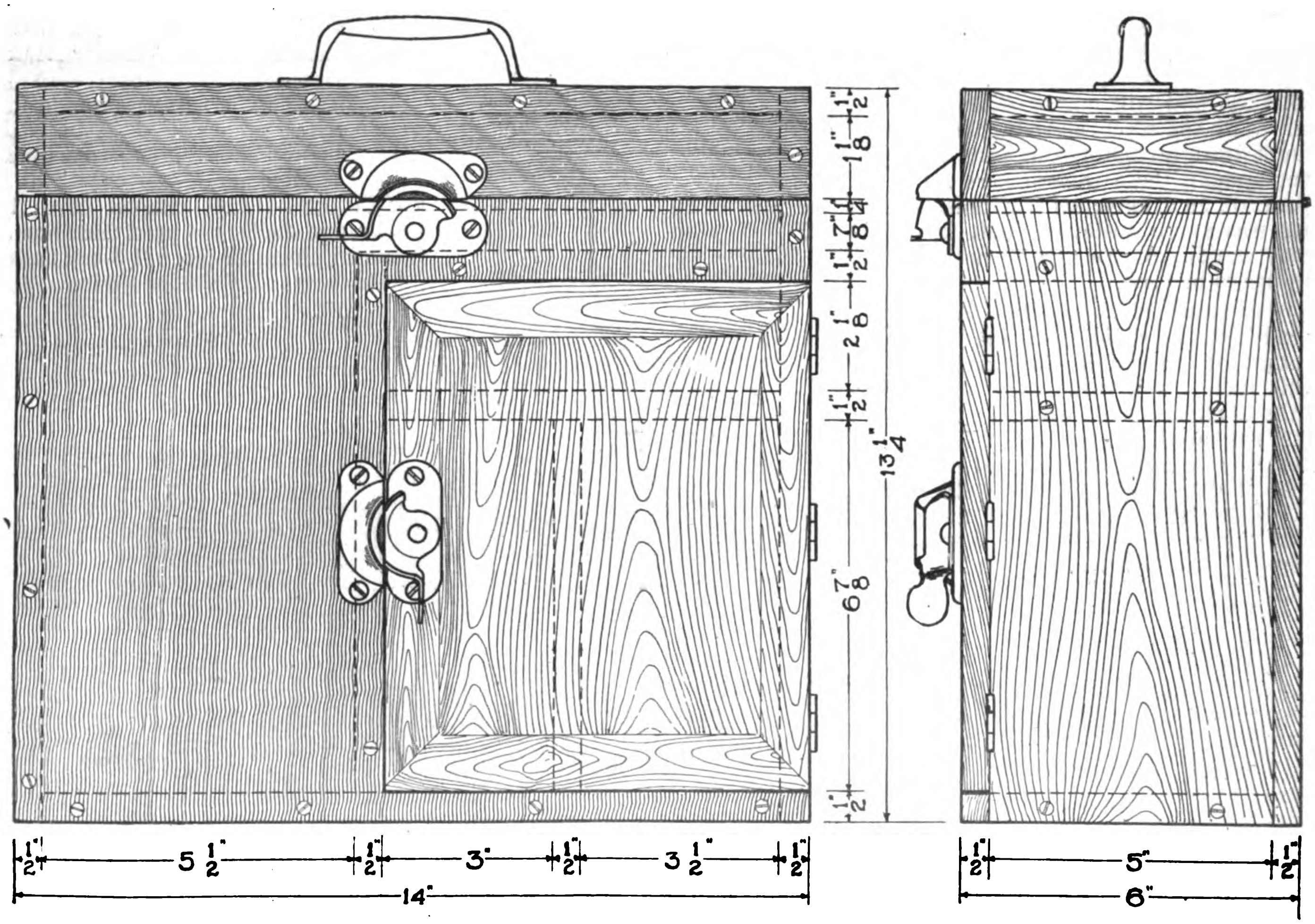


Figure 1—Construction of the case with compartments for the meter, telephones, B battery and A battery

The drum switch and bridging condensers are shown in figure 3. The switch body is constructed of ¼ inch fiber or bakelite; the drum is turned from the same material; the contact fingers are of sheet phosphor bronze and the contact plates are of sheet copper. The latter are fastened to the drum by pins at the corners driven into drilled holes. The bridging condenser is built up of two pieces of sheet copper separated with oiled linen or empire cloth, and are clamped between two thin pieces of fiber to the rear of the panel.

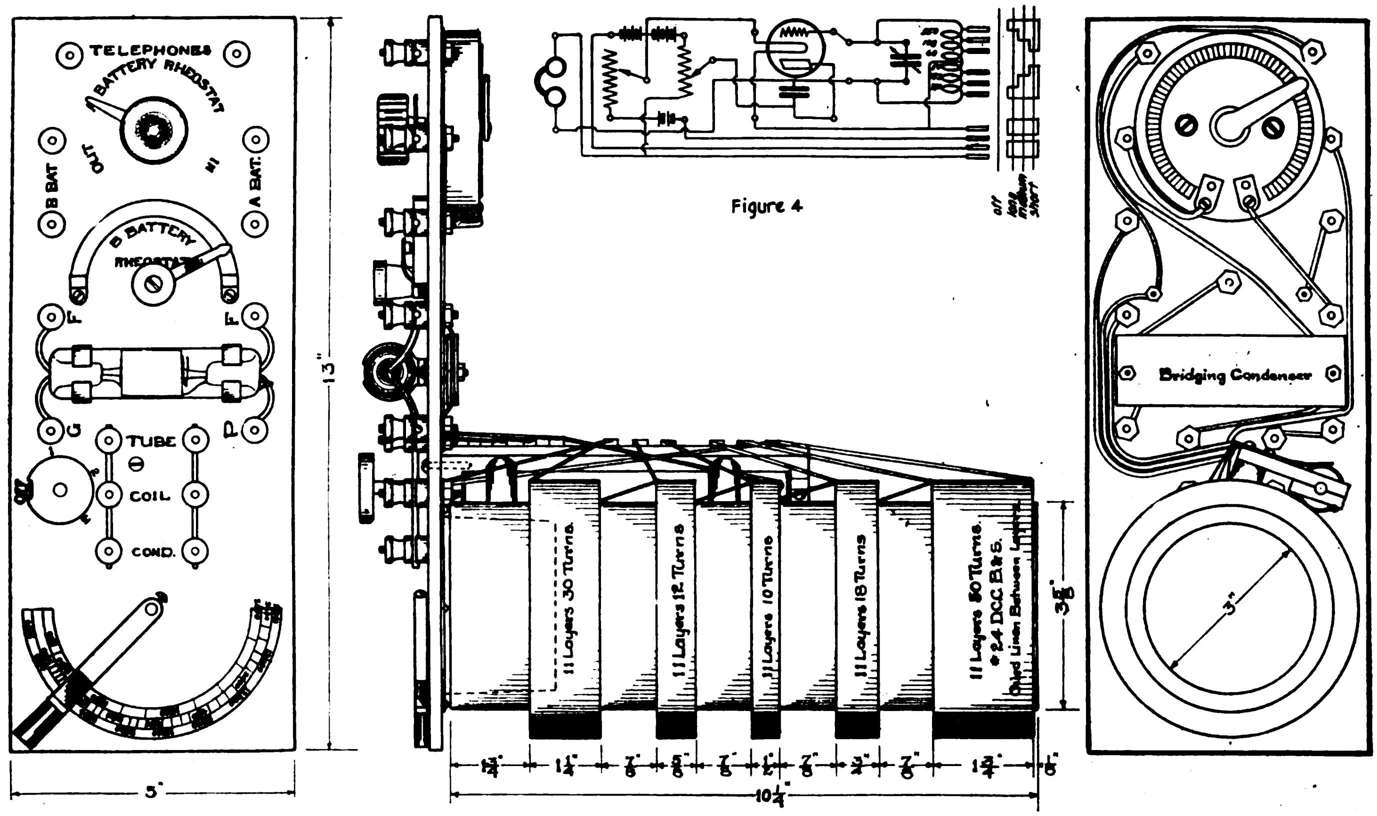


Figure 2—The location of the various parts of the meter according to scale. Figure 4—Wiring diagram showing all connections

ends and cut them off flush with the winding. After the shellac has hardened the ends cannot be pulled loose without tearing the tape in two.

The wiring diagram, figure 4, shows all connections. All joints should be well soldered and taped. The use of cotton sleeving or empire cloth tubing on the connections improves the appearance. Make all connections as short as possible.

Before finally assembling the panel should be marked. The wavelength scales under the condenser handle will have to be scratched in with dividers as four semi-circles, the calibrations to be placed later. The lettering is best done with steel stamps such as are used in machine shops for marking tools, etc. The letters may be filled in with white ink to make them appear plainer, if desired. When all is finally assembled the meter should be calibrated by comparison with any other wavemeter, or sent to one of the various State Universities or the Bureau of Standards for calibration. If constructed as shown, no trouble will be experienced with a good tube in producing strong oscillations throughout the range of the meter, as the windings have all been carefully worked out for the best results.

With modern ratio apparatus this instrument must of necessity be fundamentally important. Yet to my knowledge there is none on the market at the present time. For the earnest experimenter of limited means, no single piece of apparatus could be more highly recommended, since it is not only fundamentally a wavemeter, but it may be used as a receiver or transmitter for both damped and undamped waves in telegraphy or telephony. The wiring is also arranged so that the tube and its accessories, the inductance, or the condenser may be used independently.

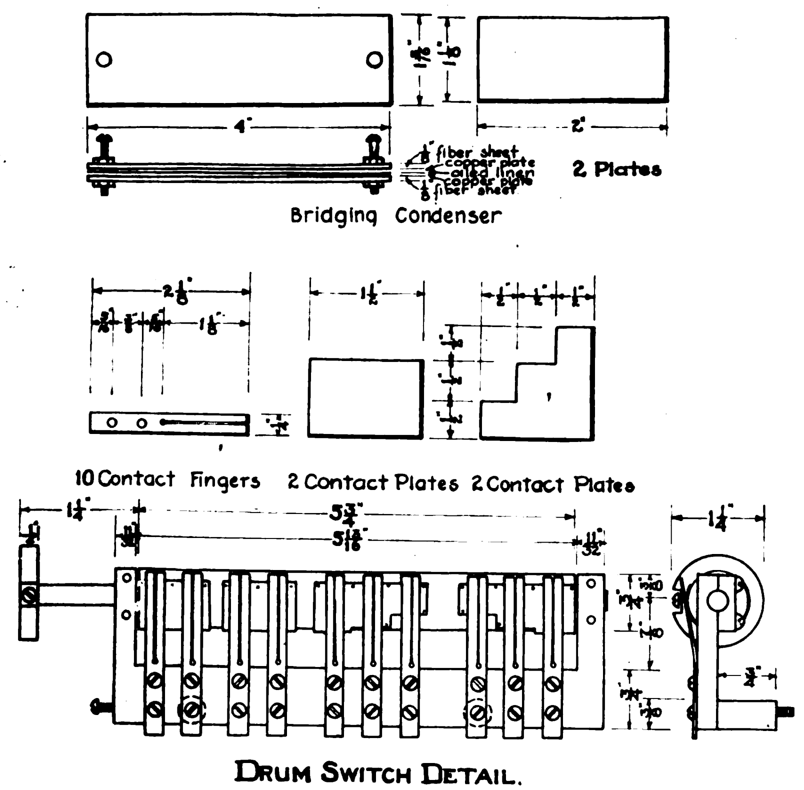


Figure 3—Detailed constructional plans of the bridging condenser and the drum switch

Combined Kick-Back Preventer and Switch Panel for Experimental Radio Stations

By J. A. Weaver

SOME form of a kick-back preventer is a necessity in every well appointed radio station, and as pointed out in the article, "The Fire Underwriters' Rules Applied to Amateur Stations," which appeared in the March issue of the WIRELESS AGE, the code calls for a transformer in the circuit, or two condensers across the line in series. However, the high resistance shunt is entirely satisfactory, is in general use in commercial stations, and also seems to be the type in general favor amongst amateurs. It is also relatively cheaper and easier to construct and occupies less space than any other type. For these reasons it has been selected for use on the panel about to be described. The form of the resistance elements here suggested is somewhat novel, as will be seen when we take up their construction later on. The idea of grouping the kick-back preventer and several circuit switches on a single panel will be found to have many advantages, as it not only follows good electrical practice and presents an attractive appearance, but also is very handy from the operating point of view. The panel is intended to be mounted in a sheet-iron cabinet with hinged cover to conform with standard practice, and this cabinet can then be mounted in the handiest position available, either upright on the floor or inverted on the under side of the operating table close to the front edge, so that the circuit switch may be used to start the rotary gap motor with ease and dispatch. Of course, if more than two circuits are desired, the panel may be easily designed to accommodate the desired number, but

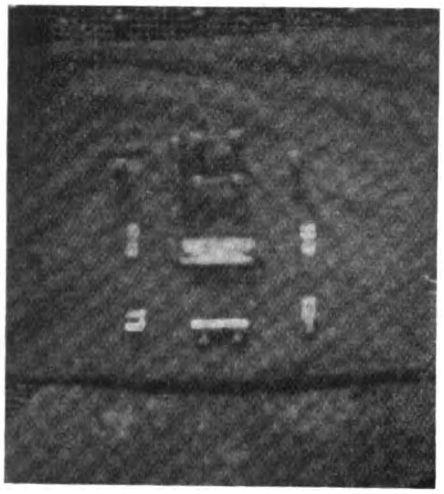


Figure 3—Front view, showing finished panel

two switches, one for the transformer circuit and the other for the rotary gap circuit, are usually all that will be desired, and they make a symmetrical design. The concentrated and individual control of the rotary and transformer circuits will be greatly appreciated in use, as it allows one to instantly cut out either circuit while adjusting the gap or making other adjustments, thus avoiding the danger incident to the accidental closing of the key. Having the circuit separately fused, and the fuses close at hand will avoid much annoyance when one happens to blow, as it can be instantly located and removed without journeying to the basement or other remote fuse location. If this panel is fed by a separate pair of feeds direct from the meter it will make current supply to the radio set entirely independent of the rest of the house and allow complete control of the circuits from the handiest single location possible.

The material necessary for construction is as follows: One piece of polished slate 18½ inches long by 9 inches wide by 1 inch thick. One piece of hard drawn copper tubing 7 inches long by 5/16 inch outside diameter. One piece of hard copper strip ½ by 1/16 inch and 5 feet long. Two 30 amp. two-pole spade handle, panel-board knife switches. The hinge jaws of the switches should be equipped with lugs for attaching to fuse clips, and the other set of jaws should be also equipped with lugs for taking a binding post thumbnut. Some makes of switches do not have

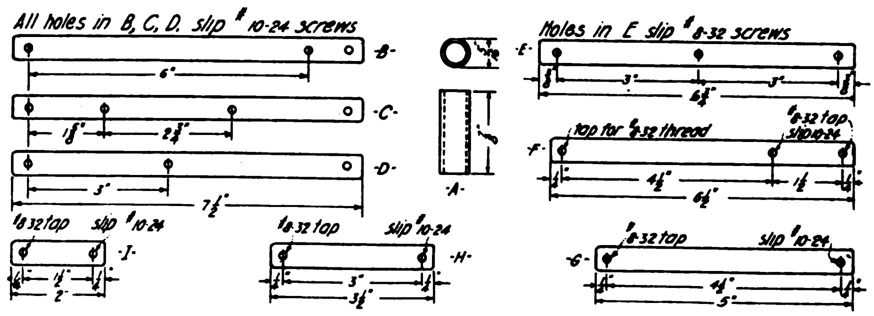


Figure 1—Detailed construction of various parts

these lugs stamped out of the same piece as the switch jaw, but use separate little pieces of copper strip for the purpose. In buying this type be sure to get four for each switch; six individual switch jaws, three with lugs for attaching to fuse clips and three without will also be needed; fourteen 30 amp. fuse clips; seven cap nuts 10-24 thread; seven machine screws, either iron or brass 10-24 inch and a half long round head; half dozen 8-32 battery nuts; two dozen brass or iron machine screws round head ¾ inch

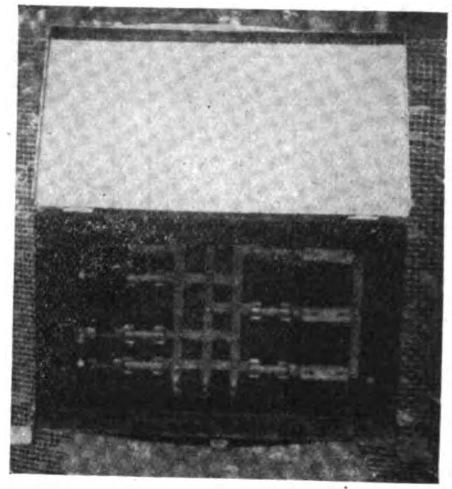


Figure 3—Rear view of panel, showing all parts in place

long; four like the last, but 1 inch long; four thumb-nuts 8-32 thread; three lugs for busses. Some burrs and a little sealing wax complete the list, exclusive of the fuses and resistance elements.

The first thing to do is to cut the copper tubing up into seven pieces with a length of ⅞ inch as shown in the sketch at "A," figure 1. These pieces should have the ends cut square and if available a lathe should be used for the purpose, but if they are cut with a hack saw be careful to cut square and finish up with a file. If the tubing is held in a vise while cutting, a piece of iron rod should be inserted in the tubing, where it is gripped by the vise jaws to prevent crushing. These pieces are the pillars to support the buss bars. Now cut the copper strip up into pieces of various lengths as indicated in the drawings, figure 1. Make two like "G," two like "I," and one of each of the rest. "B," "C" and "D" are buss bars, "E" is the connecting bar for the three resistance unit clips, "F" is the lower circuit connecting bar, "G" shows the two inner circuit connecting bars, "H" is the center ground terminal connecting bar, "I" shows the two upper circuit connecting bars. The ends of the bars should be filed smooth and square, and the corners slightly rounded. The location, size of noles and those which should or should not be tapped are clearly given in the dimensions on each piece shown in figure 1. After all the parts mentioned and shown in figure 1 have been made, they, with the rest of the copper parts, should be polished and lacquered. In buffing the parts do not bend the bars. To avoid this it is best to drive a small brad in a piece of board and place the bars on the board with the brad protruding through a hole to hold them when they are brought against the wheel. This will allow you to use as much pressure as necessary without bending. Clear lacquer should be used, as gold lacquer does not look well on copper. The parts should be slightly warm when lacquering, but not so hot as to scorch the lacquer. If no means are available for polishing the copper parts it will pay you to have it done at some plating shop, because the whole appearance depends on nicely polished metal, which, contrasted with the glossy black finish of the slate panel, makes the whole job "a thing of beauty and a joy forever."

While the lacquer on the metal parts is drying you can turn your attention to the laying out and drilling of the slate panel.

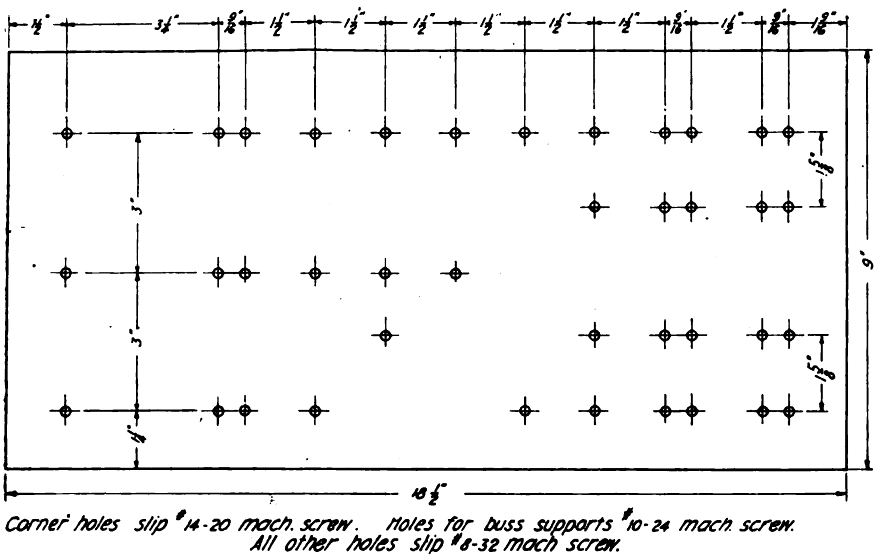


Figure 2—Dimensions for constructing the slate panel

Procure a sheet of thin cardboard or heavy paper and cut it to the dimensions of the panel. Lay out the location of each and every hole to be drilled as shown in the drawing, figure 2. The drawing is complete and dimensions are also given, so it should not be difficult to lay out the template. After the template is laid out arrange the various parts on their respective locations and check up the accuracy of the holes as they are marked on the template. Remember, a correction can be easily made on the template, but when a hole has been spotted or drilled in the slate or marble board it is another and a sadder tale! If the template is of cardboard, as in this case, it is laid directly on the front face of the panel and clamped in position. Take a prick punch, or a center punch ground to a sharp point, and mark through the cardboard onto the panel with a light tap of a hammer. The cardboard template is removed and the punch marks spotted. After "spotting" the panel is ready for drilling, which can be done best on a drill press, but if necessary a breast drill can be used. Lay the slate on a flat board and drill on the "spots." Use a drill having the cutting lips ground at a short angle and run it at very slow speed, using water as a lubricant. Use moderate and steady pressure. When nearing the completion of a hole release the pressure and let the drill come through by the weight of the drill press handle or with a very light pressure. This will prevent a jagged hole on the other side. Drilling slate or marble is like drilling wood unless you strike a metal vein. Then it is worse than the hardest steel, and drill after drill will be caught and nicked or broken in getting through. It is customary to bush a hole if the vein is bad. When the panel has been drilled from the front clean it off and turn it over on a clean piece of tissue paper laid on the wood board, and with a ½-inch drill or larger countersink all holes but the corner ones for a depth of about ⅝ inch. The edges of the slate, if rough, should be filed smooth with a large flat file having rather coarse and single cut teeth.

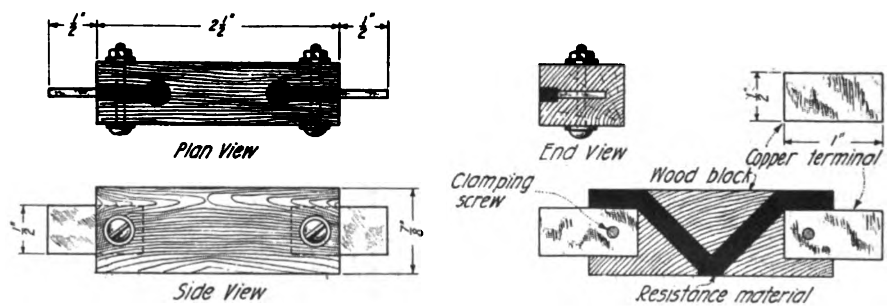


Figure 4—Constructional plan of the resistance element

After the filing is finished the parts may be mounted. Mount the switches first. Each screw should have a burr slipped on it to give a good bearing to the screwhead in the bottom of the countersunk holes. The panel should be propped up on edge so you can get at both sides at once, thus making the mounting an easy matter. After the switches are mounted make sure they work smoothly before finally setting up tight on the screws. In mounting the fuse clips snap a fuse in place to keep the clips in proper alignment when tightening the holding screws. In mounting the clips for the resistance elements follow the same procedure, using a piece of metal to keep them in line. The buss bars are put into position by inserting the long 10/24 screws through the holes in the slate and connecting bars from the back of the panel. Slip a copper pillar over the projecting end of the screw and place the buss bar in position with the ends of the screws through the holes in same, and then screw a cap-screw on the end of each screw. The upper pillar of the central or ground buss should have several burrs placed under it to account for the thickness of a connecting bar which is lacking here, as this pillar is only for mechanical support of the middle buss. By referring to the photo in figure 3, which shows the finished panel with all parts in place, the proper position for each part will be clearly seen. When all parts are mounted the countersunk holes are filled with sealing wax.

The material necessary for the construction of the resistance elements follows: One strip of hard wood (maple preferred) 7/8 x 5/8 x 7½ inches long; one piece copper strip ½ x 1/16 x 6 inches long; six battery screws and 8-32 nuts; some burrs and a small quantity of plaster of Paris and lamp blank.

Cut the wood strip up into three pieces each 2½ inches long. Slot the ends of each piece with a thin bladed saw for a distance of half inch, as shown in the drawing, figure 4. After the copper strip has been cut up into the six pieces, each one inch long, a piece is driven into the saw slot in each end of the wood blocks. A hole to slip an 8-32 battery screw is drilled through the wood and the copper piece from the side of the block, the screw is inserted and a burr and nut put on the projecting end and drawn up tight. Now, on one of the narrow sides of the block mark the center, and drill through it on an angle with a quarter inch drill, so it will come out on top a half inch from the end, or right beside the inner end of the copper terminal piece. This is made clear in the sectional view of the resistance element in figure 4. Each end of the three blocks is treated in the same way. On each of the blocks where the two holes meet at the center on the bottom of block trim the edges of the holes with a penknife so it will be a single hole and deepen it somewhat so that when the compound is pressed in, it will join the ends of the "V." Trim the edges of the holes where they come out on top and cut a slot over the top edge of the terminal piece so that the compound will get a good contact with same when filled in place. This is also shown in the sectional view of the resistance elements in figure 4. The resistance material is a compound of plaster of Paris and lampblack mixed dry and made into a paste with a little thin shellac as a binder. The resistance of the compound when dry and made into a rod four inches long by a quarter inch diameter should be about 5000 ohms or even greater. It will stay across a 110-volt line indefinitely without heating—the condition it must meet in service. No exact proportion of ingredients can be given. Much depends on how well they are mixed and only a small amount of lampblack is necessary. It is necessary to make up a few batches of different proportions for testing before the right combination is found. It may be stated that the method and ingredients for making the resistance elements is only offered as a suggestion and there is plenty of room for originality. Graphite from a very hard drawing pencil finely powdered may be substituted for the lampblack and whiting could be used instead of plaster of Paris. The method described has been found satisfactory, but another and much used method of creating a high resistance is to paint the space between the two contacts with a coat of flake graphite and alcohol, putting it on in an extremely thin coat and giving one coat after another until the right resistance is created. This method may be applied with little change in the form of the wood blocks. When the compound is dried out and perfectly hard (which will take a long while) the wood blocks can be given a coat of asphaltum paint.

The sheet iron cabinet for the panel which is shown in the photo, figure 3, is made of No. 14 gauge metal having a hinged cover and snap catch to hold it shut. The feet are made of two pieces of 2-inch light angle iron riveted to either end to keep the bottom of the box raised a short distance from the floor. Holes are provided in the end and bottom for the entrance of wires. The inside dimensions are 19½ inches long by 11½ inches wide by 4 inches deep. The panel is mounted in it with four 14-20 machine screws. It is beyond the ability of most amateurs to make the metal cabinet, so specifications sent to a sheet metal shop is the best plan. A wooden cabinet lined with asbestos or metal could be substituted if desired. In conclusion, it may be mentioned that the fuses used for the kick-back preventer should be not over 3 or 5 amp. The others should be of proper size to protect the apparatus in each particular circuit.

The Regenerative Receiver vs. Cascade Amplifier

The Relative Merits of Those Vacuum Tube Circuits for Radio Reception at Amateur Wave Lengths

By Howard W. Lewis

In order to intelligently discuss the respective merits of the regenerative vacuum tube receiver and the cascade vacuum tube amplifier for radio reception at amateur wave lengths, it must be considered that amateurs are practically limited to the use of spark sets and that undamped wave transmitters at short waves are still in their infancy. The present question, therefore, narrows down to a consideration of damped wave reception at high frequencies. Obviously, if continuous waves are to be received, an oscillating audion circuit is required, either with or without additional audio frequency amplification.

Let us now examine the circuits employed in each system. Figure 1 shows a typical regenerative receiving circuit in which the vacuum tube is caused to oscillate by means of electromagnetic "back coupling" between the "tickler" coil (T) of the plate circuit and the secondary (S) of the receiving loose coupler. Detection, amplification and generation of local oscillations occur simultaneously in this tube and its associated circuits. Figure 2 shows the form of single step cascade vacuum tube amplifier usually adopted by amateurs. In this arrangement, tube No. 1 acts as a detector and tube No. 2 as an audio frequency amplifier. These two

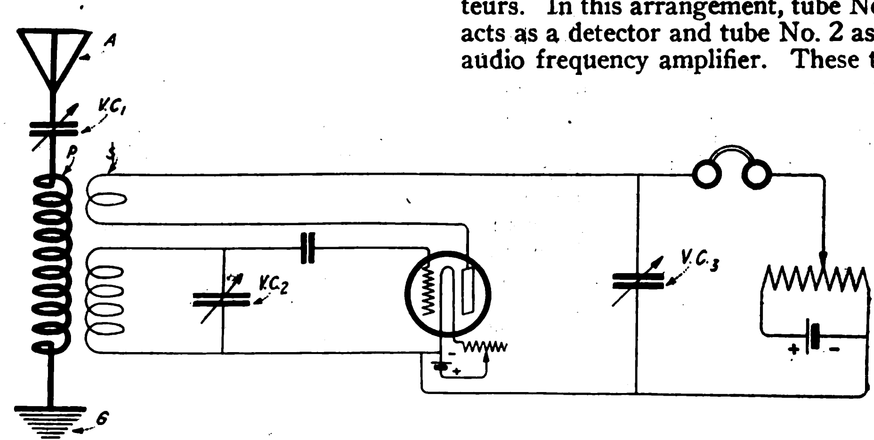


Figure 1—Typical regenerative receiving circuit in which the vacuum tube is caused to oscillate by means of electromagnetic "back coupling" between the "tickler" coil of the plate circuit and the secondary of the receiving loose coupler

tubes or stages are coupled together by the transformer (T). There should be no locally generated oscillations. The same antenna, loose coupler, and primary and secondary variable condensers are used in either case.

The following interrelated factors will be discussed in order to form a basis for comparison:

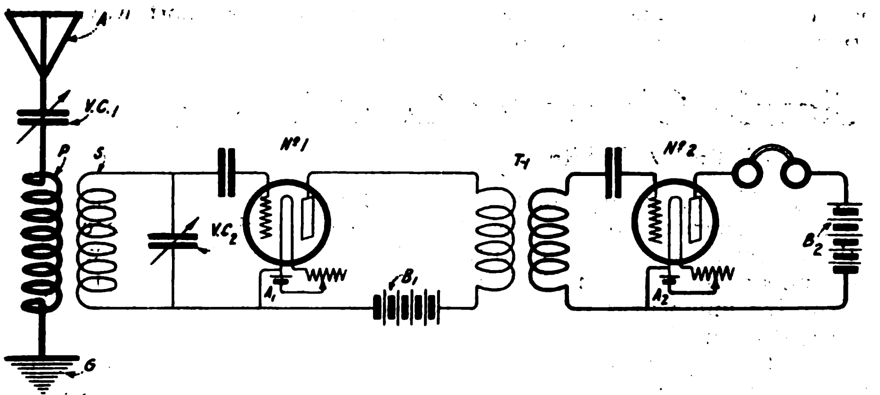


Figure 2—Single step cascade vacuum tube amplifier

1. Results obtainable.
2. Simplicity.
3. Ease of construction.
4. Ease of manipulation.
5. Quality of signal note.
6. Interference.
7. Reliability.
8. Cost.

In the hands of a skilled operator, particularly one who thoroughly understands all the necessary adjustments, excellent results can be had from either of these circuit arrangements. In the majority of cases, particularly for the amateur and often for the expert when time does not permit of careful tuning, much louder signals are obtained from the audio frequency amplifier arrangement of figure 2 than from figure 1.

A casual inspection of the diagrams given above would indicate that the circuit of figure 1 is the more simple. That this difference is more apparent than real, may be understood from the following.

(a) While the circuit of figure 2 is the one usually employed by amateurs, there is no reason why a much simpler one cannot be used for the same purpose. More than one filament battery and rheostat, and more than one plate battery are not necessary. Circuit diagrams, recently released by government authorities, show as many as five vacuum tubes operated from one A and one B battery.

(b) The transformer T, between the detector and amplifier, is not always necessary and in some cases is of no help at all.

In figure 3 is shown a recent form of cascade amplifier which is simpler than the arrangements usually employed, and which gives excellent results. It will be noted that two batteries, one transformer, and one filament rheostat have been eliminated. A small audio choking iron core inductance has been inserted in the plate circuit of the detector tube. This arrangement is no more complicated than the regenerative circuit of figure 1 and has two less adjustments which will be explained further on.

The regenerative circuit requires a greater number of variable elements than does the amplifier. In addition to the usual primary and secondary tuning condensers and loose coupler adjustment, variable coupling is required between the "tickler" coil T and the loose coupler secondary S, figure 1. A variable condenser is required to by-pass the radio frequency around the telephones and plate battery. In many cases also, it is necessary to provide a means of adjusting the plate potential—see potentiometer of figure 1. It is true that the amplifier of figure 2 or 3 requires two vacuum tubes instead of one as well as a choke coil, but these are easier to provide than the ordinary instruments required for a successful regenerative receiver.

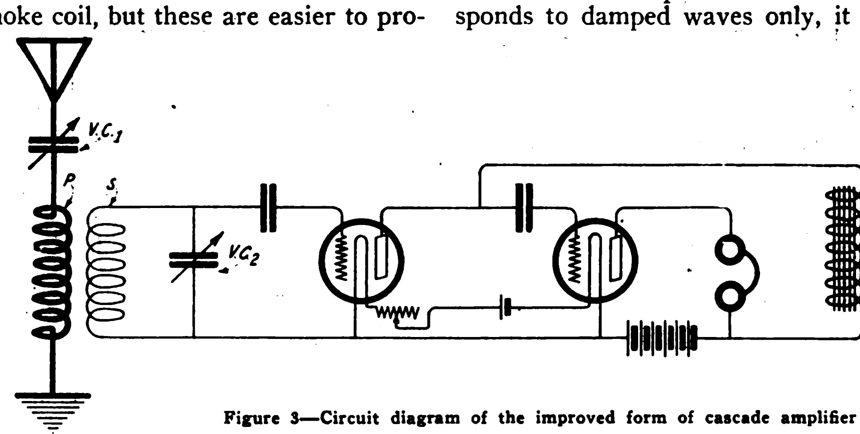


Figure 3—Circuit diagram of the improved form of cascade amplifier

When ease of manipulation is considered, the superiority of the amplifier circuit becomes at once apparent. After the filaments are lighted and suitable plate potentials applied, no further adjustments are required, leaving the operator free to devote all his attention to tuning the primary and secondary circuits and copying the messages. With the regenerative receiver, however, not only are these adjustments necessary but the "back" coupling and the variable bridging condenser VC3 must be regulated. It frequently happens that these two latter adjustments must be repeated if the tuning is changed. For the maintenance of steady oscillations and the prevention of "spilling," it becomes occasionally necessary to adjust the filament temperature and the plate potential. These numerous adjustments are particularly "cranky" at the short wave lengths used by amateurs.

When an oscillating regenerative receiver is used for the reception of damped wave trains, the characteristic tone of the spark note is lost and all signals heard in the head telephones are harsh, hissing sounds irrespective of whether the transmitter employs an open or rotary spark gap or a quenched gap. This not only nullifies the well-known beneficial effects of a high spark frequency, but renders identification of the sender by recognition of his spark note impossible. On the other hand, when a cascade amplifier is used, the detecting action of the first tube is not interfered with and that of the received note is determined solely by the spark (group) frequency of the transmitter, the same as with a mineral detector.

The question of freedom from interference will continue to be of growing importance as the number of stations attempting intercommunication within a given area increases. When it is noted that the oscillating regenerative receiver responds to both damped and undamped waves, while the cascade amplifier receiver responds to damped waves only, it will be apparent that the latter is more free from unwanted signals than the former. Amateurs will find this particularly true since the war, inasmuch as a number of very powerful undamped wave transmitters have been established whose higher harmonics are especially troublesome to short wave oscillating receivers. These difficulties are accentuated by the fact that individual spark transmitters cannot be recognized by their peculiar spark note when an oscillating regenerative receiver is used.

If the apparatus is properly constructed and carefully wired together using stranded rubber covered wire and soldered joints, and if due attention is paid to maintenance of A and B battery voltage, these circuits are equally good from the point of view of reliability.

For the man who makes his own apparatus, the cascade amplifying receiver will probably cost a little more, due to the fact that two audion bulbs must be provided instead of one for the regenerative receiver.

Last but not least, it is to be remembered that the cascade amplifier is not limited to a single step as indicated in figures 2 and 3, but that two or even three additional steps may be attached thus producing enormously amplified signals suitable for the operation of loud speaking devices as used in Signal Corps and Naval operations during the war.

From a thorough consideration of the foregoing factors, particularly those of the signal note, interference, and ease of operation, there is no doubt but that the cascade audio frequency amplifying receiver is to be preferred to the regenerative oscillating receiver for short wave amateur use.

An Unusually Simple Circuit for Long Waves

By Elliott A. White

An oscillating regenerative circuit of extreme simplicity for the reception of long damped or undamped waves is shown in Figs. 1 and 2. The only variable elements are a variometer V and a feedback condenser C2 (Fig. 1), or a variable inductance L and tuning condenser C1 besides the feedback condenser C2 (Fig. 2). Tuning is done entirely by V or by L and C1, the strength of the feedback being adjusted by C2, for which (with a loss of flexibility) a small fixed condenser may be substituted, though the latter is not recommended. The circuit is very stable in operation. Its lack of sharp tuning is no disadvantage with the long waves, where there is practically no interference. Further stages of amplification may be added by substituting the primary of a second amplifier transformer for the telephone P; but the set is not adapted to give efficient results with more than two stages of amplification. The circuit gives particularly good results with the Signal Corps two-stage audio-frequency amplifier SCR-72, a detector bulb being supplied, the clips marked "Radio" being connected in the detector plate circuit, and the feedback connection being made to the third telephone binding post from the left on the panel.

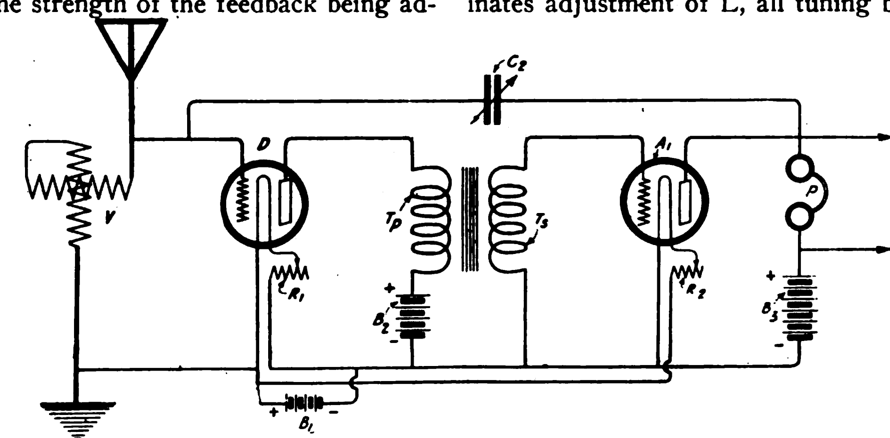


Figure 1—Diagram of an oscillating regenerative circuit containing a variometer and a feed-back condenser

The dimensions of the variable elements are as follows for wavelengths up to the longest (NSS-17000 meters): V-175 to 250 millihenrys maximum inductance, depending on the size of the antenna. L-60 to 125 or 175 millihenrys maximum inductance, depending on the capacity of the antenna. For this the largest or second largest sized honeycomb coil (175 or 125 millihenrys respectively) is generally sufficient, and may conveniently be supplied with three or four taps, at 1/8", 1/4", 1/2" and 3/4" from the inside edge, measured on the face of the coil. This practically eliminates adjustment of L, all tuning being done with C1. The Condenser C1 may be of either .0005 or .001 microfarad maximum capacity (17 or 43 plate as usually manufactured). The smaller size of .0005 microfarad is sufficient for C2. It will be noted that the capacity of C1 is added to (in parallel with) that of the antenna to determine the wavelength. The variation of C2 has only a slight effect on the wavelength adjustment. Since, with a given antenna, the sharpness of tuning depends on the resistance of V or L and on the capacitance of C1 compared to the inductance of L, C1 should be kept relatively small and the resistance of V or L kept as low as possible. The tuning may be made still sharper with corresponding increase of L or V by placing a series condenser in the antenna circuit. To reduce induction noises and improve stability a small fixed or variable condenser may be connected in parallel with V in Fig. 1. No detector or amplifier grid condensers or leaks are necessary.

Outside of these variable elements the rest of the circuit comprises the vacuum tubes D and A1, detector and amplifier respectively, preferably of the high vacuum type (VT-1, VT-11, VT-21, etc., Class II VT). A battery B1 of 4 or 6 volts supplies all the tube filaments in parallel. R1, R2 are the filament rheostats. For the high vacuum type of tube these may be fixed. With a 4-volt battery no filament resistance is necessary for the VT-11; for the VT-1 fixed resistance may be used of 1.05 ohms or a little more for the detector and 1 ohm for the amplifiers. The detector grid is connected to the positive side of B1 and the amplifier grids to the negative side of B1 through V or L and the amplifier transformer secondaries respectively. The plate batteries of 22½ volts or more are indicated at B2, B3. By inserting a condenser in the grid of A1, it is possible to use one set of batteries for the plate circuits, but it is not recommended. B2, B3 may be of fixed voltage. The filaments are grounded.

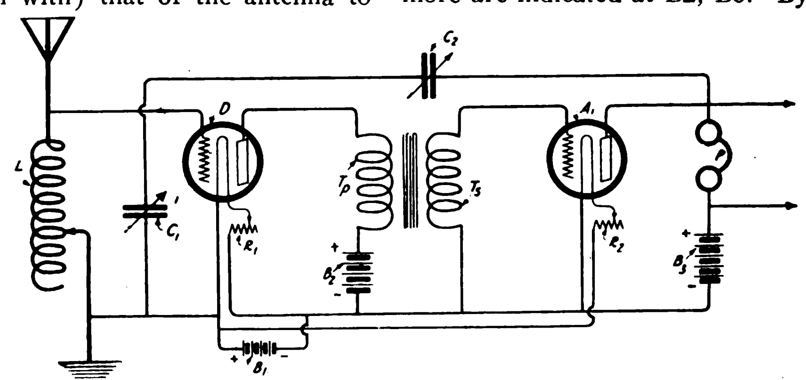


Figure 2—Diagram of an oscillating regenerative circuit containing a variable inductance and a tuning condenser in addition to the feed-back condenser

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

Variometers and Their Construction

By Thos. W. Benson

THE variometer is used extensively at present in regenerative receptors but has received little consideration as to construction details. Invariably they are of the ball secondary or plain tube type. In connection with some experimental work the writer has designed two types of variometers differing from the above. They are described here and are offered on the basis of being more compact, easily constructed and still capable of being built with a large range of wave lengths.

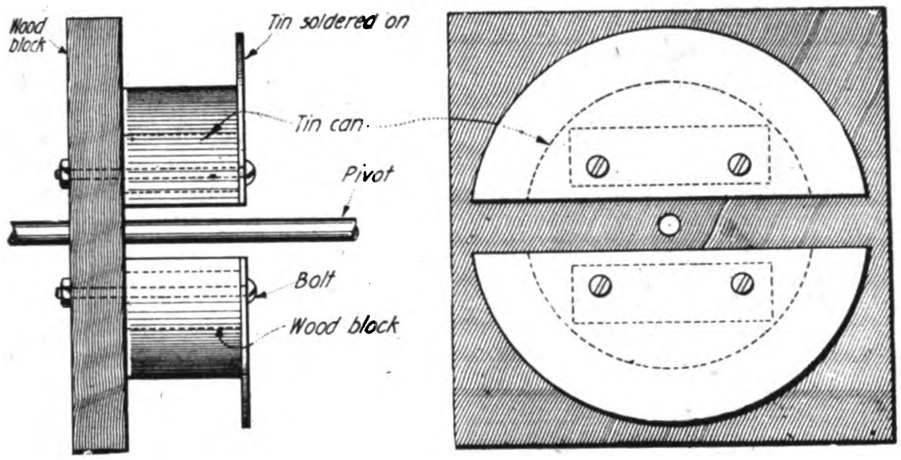


Figure 1—Construction of the form upon which the coils of the variometer are wound

The figure 4 variometer is made on a form shown in Fig. 1. A tin can of the proper diameter, say 4", is cut off to a height of 1½" and then slit in half, removing a strip ½" wide down the sides and across the bottom. A hack saw is best for cutting the corners, shears being used for the flat metal. Each half has soldered to it a semi-circle of tin to form a side ¾" high.

A board 6" square has a ¼" hole drilled in its centre, the can halves being attached to the board by bolts or long screws so the sides of the original can form a circle.

A ¼" rod is fastened to a bench or table and the board pivoted on it. The winding is done in the form of a figure eight, the wire crossing between the halves of the can after each half turn. Banked layers to the amount desired can be rapidly wound by rocking the board back and forth with one hand and guiding the wire into place with the other. For the stationary coil the ends of the wires should come at the outside of one coil. The movable coil should have the leads brought from the center.

When the winding is complete melted paraffin is dropped in several places on the coil to hold it together while the form is being removed. If desired the coil can be taped up and used in its present form, but it can be further improved in point of ruggedness by casting in plaster of Paris.

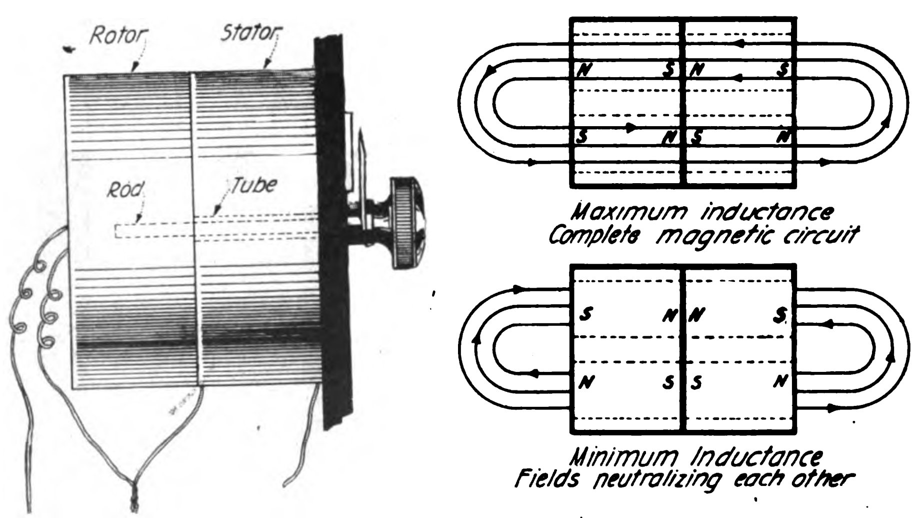


Figure 2—Method of mounting the coils and diagrammatic representation of maximum and minimum inductance

To do this lay the coil on a sheet of glass slightly rubbed over with vaseline. Make a ring of paper or cardboard to fit around the coil and come even with the top. A two inch length of brass tubing with an internal diameter of ⅛" is stood exactly in the centre of the coil. Plaster of Paris is mixed with water to a thick paste and poured into the form. Before the mixture hardens two brass machine screws are inserted so the coil can be mounted on panel. After hardening the cast may be brushed over with melted paraffin to act as a binder and lubricate the rubbing surfaces.

The movable coil is treated in the same manner except that a ⅛" brass rod long enough to reach through the movable coil and the containing case is inserted in the centre to form a means of turning the coil.

The coils are mounted in the case as shown in figure 2, being connected so that the current will flow in the same direction in adjacent halves of the coils when the pointer rests on 180° or maximum inductance. A word as to the theory of operation. Each half of the coil possesses a magnetic field, the two halves of each coil forming a magnetic circuit. In one position the fields of both coils will be in the same direction. Turning the secondary through 180° causes the fields to oppose each other, giving minimum inductance. This is shown diagrammatically in Fig. 2. This type of variometer can also be used as a short wave coupler, a 90° turn varying the coupling from minimum to maximum.

It is extremely rugged, can easily be

built with coils of equal inductance without calculation or experiment and will be found to have a wide range of adjustment.

The second type of variometer is made as shown in Fig. 3. At A is shown the form for the stator made of wood sides and heavy cardboard strips at top and bottom. Slots cut into the wood at the ends of the strips have strips of fiber forced in them to prevent the winding from slipping off. The winding can be done in single or banked layers, the turns being pushed aside at the centre to permit the rod to pass.

The rotor is cut from wood as shown at B and the edges rounded. Here also fibre strips are inserted to hold the wires. The windings on stator and rotor should have equal values of inductance, the usual practice being to wind equal lengths of wire on both.

After assembly the rotor is fastened to the shaft by a long brass screw run in from one side. The leads from the rotor are preferably brought through holes in the stator near the shaft after wrapping the wire once or twice around the shaft to allow play. The stator is mounted in the cabinet by two strips of brass attached to the edges with small brass wood screws as shown in the illustration.

This variometer is likewise compact and rugged and still has the windings close together, thus obtaining highest efficiency in operation.

No data as to size of wire, etc., has been given, the object being only to show constructional details. The dimensions given are proportional and by retaining them the constructor has a symmetrical instrument.

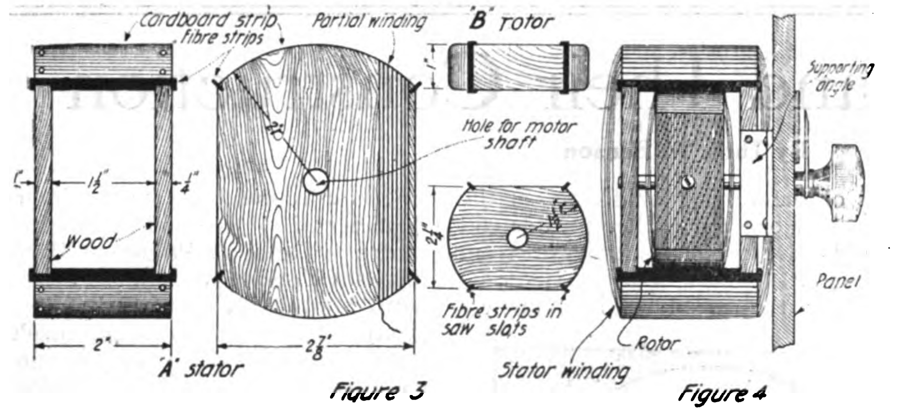


Figure 3—Plan view of the new type of variometer. Figure 4—Variometer mounted

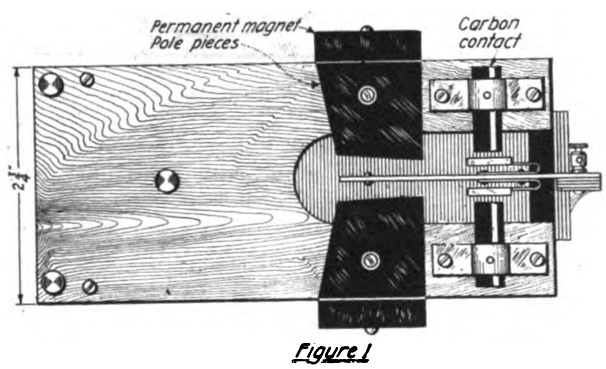
A Small Rectifier for Charging Storage Batteries

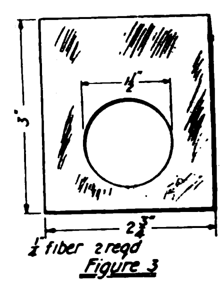
By Armo A. Kluge

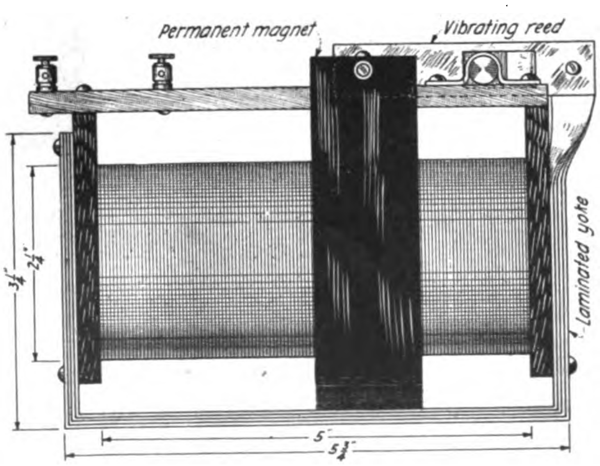
STORAGE batteries are universally used in amateur radio stations for operating the filaments of vacuum tubes and their upkeep forms one of the greatest items of expense connected with a receiving set. Nearly every station has a source of alternating current supply, however, and by the construction of a small rectifier the batteries can be charged from this source at a trifling cost. This should be of particular interest to amateurs who contemplate the use of multi-stage amplifiers and vacuum tube transmitters which require considerable current.

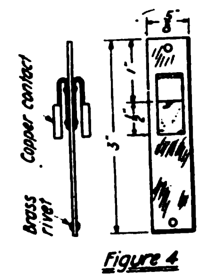
The rectifier to be described is of the magnetic type having a vibrating reed for changing the connections of the circuit so as to rectify the current. This reed is the weak point of most amateur rectifiers, as it is usually not designed for the frequency at which it must vibrate, while if designed according to principles of physics a most efficient rectifier will be produced. The rectifier here described is designed for operation on 60 cycle supply current, so that the reed must vibrate 120 times per second.

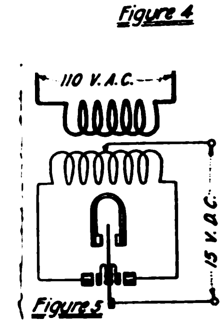
Figure 1 shows a top and side view of the completed instrument. It consists essentially of a small step-down transformer, a permanent U-shaped magnet with two small pole pieces, and a vibrating reed, one end of which is attached to an extension on the core, and the other end is free to vibrate between the poles of the magnet. This reed carries two contacts on opposite sides for alternately mak-

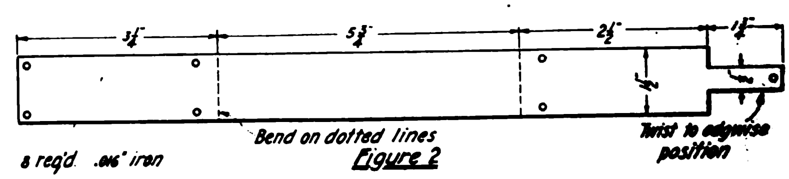












Detailed and assembled views of various parts of the rectifier ing contact with either of two stationary carbon contacts.

The core for the transformer is composed of a bundle of iron wires assembled in a fiber tube 5½ inches long and 1½ inches outside diameter, with a 1/16 inch wall. Annealed iron stove wire cut to the proper lengths will be satisfactory for this core. After the end pieces and the windings have been put on the core a magnetic yoke is screwed on to the end pieces to complete the magnetic circuit. This yoke is laminated of eight pieces of transformer iron, measured and bent as shown in the detail drawing, figure 2.

The secondary winding consists of two layers of 67 turns each, No. 14 D.C.C. magnet wire. About ½ pound will be required. A tap is brought from the mid-point of the two layers to a binding post on the fiber top, while the ends are connected to the stationary carbon contact posts. The primary winding which is wound over the top of the secondary, consists of four layers (520 turns) of No. 22 D.C.C. magnet wire. About ¾ pound will be necessary. The leads from this winding are brought to two binding posts at the end of the fiber top. The transformer will consume about 100 watts on 115 volts, and will deliver 15 volts, 6 amperes, on the D.C. side. In case a smaller output is desirable, the addition of two layers on the primary, making a total of 780 turns, will give an input of 50 watts and an output of 10 volts, 4 amperes.

Figure 3 shows a detail of the fiber end pieces, made of ¼ inch fiber, and having a 1½ inch hole for the insertion of the core. Figure 4 shows the details of the vibrating reed which can be a piece of clock spring with two small contact springs riveted on

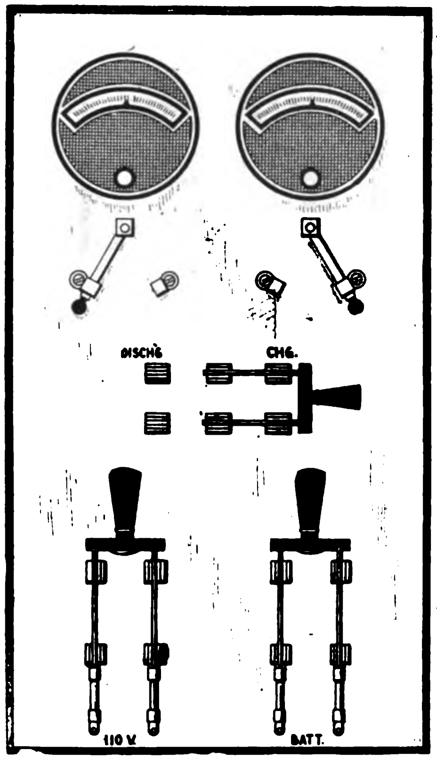


Figure 6—Suggested design for mounting the meters and switches used to connect the rectifier with supply current

the sides. These contact springs carry copper lugs at the ends for the contact faces. The small brass rivet near the free end of the vibrating reed is necessary to prevent the reed sticking to the permanent magnet on contact.

The circuit for the rectifier is shown in figure 5. At each reversal of the alternating current the magnetic polarity of the core—and thus of the reed—is changed, and the reed is attracted by the opposite pole of the permanent magnet. This results in a change of the contacts so that the polarity of the output terminals remains the same. This polarity depends upon the position of the permanent magnet and must be determined when the rectifier is first assembled. An easy way to do this is to put the two leads in a glass of water, the one giving off an excess of bubbles being the negative.

In addition to the rectifier, a small ammeter (0-10), a volt-meter (0-8), and a hydrometer should be included in the equipment for charging batteries. A suggested design for mounting the two meters and the necessary switches for permanently connecting the rectifier to the battery and supply current is shown in Figure 6. The small two-point knife switches are for throwing the meters out of circuit, the D.P.D.T. switch for connecting the storage battery to either charge or discharge, and the two fused switches for the supply current and storage battery connections.

A word with regard to the care of batteries. They should be charged every two weeks, even if only an hour's charge is necessary. Distilled water should be added when the solution gets below the top of the plates. While connected to the supply current a three-cell battery will read 7.5 volts when fully charged.

Construction of a Laboratory Transformer

By Thos. W. Benson

THIS transformer will be of interest to those who have occasion to use voltages ranging between 5 and 1000 volts. It will have constant service capacity of 250 watts, which rating can be exceeded for short runs. It may be connected directly to 110 to 220 volt supply mains, requiring no extra inductance or resistance.

The outside dimensions of the core are 6" x 8", the cross section measuring 1½" x 1½". Twelve pounds of iron will be required cut into strips and 1½" x 6½" and 1½" x 3½". Sufficient strips should be cut to make a pile of each size 3" high. Divide each pile into two equal parts, thus getting material for the four legs of the transformer. The longest strips form the winding legs. The strips should be painted with shellac.

To assemble them, provide a device as shown in Fig. 1. Two pieces of wood are mounted 8" apart on the base with a third piece arranged to form a back. Now by putting alternate pieces of core against the ends of the arrangement the core can be quickly built up. After a pile 1½" high is obtained, it should be carefully removed and tightly bound together with friction tape. The other winding leg is built up in the same manner.

Heads are now fitted to the two windings cores. They are cut from ¼" fibre to the size shown in Fig. 2 and slipped over the ends of the cores. The cores are now wound with three layers of empire cloth or paper shellacked into place.

On one leg wind 10 layers of No. 18 D.C.C. wire, tapping at each layer and tagging the leads A, B, C, etc. Each layer should be given a coat of shellac to hold the wire into place. The coil after winding should be placed in an oven to dry thoroughly. Stranded lamp cord in one foot lengths should be used for making taps.

The other leg is first wound with four layers of No. 14 D.C.C. wire (2 lbs.), tapping each layer and tagging the leads 1, 2, 3, etc. This winding is covered with three layers of empire cloth and the fine winding then put on. The latter consists of ten layers of No. 24 D.C.C. wire (1 lb.), which is also tapped at each layer, tagging these leads a, b, c, etc. After thoroughly shellacking this coil it should be baked until dry.

The transformer may then be assembled. Stand the two wound cores on their end and insert the cross pieces of core iron in the slits at the end of the cores as in the usual construction.

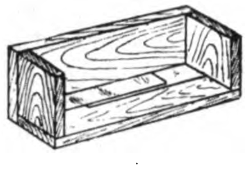


Figure 1

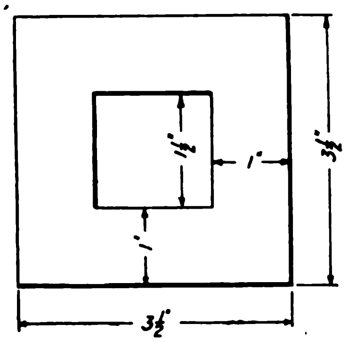


Figure 2

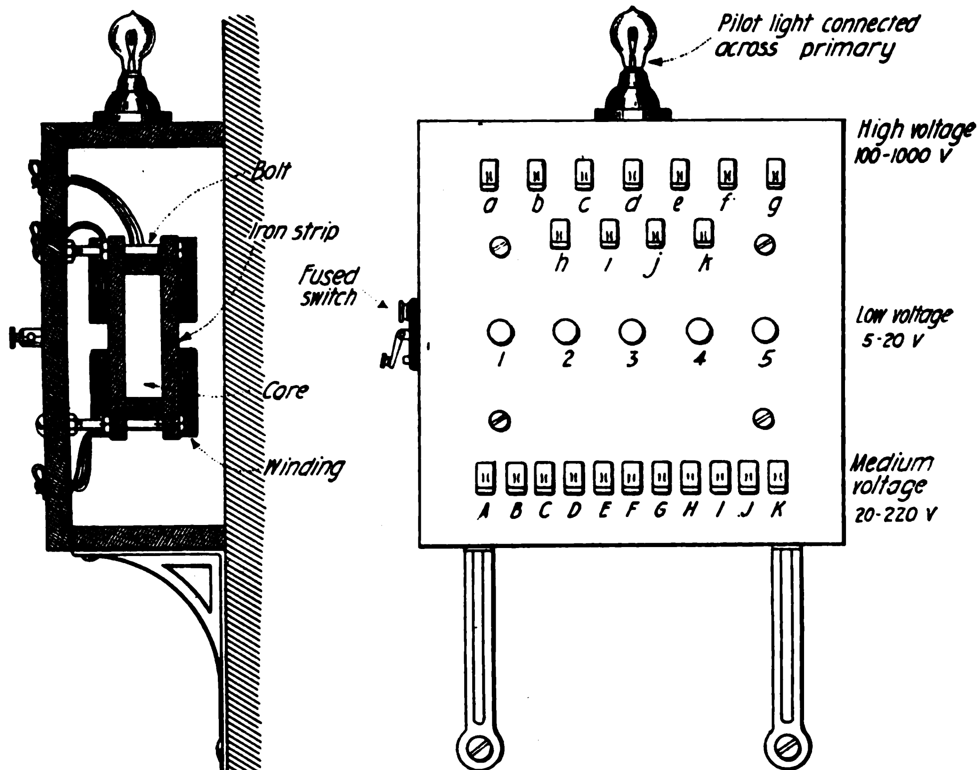


Figure 3

Figure 1—Box for assembling core. Figure 2—Dimensions of coil heads. Figure 3—Transformer completed showing interior arrangement and method of connecting leads

At Fig. 3 is shown a good method of mounting the transformer in a box on the wall. Bolts are used to support it clear of the box, which should be lined with asbestos and holes cut in the bottom and top to allow the air to circulate.

On one side a fused switch and an indicating lamp is mounted to show when the power is on and thus prevent accidents.

The front of the box has binding posts that are connected to the taps from the coils and marked accordingly. Spring binding posts obtained from old batteries will be suitable, but screw binding posts are preferred for the low voltage connections where heavy currents are drawn.

As to the voltages and how obtained: If the house service is 110 V, connect the leads from the switch to the taps A and F on the No. 18 winding. Should it be 200 V, connect to taps A and K. Between post A and K it is possible to draw from 20 to 220 V in steps of 20. This coil acts as an autotransformer.

Between posts 1 and 5 the voltage ranges from 5 to 20 in steps of 5 volts, The fine winding will give voltages between 100 and 1,000 V by spanning the proper number of sections in steps of 100 volts.

This transformer will work direct on 60 cycle current; for 25 cycle supply insert a choke coil of the same general dimensions as the No. 18 winding on the transformer proper. On 133 cycle current the rating will be cut down to 125 watts at full load, due to the higher choking effect of the primary in the higher frequency.

It is advisable to put fuses in the primary circuit that will blow if an overload comes in on the transformer. This will effectively prevent damage to the device.

A rheostat may be included in circuit if fine variations of voltage are desired.

Use extreme care with the 1000 V secondary or a nasty shock if not a fatal accident may result.

Construction of Variable Condensers

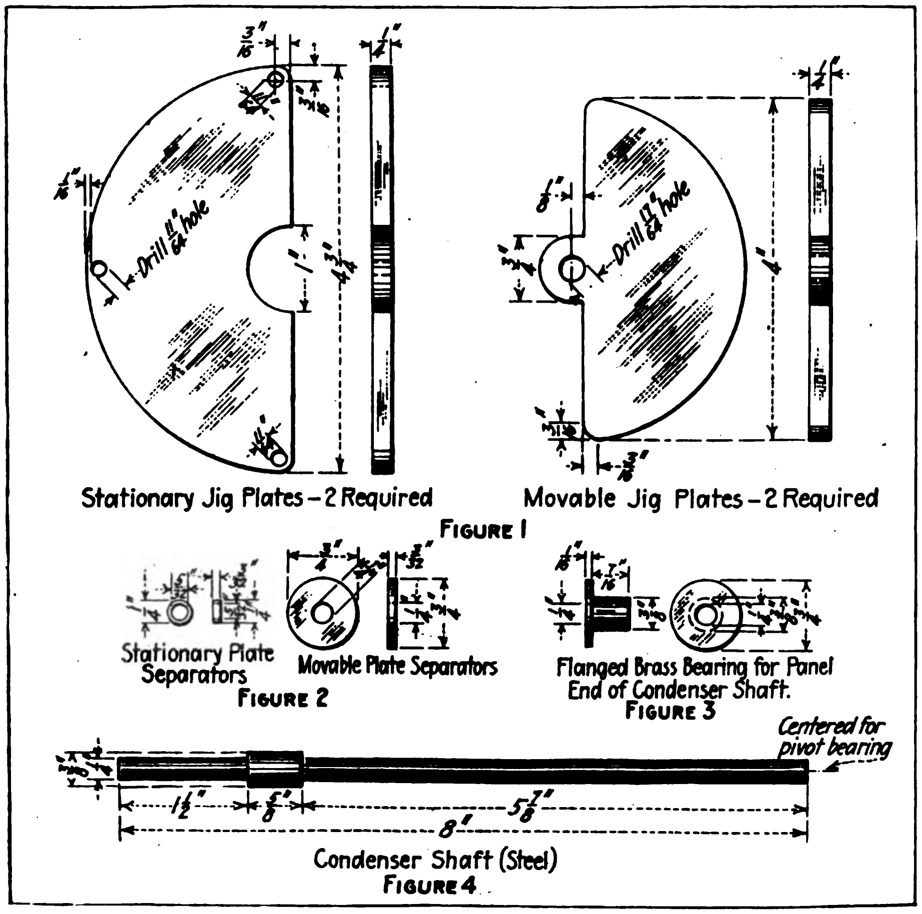
By Ernest G. Underwood

PROBABLY a great many amateurs have made more or less earnest attempts to construct their own variable condensers. In the majority of cases, however, one is apt to give it up as hopeless unless he goes about it in the proper way. The variable condenser is one of those pieces of apparatus which the amateur cannot well be without, but he has been forced in order to provide himself with a condenser which was at all satisfactory, to purchase one of those on the market.

It is the intention of this article to give a few suggestions regarding variable condenser construction which, if followed out, should enable the amateur to build his own variables for his particular purposes.

The three most important parts of a condenser, and the things which are also usually the most difficult for the amateur to construct are the plates, the spacers, and the shaft. The accompanying drawings give dimensions of jigs which were used for making the condensers which I am incorporating in a new receiver now under construction. It is the use of these jigs which makes it possible to uniformly shape the plates in order that, when the condenser is finished, it may be neat in appearance.

The size of these jigs as well as dimensions for all holes, are shown in figure 1. The jig plates were turned from "XX" Grade Steel, and should be not less than ¼" in thickness. These plates were made for me by a machinist, from drawings furnished. He shaped them, bored the holes, and tempered them. Their cost will vary according to the cost of the material and labor, and if several condensers are to be made, the initial cost will be



Detailed constructional plans for the variable condenser

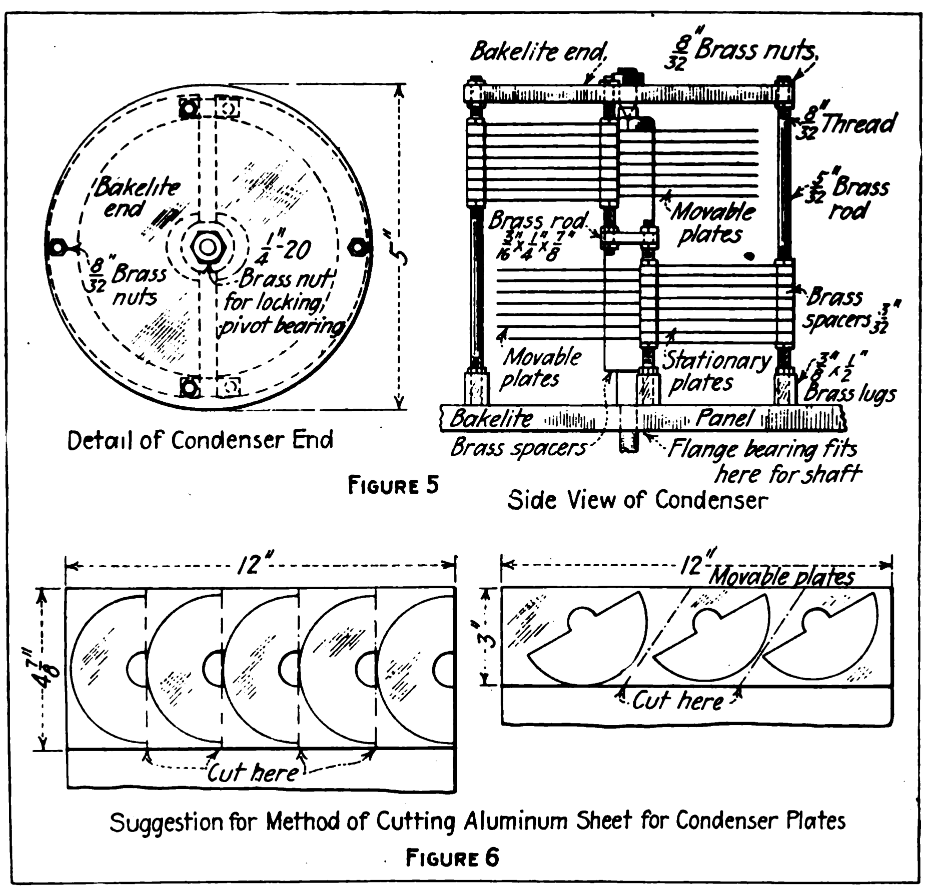
more than compensated for by the money saved, the appearance of the finished condensers, and the pleasure to be derived from their construction.

Attention is called to the fact that the front and inside edge of the movable plates is 1/8" distant from the center of the shaft hole. This spacing is desirable in order that a low zero value of capacity may be had. This distance, of course, may be increased if desired.

No. 20 or 22 gauge sheet aluminum is preferred as the material from which the condenser plates are made. A thinner aluminum bends easily and is harder to keep in shape, thus tending toward short circuits. The use of heavier aluminum simplifies assembly considerably and makes for a more rugged unit. This sheet aluminum comes in 12" widths.

Figure 6 shows the method of cutting and laying out the plates. The aluminum is first cut into pieces of about the proper size for the plates. Three or four of these pieces are clamped between the jig plates in a vise, and the holes bored. If the jig plates have been carefully aligned, the drill in passing from the hole in the front plate into the aluminum, will then pass out through the corresponding hole in the rear plate. A little care will be needed in handling these jigs but it will not be long before it is possible to use them quickly and accurately. It is well to drill all the plates first before attempting to shape them. After drilling has been done, take three or four plates and clamp them between the jigs, using No. 8-32 machine screws as clamping screws for stationary plates, and 1/4-20 machine screws in the case of the movable plates. After the plates have been securely clamped, they are again placed in the vise and as much of the surplus aluminum as possible is cut away with a hack saw. A fairly coarse file is then used to cut them down to the point where the file strikes the hardened steel jigs. After the plates are removed from the jig, the rough edges are taken off with a file and finished with sandpaper. They must then be flattened. This may be done as follows: Place the plates on a perfectly smooth board and tap lightly all over with a wooden hammer if this is available, until they lie perfectly flat.

We will next consider the brass spacers which separate the movable and stationary plates. These washers are shown in figure 2. The small ones are made from 1/4" brass tubing, the large ones from 3/4" round brass rod which has been drilled in the lathe before being cut off. In cutting off these separators, care should be taken to see that they are all exactly the same thickness. It is a rather difficult matter to get these spacers exactly the same size in the average lathe. This difficulty, may be gotten around by cutting off several more than will be required for the particular job in hand, and selecting the ones which are suit-



End and side views of the condenser and method of cutting the plates able for use, with the aid of a micrometer or gauge, or if they run somewhat over-size, they may be ground down one or two thousandths of an inch by rubbing them over a piece of fine emery cloth laid on a flat surface.

The shaft is turned up on a lathe from either steel or brass and is centered for a pivot bearing in one end (see figure 4.) A flange bearing is used for the panel end of the shaft. A gear wheel may be mounted on the large part of the shaft (which also acts as a thrust bearing for the shaft) into which a smaller gear wheel, controlled by a small knob on the front of panel, meshes. This gear reducing arrangement provides a fine adjustment for the condenser, and when used in modern oscillating circuits, is an extremely handy affair.

Figure 3 shows the flanged brass bearing used on the panel end of the condenser and against which the enlarged portion of the condenser shaft thrusts.

The assembly in figure 5 shows a balanced type of condenser with which no counterweights or friction bearings are needed. Such a condenser will always hold its adjustment. The bakelite end which holds the pivot bearing is also shown in this figure as well as the arrangement of tie rods. These tie rods are of 5/32" round brass and may be threaded 8-32. Care must be taken to make sure that the holes in panels are in perfect agreement with each other as well as with the holes in the plates; otherwise, the condenser will not properly line up and the shaft will bind. The use of a little care in laying out these pieces will prevent any such thing as that.

Finally, a connection is brought off from the movable plates by means of a flexible bronze ribbon fastened to the hub of the gear wheel or to the shaft and after having been wrapped around the shaft two or three times, terminated at a stud fixed in the panel. A stop must also be provided either in the condenser itself or on the front panel after knob and pointer have been attached, to prevent the movable plates from making a complete revolution.

These suggestions should help those who desire to construct their own variable condensers. Condensers of any size and plates of any shape may be made in this way, and the plates may always be depended upon to line up nicely when finished.

A Receiver-Transmitter

By C. C. Henderson

THIS is for the amateurs who use the heterodyne hook-ups for receiving.

I have assumed that we all know that when an audion is in the oscillating state a continuous or undamped wave is set up (generated), the characteristics of which are similar to the wave sent out by an arc transmitting station.

An oscillating circuit consists of an inductance and capacitance and this is just what we have in our receiving sets. Tune the receiver to say six hundred meters. Make sure set is oscillating. The result is that a six hundred meter undamped wave will be radiated from the antenna which—provided perfect resonance has been obtained in the receiving circuits—can be heard by another station several miles distant. The length of this wave is changed simply by tuning the receiver to any desired wave. Most operators know the approximate instrument setting of their receivers for any desired value. For those who are always changing hook-ups, resonance can be obtained by overloading bulb filament until a low hum is heard in the phones; next tune primary and secondary circuits until this note "clears up" and maximum strength of phone signals is obtained.

I have had good results on both sending and receiving with wave lengths from 124 meters up to about 8500 meters. Above this value the oscillations become feeble and good results can hardly be looked for.

There are several ways of breaking the generated wave up so as to enable the operator to form code characters. The hook-up shown in the accompanying diagram will give best results however, as it eliminates entirely any compensating or back wave. "A" is an ordinary telegraph key and shunted around the key is a small single pole, single throw switch, "B" which is opened only when operator desires to transmit on receiving "transmitter."

I was on one of the American battleships that formed a unit of the British Grand Fleet during the last thirteen months of the war. Up to the time of our departure for the other side almost every ship in the American Navy was relying on crystal detector reception for all ordinary work. We finally arrived at our base in the North Sea and discovered that Galena and other detector crystals were not going to do the work, so audion reception was started. All ships had to listen in on the same wave-length and this caused the trouble. Using a heterodyne hook-up we could hear innumerable high pitched notes in the receiving phones at all times. Another operator and myself started to ponder over the mystery. I found that by touching some bared portion of the receiver the receiving note was broken. After several days of experimenting communication was established with the battleship New York and a week later the five ships of the American squadron were having a gay old time. But, of course, every good thing has a climax and ours came with a rush. The British operators copied our stuff but they were not in on the secret. I believe a few uncomplimentary remarks were passed about British operators and one of the British flagships managed to collect some convicting evidence. Result was that several senior operators (including myself) were treated to five days solitary confinement in ship's brig for "unauthorized radio communication." It might be noted in conclusion that Admiral Beatty, British Commander-in-Chief, ordered a two day test on "receiving transmitter" work shortly after the "martyrs" to the cause had been released from confinement. Far be it from me to expect any "laurels" for the Yankee "achievement." Due credit must be given to J. McGarry, U. S. S. Florida, and an unknown operator on the New York. I also wish to extend my heartiest congratulations to the British operator who managed to get the "goods" on us. Why? Because we were never able to locate him. Probably "sunk without a trace."

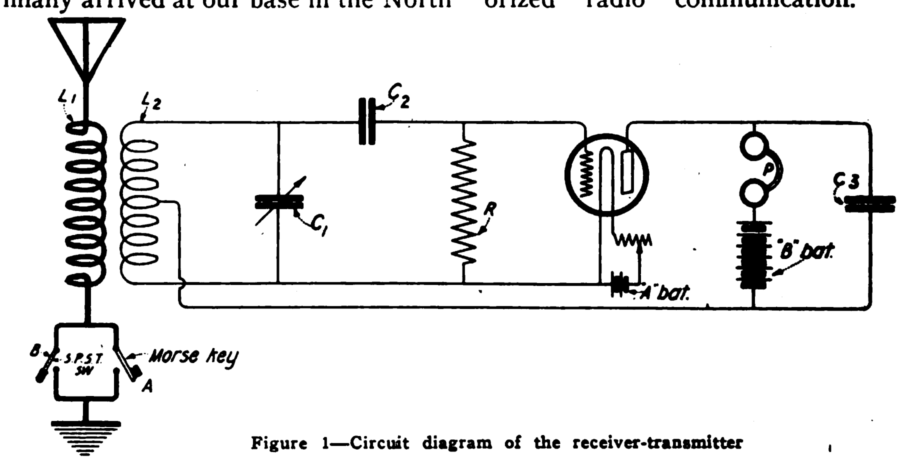


Figure 1—Circuit diagram of the receiver-transmitter

Amateurs On the Job

By Maurice Henle

A FEW short months ago occurred a little drama in the town of Greenville, Ohio, represented by a tiny dot on the map and situated not so far from Cincinnati. Belasco would probably not pause to witness it; nor would Maeterlinck; but it was a drama nevertheless, a real drama.

At a number on West Main Street a youth mounted the stairs to his room. The sun had long since disappeared from view beneath the horizon, and the mystery of the night was abroad. It was one of those nights that make the youthful American mind wander and wonder what is happening away out in the big world, the world into which he hears going those shrieking far-off moanings of the rushing locomotive. He mounted the stairs and closed the doors.

He placed the phones about his ears, threw in his aerial switch and tuned his coupler. A few buzzes; the weather report; he tuned again; the baseball score; the time—

He had now tuned down to about 200-meter wave length, and...

"Hellooo....."

He heard it as distinctly as if his own voice had uttered it. But he hadn't spoken and neither had anyone else in that room or that house. It had come from those receivers so snugly entwined about his head. It was a voice from out the darkness through the greatest annihilator of time and space!

C. H. Katzenberger, now only 19, who was thus thrilled with this revelation of wireless telephony, since has come to Cincinnati to attend a technical school. He lives at the Central Y. M. C. A. and there has installed another wireless set, for he says now his life is not complete without one.

He built the aerial upon the "Y" roof with the permission of officials and strung the wires himself to his room, No. 601. He has received from Key West, Portland, Arlington, and many other far-off places.

* * *

"And it shall come to pass in the year 1919 A. D. that there shall aris a powerful organization to whicl everyone of the more than 250 amateur wireless operators in and around Cincinnati will belong; which shall hold regular meetings to which all members may attend and discuss problems of wireless which arise so that all may benefit; that there shall be a cozy clubroom with comfortable chairs and plenty of magazines where all may drop in and chat and meet their fellow operators; so that they may thus profit in wireless and communication!"

Dorman Israel, prominent wireless amateur in Cincinnati

No, patient reader, with your mind teeming with vacuum tubes, and aerials, and detectors, and loose couplers, and antennas, and one hundred and one of the vitals of wireless—this is not a parody on the Book of Books. It is a page of the unwritten Bible of the amateur wireless operator, a lore which has been learned by heart by every earnest devotee of the greatest of indoor sports, not even excepting African golf, spooning, and billiards.

Wanted: A wireless club!

Wanted! And badly wanted. It is this lack of co-ordination, and only this lack of co-ordination which is retarding the Cincinnati amateur wireless operator, and holding him back from better things. It is this lack of co-ordination and unification which made amateur wireless operating at times so miserable a pursuit, especially before the war. For the amateur who cannot send properly is a meddlesome beggar; and that is one strong reason why a club of operators is imperative.

The plan in the minds of most amateurs is to have a sort of Congress, with an upper and a lower house. In the upper branch would belong only licensed operators. They would be the more skilled; those with better equipment, and surely with a better understanding of the code and instruments in general. In the lower house would belong that great army of unlicensed operators—those who receive only and do not send.

And the two bodies, members of the one club, would meet in separate session and discuss the problems of their respective worlds. The little difficulties which arise would be ironed out, not only to the satisfaction of the operator who is perplexed, but for the benefit of the entire membership as well, which also might be puzzled with those same problems at some future time.

As soon as a member of the lower house is proficient and acquires an operating license, he would automatically leave that branch and be enrolled on the roster of the upper house, where he would immediately be thrown into contact with fellows who have had more experience and from whose gossip and debates he could obviously profit.

And not only does he want a place where he may gather with his fellows, but he also wants competent instructors from whom he may learn the latest in what he considers far more important than meals.

That is what is wanted in Cincinnati. And that is what is utterly lacking.

There can be just a certain amount

of straining at the leash before the bonds will burst. The strong man will make his muscles bulge, his face grow purple, but it is just that last scintilla of effort under which the encircling ties will snap.

And so it is with the wireless situation in Cincinnati. The old laws of supply and demand hold good. And as the club is wanted, so have rumors and even more than rumors been radiated through the air waves.

Let us go back two years or more. Amateur wireless was gaining a strong foothold in the Ohio valley. More and more young men were buying instruments. The Ohio Valley Wireless Association had been organized and had "flivvered" for lack of members and executives. Over at Hughes High School a wireless club had been formed for students of the school who owned wireless sets at home. And a complete outfit was set up at the school, so that keen interest was being displayed by the students. Then came the war.

Immediately, of course, the government tabooed wireless in Cincinnati and the country. Seals were placed on the sets with heavy penalties attached for breaking them. The aerials were brought down and stowed away in the garrets to be kept there until the Germans signed on the dotted line.

But above all these activities, one effort stood out as pre-eminent. The Union Central Life Insurance Company which owns a skyscraper in Cincinnati, second in beauty and height only to buildings in New York, conceived the idea of building an amateur station. The outfit was to be installed in their building, and at the same time a Wireless Club would be formed for the amateurs in and around Cincinnati in order to stimulate and develop interest in wireless telegraphy. The company planned to have men who understood wireless telegraphy give lectures and practical demonstrations, just as the amateur would wish it. But the war stopped all of it.

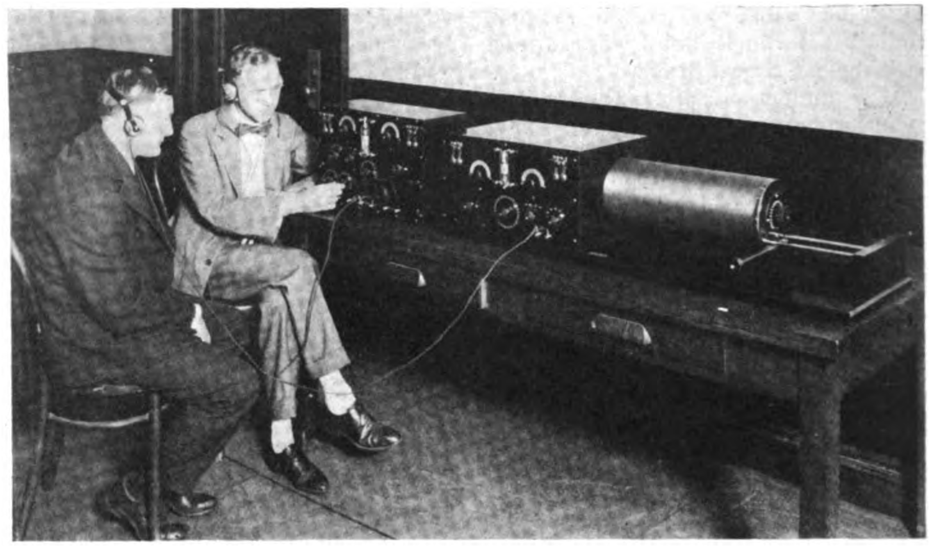
Now, the ban has been lifted, for since the 15th of April last, amateurs have been permitted to break the seals of their instruments and receive messages, and with the lifting of the ban on transmitting, on Oct. 1, activity by the Union Central company was again renewed. On the very day of the lifting of the ban, the aerial was brought out and extended from the eighteenth to the thirty-fourth floor at a ninety degree slant, the tap for the lead-in being brought into the thirtieth floor where the station is located.

The coming to Cincinnati recently of a Captain J. P. Gray, of the United States Coast Guard Service, to make a preliminary survey of possible locations for a government wireless station for use by the army, the weather bureau, and other governmental departments, was the signal on the part of the management of the building and W. C. Winall, chief electrician, to endeavor to have that place designated as a government station.

The federal authorities contemplate establishing five or six stations in the Ohio Valley and to equip many government boats on the Ohio river in case of floods, or other emergencies. Captain Gray has recommended the Union Central Building, Hughes High School, the federal building, and several others.

And—to digress—Winall, after telling of a letter he sent to Captain Gray urging designation of the Union Central Life Insurance outfit as a government station, reveals one of the most interesting sidelights of the great part Cincinnati played in the war, and the part wireless came near performing.

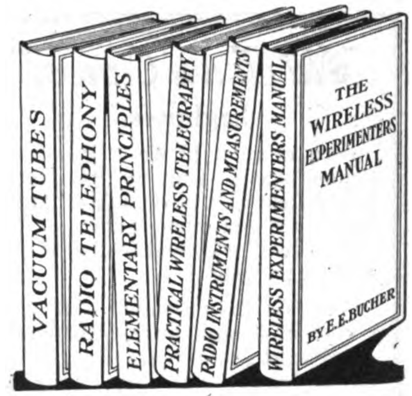
Rumors had been flying thick and fast that radicals planned to blow up



Wireless apparatus used by the Union Central Wireless Club

Which Way?

Franklin Studied Electricity via The Kite String



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Mr. Bucher's New Book Ready To Ship

THE WIRELESS EXPERIMENTERS' MANUAL — By Elmer E. Bucher

The only book published that comprehensively covers the theory and design of amateur wireless transmitters and receivers. Construction of transformers, high voltage condensers, spark gaps, aerials, masts, receiving sets for long and short wave length reception are described in great detail.

Construction and operation of a 50-miler buzzer transmitter, regenerative receivers, cascade amplifiers, preferred circuits for long and short wave receivers—all these are covered.

Direction finders, underground aerials and the use of Weagant's static eliminator for amateurs are the subjects of special chapters.

The amateur is told how to measure the inductance, capacitance and resistance of his aerial, how to check up the efficiency of his station. Construction of quench-gap transmitters, methods of measuring the internal impedance and amplification of constant of vacuum tubes are explained.

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PRACTICAL WIRELESS TELEGRAPHY — By Elmer E. Bucher

More than 60,000 copies of this book have been sold to date. It is used in practically every school, college, and library in this country.

PRACTICAL WIRELESS TELEGRAPHY is the recognized standard wireless text book. It furnishes much information of utmost value in regard to the very latest styles of wireless sets now in use.

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not only the telephone building, but the telegraph companies as well, with the object thus of severing Cincinnati from the outside world. As soon as the rumors had been definitely traced and some truth to them found, steps were taken immediately to stave off a possible attack by the radicals, and to fortify the city if such a move were made. The Western Union was ready to remove its offices in an instant, and complete trunk lines could have been connected immediately, if the main ones had been blown up. Not only this, but Winall urged the navy officials to consider the wireless station, then dismantled, at the disposal of the government, saying that it could be put in operation in twenty-four hours.

Throughout these uncertain times there remained with Winall a man who had helped him put up the set, Ira Holden by name. He and Aaron Hubbell were pioneers in wireless operating in Cincinnati, having set up the very first instrument ten years ago, which since has multiplied until hundreds of them bind a band of unseen ears about the city. The training Hubbell received, by the way, stood him in good stead in the war, for eighteen months he served in France as an aviation wireless tester.

But to return, the idea of the Union Central Life Insurance Company establishing a Wireless Club has not been abandoned; on the other hand it has been strengthened; but until the ban on sending is lifted, nothing will be done to organize it.

The spark and arc receiving sets with a temporary aerial have been put up with good results; messages have been received since April 15th from the following stations:

Arlington, Charleston, Great Lakes, Pensacola, New Orleans, Cuba, San Diego, Cal., New Brunswick, Annapolis.

The lowest points of the permanent aerial will be not less than 250 feet above the ground and the upper will be about 485 feet above the ground. This aerial will not be vertical but will be offset about 100 feet. It will be composed of phosphor bronze stranded wire. The sending set is to be a 500 cycle equipment, 20,000 volt.

The building in Cincinnati which has an antenna strung from the eighteenth to the thirty-fourth floor

1 kw. power. They have a powerful transformer and motor generator. As yet, the company has not purchased a quenched spark gap, which is the only article needed.

This is about the most complete outfit in Cincinnati, and will undoubtedly be looked upon as the "mother station," of the vicinity.

* * *

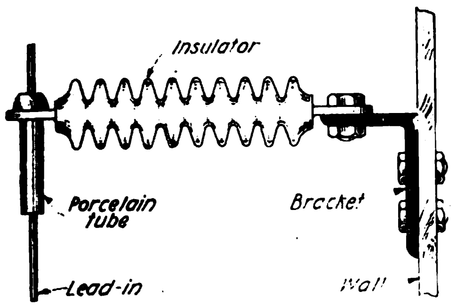
Red-blooded Americans, who helped lick the Boche with their knowledge of dots and dashes, are coming back, and with them come weird and bizarre tales of adventure. And they have brought back new ways of wireless which they will put to use in their private operation of wireless. For wireless is the one thing which is all mighty to the fiery minds of the red-blooded Americans.

A long and happy life to the hundreds of Temples of Experimenting.

Lead-in Construction

By Henry Klaus

MANY amateurs, especially in cities, are compelled to put their aerials on buildings and the lead-in must be kept clear of everything. The accompanying sketch suggests an inexpensive but efficient way to insulate the lead-in from the building.



Constructional view of lead-in

A common electrose strain insulator is bolted to a bracket fastened to the building and a porcelain tube put through the other eye and the lead-in is brought through this tube. Two or three of these will hold the wire firmly.

Sealed Detector

By L. B. Salt

THE accompanying sketch shows a very good sealed detector which I made about a month ago, and which, as far as I can see, is as sensitive today as when it was made.

Details of the sealed in detector

out lamps can probably be picked up at any garage for nothing.

Several of these detectors can be made up of different crystals, and any one of them inserted in the set in a second.

If one desires to cover the crystal completely, different color sealing wax should be used to designate a certain kind of crystal.

This detector makes a neat looking one on a set, and is small and rugged for a portable set.

The main holder is the base of an automobile lamp. The glass was broken away level with the top of the base and the two wires bent in such a way that a thin piece of crystal could be inserted between them. A test buzzer was used to find the sensitive part of the crystal, and a small piece of sealing wax was melted into the base to hold the crystal and lower part of the wires. Then more wax was put in until it was level with the top of the base. The test buzzer was kept going all the time to be sure that the crystal did not move while putting in the wax.

The wax which I used was taken from the top of a flash-light battery.

The socket into which the base fits can be bought at any automobile supply house for a very little, and burned

Prize Contest Announcement

The strike of the printers, which placed this magazine eleven weeks behind its scheduled publication date, so multiplied the difficulties with the prize contests that no manuscripts have been received on several of the selected subjects. It is clear that the situation is entirely due to the unexpected series of printing delays. For example, the closing date for the March issue contest was set at February 14th, whereas the magazine was not delivered to readers until this date had gone by. Similarly, February 29th, as the closing date for contests originally announced for the November and December issues, did not provide ample opportunity for contestants to send in their manuscripts.

These contests are run for the benefit of our readers, to provide them with funds to continue their experiments. It, therefore, seems fair to all to make the following new offer:

The subject for the April issue will be:

"Mast Construction for the Average Amateur"

Closing date March 17th.

The subject for the May issue will be

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

Closing date April 3rd.

Contestants for the prizes are requested to submit articles on either of these subjects, or both of them, at the earliest practicable date. An additional contest subject will be announced in the March issue.

PRIZE CONTEST CONDITIONS—Manuscripts on the subjects announced above are judged by the Editors of The Wireless Age from the viewpoint of the ingeniousness of the idea presented, its practicability and general utility, originality, and clearness in the description. Literary ability is not needed, but neatness in manuscript and drawing is taken into account. Finished drawings are not required, sketches will do. The contest is open to everybody. The closing date is given in the above announcement. The Wireless Age will award the following prizes: First Prize, $10.00; Second Prize, $5.00; Third Prize, $3.00; *in addition to the regular space rates paid for technical articles.*

All manuscripts should be addressed to the Contest Editor of The Wireless Age.

An Indoor Loop Antenna

By L. W. Van Glyck

ALTHOUGH the simple antenna herein described is now quite common it is seldom used by experimenters in general. This antenna possesses both advantages and disadvantages when compared with the usual amateur type. It possesses the advantage of picking up less static. It is portable, compact, and easily constructed at a much lower cost than the elevated type. It is highly directive, receiving best from stations lying in its plane, and practically not at all from stations at right angles to its plane. If it is turned so that its plane is parallel to the surface of the earth it receives equally well from all directions. On the other hand the antenna herewith described will not pick up as much energy from the transmitting station as the average out-door antenna, but what does that matter in this age of vacuum tube amplifiers?

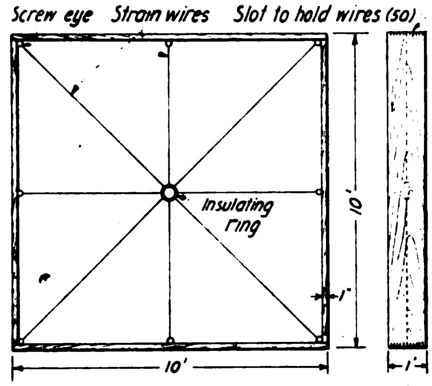


Figure 1—Construction of the insulating ring

The frame is constructed of any soft, light wood, such as basswood. It is wound with 60 turns of No. 20 or No. 22, single silk covered wire, the wire running through the slots in the corners of the frame. These slots may be made with a fine toothed saw. The two ends of the wire are brought to binding posts in the frame at any convenient point and connected to the loose coupler as shown in figure 2. The method of connections is optional, but I have found the hook-up as shown to work very well. It is advisable to use a one-step amplifier for distances over two or three hundred miles.

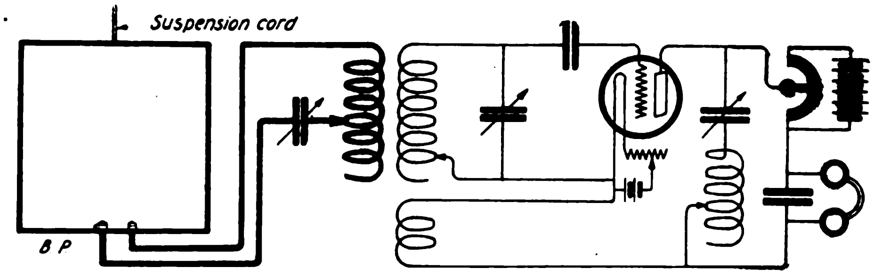


Figure 2—Diagram showing the binding posts and connection to the loose coupler

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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Ambitious Program for Bayonne

PLANS for one of the most powerful amateur radio telephone sets ever erected in the Atlantic seaboard section of the country are being considered by members of the Peninsula Radio Club, 17 West 31st Street, Bayonne, N. J.

The club has installed a receiving set of the latest type obtainable; an efficient amplifying set also has been installed.

Members of the club are desirous of interesting Jersey City wireless "fans" in their work, and Secretary Oliver, in behalf of the club, extends to all Jersey City amateurs an invitation to communicate with him and to visit the clubhouse and inspect the plant. It is hoped that some of the Jersey City enthusiasts will join the local organization. Especially is it desired that young men who have never taken an active part in wireless experiments interest themselves in the meetings of the club, which take place each Monday night. At each meeting experiments are made with different types of bulbs and code is practiced.

New Facilities for Amateurs

LOUIS G. PACENT, well known to New York amateurs, has organized an electrical company, through which he expects to serve amateurs to "a greater extent and in a better way than ever before."

Mr. Pacent spent the past ten years with the Manhattan Electrical Supply Company, in charge of their radio departments and all their radio activities.

In his new capacity he will deal in radio and other electrical apparatus for electrical, laboratory, and communication purposes. Every piece of apparatus will be thoroughly tested before it is offered for sale.

Radio men, experimenters, professors, instructors, government authorities and all other interested persons are at all times invited to visit the rooms at 150 Nassau Street, New York, where a complete line of all the latest equipment will be on exhibition. A radio reference library, files of current technical periodicals, special reports—these and years of experience will be at the disposal of all interested persons.

Radio Intelligence Post of the Legion

THAT wireless men will stick together in peace time and keep alive the friendships which grew out of association in the war was demonstrated in the enthusiastic meeting of the Radio Intelligence Post of the American Legion, held at the Berkley Hotel, New York City, on February 3. An unusually entertaining evening was enjoyed and a very attractive program was outlined for the future. The Secretary is eager to communicate with men who served in the Radio Branch of the Military Intelligence Division, both overseas and in the U. S. The Secretary is Arthur L. Bernhard, 1679 42nd Street, Brooklyn, N. Y.

The style of this wireless set indicates in a manner the high type of the present-day wireless amateur

Marconi Expresses Gratitude

T. COMMERFORD MARTIN, chairman of the electrical committee which is raising, in honor of Marconi, a special fund for the Italian War Relief Fund of America, has received a very interesting letter from the distinguished president of our association.

"I cannot tell you how deeply touched I am at this unexpected proof of the sympathy of the American people for my country," Mr. Marconi says, "nor how greatly honored I feel that my American friends should wish to associate my name with a praiseworthy and noble object. Please allow me to express to you and to all who have contributed to this scheme for a special fund, my sincerest and most heartfelt gratitude.

"With regard to the sum of $2,500 which you state is immediately available, you may send it to me and I will arrange for its distribution in Italy."

Mr. Marconi added heartfelt thanks "for the great honor which you and all other American friends have done me."

As previously stated in these columns, each subscription is accompanied by an autograph card, with the object of assembling all these cards later in a memorial album to be delivered to Mr. Marconi. Such cards can be obtained from the Committee at 29 West 39th Street, New York City.

"Y" Courses for Ex-Service Men

EX-SERVICE military and naval men, many of whom spent their last months overseas in taking up their educational work, are to have their opportunities continued at home in plants already well equipped and most readily adjusted to suit the needs of soldiers. The facilities of the Young Men's Christian Association and its complete organization in all parts of the country will be at their command for practical education, through free scholarships, as soon as local arrangements in the various cities can be completed.

The army's responsibility for educating the uninjured soldier ceased as soon as the red chevron appeared on his sleeve; but his need for training did not vanish in civilian life. Thousands of men who were interrupted in their life plans by enlistment in the Service, as well as hundreds engaged in the war industries, need further educational opportunities.

These are among the reasons which led to the decision to continue the educational service of the camp and cantonment. The cooperation of nearly two thousand Associations in the United States makes possible the completion of these plans. The enterprise, which will interest thousands of men in these groups, enlarges and extends the educational opportunity of many communities, and by its extension division reaches out to thousands of communities where no Young Men's Christian Associations exist. In addition, in a more limited way, it opens the portals of technical and collegiate instruction to young men properly qualified.

It is the aim of the United Young Men's Christian Association Schools to give the ex-service man just what he most needs, whether it be a short course initiating him into a new occupation, or a longer day or evening course preparing him for more technical efficiency. Because many will feel that they cannot go away to study, or give time during the day, the Association Schools will offer most of their courses at night in the cities where the students live.

For the correspondence courses, of which there is great need, the work will be conducted from one center.

Among the courses (correspondence or resident) that will be of direct interest to WIRELESS AGE readers are:

Radio Telegraphy,
Electricity and Magnetism,
Electric Storage Batteries,
Electric Wiring,
Electric Lighting,
Electric Testing,
Direct Current Machinery,

Applied Electricity for Practical Men,

Alternating Current Electricity,

Applied Electro-Chemistry and Welding.

Electrical Engineering (condensed).
Complete Electrical Engineering.

Scholarships will be apportioned to various States in proportion to population. The award will be made by special local committees composed of competent men, and including men who have been in the Service. They will be open to applicants who show ambition, earnestness and ability to complete the course desired.

Selection of individuals for scholarships will depend first upon the applicant's character. He must be one who will be a desirable member of a school, and must show his honorable discharge. The applicant must give satisfactory evidence of being sufficiently interested in, ambitious for, and capable of completing the course desired, and must be able to meet regular entrance requirements essential to profit from such a course, such as age, sufficient general education, and technical experience.

Part of these scholarships will be available in the nearest United Y. M. C. A. School. A large number will be open through correspondence courses conducted by highly qualified experts. A small number will be offered in special technical schools.

The Extension Division of the United Y. M. C. A. Schools has decided to also help those who live where no organized "Y" exists, and who are not eligible for scholarships, by selling the same high-grade courses at a very nominal price. This school is not operated for profit.

Further information can be secured from the nearest "Y," or by addressing Headquarters, United Y. M. C. A. Schools, 347 Madison Avenue.

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.

T. C. R., Montgomery, Ala.

We regret that we are unable to inform you as to where it will be possible to secure a design for a 2 KW. arc set.

* * *

H. S. B., Huntington, N. Y.

Reference to the use of closed loops for reception of radio messages was made in June, July, and September issues of the WIRELESS AGE. Further articles in this connection will appear at an early date.

* * *

J. P. S., Buffalo, N. Y.

For the construction of a condenser suitable for use with a 1½" spark coil, you are referred to articles which will be printed in early issues of this magazine. We are unable to give you the inductance value of your antenna but its fundamental wavelength is somewhere in the neighborhood of 230 meters. For the construction of an oscillation transformer for 200 meter work, we refer you to prize articles printed in recent issues.

* * *

J. G., East Orange, N. J.

It will be all right for you to use condensers of .0008 mf. and .001 mf. instead of the 21 plate condensers recommended by Mr. Sterns in his description of the "Universal Receiver." The receiving range of this receiver on 200 meters compares very favorably with the range when the average amateur short wave receiver is used. The "Paragon" mentioned is, however, very much more sensitive than any other receiver of which we know.

J. R., New York City.

A license of any sort is not required for the operation of a receiving outfit.

* * *

G. N. G., East Orange, N. J.

As far as we know, there are no loose couplers on the market having a maximum wavelength range of 300 meters. From what you say we gather that you are after a super-sensitive and extremely selective receiver for amateur wavelengths. The construction of receivers of this type has been described in recent issues of this magazine, or such a receiver may be purchased.

In the construction of a vacuum tube the amount of energy which any vacuum tube will furnish depends entirely upon the value of energy put into that tube. The problem then resolves itself into a problem of designing a tube which will stand high voltages and high currents. Power is measured in watts, not in amperes and the power is the product of the current and the voltage. With regard to the use of vacuum tubes for receiving work, the spacing of the elements is not the only consideration. The degree of vacuum has a great deal to do with the value of plate voltage required to bring the tube into sensitive condition. The audiotron is a tube of low vacuum, whereas the Marconi V T and the Westinghouse tubes have been thoroughly exhausted.

For a discussion of damped and undamped waves, we refer you to "Practical Wireless Telegraphy" by E. E. Bucher (Wireless Press, Inc., N. Y. C.). You will also be able to find in this text book a discussion of the oscillating audion.

As you will learn after referring to the above mentioned book, damped waves are emitted in groups at an audible frequency. The frequency of the waves themselves, however, is so high as to be inaudible. It is apparent, therefore, that if we wish to superimpose impulses at speech frequencies upon an electro-magnetic wave, we should choose that wave which on its own account produces no audible frequency at the receiving station, for, otherwise, the sound produced due to the discontinuity of the wave itself would interfere with the sound produced by the voice modulation.

The induction-like noise to which your receiving set has been subject is, we gather, due in all probability to the fact that somewhere in your vicinity a high tension line is discharging to the branch of a tree or to the earth, due to faulty insulation at some point. If, as you say, you are able to get it with the aerial disconnected entirely, it is probably nearby. If you can rig up a few turns of wire on a loop 2 or 3 feet square and arrange your receiving set so that it is portable, it will be possible for you to follow the electric light lines in your neighborhood and locate this discharge merely by moving always in that direction in which the strength of the signal increases. Upon locating the fault, if you will point it out to the Public Service people, they will, no doubt, remedy the matter. This procedure has been followed in many cases by amateurs.

* * *

H. T., Presto, S. D.

Probably the interference which you experience is due to the discharge of lightning arresters at the power station. Your proximity to this station is unfortunate. You will probably be able to do more for yourself by experimenting in an effort to learn the source of this interference than by listening to any suggestions which we might be able to make.

J. F., Jr., Danville, Ill.

If you are using an audion detector and a sensitive receiver, you should be able to get fair results with the antenna which you sketch. Your transmitting range, however, will be limited. It would be much better if you were able to stretch an antenna between the top of your galvanized iron pole and the roof of some nearby house or a tree.

* * *

C. N., Valdosta, Ga.

The instrument which you have in mind is called a telegraphone and consists of a steel wire traveling between two electric magnets. The messages are recorded upon this steel wire magnetically and upon running the wire through between the magnets a second time the message is reproduced. This instrument costs several hundred dollars.

* * *

B. J., Canton, China.

The design of the aerial of which you forward a sketch is as far as we are able to say O. K. If you have it available, you should, however, use copper instead of galvanized iron. Owing to the fact that you failed to tell us the length of this aerial, we are unable to give you the fundamental wavelength. You may figure this roughly for yourself by multiplying the overall length of wire (from the apparatus to the end of the antenna) in meters by 4.

* * *

C. P., Hartselle, Ala.

For the purchase of a small tape recorder, we refer you to J. H. Bunnell & Co., New York City.

* * *

W. H. O., Ridgewood, N. J.:

If you wish to increase the range of the set shown in figures 108 and 109 of "How to Conduct a Radio Club" to 18000 meters, a variable condenser having a capacity of .001 mf. should be substituted for C_2 and a like condenser shunted from the antenna to the earth. With reference to figure 109, increase C_1 and C_4 to .001 mf. and shunt a like condenser, antenna to earth.

* * *

R. J., Woodhaven, L. I.:

The April and May issues of THE WIRELESS AGE, contain diagrams and working drawings for construction of amateur receiving apparatus that will meet all your requirements.

The secondary voltage of a transformer for amateur work should lie between 15,000 and 18,000 volts.

Any electrical supply house in New York City can put you in touch with manufacturers that will construct special taps, binding posts, bushings, contacts, etc. for you.

Book Reviews

The Outlook for Research and Invention. By Nevil Monroe Hopkins, M. Sc., Ph. D. Cloth binding, 241 pages. Van Nostrand. Price $2 net.

With the expressed purpose of developing efficiency of research, Dr. Hopkins has prepared this book for the guidance of those who have the inventive turn of mind, but lack the facilities to determine the status of the prior art and the needs of the world in the broad field of technological development. The author has quite evidently designed his book for "tens of thousands of men working upon problems, in the history and conditions of which they are ignorant," noting moreover that "they are frequently working upon problems they are not educationally equipped to develop." The mere fact that inventions are patented at the rate of nearly 50,000 a year, but very few Americans are advancing the sciences at all, illustrates the need for a text such as the present one.

Eight chapters guide the reader to an understanding of the limitations of research, as well as its productive channels, equipment and methods, the canons being largely based upon the first-hand experience of the author. Every observation made is pertinent and clearly expressed; the guide posts set up are sharply defined and easily comprehended by the most inexperienced. It is refreshing to find a book with so serious a mission written from cover to cover with a simplicity of style that makes its reading less a task and more a pleasure. Contributing materially to its usefulness also is an appendix listing and describing problems awaiting solution in physics and chemistry, including a generous section on electricity and its application to radio.

This book is obtainable through the Book Dept., The Wireless Age.

Airplane Photography. By Herbert E. Ives. Cloth binding, 422 pages, 208 illustrations. Lippincott. Price $4 net.

The utility of the camera in association with flight has been obviously underrated, due to its military origin and cessation of the war-time demand. Future developments are certain, however, and it is one purpose of this volume to define the general principles which will apply to all uses and purposes which photographing from the air may be put. One of the lines of quickest development is described in a chapter devoted to pictorial and technical uses; it is in recording to best advantage the entire form and location of buildings, pictures which are destined to be extensively used in the study of architecture. The vertical aerial photograph, too, has such apparent advantages over any ordinary surveyor's map. that one logical use will be in advertising real estate developments. Landscape gardening, geological surveying, city planning, progress in engineering projects, the characteristics of wrecks, fires and floods for insurance underwriters, are among the uses the author selects as available for the peculiar merits of the view from the air.

A large portion of the book is devoted to a discussion of the fundamentals of photography, and to scientific methods of study, test and specification, so that the reader may understand the most advanced methods and perhaps contribute to future progress. A final chapter is devoted to future developments in apparatus and methods, prophesying the next steps in lens design, camera suspension, color photography and practical photographing at night.

To those who are seriously interested either in the practice of aerial photography or in its development, this volume will prove both informative and inspirational.

This book is obtainable through the Book Dept., The Wireless Age.

Inventions of the Great War. By A. Russell Bond. Cloth binding, 337 pages. Illustrated. Century. Price $1.75 net.

The more important and interesting inventions which were war-born or highly developed during the period of hostilities are described in simple language in this book. The story of research and development is fascinating in itself, but a great deal has been gained by the author's manner of including the human interest which lay behind solution of each problem. Of special interest to wireless men is the chapter, "Talking in the Sky," in which vacuum tube wonders are referred to, long distance radio is explained, airplane transmitting equipment is discussed in initial and later stages, high speed telegraphing methods are reviewed, and the utility of the radio compass described.

This book is obtainable through the Book Dept., The Wireless Age.

The Realities of Modern Science. By John Mills. Cloth binding, 321 pages. Illustrated. Macmillan. Price $2.50 net.

For those who have been unable to comprehend the isolation of the electron, which has been discussed in numerous learned treatises by radio engineers, this volume offers an easy means to an understanding of the new terms by which scientists are explaining the phenomena of all physical science. To students of electricity who have not had the advantages of the more advanced courses Mr. Mills' book is invaluable, for most of the phenomena of electricity are treated in elementary texts without reference to the electron, now universally recognized as the fundamental entity.

As an introduction to the study of science the volume is particularly welcome. In chronological order it develops fundamental concepts, gradually leading up to important chapters on molecular and electronic motions.

This book is obtainable through the Book Dept., THE WIRELESS AGE.

Electricity at High Pressures and Frequencies. By Henry L. Transtrom. Cloth binding, 240 pages. Illustrated. J. G. Branch. Price $— net.

This volume bridges a gap for practical electricians who are interested in the subject of high pressures and frequencies but, due to the highly technical language employed by the average author, have been unable to get a real grasp of the subject. The high frequency currents of radio communication are clearly explained in principle and effect, not with the thoroughness demanded by the scientist, perhaps, but quite adequately for those who have not had the advantages of higher technological education.

This book is obtainable through the Book Dept., THE WIRELESS AGE.

Principles of Radio Transmission and Reception with Antenna and Coil Aerials. Bureau of Standards, Scientific Paper No. 354.

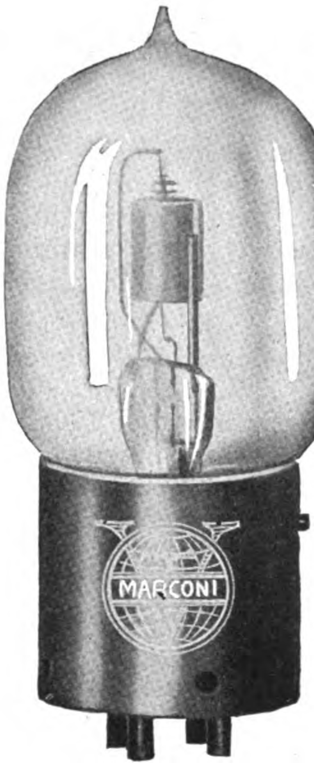
The functioning of the two principal types of radio aerials is worked out quantitatively from fundamental electro-magnetic theory. Experiments have verified the formulas and conclusions presented. Formulas for the current received in either antenna or coil aerial in terms of current in either type of transmitting aerial are given, as well as comparison formulas giving the relative performance of antenna and coil aerials under various conditions. The advantages of the condenser type of aerial are presented. The theory and nature of radiation are discussed, and applied to the elucidation of some current fallacies. The basic principles of design of aerials are given. Desirable lines of future research are pointed out. The use of the coil aerial as a direction finder, interference preventer, reducer of strays, and submarine aerial are *not* among the subjects treated.

The Determination of the Output Characteristics of Electron Tube Generators. Bureau of Standards.

Owing to saturation and rectification effects in three-electrode vacuum tubes, the currents which they deliver to any type of output circuit, when used as a generator, are heavily loaded with harmonics. Experimental results indicate that the frequency of the oscillating currents generated is the natural frequency of the output circuit. Hence this circuit behaves as a filter in series with the tube and the D. C. power system, and the useful output current is approximately sinusoidal, whatever the distortion of the tube currents, depending in amplitude solely upon the fundamental constituents of the tube currents. General expressions are derived for the power and current output in terms of static characteristics of the generating tube, and are corroborated by experimental results obtained with a particular tube.

These papers are now ready for distribution. Any one interested may obtain copies by addressing a request to Bureau of Standards, Washington, D. C.

A WARNING



Fleming Pat. No. 803,684
De Forest Pat. Nos. 841,387-879,532

to Manufacturers
Importers
Dealers
Jobbers
Agents
Amateurs
Purchasers
Users of

Vacuum Tubes

The Marconi V.T. Patent is Basic

United States Letters Patent to Fleming, No. 803,684, November 7, 1905, has been held to be valid by Judge Mayer of the United States District Court for the Southern District of New York, and by the United States Circuit Court of Appeals for the Second Circuit.

It is a basic patent and controls broadly all vacuum tubes used as detectors, amplifiers or oscillions in radio work.

No one is authorized to make, sell, import or use such tubes for radio purposes, other than the owners of the patent and licensees thereunder. Any others making, selling, importing or using them alone or in combination with other devices, infringe upon the Fleming patent and are liable to a suit for injunction, damages and profits. And they will be prosecuted.

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Do not take chances by making, importing, selling, purchasing or using vacuum tubes for radio purposes not licensed under the Fleming patent. By selling, purchasing or using licensed tubes for radio purposes you secure protection under the Fleming patent and avoid the risk of litigation for infringement thereof.

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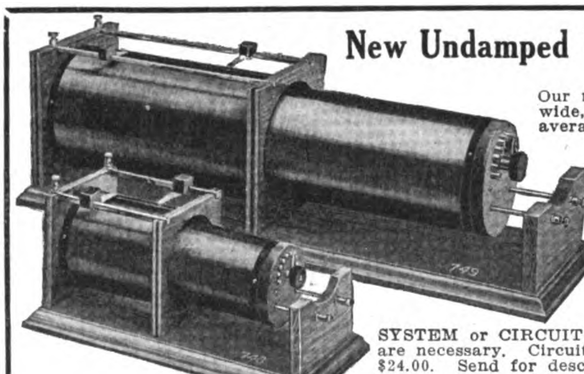

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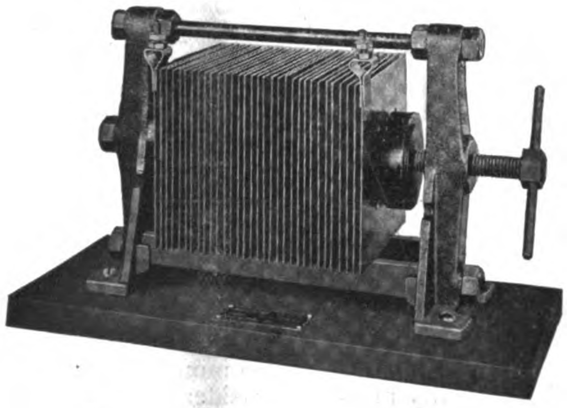

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Folders describing any pieces of "Amrad" apparatus will be sent on request. Write for them.

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The Wireless Age

Volume 7 Number 6

The Lafayette Trans-oceanic Station Near Bordeaux, France, Showing Eight Towers, Each 825 Feet High

How Vacuum Tubes Are Tested
Radio Operating as a Career

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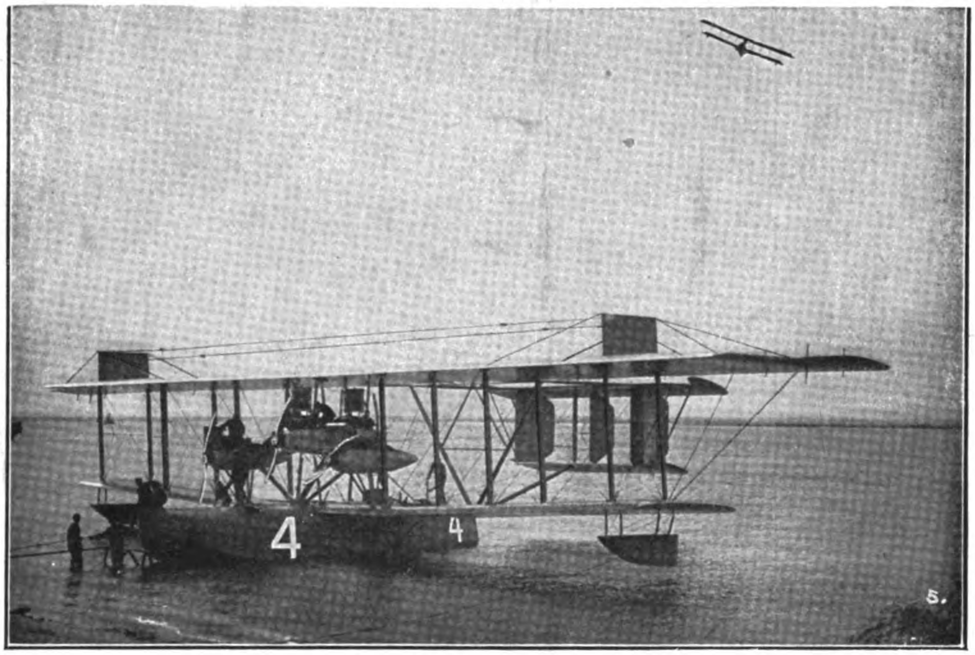
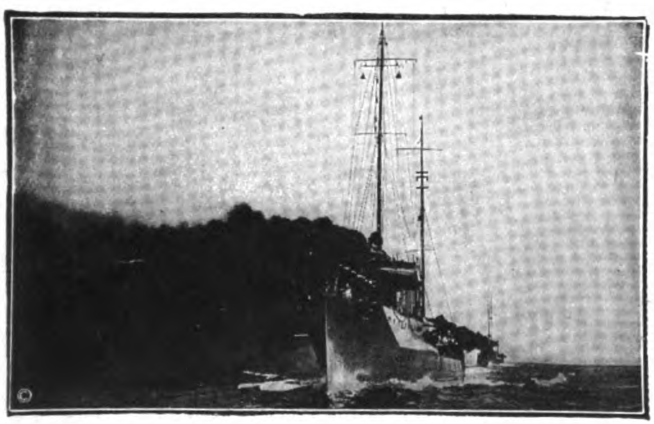
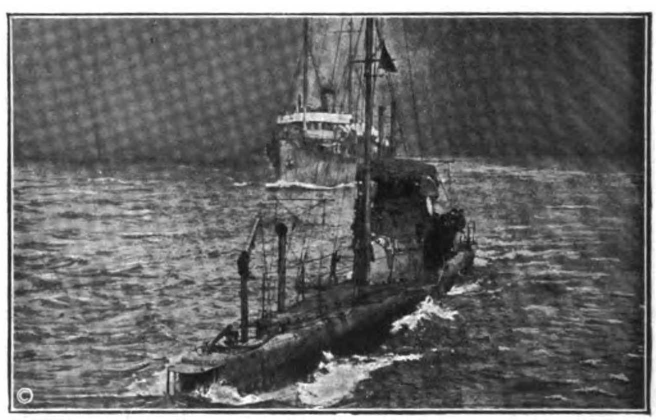
Extract from New York World, June 3, 1919.



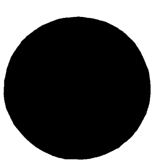
NC-4—ELECTROSE Equipped



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



U. S. S. G-2—ELECTROSE Equipped.



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

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Vol. 7 Contents of **The Wireless Age** for March, 1920 No. 6

Edited by J. ANDREW WHITE

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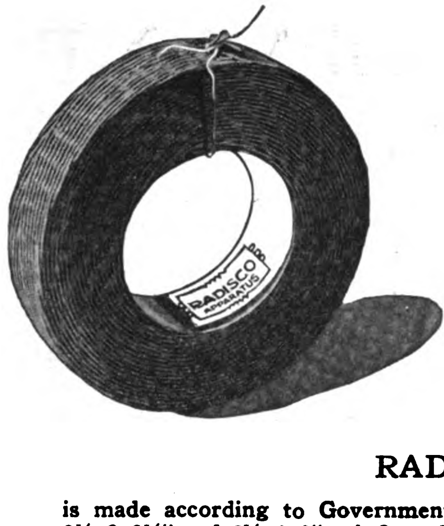

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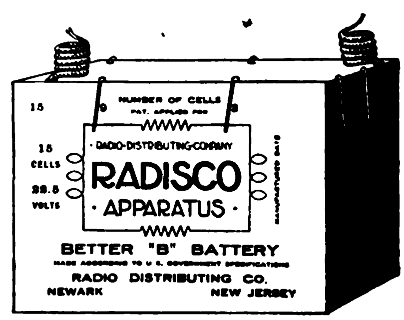

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BRONX, NEW YORK CITY.
Amateur Wireless Equipment Co.,
1390 Prospect Ave.

CHICAGO, ILL.
Chicago Radio Laboratories,
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511 W. Washington St.

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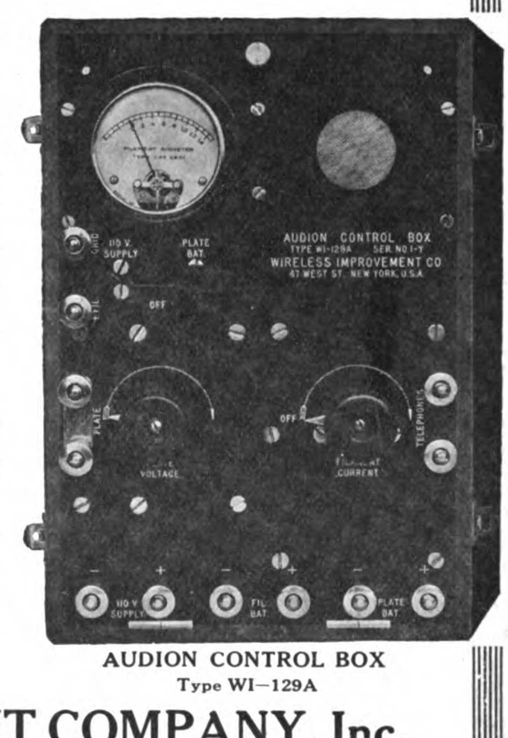
We claim, without hesitation, that this instrument is electrically and mechanically the finest amplifier made in this country either for Navy, Army, or commercial account, It is an ultra refinement of the Navy Amplifier and, for those who require the best appearance as well as the best operating results, we offer it at a price which, comparatively speaking, is extremely low.

The above is equally true of our Audion Control Box, Type WI-129A, which contains a filter system so that it can be used on a 110 volt line as well as with a battery.

The price of either instrument is $75.00, which will be refunded without question if the purchaser is not fully satisfied.



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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. 3)

Vol. 7. No. 6. MARCH, 1920

THE WIRELESS AGE

WORLD WIDE WIRELESS

America and France Linked by Wireless Telephone

ANOTHER triumph of the wireless telephone is recorded. American engineers have succeeded in talking over the wireless telephone direct from New Brunswick, N. J., to points in France.

A. E. Reoch, plant engineer of the Radio Company of America, reports that the talk to France was accomplished at the New Brunswick wireless station of the company by using the new Alexanderson alternator.

Scientists who discussed the situation predicted that before next Summer wanes it will be possible to obtain a direct wireless connection with London, Paris, Berlin or even Tokio with the same ease as to call up any point on the wired long distance service and hear the human voice perfectly.

Marconi on the Future of Wireless

GUGLIELMO MARCONI, in a signed article in the Nuvo Giornale of Florence on the predicted revolution in wireless communication, says:

"Eventually science will find a way of directing electrical energy without wires in an absolutely straight line. The result will be less expenditure of energy for short distances and hence less expense for messages. Once directive control has been established we shall undoubtedly be able by means of powerful machines to girdle the whole world with waves of electric energy without wires."

Marconi describes a radio telegraphic receiver no bigger than a gramophone by means of which, without any other communication with the atmosphere, he receives all day in his study every scrap of wireless news sent to the European press. He says that very soon with an instrument of this kind "bankers, politicians and business men in general will be able from minute to minute to keep themselves in contact with both hemispheres." He continues:

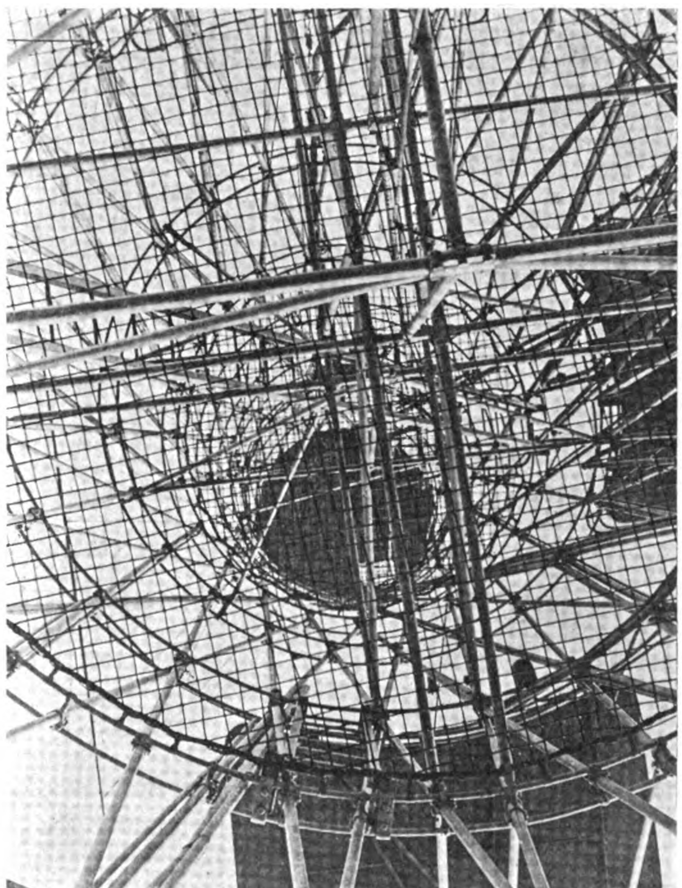
"Very soon, too, that miserable ticking machine on which all newspaper offices depend will yield place to this mighty invention, which is suitable for news sending, news receiving and simultaneous communication with any number of receiving stations.

"With that installment of radio telegraphic receivers throughout the civilized globe in every public school, university and library, the prevailing languid interest of the public in international happenings will be immensely stimulated."

An English Home Wireless Telephone

A COMPANY is offering for sale in Great Britain a "home wireless telephone" apparatus contained in a box light enough to be carried by a leather handle. It is said the outfit is capable of receiving messages from all the principal wireless stations in Europe.

It needs only to be placed on a table and the sounding telephones connected and it is ready for use. No external "aerial" is required. It costs $150.



This mystic maze becomes clear when it is explained that it is a view from the inside through the top of a wireless tower aboard the U. S. S. Army Rifle

Ban on German Wireless to American Press Lifted

AMERICAN correspondents in Berlin have had restored to them the privilege of using the direct wireless to America, as a result of vigorous protest by several newspaper men against the application to them of Paragraph 197 of the Versailles Treaty.

In answer to the protest which the American correspondents sent to the German Foreign Office and which was then placed before the naval sub-commission headed by Admiral Charlton, of the Inter-Allied Control Commission, the Foreign Office was advised that there is no objection to restoring the use of the wireless to the American press.

Congress Considers New Navy Radio Bill

CONSIDERATION of the Greene resolution sponsored by Secretary of the Navy Daniels authorizing the use of naval radio stations for commercial and press messages was begun March 1 by the House Committee on Merchant Marine and Fisheries.

The resolution states that in view of the recent executive order of the President returning all radio stations taken over by the Government to their owners and removing war-time restrictions, it is unlawful under the act of August 13, 1912, for the naval radio stations to handle commercial messages except where there is no commercial radio station operating continuously for general public service within 100 miles.

A strong effort has been made to induce Congress to authorize the Naval Communication Service to continue to handle commercial messages, not as a competitor of the private companies but as an aid to them, taking only such business as they cannot care for and at such rates as they have fixed.

Officers of the naval radio service have prepared a bill which gives the Government the right to transmit messages over its installations when communication through other channels is congested or for any reason interrupted. The measure also excludes private companies from the Canal Zone, certain of our Pacific possessions and unless authorized by the Government, from American possessions in the West Indies. All these areas will have a Government radio service and the naval coast stations will also be allowed to handle commercial messages between ships and the shore.

The plan also involves the transfer of radio control from the Commissioner of Navigation in the Department of Commerce, to a national radio commission of four members.

Savannah Gets New Navy Wireless Station

THE new wireless station in Savannah will be situated on the Ogeechee road site.

At present the station only has one 125-foot tower; the new station will have two.

The city contributes the site for the station. The new plant will be modern in every way with a California bungalow style of building.

Buffalo to Have New Government Radio Building

THE government is proposing the erection of a new radio building in Buffalo. According to a circular, sealed proposals for the building were sought.

The building, which is to be erected on army land adjacent to the lighthouse department grounds, will be two stories in height, of frame construction.

Movies Picture Operation of Wireless Telephone

THE wireless telephone is being presented as a scientific feature of the Goldwyn-Bray Pictograph. In the stress of the world war, the mechanism was perfected by which the human voice talks across the ocean, and the Bray Pictures Corporation shows how the marvel is accomplished. The device for transmitting electric waves which travel great distances is pictured so that even a child can understand how the electric waves are made to carry sound.

Wireless 'Phone Messages Between Berlin, Sweden and Moscow

TRIALS of the wireless telephone between Berlin and Karlsborg, Sweden, a distance of 435 miles, and between Berlin and Moscow, a distance of 1,055 miles, have proved successful, according to accounts of the tests in the Berlin press.

Wireless Reports Shipwreck Off Newfoundland

TWENTY-ONE men perished as a result of sinking off Newfoundland of the British steamer Bradboyne, formerly the War Panther, according to wireless advices received at the Marine and Fisheries Bureau.

A lifeboat from the steamship Oxonian, attempting to rescue the crew of the Bradboyne, was swamped, with loss of the second officer and five members of the crew. Fifteen men perished when the Bradboyne sank.

Captain G. D. Rees and second officer Bellas of the Bradboyne were picked up by the steamer Monmouth. The Oxonian wirelessed she was returning with 26 members of the Bradboyne's crew.

France Plans Colonial Wireless

THE head of the French government wireless department has worked out in detail a plan which, if it is adopted, will put France in wireless communication with all French territory the world over.

What he proposes is a continuous line of wireless stations of about 3,700 miles range which will include Tahiti, New Caledonia, Indo-China, Djibuti, Senegal, Martinique and France.

France, of course, would be the center of this world-wide system of communication, and would do its part with one station of medium power for the transmission of messages to North Africa and three stations of sufficient power to reach respectively the United States, Martinique and Brazil, and West Africa and Djibuti.

In addition to the four stations in France, the plan calls for three double stations, which means a large station and a medium one respectively, in West Africa, at Djibuti and in Indo-China; stations of high power at Martinique, Tahiti and New Caledonia, and stations of medium power in Morocco, Algeria, Tunisia, Congo, Madagascar and French India.

Peru Opens Two New Stations

THE Peruvian Department of Internal Affairs has announced that the radio stations which have been under construction for some time past at Eten and Trujillo are now in operation. This gives Peru a service without interruption from north to south, with stations at Paita, Eten, Trujillo, Lima, Callas, Pisco, Chala, Arequipa and Ilo. Radio stations were first established to provide communication between the capital and the eastern Mentana and Iquitos on the Amazon. This line, with relays at Pto. Bermudez, Masisea, Orellana and Requena, all points on the Ucayali river, has been in successful operation for the past decade and has proved of the greatest benefit, as a number of weeks are ordinarily consumed in making the overland trip from Lima to Iquitos, the head of river navigation in the Amazon basin.

Wireless Saves Man's Life at Sea

HOW a man's life was saved by wireless communication which changed the courses of two ships was told on the arrival at Baltimore of the Shipping Board steamer West Hartley, from Avonmouth and Manchester.

While the West Hartley was bound out from Baltimore on her last trip, Ignacio Minan, forty-eight years old, was taken seriously ill. There was no doctor on board, and Captain E. J. Preston, believing that a surgical operation was needed to save Minan's life, got into communication with the transport President Grant, eighty miles astern, bound for New York. The two ships turned about and met.

Minan was unconscious when the transfer was made in a small open boat. The operation was performed aboard the President Grant.

Sister Missing 13 Years Found by Wireless

LOCATED by a wireless telegraph dispatch sent out from her brother's amateur plant, Cleo Archer, 17 years old, lost for 13 years, has been restored to her mother's home in Toledo.

Two weeks ago Lester Archer sent out a wireless call to all amateur plants within the radius of 800 miles, asking them to help locate his sister. Eventually he was informed that she could be found on a farm near Rockford, Ohio. Young Archer went to the farm of Ellis Williams and claimed his sister, who had been removed from a children's home near Lima, Ohio, thirteen years ago and had been sought by her mother in many cities.

U. S. Weather Reports by Wireless

THE sending of weather forecasts by wireless telephone to Wisconsin farmers is a plan now being worked out by the United States weather bureau station at the University of Wisconsin, to carry information concerning sudden changes in weather more rapidly.

Such a plan will eliminate telegraph service and slow telephone communication to individual farmers. Farmers within a radius of 100 miles of Madison, who install an inexpensive wireless telephone receiving outfit, such as is now built commercially, will be able to receive the new service at a certain time every morning. No code need be learned for the wireless telephone message is received like a wire telephone message.

The present plan is for the weather bureau to send the weather report to the physics department at the university, to be sent out from the university wireless telephone station to all persons who wish to receive the service.

Shipping Losses Prevented by Wireless at New York Port

WHEN the most severe storm of late years struck the North Atlantic Coast recently, early warnings are credited with having prevented serious losses to shipping. The gale sweeping in from the sea reached a velocity of seventy-two miles at Block Island. Wireless requests for position were received in New York from thirty-nine ships which were uncertain of their bearing at sea.

Storm damage was general all along the coast from Boston to the Chesapeake. From practically every resort along the Jersey Coast came similar reports of damage to boardwalks, bath houses and beachfront buildings.

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"The Wireless Disturbance"—Not mysterious enough, however, to be considered a possible message from Mars.—By Fontaine Fox

German Wireless News Service

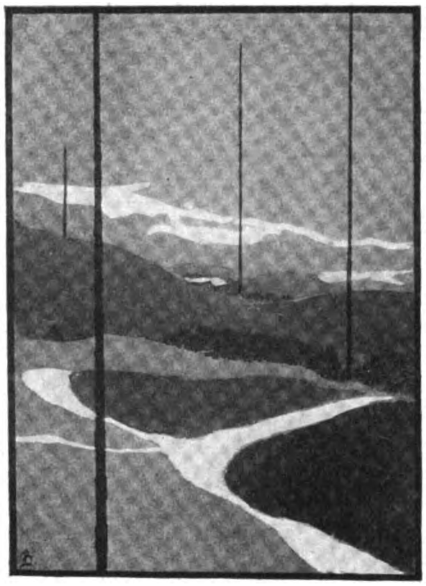
THE first German paper to install a wireless plant for collection of news is the Danzig Gazette. The first dispatches have arrived without mutilation.

This is the first concrete result of the Giesberts plan to establish an entire chain of wireless stations connecting the larger papers of Germany.

Commercial Radio Across Atlantic and Pacific Opens

First Direct Communication Between United States and Great Britain Inaugurated with Congratulatory Messages—Service to be Extended

COMMERCIAL wireless telegraphic communication direct from the United States across the Atlantic and Pacific oceans was realized for the first time at 12:01 o'clock on the morning of March 1st. The huge trans-oceanic wireless stations were turned over by the Government to the Radio Corporation of America at the stroke of midnight, February 29th.



The first wireless message since war control was lifted was sent through the New Brunswick (N. J.) station. The message marked an epoch in wireless history. Never before has there been established direct communication between the United States and England. Before the war the United States communicated with England by way of Canada. During the war the only wireless communication with England was under Government control.

Edward J. Nally, president of the Radio Corporation of America, issued the following statement:

"While the radio stations were controlled by the Navy Department, it was not possible for us to develop the full commercial possibilities of the wireless. The Radio Corporation of America, which took over the Marconi Company and all radio inventions and improvements of the General Electric Company, is now free to go ahead with the large plans for the development of a wireless service that will bring quick communication with all parts of the world.

"It will take some time to make the necessary readjustments. On the first day of the return of the wireless we devoted ourselves to communication between New York and Great Britain. In the near future we will develop the service with Norway.

"From San Francisco we are providing service with Honolulu and Japan. Later on, we will develop wireless communication with China, South America and the West Indies. Work is already being done in connection with a super-high power plant in South America."

Within a few weeks, the Radio Corporation expects to reopen the Tuckerton (N. J.) plant, which has been put out of commission by storms. This plant, which was partly under French ownership, was purchased some time ago and will be used for commercial communication with the high-power station at Lyons, France. Commercial communication with Norway will be by way of two stations in the neighborhood of Cape Cod. The duplex circuit will be employed. The Marion (Mass.) station will send to Stavanger, Norway, while Chatham, Mass., will receive messages sent from Naerboe, Norway. All four of these stations will have the same modern high-power equipment as the New York-Wales system.

The first three messages from the New Brunswick Station follow, in the order in which they were sent:

Godfrey C. Isaacs, Managing Director, Marconi's Wireless Telegraph Company, Ltd., London:

May this message, which opens commercial wireless telegraph service between America and England, mark an epoch in history from which the achievements of the future shall date. Communication is the leverage which shall lift the world to better understanding and thus lead to closer ties of friendship between all nations. It is the mission of our respective companies to so strengthen and improve the wireless service that distance shall be made negligible and communications practically instantaneous.

EDWARD J. NALLY.
President Radio Corporation of America.

President of the Chamber of Commerce, London:

Now that the war controls have ceased and the Radio Corporation of America has been honorably discharged from the service, we foresee closer and quicker business association, and we are confident that this new means of prompt communication and understanding will enable the business men of New York to work more closely with the business men of London, not merely to the advantage of themselves, but for the greater progress and benefit of civilization.

ALFRED E. MARLING, President.
New York Chamber of Commerce.

Imperial Commercial Association, 4 Callum Street, London, E. C. 3.

Upon the occasion of the opening of commercial wireless service between the United States and Great Britain, the Merchants Association of New York desires to extend to the Imperial Commercial Association of London its cordial greetings and its good wishes for the continued growth and success of your esteemed organization, and further to express the hope that the hearty co-operation with our association which has existed in the past may continue in the future.

WILLIAM FELLOWES MORGAN.
President, The Merchants Association of New York.

Mr. Nally received this reply to the first message:

Edward J. Nally, President, Radio Corporation of America, Woolworth Building, New York City:

Your first message by the new direct wireless service between America and England expresses exactly the desires animating the activities of every one here. We are certain that this day will pass into history as one upon which was forged a most valuable link of communication between the English-speaking peoples of two great continents. The British nation whole-heartedly desires the closest possible friendship with the United States of America, and my company, imbued with the national sentiment, will spare no pains in contributing to the fulfillment of this desire by assisting in the provision of practically instantaneous means of communication.

GODFREY C. ISAACS, Manager Director.
Marconi's Wireless Telegraph Co., Ltd.

Smaller stations reverting to private ownership include those of the United Fruit Company at New Orleans and Boston, the Mutual Telephone Company in the Hawaiian Islands, the International Radio Telegraph Company at Brooklyn, and Newport, and the Marquette and Bessemer Dock & Navigation Company, at Conneaut, O.

Interplanetary Radio Signals?

Varied Views On the Question Whether Inhabitants of Mars Have Been Trying to Signal Us By Radio

ARE there intelligent beings on the planet Mars, and have they been persistently signaling us by radio across several hundred million miles of interplanetary space? This is the question which has been agitating the scientific world for the past few months.

Guglielmo Marconi, who has protested against the interpretations put upon his original statement that mysterious radio signals may arise in any point of inter-planetary space

Interruption of the Marconi wireless instruments by mysterious undecipherable signals, which were noted before the war and have been publicly referred to since, were discussed by Marconi in an interview published by a London newspaper on January 27th.

"We occasionally get very queer sounds and indications, which might come from somewhere outside the earth," said Signor Marconi. "We have had them both in England and America. The Morse signal letters occur with much greater frequency than others, but we have never yet picked up anything that could be translated into a definite message.

"The fact that the signals have occurred simultaneously at New York and London with identical intensity seems to indicate that they must have originated at a very great distance. We have not yet the slightest proof of their origin. They might conceivably be due to some natural disturbance at a great distance—for instance, an eruption of the sun—causing electrical disturbances."

Asked whether possibly attempts were being made by another planet to communicate, Marconi said:—"I would not rule out the possibility of this, but there is no proof. We must investigate the matter much more thoroughly before we venture upon a definite explanation."

He added that the mysterious sounds are not confined to any particular diurnal period. They are equally frequent by day and night.

Marconi said that Morse signal letters occur with much greater frequency than others, but nothing has been picked up that could be translated into a definite message.

"They are sounds," Marconi added. "They may be signals; we do not know. They are not what operators call atmospherics, and we have nothing to guide us at present as to how they are caused. We do not get them unless we set up a special wave length, very much greater than the wave length ordinarily used. Sometimes there may be a long wait before we hear anything, or we may hear these sounds in twenty minutes or half an hour. They occur when we are using a wave length of approximately 100 kilometers (100,000 meters), which is three or four times the length used for commercial purposes."

"We have not yet the slightest proof of their origin."

Later, the distinguished inventor of wireless said that investigations are in progress regarding the origin of the mysterious signals, insisting that "nobody can yet say definitely whether they originate on the earth or in other worlds."

Probably no single statement relating to the radio art has caused more widespread comment. Opinions and discussions on the subject have come from all quarters of the globe. In the mass of material which has reached the Editor of WIRELESS AGE, many phases of the question are reviewed. It is impossible to deal with the multiplicity of angles and viewpoints represented, but a few selections have been made to the end of illustrating the diversity of thought on the subject.

Dr. E. F. W. Alexanderson, chief engineer of the Radio Corporation of America, states that no unusual interference or mysterious wireless signals have been noticed by the officials of his company. He believes that the disturbance, if any existed, was purely terrestrial since the persons who have noted it assert combinations of the Morse code have been received.

"It is impossible for the people of Mars or any other planet to know the Morse code," in his opinion. "The supposed signals which are considered unusual probably are produced by some spark station and are being heard at a greater distance than ordinarily because of the clearness of the atmosphere and the absence of static. The fact that the mysterious signals are partly decipherable bears out my contention."

Dr. Charles P. Steinmetz, inventor, and for many years the chief consulting engineer of the General Electric Company, believes it possible to communicate with Mars, but notes: "The probability that these strange wireless messages noted by Marconi really do come from Mars must, to the practical mind of the day, be regarded as a wild dream. It nevertheless opens up interesting scientific speculations, and we know that many of the speculations of half a century ago have now become tangible realities. If the United States, for instance, should go into the effort to send messages to Mars with the same degree of intensity and thoroughness with which we went into the war it is not at all improbable that the plan would succeed. To do so would mean the consolidation of all the electric power in the country into one great plant or sending station. Lofty towers would have to be erected, 1,000 feet high or more, and the cost of the attempt might be a billion dollars."

Dr. Steinmetz notes: "When Mars is nearest the earth the distance is about 50,000,000 miles, but the distance varies, and at certain periods Mars is as far as 250,000,000 miles away. These changes from extreme to extreme take place within a few years. It has been stated, I notice, that these strange messages apparently come in about 100 kilometer wave lengths, a little less than seventy miles. That is much longer than any wave lengths required for our greatest earth messages, and those lengths could be accurately measured. Now 100 kilometer wave lengths would be quite sufficient to transmit wireless signals through 50,000,000 miles of space or more. It is just about what we might expect in wireless communication with Mars.

"These messages must be received in the Morse code, for telegraph signals must come either short or long, that is, by dots or dashes. What makes them strange is that they are so mixed up that they cannot be understood. The proper thing to do when these strange messages come is to keep a careful record of them. If a number are received with the same degree of intensity in different parts of the world, say in London, New York and Australia, all being of these unusually great wave lengths, we could then reasonably suppose that they must have come from some point outside of the earth as the

Dr. James Harris Rogers, sponsor of an underground wireless system hopes to receive signals from another planet

distances at the various places where they might be received would have no effect upon the result. In addition to noting the intensity of such messages at various places, by keeping a record of them it could be ascertained, when enough had been collected, whether any parts of these undecipherable Morse code messages were similar, that is, if there was a reasonable conformity in sequences of the strange code. If that could be proved, it would evidently indicate that they were sent from an intelligent source, but if no harmony could be found, it would be apparent they must be due to unexplained atmospheric conditions.

"Another evidence for determining whether these messages came from an intelligent source would be to note the force with which they come, as the distance between the earth and Mars changes within a few years. At 50,000,000 miles the signals would doubtless be stronger than when several million miles further away. Provided such records could be kept, we could surely arrive at a very definite conclusion as to their origin. It is true we might not be able to decipher the code, but it would indicate very satisfactorily that messages could be sent from one planet to another and that intelligent beings were inhabiting the planet from which they came."

The Mars theory may be all imagination and a wild dream, according to Dr. Steinmetz, but he values it as an interesting subject and one which is not without its possibilities of success.

E. Leon Chaffee, assistant professor of physics at Harvard University, thinks the so-called messages are nothing more or less than static. He believes: "There are two possible causes for the troublesome messages that have been bothering wireless operators by cutting in on their real messages. One of the most probable causes is extraordinary atmospheric disturbance, perhaps sun spots. The other, which is improbable, is that the interruptions are coming from some high-powered wireless station where experiments are being carried on in Japan or some distant country. That is only a bare possibility."

Interest manifestly outweighs skepticism among radio experts at the Navy Department. Proponents of the theory noted that they would enjoy the advantage of having no competent disputants, at least until science in some way accounted for the mysterious interruptions that had been experienced ever since wireless telegraphy was perfected.

"These interruptions or 'influences' are entirely distinct in their registering effect from influences readily traceable to atmospheric or static conditions," according to Captain W. S. Bryant of the naval communications service. "They record with a feeble or 'mushy' intensity as compared with the clashing effect of static disturbances. I confess that they have been a much greater source of annoyance, however, than of interest. Whether or not they emanate from Mars, as suggested by Marconi, seems to be an open question so far. It is at least one that affords pleasurable exercise for the imagination."

If the inhabitants of another planet do signal us it won't be in the Morse code, according to Prof. Harold Jacoby, head of the department of astronomy of Columbia University.

"Marconi speaks of the Morse signal letters occurring more often than any others," observes Prof. Jacoby, "and that fact alone seems to me to show that these messages are not extra-terrestrial, but come from some place on the earth.

"It is highly improbable that the people of another planet, if there are any such, would be acquainted with the Morse code, which is a complicated system of dashes and dots based on our alphabet. It was invented by Morse and cannot be regarded as universal among civilized peoples.

"Marconi cites the fact that the sounds have occurred with equal intensity in New York as in London as proof that they come from a very great distance. But it seems to me that this is only proof that they come from equal distances. The messages might be sent from some point equally distant from New York and London and yet not from a point beyond the earth."

If wireless messages are being received from some other planet the signals are not from Mars, but most probably from Venus, according to Dr. C. G. Abbot, Director of the Smithsonian Astrophysical Observatory and Assistant Secretary of the Smithsonian Institution. Dr. Abbot makes no claim that the mysterious wireless signals do come from another planet but says, if they do, Mars is eliminated as a possibility because known conditions on that planet probably would not permit the existence of any form of living creature.

Dr. Abbot notes the fact that on account of the greater distance, nearly two and one-half times less radiation from the sun reaches Mars than reaches the earth. It is probably nearly 100 per cent. colder on the average on that distant planet than on the earth. Knowing what low temperatures occur on this earth in the course of the winter season, it will readily be realized what 100 degrees colder would mean.

Intermittent waves, which seemed to be repeated with persistency, were recorded at the end of January at several wireless stations in Baltimore. The signals did not resemble a code but repeated a formula, over a wide range of wave lengths. It is said that they were heard with equal ease by commercial and amateur stations at a time when London announced that identical "messages" were being recorded in a British station.

Opinions expressed from Johns Hopkins University show scientists are divided on two theories—first, that the emanations are due to celestial disturbances, and, second, that the mystery may be explained by reactions from internal disturbances near the earth's core. Dr. Joseph S. Ames, professor of physics and director of the physical laboratory, thinks the information thus far made public by Marconi on the phenomena he observed is insufficient to provide a basis for scientific discussion.

That the undecipherable signals originate in some other world appears a possibility to J. Loring Arnold, professor of physics at New York University. He states:

"It seems to me not improbable that these unusual sounds may be caused either by some influence of the sun or by some planet's efforts to communicate with us. However, the latter explanation is mere supposition at best, and the great inventor's explanation seems the most logical."

Isabelle M. Lewis of the United States Naval Observatory believes that if Mars is indeed trying to signal to the inhabitants of our planet by wireless, a continual record of the nature and intensity of the disturbance will soon reveal the fact. The next six months should settle the question.

Dr. James Harris Rogers, sponsor of an underground wireless system, believes that within a year wireless communication will be established with Mars. He announces his intention to tune his receiving apparatus to 100,000 meters and hopes to get signals from another planet. He thinks that if Martians are sending their signals they selected this long wave length so as not to be confused by any signals used on this planet.

A New York radio engineer, L. J. Lesh, believes it possible to build a gigantic sending station and finally to devise a code for communication with the radio experts on Mars.

Although he believes that one of the methods of constructing a station would be to erect huge antennae suspended by balloons like the British dirigible R-34, he asserts that a still better way would be to use huge and brilliant shafts of light as antennae for the system. Still another idea put forward by him is that two immense sky-high towers be erected with wires or antennae suspended from them.

"Possible but not probable," is the comment on the Mars signaling made by Dr. Samuel A. Sheldon, head of the department of electrical engineering at Polytechnic Institute of Brooklyn.

"It is an interesting conjecture, but I should call it hardly scientific," he says. "Of course we would have to suppose that the Martians are an older and much wiser race than ours, and that they have learned a great deal more about sending wireless messages than anything we know. But even with that supposition a man must have a very vivid imagination to picture a sending station powerful enough to reach across the vast distances that lie between the two planets at their nearest approach.

"What may have caused the mysterious disturbances on Mr. Marconi's instruments has probably had a natural origin. We know there are certain black spots on the surface of the sun which recur periodically, and which are accompanied by electrical storms of unimaginable fury. We also know that these spots have been unusually large and variable during the last few months. What is more likely than that they have sent out radio waves which have jumped the gap between the sun and the earth and disturbed the instruments here and in London with an equal intensity?"

Commander R. L. McConnell of the U. S. Navy, radio supply officer at the Brooklyn Navy Yard, is equally skeptical of the Martian origin of any radio waves that have reached the earth.

He looks upon inter-planetary signaling, however, as an imaginable next step. According to his view, if the Martians have learned of the existence of radio waves, there are only two conceivable methods they would employ for signaling with them—the modulated (that is, the telephone) method and the interrupted or dot-and-dash method. Of these the dot-and-dash method would be the easiest and most probable to be used, as the telegraph was used before the telephone. Of course, their code would not be the same as ours, but it is not at all

Charles P. Steinmetz, of the General Electric Co., notes that the Mars theory opens up interesting scientific speculation

unlikely that some of their individual signals would correspond to letters of our Morse alphabet.

"The power plant for such a radio station would have to be an enormous building, covering hundreds of acres. The antennae for such a station would reach half way across North America, and the cables used for it would be as thick as the largest tower of the group of buildings here in the Navy yard.

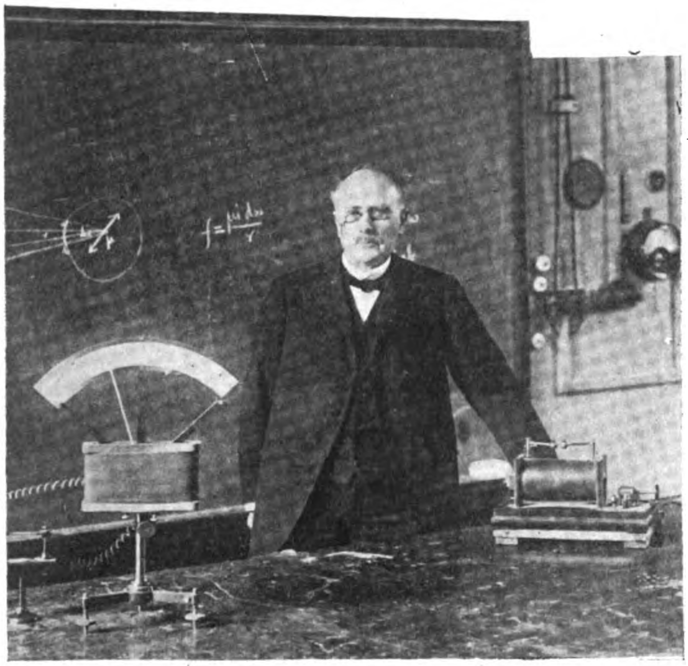
"That's what the Martians would have to construct on their planet to get their signals across to us. Perhaps they have done so. But it looks very improbable to me that they have."

Elmer A. Sperry, president of the Sperry Gyroscope Company, offers to send signals directly, by means of powerful searchlights, to the planet Mars; and then if there are any inhabitants there they can answer. Two hundred 60-inch searchlights such as were used in the war he thinks would do the trick, although he would wait until 1924, when the planets are nearest one another, before trying it.

Dr. Louis Derr, of Massachusetts Institute of Technology, with much vigor denies that the messages occur from disturbances on the sun. "The sun is an enormous body that sends out magnetic storms like waves; they don't come in dots and dashes," he says. "You don't expect an elephant to dance a jig."

The wireless messages received at the Marconi station, in the Massachusetts professor's opinion, come from some distant worldly station.

Opinion from those of lesser attainments bulks large in quantity and quality. Many amateurs take the subject seriously; others deal with it in lighter vein. Even the lay public has had a large and generous say, for as one non-technical writer expresses it, "a great public stands respectfully attentive in the presence of specialized wisdom." After balancing skepticisms and desires, this man is forced to "the admission of a magnificent chance, and it is the magnificent chances that give zest to human life."



Prof. Edouard Branly, leader of French scientific opinion, who thinks the discussion of signals from Mars is based upon a highly improbable succession of coincidences

Another notes: "Certain it is that we are not always to be hermits in the great spaces of the skies. Certain it is that some time we shall find a language common to the universe and discover a means of communication. Perhaps the great Marconi is already on the way to the solving of the problem and the abolishment of the distances and the silences that now separate us from the other worlds and their peoples. The first message will be real news."

"The appeal of such a subject," observes another, "is hardly to be overestimated." In agreement with this view is one which characterizes the present "an ideal time in which to bring out this notion because the world is not prepared to believe almost anything except the obvious truth and we can already see an increase of interest in wireless which may stimulate the amateurs—if, indeed, they need stimulating in their fascinating work."

The disturbances may not be the result of efforts by other worlds to communicate with us, says one writer who evidently believes they are caused by the contestants in another great war on some distance planet.

Scores of opinions have been given on the value of the things we can learn from the Martians, who presumably have reached a more advanced civilization, yet through all of these runs the strain of doubt of communication success; a typical expression on this point is this one: "But when it is remembered that our wireless devices are the product not only of mind but of metals, and of long years of experimentation in a dozen branches of science, it's discouraging."

Then there are many who have written in facetious mood. Representative of the comment in lighter vein is the apprehension that the Martians won't care to communicate with us, that "we are not certain that whatever inhabitants the stars may hold would not be too uppish to lean over the cosmic fence and ask us how our gardens are getting on."

Some of the most amazing flights of fancy are to be found in American newspaper editorial comment. In one editorial column it is suggested that the signals "may come from the earth's center for all we know. Planetary transmission is doubted except in the automobile world." In another it is advanced that the undecipherable signals "may be nothing more than radio messages from Bolsheviki Russia explaining the beauties of the Lenine-Trotzky formula for perfect human happiness." In mock seriousness it is also commented: "They probably proceed from the inner consciousness of small nationalities, still clamoring for the right of self-determination."

The assertions of astronomers, eliminating Mars as the source of signals but conceding Venus as a possibility, have brought forth many fanciful constructions of the subject. One editorial complains that most of the earth's population are a bit "fed up" on the warlike planet at the present time "and would welcome more cordially overtures from almost any other planet." Another asks: "What could be a greater or more agreeable change than a transition from the harsh commands of Mars to the gentle influences of Venus?" It is also suggested that, "there appears to be only one way to settle the raging controversy, and that is by referring the decision to the ouija board." One writer pleads that there should be no doubt in the minds of thoughtful persons "that somebody, or some planet, somewhere, is trying to get in touch with the United States Senate," desiring "some pointers on the most marvelously incomprehensible doings that have ever been known." It is also urged that "scientists of this sphere perfect their receiving apparatus and discover a rosetta stone whereby the language of that other globe may be translated." This, presumably, will result in them "telling us what they think about prohibition."

Foreign comment also has some interesting features. Sir Frank W. Dyson, astronomer royal of Great Britain holds the opinion that it is quite possible to get waves from other planets. Sir Richard Gregory, professor of astronomy at Queens College, London, and editor of the scientific weekly *Nature,* thinks the whole proposition "unbelievable as well as a dream." Professor Howe is conservative but not scornful in his observation: "All we know is that electro-magnetic waves are received from an unknown source. The most important part of Signor Marconi's statement is his attribution of the noises to alphabetical letters. It is not inherently impossible that the people inhabiting Mars have a life, language and Morse code similar to ours." Mrs. Ellen Roberts Blackpool, however, is not content to stand by the stereotyped versions and in a London letter to Marconi advances the novel theory that "the spirits of departed wireless operators gone to other planets are trying to get into communication with you."

Italian opinion shows a wide division, Father Alfani, director of the Ximenian Observatory in Florence, terming the spread of rumors on planetary messages "absolutely scandalous," while Professor Domenico Argentieri, in this same city, thought: "Because of the regularity with which the signals have been observed, scientists believe they are due, not to mechanical, but to intelligent force." From Rome, word comes that the Vatican will make an investigation, the theory of planet signals being of such interest that Pope Benedict has directed Cardinal Maffi to make a report.

Absence of skepticism, too, is notable in the statement of Dr. Hubert Bianchi, M.P., who for many years was director of the Reggio Calabria wireless station. He says "that fifteen years of study and experimenting on the subject, convinced him that the mysterious signals are quite unexplained on the hypothesis either of earth currents or of disturbances arising from atmospheric discharges or even of stray signals from neighboring stations.

"When I began my investigations in 1905," he writes, "I noticed almost nightly, between midnight and 12.45, that our telephone and the Morse key inserted on a coherer wire, were registering rapid rhythmical signals, which could not be deciphered. These were followed by brief intervals of silence. The whole process resembled the regular transmission, only much quicker than normal. My corresponding station at the Villa San Giovanni and Messina never experienced phenomena of this sort."

Out of Germany comes word from Professor Einstein that he personally is "inclined to believe that these wireless interruptions are due either to atmospheric disturbances or secret experiments being carried on by some other system of wireless telegraphy." Professor Arrhenius, of the chair of physics in the Technical Institute at Stockholm, Sweden, thinks the planetary theory unworthy of serious consideration and believes it is more probable that the wireless apparatus may have been influenced by the sun.

The French Academy of Sciences evidently considers communication between the earth and the planets as among the possibilities. It has undertaken to act as judge for a prize of 100,000 francs ($20,000), to be given by the Academy for the best means of making a sign to a heavenly body and the receipt of a reply.

French savants are inclined to attribute the unexplained wireless impulses to earthly causes. Most of the French press treated the whole matter as a joke, under such headings as "Hello, Central give me the moon," but some of the more serious journals devote studied attention to the questions raised by Marconi.

Professor Edouard Branly, inventor of the coherer, thinks that the fact that signals come in letters of Morse code tends to discredit the theory that they are of other than earthly origin. He says:

"If we attribute these phenomenas to solar eruptions, how can we explain that they come in Morse? If we attribute them to inter-planetary sources (admitting that planets are inhabited), we must then admit that their people have reached a degree of development comparable to ours and that their science has led them to construct instruments similar to ours. This would be a succession of coincidences that I would call improbable.

"It might be that solar eruptions were the cause of wireless phenomena, since light has certain effects on electro-magnetic currents. It might be possible that these disturbances caused raps in our receiving instruments, but not letters of the Morse code."

General Ferrié, head of the military wireless, notes:

"We have heard nothing abnormal recently at the Eiffel Tower. We have disturbances which bother our communication, but they are continual. We attribute them to atmospheric variations and sometimes to the magnetic influence of the sun. We call them parasites of radio, but we do not think they are supernatural."

Marconi's original statement, in so seizing upon the imagination of the world, has been so widely discussed and distorted that a supplementary statement has been issued by the famous inventor. In this he says:

"I desire to protest against the interpretations that appear to have been put upon statements which I have made with regard to the possible sources of what are being termed mysterious messages from the unknown.

"Wireless messages are transmitted through the ether by the agency of electro-magnetic waves of definite lengths which can be adjusted, and in order to receive such messages the receivers must be tuned to the particular wave length that is used for transmission.

"At times signals are received which are apparently due to electro-magnetic waves of great length (up to hundreds of miles) and these signals are of the same character as those commonly called X's, or strays. Occasionally such signals can be imagined to correspond to the Morse signals for certain letters, and these signals occur at all seasons and irregularly.

"The sources of such signals are not known. They may be in the atmosphere or outside it and due to electrical disturbances. If outside the atmosphere they may arise in any point of inter-planetary space where it is well known electrical disturbances occur.

"Obviously, since the planet Mars is situated somewhere near inter-planetary space, the source of such signals might be on it or any other planet. There is nothing, however, to show that this is the case nor must any purely fanciful speculations of mine be interpreted to mean that I asserted having received any intelligible or unintelligible messages from Mars or from any other point in space outside the earth."

Hearing Things

Radio Operating as a Career

Just What to Do in Order to Become a Member of a Dignified, Fascinating and Highly Paid Occupation

By Pierre H. Boucheron

Formerly Naval Radio Instructor

The operator has many chances to study navigation

THE aftermath of war brings a new era of opportunities to the young man contemplating the study of radio telegraphy, either as a profession or as a stepping stone to radio engineering. There has been a great increase in the number of American vessels, and today it is indeed a small and unimportant ship which is not equipped with radio apparatus. At present there is a great demand for radio operators, a demand which greatly exceeds the supply, and which will probably continue for some time to come. It is no uncommon occurrence for a ship to be held up several days at a port, unable to sail on account of the scarcity of competent operators.

This state of affairs is hardly surprising when one considers that the number of American vessels is rapidly approaching the 3,000 mark, as compared with the few hundreds of pre-war days. Today, the Seven Seas are literally dotted with ships of the American merchant marine. Each ship means another opportunity. And this boom is not a temporary one, for it is inconceivable that the United States will relinquish its re-established position in ocean transportation.

This article will therefore concern itself with the advantages, opportunities and profit which may be had with remarkably little effort on the part of the average individual who aspires to become a radio operator, mentioning the most rapid and effective way in which he may prepare himself.

Primary Considerations

First, just what are the desirable qualifications? And are there any assets which materially assist in the business of preparation?

The most desirable age for beginners is within the years from 18 to 25, because during this period the mind readily absorbs new material, perception is more rapid and the senses are keener than at a later age. Particularly is this true in the matter of learning to read the Continental Morse telegraph code. It must not be inferred that an older man cannot learn the profession; it may take him longer to become proficient, but he has one advantage over the young one, for once he learns a subject his developed brain retains the knowledge more firmly than it remains in the more pliable mind of the younger man.

A common school education is sufficient. A high school or college graduate, however, may make more rapid progress, and he certainly will have decided advantages as he advances to more responsible positions.

Experience as a land line telegraph operator or familiarity with the Morse or Continental is an initial asset; ability to read signals on the sounder makes it possible to cut down two months of preliminary training in code practice.

The advanced radio amateur has a very material advantage over any other class of embryo Marconi, and with a little additional prepartion and study may easily secure a government commercial license.

Attending a School

There are several ways in which you may become a professional radio operator; your selection should naturally be the one most readily available to you under existing circumstances. For instance, if you are an absolute beginner, the most satisfactory start is to attend a reliable radio institute or school,* securing either day or evening instruction. With resident instruction you will learn the fundamentals of radio theory together with practical operation of all manner of apparatus, and will become proficient in sending and receiving messages. It is most important that you attain skill in key manipulation as quickly and as efficiently as possible, as it is really the stock-in-trade of the professional operator.

Mastery of the code is the most difficult task of the beginner. It is essential that you devote as much time as you possibly can to the practice of sending and receiving. Your progress in learning and the length of time it will take to complete your course depends materially on your sending and receiving speed. To complete a radio course at a resident school requires, roughly estimated, from two to four months and depends entirely on the following conditions:

1. Your previous knowledge of either radio or wire telegraphy.
2. The degree of enthusiasm, the adaptability and the consistency you display in your studies and *code practice.*
3. The extent of your education.
4. The amount of time you are able to devote to study. If it is necessary for you to earn your living while undergoing instruction, attending night classes is the most logical thing to do, although this, of course, may take a longer period of time than day instruction.
5. Your resources while learning, though this is really secondary, as tuition fees are very reasonable compared to other forms of instruction.

Home Study

Although attending a resident school is the most effective way for the novice to begin, it is nevertheless possible to become a proficient operator by home study; in fact a great many professionals have never attended radio schools nor received systematic technical instruction on the subject. The home student must, however, be very careful in code practice as it is very easy to acquire undesirable mannerisms and poor style of operating. Professional operators should be questioned on any points not quite clear, and from them should be learned the proper manner of holding the key, making and spacing telegraphic characters, how to copy signals accurately, and other points which must be specifically brought to the attention of the beginner in person.

It is very essential that the home student erect a com-

*Marconi Institute, New York City and San Francisco; various Y. M. C. A.'s; and the Eastern Radio Institute, Boston.

plete radio receiving station, and if his means permit him, a sending outfit as well. The experience acquired in the process of installing will prove valuable in the future government examination, and a home station permits its owner to personally "listen-in" on *actual* radio operating and secure the necessary practice in receiving by intercepting and learning to copy press dispatches, weather reports, commercial messages, etc., in the regular operating fashion. The student, too, thus becomes familiar with the various forms of "static" or atmospheric disturbances and he learns to read signals during its presence, which is quite a feat in itself. The importance of learning to read through "static" is recognized by all schools, some of which have specially constructed automatic sending machines so arranged as to mingle artificial "static" among the transmitted signals, thereby teaching the student to copy through this form of interference. By having his own receiving set, the home student also becomes familiar with the art of "weeding-out" unwanted signals as well as reading and copying through a certain amount of interference.

LEARNING TO RECEIVE

Sometimes it happens that after the home student has installed a receiving outfit, provided himself with a good text book on practical radio telegraphy,* and has had several weeks of practice, he finds himself unable to make out three consecutive letters while listening-in with his receiver. If this is the case he should not become discouraged, as this is due to his ear not having reached a point where it is readily able to quickly recognize and retain the meaning of each character while it is being transmitted. There are two general ways of acquiring the necessary receiving speed up to the point where the home student may at least read one or more words out of every five intercepted on his receiving set. One method is by securing the aid of a friend and devoting a certain amount of time to the practice of sending and receiving, each taking turns at sending and receiving. This method, to be of value, must be practiced in a systematic manner and in accordance with a carefully planned schedule. Little benefit is gained by practicing four hours one evening, and not at all during the remainder of the week. It is better to spend one hour each day in conscientious practice and keep it up consistently. Because resident schools are very insistent in the matter of regular code practice their students make good progress; it is required that from three to four hours be devoted to sending and receiving practice each day in the day classes, and from one to two hours in night sessions.

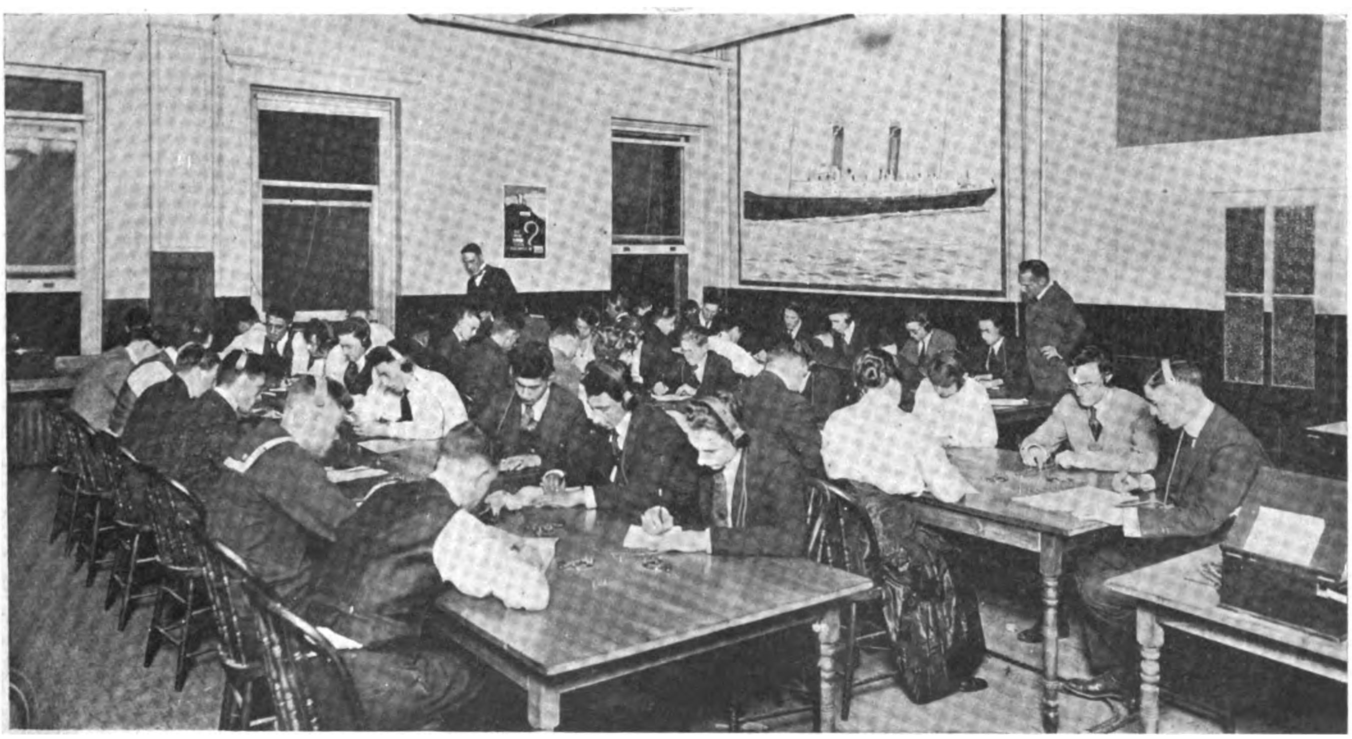
Another method of learning, which may be resorted to in the absence of a fellow-student, is by automatic sending machine.* These are usually operated by a clock spring or a small electric motor which causes a disc, cylinder or tape record to move in such a manner as to accurately reproduce the transmission of dots and dashes, either in connection with a high frequency buzzer and telephone head receivers, or with a telegraph sounder. The beginner may adjust the automatic transmitter so that it will send as slow as two or three words a minute and as the student gradually learns to quickly recognize each individual letter, the speed may be slowly increased up to twenty or twenty-five words per minute, which is the acknowledged practical and commercial speed of radio signaling today.

A word concerning sending and receiving. This concerns the school as well as the home student.

It is often asserted that sending is comparatively easy to learn while receiving is difficult. This is very misleading, for as a matter of fact, it is really quite a stunt to learn to send properly, while receiving is simply a matter of sufficient practice. At the present stage of the game it is really a delight as well as a rarity to hear a good sender, either radio or telegraph. This is largely due to improper sending instruction at the very start, resulting in the operator acquiring slip-shod and careless habits of making certain letters, such as sending *i* for *a*; *g* for *o*; *e* for *t*; etc., and unless the receiving operator at the other end has had considerable experience in reading all manner of sending he will be unable to properly copy the message. In consequence, time is lost by repetition, haranguing and the exchange of derogatory remarks, all of which is inefficient. The beginner should therefore be very particular in the manner in which he makes his characters. He should adopt a clear, decisive dot and dash form with the proper letter and word

*"Practical Wireless Telegraphy," Wireless Press, Inc., New York.

*The Omnigraph.



The most satisfactory start is made in attending a reliable radio institute or school, securing either day or evening instruction. The illustration shows a code class at the Marconi Institute

spacing and time interval. This factor is known and referred to by professional operators as *telegraphic judgment.*

There is also a right and wrong way to hold the key, and the wrong way is not conducive to the making of perfect dots and dashes. Use the first three fingers of your right hand, grasping the forward part of the key knob with the end of your thumb while the other two fingers reach out to the backward part of the knob, thereby insuring firm and yet pliable grip of the key. Also, the up and down motion should be controlled from the wrist and not from the finger ends, as is mostly done. The principle is the same as that employed in the Palmer handwriting method—it is a wrist motion and is meant to relieve the fingers from the strain of too-concentrated muscle action, thereby preventing "writers' cramp" or telegrapher's paralysis. Remember, it is just as easy to form right habits of sending at the beginning as it is to acquire wrong ones. If the right method is acquired at the start it will be retained to the end and clear-cut and easily readable sending will always be possible. On the other hand if the start is made with a careless and slipshod "fist" it will always remain a handicap.

Learning to read and copy radio signals fast and accurately is, after all, not as difficult as it may seem. The most trying and discouraging part for the beginner is from the time he first starts to the point where he can begin to copy a few consecutive words without error; when this point is reached the student takes on new life, so to speak, and he immediately begins to gain confidence in himself, which fact comes in good stead when later he attempts to copy actual signals straight out of the air.

The operator has the chance to visit many parts of the world which are seldom accessible to any but the very wealthy

In training naval radio operators during the war, it was found that the old method of sending plain English taken from a book or newspaper was improper and really retarded the student's receiving speed by giving him a false notion of his progress. This was due mainly to the unavoidable habit of guessing at words or writing down what he thought would be the following word, as well as due to the fact that the student secured practically no practice in receiving uncommon and seldom used letters, such as *x, z, q, j,* etc. In order to overcome this, meaningless and disconnected groups of letters comprising every letter of the alphabet, similar to code and cipher groups containing from four to ten letters each, were used exclusively, and this was kept up until the student had acquired a receiving speed of at least 15 words per minute, at which time he was permitted to, and could readily copy plain language or press items as well. The following are a few examples of code and cipher groups:

CODIAC	STQAINT	13084
NOMADE	NZOLXYO	78620
LASTOR	LZIMNST	59032

It is recommended that where two or more beginners have firmly resolved to learn to read the Continental Morse code, that they make up a series of practice sheets upon which has been written or typed all manner of letter and numeral combinations similar to the above, each sheet containing four, five or eight letters of code and cipher words. By the way, code usually refers to pronounceable words whether they have any dictionary meaning or not, such as LAMBASNOBE and YOKER, while cipher is an arrangement of unpronounceable letter or numeral groups having a prearranged meaning, such as LMXTO ZLNSA AOSLN 67542.

The Theory and Practical Side of Radio Operating

In addition to being proficient in sending and receiving the Morse Continental code, a professional radio operator must also be familiar with the theory and manner of operating every part of a ship or shore station installation. This can be learned from text books, coupled with a certain amount of actual experience with transmitting and receiving instruments, and this is where the advantage of attending a radio school becomes a factor.

A word of advice concerning this important subject.

Remember that in order to pass the government examination it is not sufficient that you simply learn by rote certain stock radio phrases and explanations and attempt to palm these off in the written examination. This will not do at all. You must actually know what you are writing about and know the subject well. The writer recently heard of several young men who felt very confident about passing the examination, referring to the questions as "the same old dope"; when taking the examination they answered all questions in monosylabic form, giving little or no detail and so abbreviated their answers that the examiners were unable to determine the extent of their knowledge of the subjects. As a result they were given so low a mark average that some failed to secure even a second grade license. It is most essential before you apply for permission to take the examination that you be fully versed in all subjects mentioned in another section of this article, and also that you be prepared to receive and transmit the Continental Morse code at a speed of not less than 20 words a minute—five letters to a word.

Grades of Licenses and Requirements

Before you can become a commercial radio operator, you must be examined as to your professional knowledge by government officials. If found qualified you will be granted a Commercial Radio Operator's License, of which there are three grades. The complete classification of licenses follows:

1. Commercial Extra First Grade.
2. Commercial First Grade.
3. Commercial Second Grade.
4. Commercial Cargo Grade.
5. Commercial Temporary Permit.
6. Experiment and Instruction Grade.
7. Amateur First Grade.
8. Amateur Second Grade.

In this article we shall confine ourselves to the most important commercial grades.

Commercial Extra First Grade: To be eligible for this license, an operator must have previously held a Commercial First Grade License, and have eighteen months or more of satisfactory sea or land service; it is only issued where trustworthiness and efficient service entitles the operator to confidence and recognition. The examination consists of the following subjects:

(a) Adjustment, operation and care of apparatus.

(b) Transmitting and sound reading at a speed of thirty words a minute Continental Morse, and thirty per minute American Morse.

(c) Use and care of storage batteries or other auxiliaries.

(d) Knowledge of International regulations and Act of Congress to regulate radio communication.

(e) Knowledge of U. S. Naval Radio Regulation.

COMMERCIAL FIRST GRADE: The applicant must pass a satisfactory examination in the following:

(a) The adjustment, operation, and care of the apparatus, including correction of faults and change from one wave to another.

(b) Transmitting and receiving by ear at a speed of not less than twenty words per minute in Continental Morse (five letters to the word).

(c) Use and care of storage batteries or other auxiliary power apparatus.

(d) Knowledge of the International Regulations in force applying to radio communication.

(e) Knowledge of the requirements of the Acts of Congress to Regulate Radio Communication (sections 3, 4, 5, 6, 7 of the Act of August 13, 1912).

The COMMERCIAL EXTRA FIRST GRADE and the COMMERCIAL FIRST GRADE LICENSES qualify holders for employment at any ship or land station of any class.

COMMERCIAL SECOND GRADE: The applicant must pass a satisfactory examination in all subjects prescribed for the first grade, with the exception that the minimum speed in transmitting and receiving shall be not less than twelve words a minute in Continental Morse, and the examination in the subjects will not be as comprehensive as that given first grade operators.

The student operator should provide himself with copies of the following publications which can be readily secured by addressing the Superintendent of Documents, Government Printing Office, Washington, D. C.:

Radio Communication Laws of the U. S.....15 cts.
Radio Stations of the United States........10 "
Radio Service Bulletin (issued monthly)....05 "

(The above bulletin can be subscribed for at the rate of twenty-five cents a year).

Most of these publications are usually supplied by radio companies employing operators, but it is well for the aspiring professional to procure them himself and become familiar with their contents before attempting to take the examination.

WHERE AND HOW TO SECURE LICENSES

Commercial Radio operator's licenses as well as amateur licenses of all grades may be secured after due examination by applying to any of the following named places, where are situated representatives of the Department of Commerce:

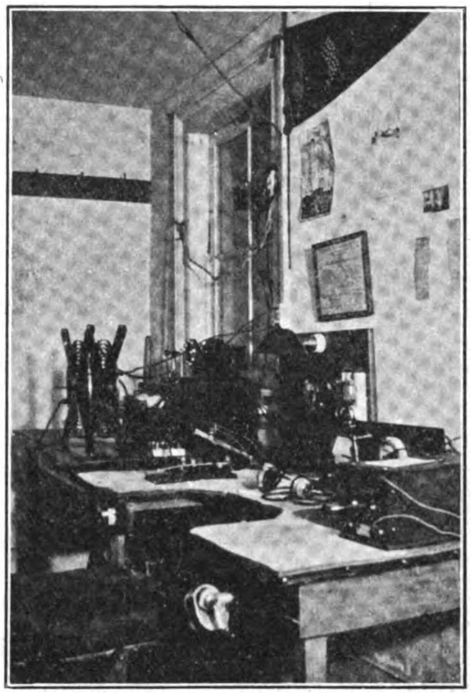
Radio Service, Customs House, Boston, Mass.
Radio Service, Customs House, New York City, N. Y.
Radio Service, Customs House, Baltimore, Md.
Radio Service, Dept. of Commerce Bldg., Washington, D. C.
Radio Service, Citizens Bank Bldg., Norfolk, Va.
Radio Service, Customs House, New Orleans, La.
Radio Service, Customs House, San Francisco, Cal.
Radio Service, Customs House, Seattle, Wash.
Radio Service, Federal Building, Chicago, Ill.
Radio Service, Federal Building, Detroit, Mich.

REMUNERATION, ADVANTAGES AND OPPORTUNITIES

The present salary of the ship radio operator is $125.00 a month for senior operator and $100.00 for junior. In addition to this, operators are given first-class accommodations and meals, which is easily equivalent to an additional $50.00, when one considers the present high cost of living. While these figures represent the standard operating wage, operators may also earn additional money in other ways. For instance, on some cargo vessels where there is need of but one operator, the steamship company will arrange to have the operator act as supercargo in addition to his radio duties. For this combination position he receives a total monthly pay of $140.00 or more, depending on the importance of the voyage. This work requires very little preparation and is of a light clerical nature such as the making out of crew lists, manifests of cargo, store lists, etc. On other vessels, either passenger or cargo operators may check freight while at foreign ports. This consists of merely standing or sitting near the ship's hold and keeping count of the quantity and nature of the various items discharged or taken on board. This work pays from 40 to 50 cents an hour. On many passenger ships, too, the OCEAN WIRELESS NEWS is published as the daily newspaper of the sea. The operator in such cases is in effect an editor of the day's news transmitted from shore, and he is allowed a liberal commission on sales of the paper to passengers.

Misleading statements are often made concerning the recognized status of the radio man on board ship, so a few words about this matter is perhaps not out of place. The United States Shipping Board Emergency Fleet Corporation states in its contract with the radio companies the following:

"Radio operators shall be treated as officers, but without executive authority, and shall be provided accommodations suitable for an officer."



It is very essential that the home student erect a receiving station

This means that the radio man is accorded all rights and privileges of a merchant vessel officer, except that he has not the authority to give executive orders to any member of the crew unless he has been specifically instructed to do so by the captain or other accredited officer of the ship. This, of course, is quite natural, since the operator is in a class by himself and is not versed in any of the ship's routine.

The opportunities of the sea-going operator are manifold. In the first place, he has the chance to visit many parts of the world which are seldom accessible to any but the very wealthy. The radio operator having spare time at his disposal while at sea can study various subjects connected with his profession, such as radio traffic problems and the higher branches of radio engineering. By doing this, he may, after a few years of faithful service and study, be advanced to such positions as inspector, constructor, chief operator, assistant superintendent, representative, manager of coastal station, and various other well paying posts connected with high power transoceanic shore stations. Or, if he so desires, and wishes to follow the sea as a profession, he may study navigation.

There is certainly a great deal to be said in favor of radio operating as a profession, and few land vocations can boast of as fascinating and profitable a career as that of radio.

Testing Marconi V T's

The Electrical and Mechanical Tests That Are Necessary to Insure Efficient Tubes

WITHOUT doubt, there are but few of the readers of this magazine who have considered the care and effort that is required to produce uniformly good vacuum tubes. A summary of the tests through which the Marconi VT's pass will be of interest to those who use vacuum tubes in their experimental work.

In addition to the electrical inspection, these tubes are also carefully inspected for mechanical defects to insure that the internal elements as well as the glass and base itself are all properly constructed and in line.

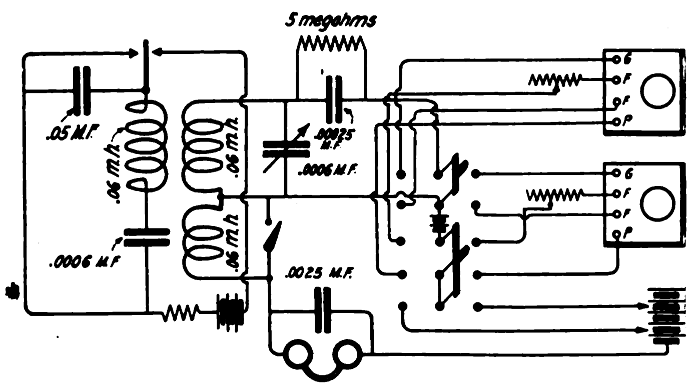


Figure 1—The circuit for the oscillation test at 250 meters

The electrical inspection—which is made to determine the operating characteristic of the tube—calls, first, for a filament which will pass a certain standard current under given conditions; second, the plate voltage required for the tubes must not fall below or exceed given values; next, the insulation resistance is measured between the plate and grid and filament terminals, this latter measurement being made only after the tube has been operating for a considerable period of time at normal current.

The sensitivity of the tube as a detector is also carefully noted and checked against a standard in the test laboratory, and finally the tubes are connected in a circuit as

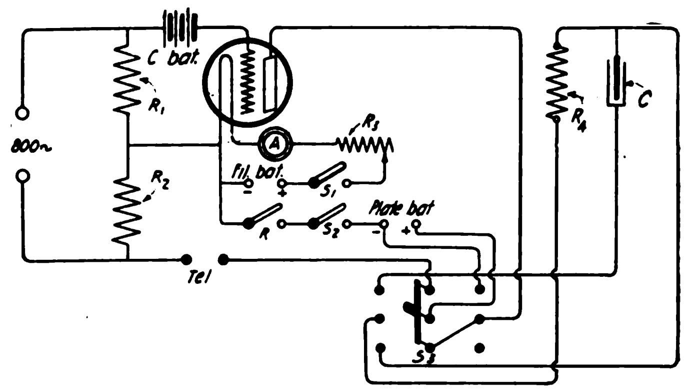


Figure 4—Circuit diagram of the Miller's bridge

shown in figure 1, for the oscillation test, where they must oscillate at a wave length of 250 meters, in a satisfactory manner, at a plate potential not greater than that required for the greatest sensitivity as a detector.

The Class II tubes are all subjected to a plate potential of 350 volts, which they must withstand for a certain

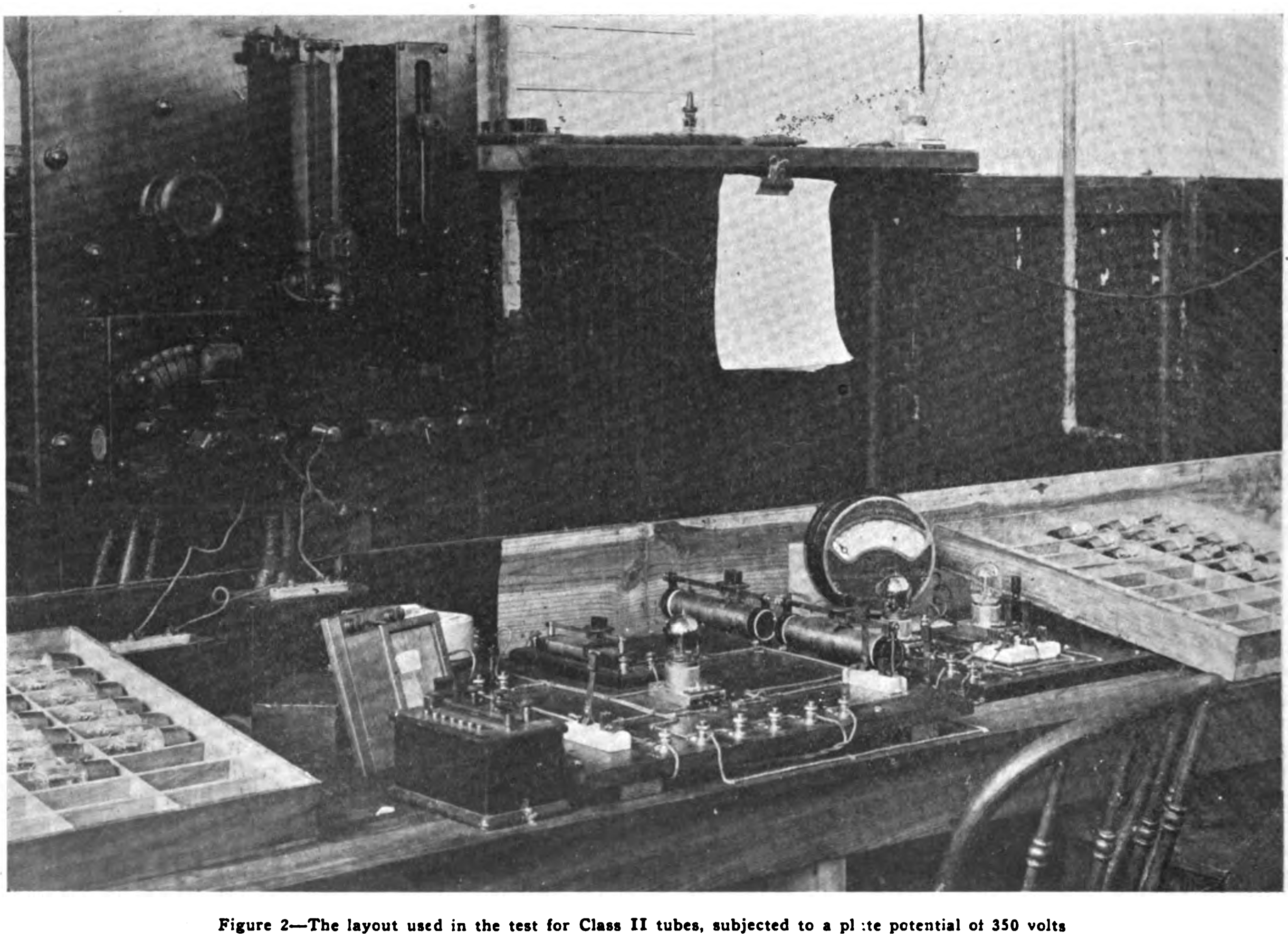


Figure 2—The layout used in the test for Class II tubes, subjected to a pl:te potential of 350 volts

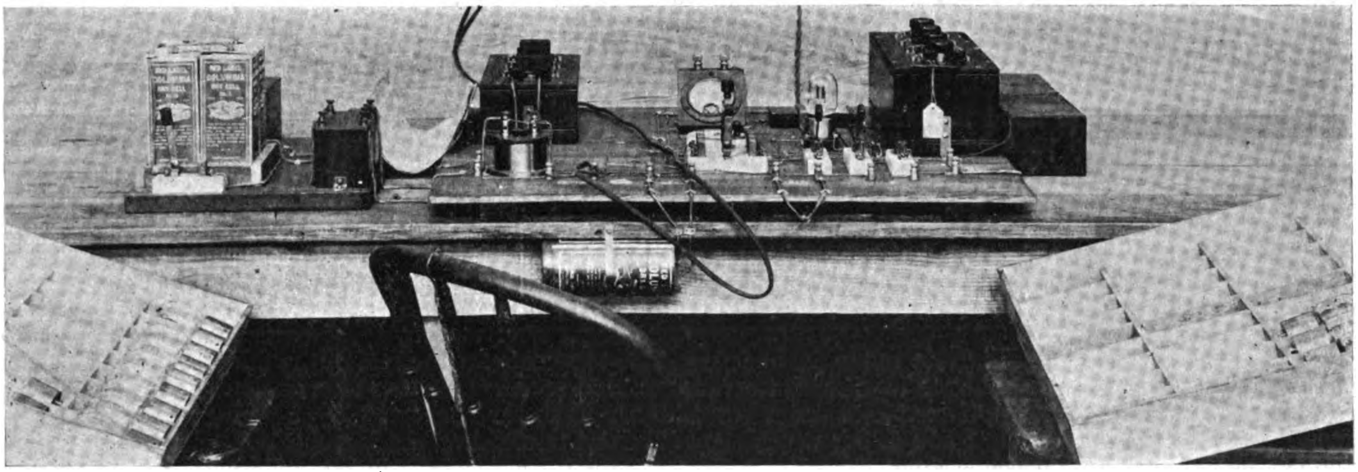


Figure 3—The instruments which make it possible to obtain the amplification constants, the internal resistance, and the voltage amplification of a tube when used with a resistance in its plate circuit

period of time or be rejected. Figure 2 is a photograph of the layout for this test. To the right is seen the plate circuit voltmeter (shunted) as well as the rheostats for the regulation of plate potential. Filament current rheostat is shown directly behind the left hand vacuum tube and the galvanometer for indicating grid current is shown beneath the generator board and directly behind a shunt resistance, the latter being connected across the terminals of the galvanometer in order to protect it in case of shorted connections within the tube under test. Figure 3 shows a photograph of a Miller's bridge set up by the use of which it is possible to obtain the amplification constants, the internal resistance, and the voltage amplification of a tube when used with a resistance in its plate circuit. A circuit diagram of the Miller's bridge is shown in figure 4. The action and operation of this bridge is described in Volume 6 of the Proceedings of the Institute of Radio Engineers. In figure 5 is shown a set-up for the oscillation test and for the detector test. A standard Navy short wave receiver as well as a standard Navy vacuum tube control box as manufactured by the Marconi Company and General Electric Company, respectively, are used in this test. A damped oscillation is supplied by the small oscillation generator on the left.

To summarize, all tubes are first tested for gas and classified as either soft tubes (Class I—detectors and oscillators) or as hard tubes (Class II—amplifiers, oscillators and detectors). The soft tubes are then tested for sensitivity as detectors, and either passed or rejected. The hard tubes are tested for amplification constant, and for oscillations, and either accepted or thrown out.

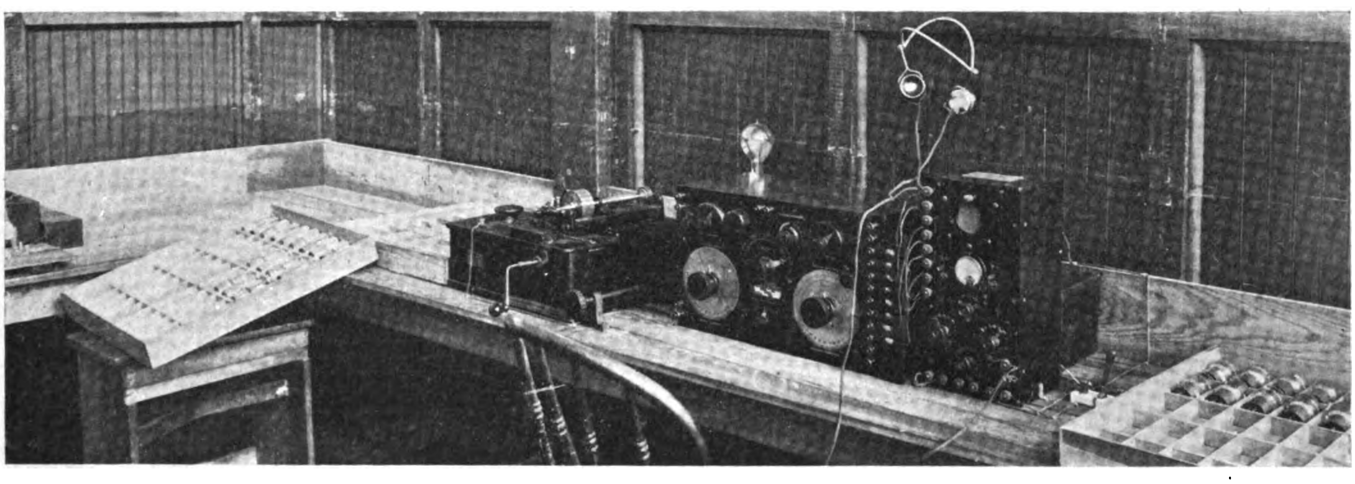


Figure 5—Apparatus for making the oscillation test and the detector test

If You Were the Editor—

It is an axiom in any magazine publisher's office that every reader is certain that the publication would be improved if the ideas he holds were adopted.

We like this spirit. We want to hear those who think The Wireless Age is not quite as good as it should be.

Let us have all those fine suggestions. It will be worth your while, for we are going to give you whatever it is you think you want.

The majority will rule, but all reasonable requests for departments or articles will be given most careful attention. —The Editor

Condenser Construction

TO those who have in mind the construction of condensers the method used by Dubilier will be of interest. The principal object of his method is to provide a condenser in which the terminal connections will fall at points spaced to such an extent that the liability of an electrical discharge between terminals at different potentials is minimized, and to avoid the necessity of employing special insulating barriers or plates between the terminal connections.

Figures 1, 2 and 3 are respectively top, side, and perspective views of a condenser, made in accordance with this method. Figures 4, 5 and 6 are views which correspond respectively to figures 1, 2 and 3, but which show another method of making connections.

With reference to figures 1 to 3, a condenser is shown consisting of several conducting plates separated by mica sheets, the plates and sheets being assembled into a rectangular shaped block. Groups of conducting plates are connected in parallel so as to form several sets of plates insulated from each other, these being of opposite polarity and connected in series to divide up the potential to which the condenser is to be subjected to such an extent as to prevent a failure of insulation or a breakdown in any portion of the insulation.

Terminals for each set of plates are provided by extending the edge portions of the plates a short distance beyond the face of the block. The terminals of the different sets are then connected so as to place the requisite number of plates in series with each other.

In order to prevent a discharge between terminals which are to be at different potentials, these terminals and their connections are brought out at different points around the sides of the block so that each terminal will be spaced a relatively large distance from the others. In figures 1 to 3 this is accomplished by bringing out the terminals of successive sets on different faces of the block, the terminals of the sets of opposite polarity in the top layer being brought out for instance at sides 4 and 6 respectively of the block and the terminals of the sets of opposite polarity in the second layer being brought out respectively at sides 3 and 5 of the block, the terminals for the sets of the third layer at sides 4 and 6, and so on. The top terminal on side 6 of the block, may then be connected by a conducting strip to the second terminal on the face 5 of the block. The terminal of the second layer, which is on face 3 of the block may then be connected by a similar ribbon to the terminal of the third layer which is in face 6 of the block. The terminal of the third layer, which is on face 4 of the block, may then be connected to the terminal of the fourth layer which is on face 3 of the block. The terminal of the fourth layer which is face 5 of the block may be connected to the terminal of the fifth layer which is on face 4 of the block, and so on.

It will thus be seen that with the above arrangement the terminal connections extend around the sides of the block in a spiral fashion. In the form shown in figures 1 to 3, the terminals 8 to 12 for instance are spaced a distance equal to the thickness of 3 groups of plates so that the chances of a discharge between such connections are minimized.

If the terminal connection between successive groups of plates be made alternately at opposite sides of the block as has been the usual practice, it is necessary to

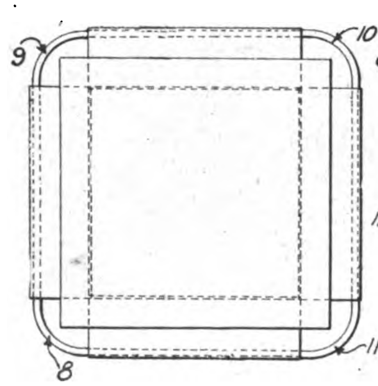


Figure 1

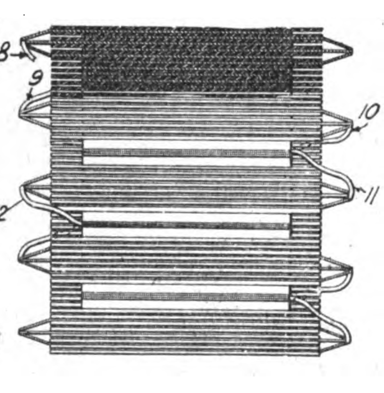


Figure 2

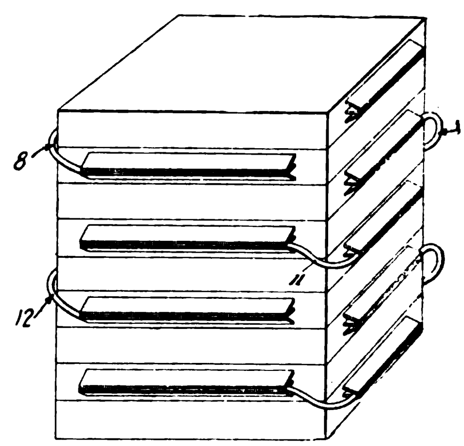


Figure 3

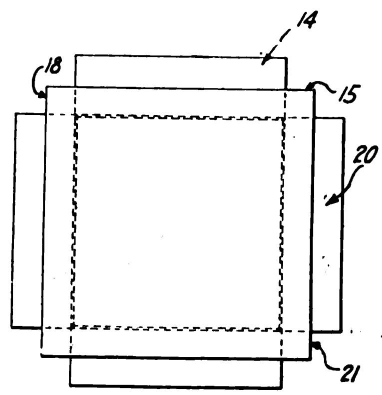


Figure 4

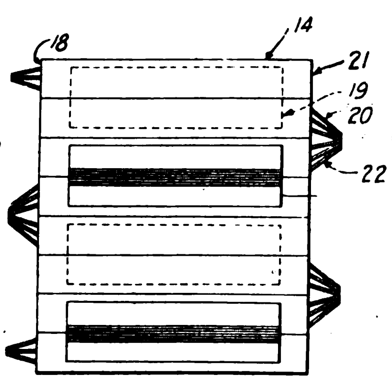


Figure 5

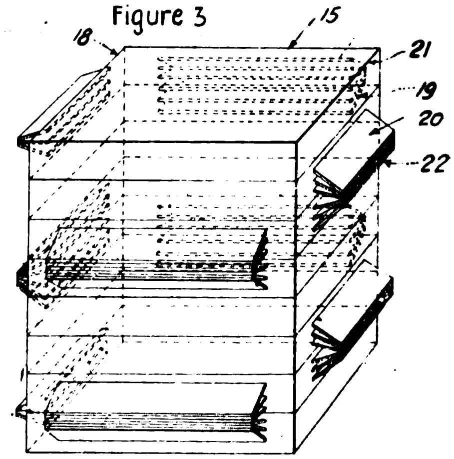


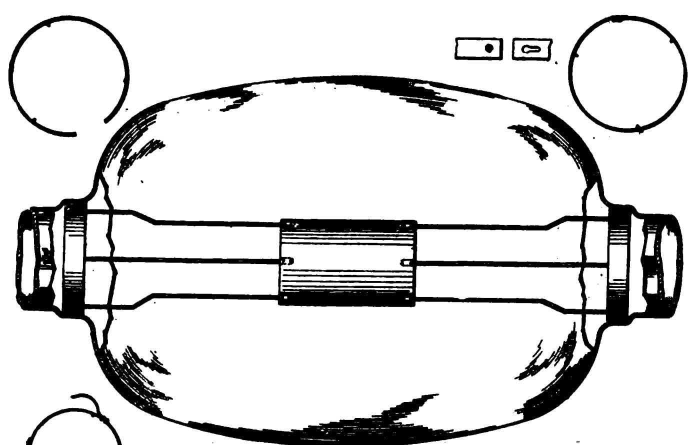
Figure 6

Figures 1, 2 and 3 are respectively top, side and perspective views of the condenser and figures 4, 5 and 6 show another method of making connections interpose between terminals and connections of different potentials insulating barriers or plates, so as to prevent brush discharge, but these insulating plates aside from the greater expense they entail, are awkward because they leave the condenser terminals in pockets or recesses with the result that such terminals are not readily accessible for making terminal connections. With a condenser constructed as per above outline the greater spacing between the connections obviates the necessity of employing insulating barriers between them, and no more insulation need be interposed between the superposed groups of plates than is used between the different plates of the interleaved groups.

Figures 4 to 6 show a condenser of different construction, but in which the same principle of connection is employed. As shown in figure 4, a group of condenser plates may be connected in parallel and provided with a terminal on one face of the block similar to the one previously described. A second group of plates is interleaved with the first but has its common terminal located for instance at the side 18 of the block adjacent to the side 15 which carries the first terminal. The interleaved groups of plates in the second layer may then have one terminal located at the side 15 of the block and the second terminal located at the side 21 of the block, etc. Terminals 14 and 19, 20 and 22, etc. may then be joined together to connect as many of the groups in series as is desired.

Vacuum Tube Construction

A NOVEL means of supporting the electrodes in a vacuum tube has been worked out by T. P. Driver, of London. A cylindrical plate which is supported from both ends is provided at each end with a set of longitudinally extended carrier-bars attached on the one hand to the anode cylinder and on the other to a metal collar which is received in an annular seating formed within the tube, at or near the point where the extending neck of the tube opens into the bulb; the seating at the respective ends of the tube being of such diameter with respect to the adjacent necks as to present, endwise, oppositely-directed annular shoulders adapted to prevent logitudinal displacements of the plate and its attached supports in either direction after their insertion in position, while lateral displacement is prevented by the engagement of the collars with the inner peripheries of the seatings with which one or both of the collars may be adapted to establish expanding spring contact. The accompanying drawing shows a side elevation of a vacuum tube, illustrating the method of supporting a cylindrical plate therein, a portion of each end of the tube being in section while the filament and its supports are omitted.



Vacuum tube showing method of supporting the cylindrical plate

Secret Radiophone

A FUNDAMENTAL requirement of commercial telephony is there shall be no delay in the transmission of signals, that is, a signal must be transmitted immediately upon its production. This requirement precludes the use of code sending as ordinarily understood, for the secret transmission of intelligence by telephone because such sending would necessarily introduce a delay equal to the time required for translation to code.

In order to accomplish the secret transmission of intelligence, H. W. Nichols proposes to so distort the signal transmitted from the sending station that it shall be unrecognizable at points between the transmitting and receiving stations, but by means of auxiliary modifying apparatus at the receiving station the signal is to be restored to its original character. A fundamental condition for this kind of distortion is that the order of the electrical states which make up the signal shall not be changed, although the intervals elapsing between successive states may be changed in any manner desired. If this condition is not fulfilled, the result will be either delay in transmission of the signal, or else superposition of one part of the signal upon another part, making the signal unintelligible.

In the arrangement shown in the drawing signals are produced by the telephone transmitter, distorted by the apparatus intervening between the transmitter and the antenna, transmitted to the receiving station, received and restored to their original forms and finally translated into audible sounds by the telephone receiver. By further reference to the drawing it will be seen that an iron wire is carried along the face of an electro magnet 3, which is energized by a battery controlled by a microphone, which serves to vary the current through the magnet in accordance with speech vibrations. The result of speech vibrations impressed upon the microphone is to vary the magnetic state of the wire as in the magnetic detector or telgraphone, these magnetic states of the wire being permanent and carried along the wire in its motion to the right.

A second electro magnet shown at 6 is affected inductively by the varying magnetic states of the wire and serves to reproduce the vibrations impressed upon it by the first magnet. There will, therefore, be reproduced in the windings of the second magnet a current which is more or less a faithful copy of the current in the first. The magnet 6 is rigidly connected to an arm, which passes through guides and is driven by a cam mechanism. This cam may be driven by the same source of power as is used for the driving of the iron wire and its mechanism. The purpose of this cam driven magnet, is to so alter the wave form of vibrations induced in it with respect to the vibrations induced in the first magnet as to be unrecognizable when transmitted from the antenna as explained later.

It will be obvious that if the motion of the wire is uniform, and if the two magnets are relatively at rest, the signal induced in the second will be practically an exact copy of that produced by the microphone. On the other hand, if there is relative motion of the magnets, it is obvious that the signal induced in the last will be distorted, as the time phase relation between succeeding portions of the signal wave will be modified. In designing and operating this cam driven mechanism it is essential that the relative speeds of the magnets shall never be great enough to superimpose one part of the message upon another. In order to efface the message after it has been delivered to the second magnet, and to place the wire into a condition suitable for the recording of a new signal, a permanent magnet is placed below the wire as shown in the figure.

The operation of the device is as follows: The distorting devices at the two stations are started in synchronism and in phase by means of a predetermined signal. The cams may be driven by clockwork in order to maintain the necessary degree of synchronism. When a signal is impressed upon the tape by means of the magnet 3 it would normally, if magnets 3 and 6 were at rest and the tape moving uniformly, require a certain definite time to be transmitted to the reproducing magnet 6. If, however, the latter is in motion with respect to the former, the time elapsing between the production of a signal at 3 and its reproduction at 6 will be variable, and therefore the message sent out from the sending antenna will no longer be an exact copy of the impressed message. At the receiving station this message is transmitted to the thermionic elements, being amplified and transformed into low frequency form. It is then impressed upon the receiving magnet 36, whose motion is similar to that of 6. The distorted message is therefore received from the tape in its normal form due to the relative motion of 36 and 39, and reproduced in undistorted form in the receiver.

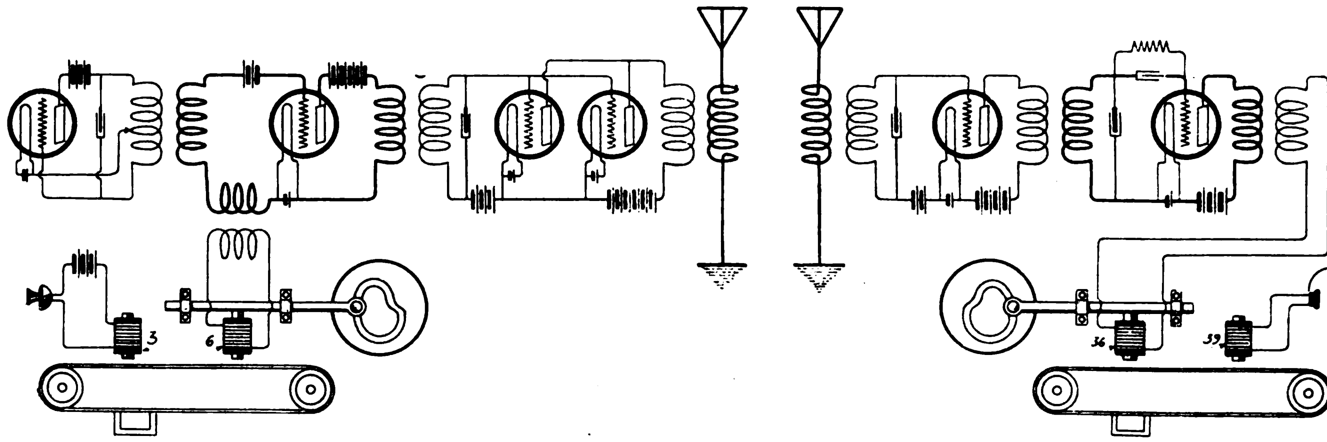


Diagram showing electro magnets and mechanical means for distorting the signal at the transmitter and restoring it at the receiver

Improved Condenser Construction

A VERY excellent method of constructing condensers has been developed by Franz Kratz. The salient features of this construction consist of two metal discs placed opposite to each other and having cylinders or pipes protruding inward from their centers, upon which the strips of paper and tinfoil (or whatever the material may be), are wound. In order to obtain a good contact between the metal discs and the two tinfoil strips, these latter are made somewhat wider than the distance between the discs, so that when the winding operation is performed, the one edge of each strip abuts against a disc and is thus caused to coil up and press firmly against it. By the pull exerted on these strips during winding, the discs are prevented from moving apart, so that no rivets, screws, soldering, spring pressure, or any other special means are required to keep the frame together.

Figure 1 represents a section through the condenser, viewed from the side, and figure 2 shows the tinfoil and paper strips as they appear while being wound onto the condenser frame or spool.

Two metal discs or cheeks with protruding ring portions or short pipes are arranged in parallel planes, so that the rings are situated opposite to each other and a certain distance apart. The space between the discs may be bridged by a layer of insulating material, supported by the rings; and upon the roll or spool thus formed the paper and tinfoil strips are wound. The tinfoil strip is made somewhat broader than the distance between the discs so that it is caused to coil up on one edge during winding and is thus pressed firmly against its disc and establishes an intimate contact with the same. By the pressure applied by the tightly wound strips the discs that serve as mountings are prevented from being shifted outward from the middle. This may also be prevented by glueing the rings to the insulation.

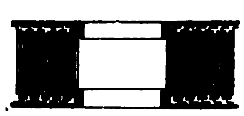


Figure 1

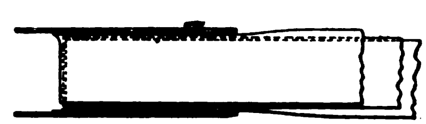


Figure 2

Figure 1—Sectional side view of condenser. Figure 2—Showing tinfoil and paper strips while being wound onto the condenser frame

One of the advantages of this method over other forms of construction is that metal mountings are employed which keep the condenser together without the necessity for any special fixing means, such as rivets.

Another distinct advantage of the condenser is that resulting from the connection of one entire edge of each tinfoil strip to its respective disc and terminal, so that the resistance of the condenser and the inductance which the rolled form of condenser would offer under ordinary methods of construction is eliminated, thus affording a condenser with a low phase angle.

An Amateur Receiver

Many amateurs will, no doubt, be interested in constructional details and circuit diagrams of a receiver developed by Ernest C. Mignon. Figures 1, 2, 3 and 4, respectively, show the layout of the receiver and the method of control, this last residing in a metallic ring shown in figure 1, as supported on a shaft coming out in the center of the "clover leaf" coil arrangement and being counter-balanced by a weight, and shown in figure 2, where a cross section has been taken through a line of figure 1. In figure 1, it is seen that not only will the metallic ring revolve so as to be concentric with either one of the three coils, but it is also possible to vary the proximity of the metallic ring to the coils, as indicated in figure 2, wherein the ring and its controlling knob are shown in full and also in phantom.

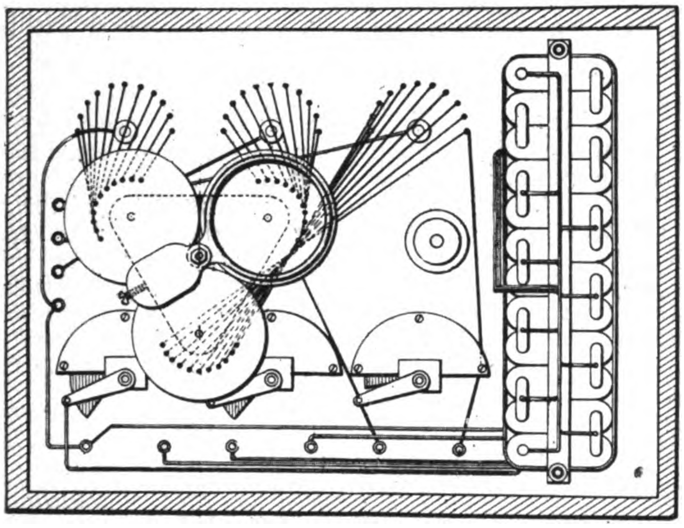


Figure 1—General layout of the new amateur receiver

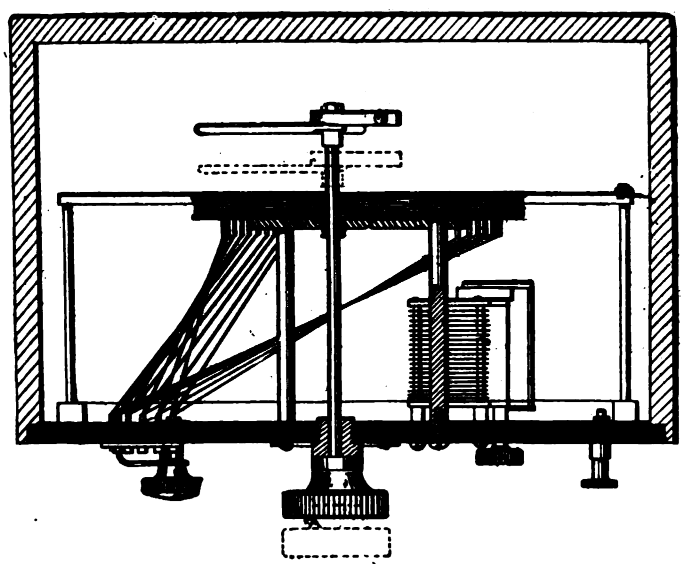


Figure 2—Showing the ring and controlling knob in full and also in phantom

With reference to the circuit diagram, figure 4, it will be seen that the receiver is the usual 3-circuit type; that is, primary, secondary, and plate circuit, and that the coupling between primary, secondary, and plate circuit, in so far as effected by the physical relationship between the coils, is uncontrollable because the coils are fixed in position. The electrical periods of the three circuits are controlled in the usual way, by variation of inductance and capacity. A movement of the metallic ring to a position concentric with any one of the coils will decrease the inductance in that coil. A movement of the metallic ring to such a position that it links any two coils as indicated in figure 3, in all probability reduces the inductance of both coils, to an extent, and slightly further inter-links their magnetic fields.

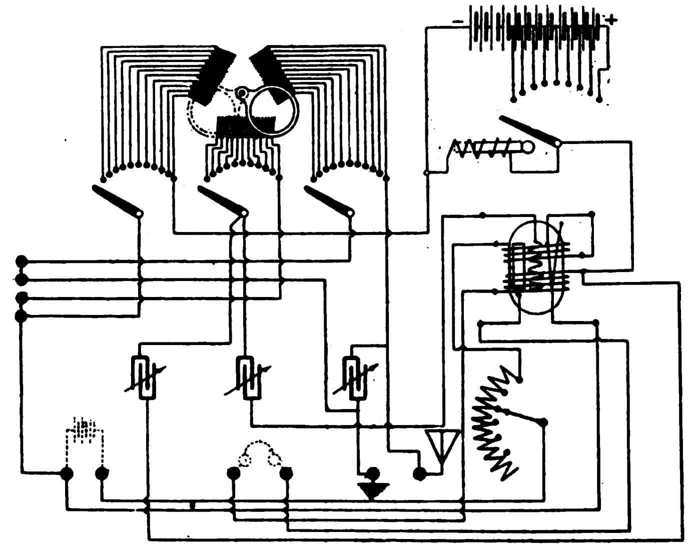


Figure 3—Showing the metallic ring linking two coils

From a strictly amateur point of view, a receiver design such as this, for use on long wave lengths, might be considered satisfactory, inasmuch as practically all the high power stations may be copied with the device; but from a commercial point of view, the scheme is decidedly impracticable, due to the fact that there exists at all times both electromagnetic and electrostatic coupling between primary, secondary and plate circuits which is uncontrollable, and furthermore it is a well-known fact that the use of a short circuited turn of inductance directly in the field of an inductance will give rise to as much as 50 per cent energy losses under certain conditions.

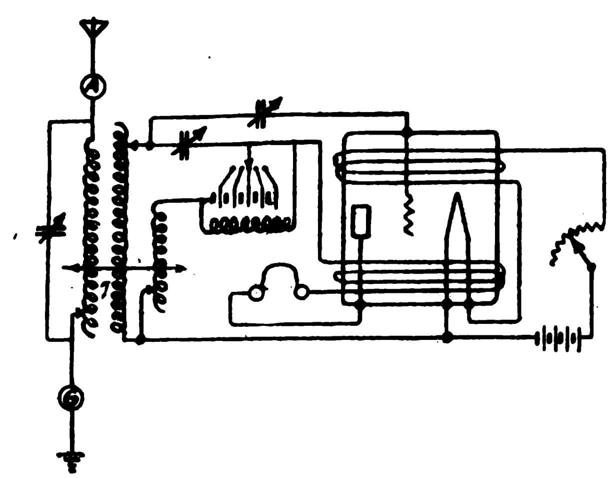


Figure 4—The circuit diagram used shows the receiver to be the usual 3-circuit type, namely: primary, secondary and plate circuit

EXPERIMENTERS' WORLD

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

A Low Power Tuned Transmitter for Local Use

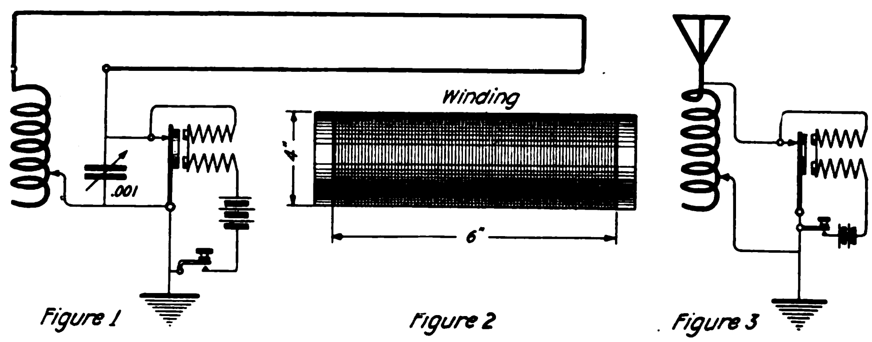
By E. T. Jones

THIS is undoubtedly the question of the hour, since it deals with a method which will make amateur operation safer and place it on a sound basis. Amateurs have already caused some little trouble, all of which could have been avoided were it not for the fact that they make use of transmitting sets with power greatly exceeding their needs.

Through accident, I discovered that if inductance of certain value was shunted across the contacts of the buzzer while the antenna and ground connections remained in their usual place, greater distances were covered with the same buzzer and the note of the buzzer was entirely controllable by varying the inductance. Screwing on the contact point and altering the tension of the spring common to the adjustment of buzzers, was thus made unnecessary. All that is required is to have the note of the buzzer (high frequency) adjusted to a pure note and one of very high pitch. It is then connected in the circuit as shown in figure 3.

Here an inductance of the dimensions shown in figure 2 is shunted across the contact points. This was wound with one layer No. 24 SCC magnet wire. A slider is connected as shown. The slider is employed in this case because, with it, greater selectivity can be had. Of course, the units and tens arrangement common to primary windings of receiving transformers can be resorted to.

With this in mind, I decided to try the arrangement shown in figure 1. A loop antenna measuring 50 ft. long with two No. 18 wires spaced 4 ft. apart, was constructed. This antenna was 35 ft. high at one end and 15 ft. high at the other. I found that it was also possible to effect tuning with a condenser of the commercial type measuring maximum .001 mfd., shunted as shown (across the antenna and inductance). Here it is seen that the antenna is used as part of the shunt, which actually increased the signal strength at the receiving station some 5 miles distant. The series inductance used is the one constructed to shunt the buzzer when it is employed on an ordinary flat top antenna.



Circuit diagrams showing hook-up of the high-frequency buzzer and the inductance used in the low power transmitter

This forms a circuit similar to the wavemeter (driver circuit and is undoubtedly *the thing* for amateur local transmission. I am using it exclusively and with vacuum tube receiving apparatus, I am of the opinion that this will transmit 10 or more miles. The greatest distance to date is five miles during mid-day.

With suitable keys, music can be played on this set.

The Submerged Receiving Aerial

By Victor R. Fisher

IN the January 1920 issue of the WIRELESS AGE I noticed an article on "Loop Antennae for Submarines," by Ralph R. Batcher. I have read this article carefully and I think it is somewhat misleading, although I have the greatest respect for the position and occupation of its author. For, relative to this submerged receiving aerial, I have evidence enough to squash the idea.

It was in either August, September, or October, 1916, I believe, that the Navy Department first conceived the idea of putting to actual test the possibility of receiving signals in a submerged vessel. At that time and date I was the radio electrician aboard the

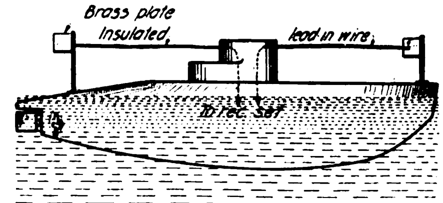


Figure 1—Showing brass plates connected fore and aft and the lead-in wire to receiving set

DSS K2. The submerging aerial was handed to me while we were still in the Brooklyn Navy Yard, with instructions that I should rig it up when we arrived at New London, Conn. This was in June.

Later, I rigged up this "antenna" which consisted of one brass plate on the after mast (which carried the main two wire aerial), and one brass plate on the foremast. Insulated wires stretched from these plates to amidships, where they entered through a supposedly watertight stuffing box on the conning tower down to the set. The two departmental representatives were Radio Expert Clark, and an aide. On questioning Mr. Clark as to how and why they decided to experiment with this idea, I was told that he had thrown into the Potomac a couple of old wash boilers and pails, and copied NAA, which seemed entirely possible, acknowledging the close proximity of his receiving gear to NAA, which acted on his set via forced oscillations.

He never would have heard NAA had he been 50 miles further away, as experiments proved.

But as to the submarine. After hooking up several thousand dollars worth of audions, amplifiers, and receiving sets (not mentioning the superfluous amount of meters, variable condensers, etc.) the K2 submerged to a depth of 9 feet. The antenna was at the time 3 feet below surface, the submarine trailing behind the USS Tallahassee at a distance of one mile and making a speed of 6 knots. All this time the Tallahassee was sending "dope" out of an American history and caused considerable bewilderment to operators of other ships in the vicinity. We heard . . . nothing.

But just as soon as one plate emerged and the other remained submerged, we could copy NFF, NAH, WDC, and NDC (Tallahassee). We would dive once more and not a sound, and all this wonderful outlay of apparatus. It all proved a fizzle.

During the thirty months of foreign service, I had the good fortune to spend one year at the French trans-Atlantic station YN (Lyons). I had considerable experience there with aerials. We used no ground for receiving, simply one immense loop, 110 feet high, 300 feet long (figure 2). We had three receiving antennae of this same style, and although one of these was situated on a farm a few blocks away, all the receiving sets were in the same room, the lead-ins coming into the room via underground insulated cables.

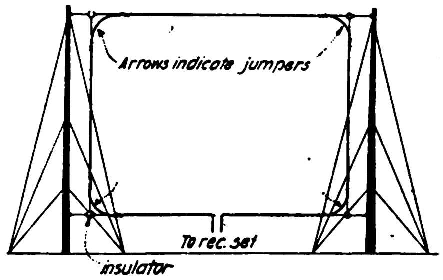


Figure 2—A single-loop antenna without ground used for receiving

The most remarkable feat ever accomplished on one aerial, I believe, was accomplished there. We had three receiving stations, one for NSS, one for NFF, and the other for NDD, and the USS George Washington. It so happened that we had a bad ground on one of these out of the way antennae which compelled us to double up on one aerial. In other words, we had to copy NSS and NFF on the same aerial, and without grounds. We kept to this plan, for it was working beautifully, until YN installed his new transmitter. Up to then we had been able to copy NSS and NFF on the same aerial, while YN was transmitting with his alcohol burning arc. But when he received his Alexanderson machine we had to abandon the idea, for he transmitted on very near the same wave as NFF and when one man copied NFF he most likely had decreased the signals from NSS enough to allow YN to break him up altogether. Lyons has a 150-kw machine and radiates 180 when it's working right.

A Successful Undamped Wave Circuit

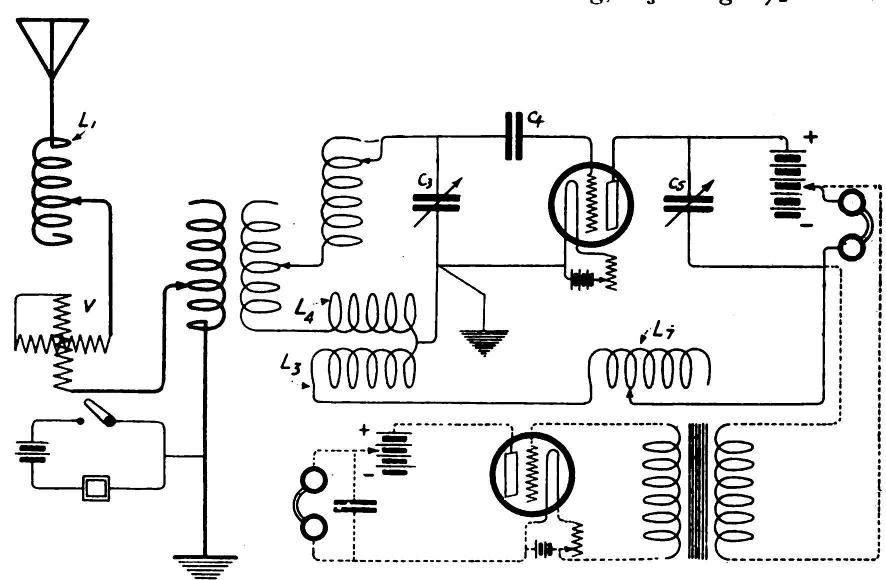
By J. C. Morris, Jr.

AN undamped wave circuit with dimensions of the units is supplied by the writer, with the belief that the set outlined possesses many advantages which will be apparent to the amateur. Very long distance records have been obtained with a set of this type, using a small aerial, therefore, it should be suitable for use with the usual amateur. The results obtained will amply repay the trouble and expense of construction.

The following dimensions do not need to be followed precisely, but have been chosen to give a suitable range of wavelength.

The primary and secondary tubes of the coupler are wound with 15 inches of wire. The former is 5½ inches in diameter while the latter is 5 inches in diameter. The primary is wound with No. 24 S.S.C. wire or with bare wire suitably spaced. The secondary is wound with No. 28 S. S. C. wire, taps to the secondary switch being taken off at suitable intervals. The primary is varied with a slider. The writer advocates the use of a slider because of the ease of adjustment. However, to avoid capacitative effects from the body of the operator, the slider should be moved by a handle of at least six inches in length, made of hard rubber or other equally good insulation.

The aerial loading coil L_1 should be five or six inches in diameter and thirty inches long, wound closely with No. 25 S.S.C., taps to the multi-point switch being taken every 3 inches or so. Precision adjustment is made by the variometer V. This variometer consists of two cardboard tubes one inch long and 5 and 6 inches in diameter respectively, wound with No. 25 S.S.C., care being taken to keep the same amount of wire on the two coils. The inductance is varied in the usual manner by revolving the inner coil within the outer.



Circuit diagram of undamped wave receiver which can also be used for the reception of long damped waves

The plate and grid loading inductances have identical values, consisting of tubes 5 inches in diameter and thirty inches long, wound closely with No. 28 S.S.C. The inductance may be varied by a suitable slider or by a multi-point switch, taps being taken from the 5, 10, 14, 16, 18, 19, 20, 22, 24, 26, 28, and 30th inch of winding.

The regenerative couplings L_3 L_4 have fixed values of inductance, but should be constructed so as to have fairly variable couplings. Good results are obtained with both coils 7 inches long, L_3 being 5½ inches in diameter, while L_4 is 5 inches in diameter. Both coils are wound with No. 28 S.S.C.

Often amateurs can make old couplers function in this position by rewinding same, or suitable variometers are sometimes substituted.

C_3 is a variable capacity of maximum value of .0005 mf. C_4 is a fixed capacity of .0005 mf. C_5 is a variable condenser of .002 mf. (Two .001 mf.

condensers in parallel may be used if desired.)

In use, the primary of the loose coupler covers about ½ of the secondary. L_8 is about ½ way in. L_7 is almost completely used. The other values depend on the wavelength of the received wave. C_3 and C_5 are varied simultaneously.

Attention is called to the filament ground connection.

Filament control is accomplished by means of the battery rheostat. B battery current may be varied either by the potentiometer or by the step by step method. Caution is advised to see that the A battery does not tend to oppose the B battery.

The writer advises bringing the bulb to a sensitive condition by the use of a test buzzer in inductive relation to the ground circuit.

This circuit may be used for the reception of long damped waves.

In order to hear the more distant stations at times, it is advisable to employ a one or two step valve amplifier. The connections of the one step amplifier are shown by the dotted lines. When the amplifier is employed, the phones are removed from the circuit and the primary of the audio frequency iron core transformer is connected in.

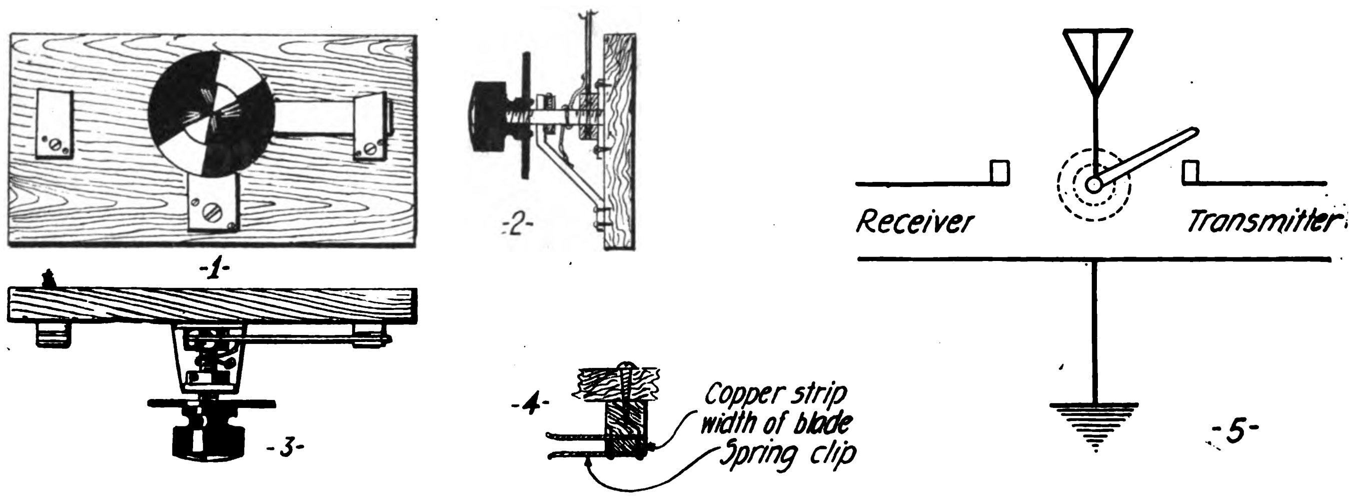
An Efficient Aerial Switch

By R. C. Hitchcock

EVERY radio station needs an efficient aerial switch. If its action is quick, snappy, and dependable, it is a great help to good radio communication. The switch here presented has all of these desirable features.

No provision for the shutting off of low voltage power is provided, as with a careful operator it was found to be unnecessary. The construction is further simplified by eliminating the ground lever. The ground wire is permanently connected to the receiver and transmitter, the aerial being switched from one to the other (see figure 5).

The main lever is about 6" x 1" x ⅛" of heavy copper. A hard rubber shield, and navy knob are mounted on the axle (see figures 2 and 3). The shield prevents the possibility of touching the switch arm, and the use of the large knob makes the throwing of the switch very easy. This navy knob is provided with a brass insert, which is screwed onto the main axle, which is threaded and fitted with nuts, as shown in figure 2. A flexible copper cable is soldered to the switch lever, coiled loosely around the axle, and then led to the copper plate and soldered, thus making positive connection at all times. The clips used may be taken from a large knife-switch, or may be built up, as in figure 4, at the discretion of the constructor. The base may be of hard rubber or of seasoned wood.



Various views of the improved aerial switch

Details are clearly shown in the diagrams. Dimensions are omitted, as they vary with the materials on hand. The design should prove satisfactory.

Spark Coil Transmitters

By Albert T. Lynch

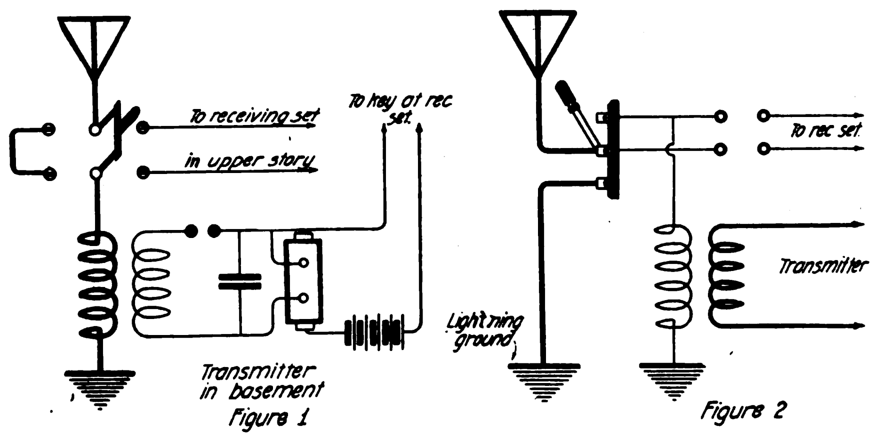
USERS of spark coils have in the past overlooked several important factors in designing the installation. A panel spark coil set is more or less difficult to construct, whereas an efficient transmitter requires no panel.

Almost without exception, amateur stations are located some distance from the ground, yet the transmitter, to be truly efficient, should be located close to the ground. This will be apparent on considering the voltage and current nodes and loops in an antenna and closed oscillating circuit. It is a well known fact that in a freely oscillating aerial the voltage loop is at the free end of the aerial, the current loop at the base; in other words, the voltage is low at the ground while the current is at the greatest value.

In the primary closed oscillating circuit the voltage loops are located at the condenser plates, the current loop being at the center of the inductance in the circuit. Hence it is a circuit transference rather than that of voltage which takes place in the oscillation transformer. For maximum results, therefore, the secondary of the oscillation transformer should be connected in that portion of the aerial circuit where the current loop is located, i.e., the ground. Sets so connected have by actual test proven their advantage.

We then can forego the panel set located in the operating room and place the transmitting apparatus in the basement with great advantage. By one stroke we make unnecessary a panel, eliminate the noise and gain efficiency.

With such an arrangement it is hardly necessary to burden the technical press with another design for assembling the apparatus. Mount the instruments compactly in a box fastened to the ceiling of the basement, using an oscillation transformer for coupling the aerial and closed oscillating circuit. A pair of No. 14 rubber covered wires can be run up through and the current high at the ground connection the importance of this part of the installation will be fully realized.



Two circuit diagrams showing the secondary of the oscillation transformer coupled to the ground section of the aerial circuit

the partitions to enable a key to be located, at the operating table for transmitting.

The ground lead should run straight to the water pipe or buried wires if pipes are not available. By remembering that the voltage is low

A difficulty is apparently introduced in the matter of switching in the receiving instruments. This can be readily overcome by the insertion of a switch as shown in the accompanying diagram. By mounting the lightning switch so it can be operated by a rod extending through the wall it can also serve as an aerial switch, open for receiving, closed for transmitting.

The transmitter should be carefully adjusted by using a wavemeter and a decremeter. A hot wire ammeter is sometimes very deceptive. The best way is to tune to 200 meters and then get another station to listen in and determine the sharpness of the tuning, loosening the coupling till the wave emitted is clear and sharp. It is well to remember that if the strength of the signal drops to half value by detuning 6 meters on the wavemeter the wave has a decrement of .02 or less. It will be found that a closer coupling can be used with a set located in the basement than one in the upper room of a house with an increase in range.

These paragraphs may cause a state of confusion in the minds of those about to construct a panel set, but it is merely a question of whether the improved appearance of your station is more to be desired than efficiency. Let the amateur decide. Of course he can build a panel set and place it in the basement; or better still, locate his station there with improvement in all respects.

The Vacuum Tube as a Frequency Multiplier

By Clyde J. Fitch

BESIDES being a detector, generator, and amplifier of radio frequency currents, the vacuum tube can also be used as a frequency multiplier. Figure 2 shows a method of tripling the frequency. This method has never been tried by the writer, and is offered only as a suggestion for the experimenter. A sinusoidal alternating current connected to terminals A and B, figure 2, will cause an alternating current of three times the frequency in the circuit L_2C_1, if the tubes are properly adjusted, and the coils L_1 and L_3 are of opposite polarity.

An explanation can be found from the characteristic curve of the tube,

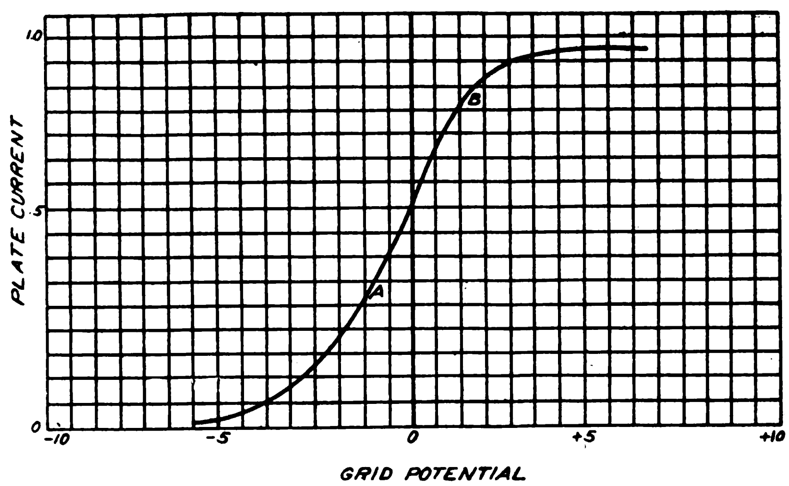


Figure 1—Characteristic curve of the vacuum tube

figure 1. The horizontal axis indicates the potential of the grid in respect to the filament, and the vertical axis, the plate current in milliamperes. As the grid potential increases, the plate current at first increases rather slowly, then very rapidly, then less rapidly, and finally becomes constant at the saturation point. By carefully adjusting the filament current and plate potential of tube V_1, we can operate it at the lower bend of the characteristic curve, at A, figure 1, and the plate current through L_3 will be peaked, as in B, figure 3. By adjusting the filament current and plate potential of tube V_2 to operate at the upper bend of the curve at B, figure 1,

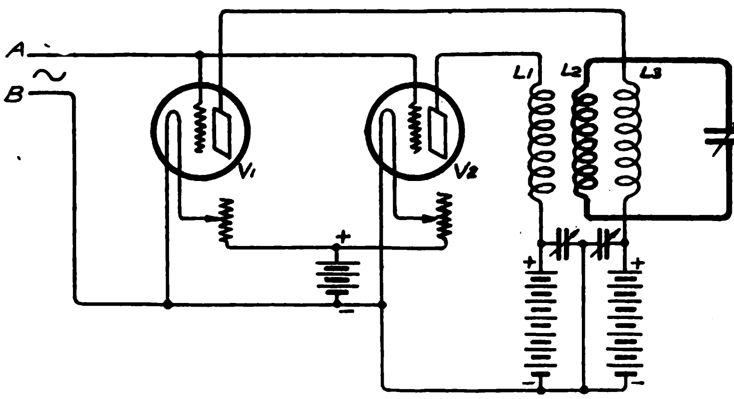


Figure 2—Method of tripling the frequency

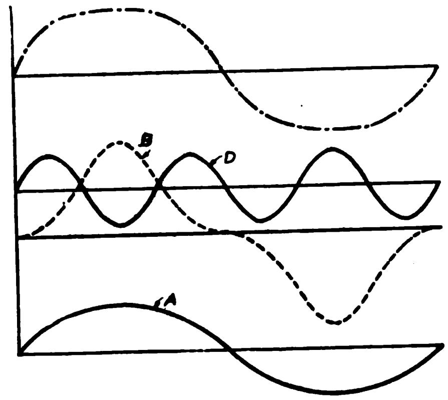


Figure 3—Graphs showing plate current resulting from various adjustments

the plate current through L_1 will be flat topped as indicated by upper curve in figure 3.

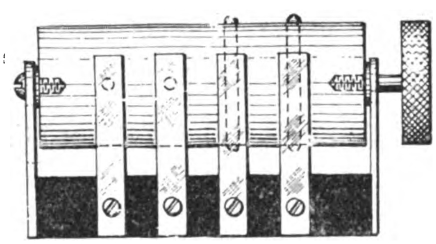
Curves B and C each indicate the presence of a strong harmonic oscillation of three times the fundamental frequency. By connecting coils L_1 and L_3 so they are 180° out of phase, and hence neutralize each other, the fundamental oscillation will disappear, and the harmonic of triple frequency will exist alone. This is shown in curve D, which is obtained by subtracting the ordinates of curve B from those of curve C. Curve D, therefore, represents the resultant current through coils L_1 and L_3 and will induce a similar current in the tuned circuit L_2C_1. Curve A represents the alternating current connected to terminals A and B, figure 2.

Circuit-Changing Switch for Receiving Sets

By Arno A. Kluge

FOR changing various connections in the receiving set when different circuits are being tried, it is often desirable to have a switch that will accomplish this in one operation, instead of using a number of separate switches. Telephone cam switches are commonly employed for this purpose, but these sometimes introduce capacity effects that are unwelcome, and are rather expensive for the amateur of limited means.

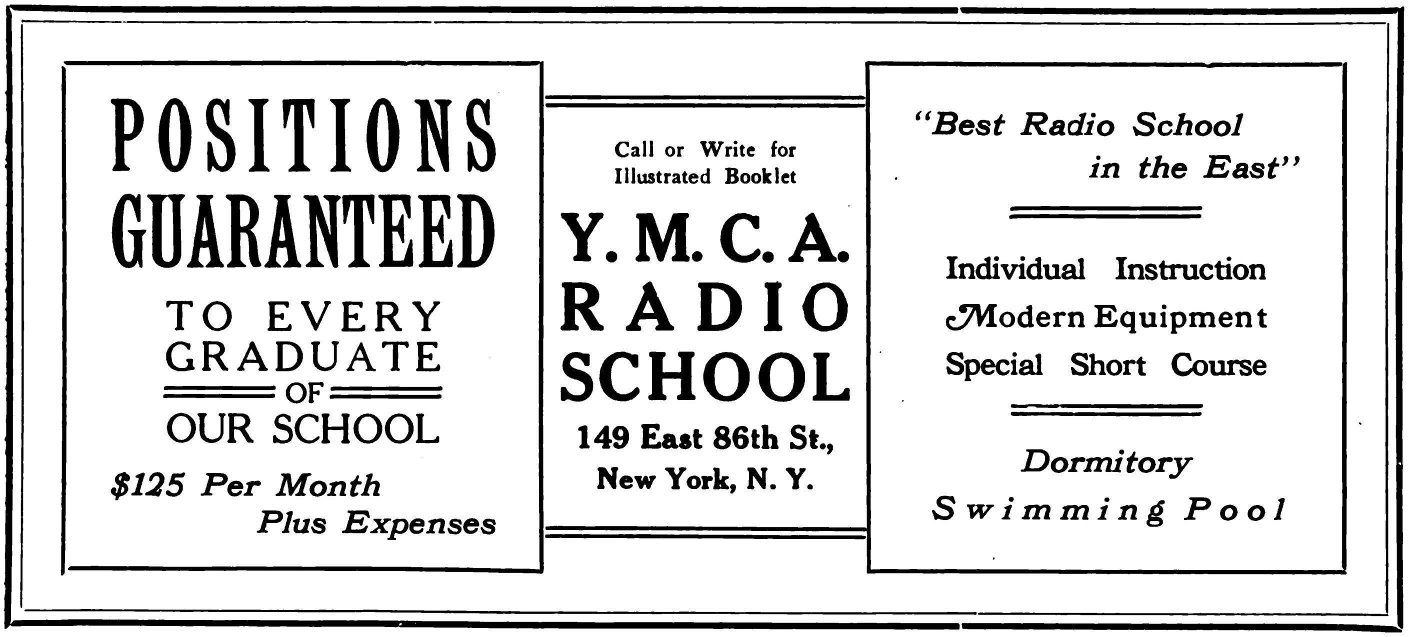
The switch here described is not open to these objections, as it has very small capacity effect and may be constructed of the simplest materials at slight cost. It consists of a rod of bakelite or well-seasoned hardwood, about one inch in diameter, mounted



Complete switch with four pairs of springs

to turn just above a rectangular block of the same material. The bearings for the rod are provided with machine screws threaded into each end, holes ¼ inch deep being drilled for the screws. The bearing supports are made of 1/16 inch brass strips screwed to the ends of the base block.

A series of contact springs touching the sides of the rod are mounted on each side of the base block, and the connections between different sets of these springs are established by means of conductors running through the rod. These conductors are made of ⅛ inch copper or brass rod, forced into holes drilled for that purpose, and projecting 1/16 inch on each side. It will be noted that one pair is at right angles to the other pair, so that the connections are changed by turning the rod through 90°. The contact springs are made of No. 28 phosphor bronze or brass, ¼ inch wide. The accompanying drawing shows a complete switch with four pairs of springs, but any number required may be used.



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A Simple and Ready-Made Aerial

By C. L. Allen

THE cartoon showing the city fisherman with all his fancy tackle but with no fish, and the typical country lad with almost no tackle, but with plenty of fish, is familiar to everyone. Perhaps the average wireless novice is like the country lad in that he has rather meager tackle with which to conduct his wireless experiments. The resemblance ends there, however, for the art of operating wireless apparatus involves a few qualifications not generally encountered in the art of catching fish. No problem is likely to cause as much hesitation, next to the financial one, as that of the aerial. The novice no sooner reads that the "longer and higher the aerial the better" than he longs for a couple of skyscrapers to stretch his wires between. However, he turns over a page only to learn that someone has actually buried the aerial in the ground—it's no longer an aerial. The novice may accept these statements, but he doesn't understand them. Such extremes are too much for a beginner, and it is as much of a mystery to him as the latest fashions showing women wearing furs in summer and socks instead of stockings in winter.

In selecting the proper type of aerial, therefore, the beginner will perhaps do well to compromise on a happy medium, especially if his purse is inversely proportional to his ambition.

The writer, being affected with the usual beginner's troubles and in addition being, paradoxically, lazy as well as ambitious, began by looking about for a "ready made" aerial. After debating several schemes and trying others he found a possible solution of the problem in the common down-spout and tin gutter of his house. The spout was of copper and the gutter of tin, both of good size, and the latter not over thirty feet from the ground, but extending completely about the house. A wire was soldered to the spout near the bottom and led into the house, with a jack knife switch placed in the circuit between the spout and the instruments.

Two grounds were available at pleasure by means of a two-point switch, one on the water pipe and the other on the gas main, the latter at the point where it entered the house from the street.

This "ready made" aerial—found on practically every dwelling, however humble or elaborate—actually offers the novice something for nothing and, aside from the moment consumed in soldering the connecting wire, involves no expenditure of time or labor. If in a given case it does not give desired results, it might be kept in mind that height is really of consequence, and a "three decker" dwelling is preferable to the bungalow type.

The arrangement offers no added danger from lightning, does not need any ground switch, is not liable to be blown down by storms and is not conspicuous before the general public.

With a tuning coil, a simple detector-condenser and a pair of four dollar 2000-ohm receivers, the writer began the job of "listening in." No fisherman ever waited for a bite with greater eagerness or with less results. However, after much trying of this and that, until patience had ceased to be a virtue, one evening, "while I nodded, nearly napping, suddenly there came a tapping, as of someone gently rapping"—and, behold! NAF (Newport, R. I.) made its first recognized entry.

There is something about hearing one's first wireless signal that is a reward for all the work and time that has gone before: like the boy's first rifle it may be a pretty slim affair but it's real, and it's his. What further joys the reading and grasping of a complete message might bring, the writer could then only surmise, for his knowledge of the code was very limited.

One of the biggest fish in the wireless pond is the time signal sent out by high-power stations, and since it calls for no knowledge of the code it is not so very difficult to angle for. However, the wireless sets usually described as suitable for time signal reception are somewhat more elaborate than the simple outfit already mentioned, and the aerials are "longer and higher." It was only by chance, therefore, that the writer was listening in late one evening, and it was only a childish desire to see the wheels go 'round that made him push the slider much further along the coil than usual, which accidentally put the receiver in tune with NAA (Arlington, or Radio, Va.) Signals came in on his tin gutter aerial, located in New England. The signals did not come in like the boom of a cannon, nor even like those of the "buzzer," but they were audible.

Subsequent trials were disappointing, especially in the daytime, and so a loose coupler was substituted for the coil and several crystal detectors were also tried. Crystal detectors remind one of the old adage "when she will she will, and when she won't she won't, and there's an end on 't." Doubtless other detectors are equally guilty. Fortunately there is nothing bigamous about having more than one detector; in fact, there seems to be safety in numbers, although two will answer nicely and also reduce the expense. The detector is the very heart of the apparatus, the *sine qua non* of the whole, yet the most satisfactory detector the writer has used to date cost about two dollars and was of a simple vertical type with a ball and socket adjustment, the galena crystal enclosed in glass, and the whole looking more like a tiny lantern than anything else. With this equipment the reception of signals at night could be depended upon fairly well, although some nights were better than others. With the approaching summer they grew weaker. The aerial apparently worked equally well during rain or sunshine.

Having tried a much-advertised amplifying device without getting the desired results, I experimented with a pair of high-priced receivers of novel design, acquired from a fellow "bug." After repeated trials no appreciable improvement was noticed and added respect was acquired for the cheaper telephones which were apparently giving results out of all proportion to their cost.

With a pair of ordinary wireless receivers bridged across a fixed condenser and with a good detector and loose coupler many of the long winter evenings will not seem so long, even in these dry times, and the total cost need not exceed ten or fifteen dollars.

By getting a book on first principles of wireless, any Tom, Dick or Harry can learn to manipulate a set and secure results. Experience is the best instructor. Moreover, the wireless telephone is already knocking at the door and will in all probability be in regular use ere long. The novice can then entertain the whole family whether they know any code or not.

Prize Contest

The next Prize Contest Subject is:

"The Design and Construction of a Simple Wavemeter, Range 150 to 300 Meters."

Those designs which are built around any one of the standard type of condensers obtainable on the market will be given preference. The data should include a calibration curve for the instrument.

The prize-winning articles will be published in the June issue. Closing date, April 17th.

Contestants for the prizes are requested to submit articles at the earliest practicable date.

To one who pays frequent visits to the stations of his amateur friends, it is surprising to note the absence in the majority of these, of any form of wavemeter. A wavemeter is a very simple thing. It is also an extremely useful device and the simplicity of its construction, together with its usefulness, should be sufficient incentive for every amateur to construct one.

PRIZE CONTEST CONDITIONS—Manuscripts on the subject announced above are judged by the Editors of The Wireless Age from the viewpoint of the ingeniousness of the idea presented, its practicability and general utility, originality, and clearness in the description. Literary ability is not needed, but neatness in manuscript and drawing is taken into account. Finished drawings are not required, sketches will do. The contest is open to everybody. The closing date is given in the above announcement. The Wireless Age will award the following prizes: First Prize, $10.00; Second Prize, $5.00; Third Prize, $3.00; *in addition to the regular space rates paid for technical articles.*

All manuscripts should be addressed to the Contest Editor of The Wireless Age.

5AP in Texas

STATION 5AP, illustrated in the accompanying photograph, is the property of Raymond L. White, of Ennis, Texas, and is located three miles from the city of Ennis, at the Lake Side Country Club.

The station is a one-room boxed building, and is something similar to the radio cabin found on boat deck of the average ocean going liner. It is situated at the end of one of the 60-foot masts, and a six-wire inverted L antenna is employed. There are no buildings or obstructions near, and when the station is fully completed some very efficient work is expected.

Station 5AP, owned and operated by Raymond L. White, Ennis, Texas

In location it is something similar to that of 9ZN.

The transmitter consists of a 1 k.w. Thordarson transformer having a secondary voltage of 24,000, twelve Murdock moulded condensers with a capacity of .0017 mfd. each, connected in series parallel (seven condensers and one rack missing), Murdock non-synchronous rotary gap. The oscillatory transformer is made of 1" x 1/16" brass ribbon and mounted as shown, the hot-wire ammeter is just to the left of the oscillatory transformer mounted on the marble slab; the necessary connections for the transmitter are of copper braid 1 1/16" in width.

The receiver consists of a navy type loose-coupler (short wave regenerative receiver coming). The arc receiver has a wave length of 300 to 18,000 meters.

The installation of a short wave regenerative receiver has since been effected. Stations on 425 meters (special amateurs) and 600 meters come in exceedingly well.

Electrostatic Coupling

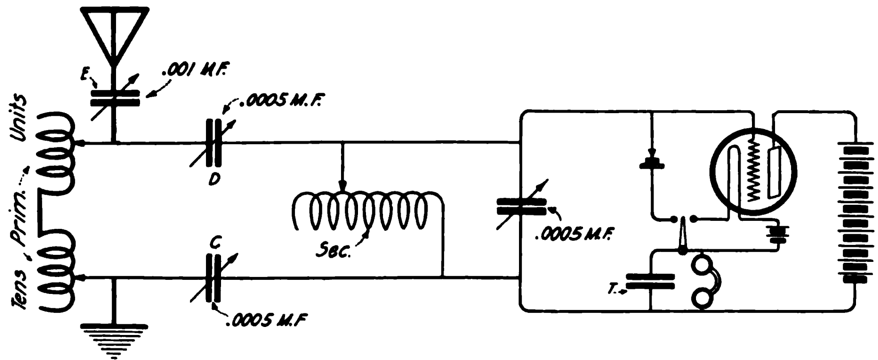
R. Newell Turner

IN the majority of cases, descriptions of radio receiving sets which are published in THE WIRELESS AGE and other magazines, refer to electromagnetic coupling.

It appears just a little odd that so few have turned their attention to the electrostatic or capacitive coupling, and I am sure experimenters would be more than repaid if they would investigate it.

I have used the "loose coupler" for some time, but I have now discarded it and have made a receiver with a capacitive coupling which is more satisfactory than I have ever found the inductive coupling to be.

The set is more compact and more rigid because the "loose coupler" is replaced by multi-layer coils which are permanently fixed. The coupling is not only easier and quicker to adjust but more complete and it affects the wave length less than the inductive couplings.



Secondary coil should be perpendicular to primary. Condenser "E" may be placed either in series or multiple. It may be omitted entirely, but better to have it as in diagram. Condenser "C," the coupling condenser connected to the ground, may be omitted, but if so, the set will be slightly less selective

The capacitive coupling is very selective and, in comparative tests, signals came in louder than with the "loose coupler."

The experimenter will find that the condenser bridged across the 'phones may be of much greater capacity than is ordinarily used.

The condenser in the primary circuit could be omitted, but it is valuable for "stiffening the circuit," as Marconi calls it.

One of the coupling condensers, the one connected to the ground, may be omitted, and although the set will be slightly less selective, you will still find it better than any "loose coupler."

In changing from the crystal to vacuum tube, a two point switch is used which closes the filament circuit when it is needed and opens it when the crystal is used. It will be seen that the vacuum tube circuit is regenerative.

Some Recent Amateur Apparatus

By W. H. Kirwan

BEFORE the war I tried to perfect three tuners, one of the 200 meter regenerative type, the other an Arlington tuner efficient on wave lengths from 600 to 3,000 meters, and the other a small 20,000 meter tuner. Success was achieved in designing the coils, but trouble came immediately thereafter because a certain European nation had the idea that it could lick the world and all the amateurs therein. Some will remember that amateur work then stopped for a while. But the original scheme about the three units did not die and all three tuners are perfected. They weigh 2 lbs. each and are about 4" x 4" x 3" in size. The highbrows claimed the tuners were no good, could not possibly work, and said lots of other things that did not in the least discourage this hard-boiled amateur.

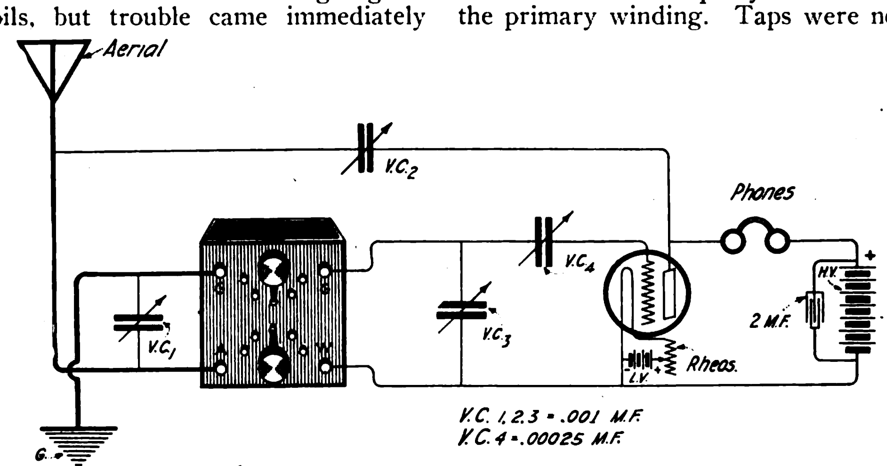


Diagram of the vacuum tube circuit used with the three tuners of 200, 600-3,000, 4,000-20,000 meters range respectively

This type of tuner is wound with 800 turns of No. 28 enameled, silk covered, or cotton covered wire, all of which were found equally efficient for the primary winding. Taps were not used; instead, a loop of the wire was brought out at 5 equal points, 160 turns apart. It was found that taps caused trouble in shorting adjacent layers. I have wound the primary coil with this wire, using a lathe for the purpose, and getting what has been called the involute winding, but fair results may be obtained by winding the coils any old way you want to. I have wound the coils so that the wire makes 1½ turns and advances across the coil ¾". This makes the pitch of the winding ½". At this point the winding returns to the width of the wire from where it started, crossing the first wire or layer twice. The winding is advanced the thickness of the wire after each 1½ turns, by properly gearing the lathe; it starts back that much quicker from the other end. This makes a coil that is self-contained and needs no outside wrapper to hold it together. Eight hundred turns are wound on a wooden form ¾" wide and 2" inside diameter. This gives an outside diameter of about 3", depending on what kind of wire you use.

The secondary is wound the same way, only the form is ½" larger in diameter; No. 32 wire, enameled, silk or cotton covered; all work equally well. The secondary should have at least 1,200 turns of wire, tapped at 5 equi-distant points and use the loop tap, not the soldered tap. These two coils will then have 6 taps or wires coming from them, the beginning, the end, and 4 taps.

Now you come to the point where no one can help you outside of yourself. Get your vacuum tube circuit ready just exactly like the diagram. Lay the coils along side of each other and test for the position of these coils, where the signals come in the loudest. You may get a signal one way, but the signal is increased by turning the coil end for end. Place these coils in a wooden box about ⅜" stock outside dimensions, 4½" x 4½" x 2¾" without the top. Have the bottom a little larger than sides, and champer off the edge. Take a small piece of paper about 1" x 2", punch 6 holes in it, mark the holes

B-1-2-3-4-5, use one on both primary and secondary, by running the wires through the holes, and see that the taps are as marked. These coils then may be put in a small box or tube just big enough to hold them and a good grade of paraffin poured into the box.

The wax not only makes the coils waterproof, which is an important factor in damp places, but foolproof as well, which is equally important.

The marked peculiarity of this tuner is the fact that it functions perfectly on wavelengths from 4,000 meters to 20,000 meters, without any tickler coil and by using electrostatic coupling only. There are 4,000 meters between each tap and all signals in between these taps are easily read by using the condensers.

These tuners were tested in Alaska and Florida, Maine and California; then thinking to make the test complete, they were tested in New York. They work equally well with a single wire 25 ft. high by 40 ft. long, anywhere.

LCM, the new station in Norway, is readily copied each evening with an aerial of this size in Davenport, Iowa, without using any amplifier, and only using a plain bulb.

XDA, the station in Mexico, comes in on his natural tone with the aerial wire connected to the ground terminal and without any ground wire to it at all, merely using the capacity of the body as a ground. I have tried the tuners with the underground aerial, and with the Jones underwater open end coils, and they function equally well, using different hookups, however. Loop aerials also work.

The 2 mfd. condenser across the high voltage battery is optional, but remember that the tuner will only oscillate properly with the aerial and ground wire connected properly with reference to the grid and wing.

Decrement and Tuning

By THOS. W. BENSON

ACCURATE determination of the decrement of a transmitter is rarely ever attempted by the amateur, though its approximate value can be readily found by those possessing a wavemeter.

Every operator has noticed that a sharply tuned set requires careful adjustment of the values of inductance and capacity for maximum signal strength, a difference of a few degrees on the condenser or a few turns on the loose coupler weakening the signal to a very appreciable extent. With poorly tuned sets where the decrement is high, the signals are not affected by a relatively large change of the adjustments at the receiving stations.

Advantage can be taken of this fact to employ a wavemeter without any changes to determine whether the decrement exceeds the limit set by the government. It will be found that at 200 meters, detuning 6 meters will not weaken the signal to less than half its intensity if the decrement is .2 or less.

Thus, when a detector and phones are employed, the decrement of a transmitter can be found roughly by placing the wavemeter quite a distance from the transmitter so the note in the receivers at its maximum intensity is comfortable, that is, not annoyingly loud. Then detune the wavemeter till the tone has dropped to half its former value. Now determine the wave length at the last setting of the condenser. If the difference between the actual wave length of the transmitter and the wave length giving half-signal intensity is greater than six meters, the decrement is too great. Should it be six meters or less, the decrement is within legal limit. This is a very handy method of checking the sharpness of the emitted wave.

The decrement can be decreased by

loosening the coupling between the primary and secondary of the oscillation transformer, thus getting the aerial circuit to oscillate freely at its natural period.

The tuning of a set is often done by means of a hot-wire ammeter but there are certain characteristics of this instrument that lead to short range and poor tuning. An ammeter may often give a high reading while the range of the station and sharpness of the wave is anything but good.

Consider a set emitting a highly damped wave with two humps, as is usually the case. This results from too close coupling between the primary and secondary of the oscillation transformer, permitting the aerial circuit to react on the primary oscillation circuit.

At the receiving station only one of the humps can be tuned to at a time, and only the energy represented in that particular hump will affect the receiver, the energy in the other hump being wasted. But the ammeter at the transmitter will record the current in both humps, which would indicate plenty of power in the aerial circuit, whereas but a portion of it can be utilized at the receiver.

Loosening the coupling and making the wave sharper may reduce the ammeter reading, but the range will be increased. This is due to the fact that the energy is lumped into one hump and has a greater effect on the receiving set. Though the actual current in the antenna is reduced, it is so distributed that it is more effective than the larger current value divided into two, and sometimes more, humps.

Therefore, when the range is out of proportion to the ammeter reading it is not always the fault of the meter nor of the receiving set. Under these conditions, check up the decrement as previously described and it will usually be found to exceed the amount permissible in an efficient set. A broad wave is not only a nuisance in the ether, but it is a waste of power, has a bad effect on the range of transmission and the sure sign of a "Ham."

Apartment House Antenna

THE apartment house has always been a draw-back to the Radio Bug. It is hard to obtain a permit to put up an antenna, and if a permit is obtained, there is always some old woman who is afraid of lightning and will complain to the owner. After which, much to your sorrow, the antenna you put up to stay has to come down. But fear not, there is still a chance, a good chance, of coming into your own.

You have no doubt heard of people using such things as beds, fire escapes, gas fixtures, etc., but when you tried to use them they did not work. Well, here is one that will, and you can sit down and listen-in to your heart's content.

You know when you have visitors and the bell rings, and you or mother run out in the kitchen to press the button so that the ticker on the door will work. Well, that's the secret. All you have to do is to unscrew the button cover and inside you will find two connections. Attach a piece of wire to one of these and connect to the antenna binding post of your set; connect another piece of wire from the water pipe to the ground post of your set, dust off the head set, connect them in—and you can sit back and listen to the music that touches your heart.

A New Club in Brooklyn

AT the first meeting of the Bedford Wireless Association, held in the radio room of the Bedford Y. M. C. A., Brooklyn, N. Y., the following officers were elected: G. Johnson, president, and J. Corcoran, secretary. Two instructors have been secured, Dr. Happe, an all-around radio man, and Mr. Bowie, formerly radio instructor in the U. S. Navy Radio School at Harvard University. They give instruction every Friday night from 8 to 10 p. m. Arrangements are being made for members to visit the big naval wireless stations and those maintained by the different local newspapers.

The club has a receiving set, 15,000 meters, and a transmitter with a motor generator, ½ k.w. transformer, 5 Murdock condensers, a rotary gap and an oscillation transformer.

All those in the Bedford district who are interested in wireless and who would like to join, see or write to Mr. James Corcoran, secretary, 420 Gates avenue, Brooklyn.

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.

F. LaB., California:
The receiving range of your outfit will depend, you understand, upon the power used at the transmitting station. Under good conditions, you should be able to receive from the medium power stations, a distance of 2,000 to 3,000 miles.

Your single wire antenna 35 ft. high and 100 ft. long, will have a fundamental wave length of about 165 meters. The two wire antenna, 25 ft. high and 50 ft. long, spaced 8 ft. apart, will have a fundamental wave length of about 120 meters. The fact that you are using a ground lead 35 ft. long will increase both these wave lengths to some extent.

The use of a vacuum tube would probably more than double your average receiving range.

We are at a loss to understand your inability to receive San Diego time signals at night when you are able to hear them at noon. It may be possible that the absorption at his wave length is greater under night conditions than under day conditions. This is sometimes the case; instances having been known where communication was possible at, say, 3,000 meters during daylight, and only possible at a much shorter wave length during night time.

From what you have to say about the action of your tuner, we are led to suggest that you procure a good text book on radio telegraphy. Instructions for the proper manipulation of a receiving transformer and explanations of the "reason why" will be given there.

A tin shack underneath your aerial would somewhat reduce its effectiveness.

Another condenser in shunt to your primary winding would increase your wave length, but we suggest the use of additional inductance instead.

* * *

F. B. A., Pennsylvania:

The current which flows through the receivers in a vacuum tube circuit is a pulsating direct current.

Coupling the plate circuit to the grid circuit will produce an alternating radio frequency current in both the grid and wing circuits. A vacuum tube is a repeater. If an impulse is thrown upon the grid of a vacuum tube, the rate of electron flow which is taking place between the plate and filament of this same vacuum tube is changed, due to the change of state of the grid. Now, if the plate circuit is coupled to the grid circuit, any change in the electrical states existing in the plate circuit as a result of impulses thrown upon the grid, will be communicated to the grid, which will in turn disturb the electrical state in the plate circuit a second time, and so on. Thus, if the grid circuit and plate circuit disturbances are properly timed by the tuning of the plate circuit and the grid circuit and by the use of a particular value of coupling between these two circuits, this reflex action will continue indefinitely and the tube is said to be in an oscillating state or to be a generator of oscillations. The frequency of these oscillations depends upon the electrical period of (usually) the grid circuit. The electrical period of the grid circuit in turn is determined by the value of inductance and capacity in this circuit. For ordinary radio work, these values are of such order as to produce frequencies above the range of audibility of the human ear. They, therefore, cannot be heard. If you wish to hear the oscillations of a vacuum tube in your telephones, it will be necessary for you to use inductance and condensers of such size that oscillations are forced to take place at frequencies lower than about 15,000 cycles per second.

The coupling between the wing and grid circuits may consist of resistance, inductance, or capacity. The effect in all three cases is the same. Resistance coupling is seldom used due to the losses which take place in the resistance. Capacitive coupling is often used on account of its simplicity and, perhaps, its convenience; but inductive coupling is usually the most satisfactory, and this is particularly true when amateur wave lengths are being dealt with; capacitive coupling being suitable in every respect only at the longer wave lengths.

* * *

W. O., Indiana:

With reference to the article describing a short wave regenerative receiver in the May, 1919, issue, the loose coupler primary should be 3¾" in diameter and 2½" in length. The size of the secondary should correspond with this.

* * *

C. R. L., Illinois:

It will be necessary for you to secure a license for transmission of any sort, in order to be on the safe side.

* * *

J. A. B., New Hampshire:

With reference to your first hook-up, if you will shunt the telephones and high voltage battery with a condenser of about .001 mfd., oscillations will be more easily obtained. The fact that your antenna and ground are connected directly across the grid circuit inductance will increase the effective resistance of that circuit to such extent as to make the production of oscillations considerably more difficult; that is, to require abnormally close coupling between the plate and grid circuits.

With reference to your figure 2: If your inductance and capacity are of the proper value, you should have no difficulty in making this work easily at any wave length. Try a variation of your inductance.

Regarding hook-up number 3, if one of your two tubes is to be an oscillator, the efficiency of the outfit cannot be materially increased, if at all, by the use of a radio frequency amplifier tube. You might better use this tube as an audio frequency amplifier.

* * *

F. G. O'B., Nova Scotia:

If you place one of the receivers of your head set on a phonograph horn the volume of the signal received will be very greatly increased, and inasmuch as you are using a three-stage amplifier this should prove suitable for time signals, etc. The resistance of the receiver may be of the usual order, that is, 1,000 to 2,000 ohms.

With reference to the data on your transmitter: Assuming that the dielectric constant on the glass in your condenser is 3, the capacity is approximately .005 mfd. From the data which you have given, the approximate inductance of the primary of the oscillation transformer is 25,000 centimeters. Under these circumstances, your maximum wave length is probably about 445 meters. If you wish to increase your wave length to 600 meters, you may do so by doubling either the capacity or inductance in your closed circuit, and, in all probability, doubling the inductance in the antenna circuit will be sufficient for that circuit.

Your 200 ft. aerial, 80 ft. high with the 3 wires, inverted L, has a fundamental wave length of approximately 375 meters. This antenna should be used for your 600 meter work.

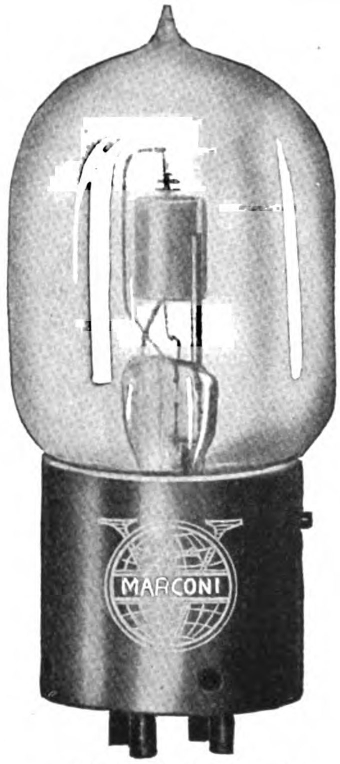
Book Reviews

Airplane Antenna Constants.

In this new paper which the Bureau of Standards has ready for distribution, methods are described for measuring the capacity, inductance, resistance, and natural wave length; also the directional transmitting effect of airplane antennas, when the plane is flying. Using these methods results obtained upon various forms of fixed antenna, as well as with one, two, and four trailing wires, are recorded.

Selenium Cells and How They Are Made. By Samuel Wein. The Progress Publishing Co.

This book should be welcomed by those who would like to carry out some of the extremely interesting experimental work which is possible with selenium cells. The publication gives a concise chronological review of the history and development of selenium cells, as well as some very practical data on their construction.



Fleming Pat. No. 803,684
De Forest Pat. Nos. 841,387-879,532

A WARNING

to Manufacturers
Importers
Dealers
Jobbers
Agents
Amateurs
Purchasers
Users of

Vacuum Tubes

The Marconi V.T. Patent is Basic

United States Letters Patent to Fleming, No. 803,684, November 7, 1905, has been held to be valid by Judge Mayer of the United States District Court for the Southern District of New York, and by the United States Circuit Court of Appeals for the Second Circuit.

It is a basic patent and controls broadly all vacuum tubes used as detectors, amplifiers or oscillions in radio work.

No one is authorized to make, sell, import or use such tubes for radio purposes, other than the owners of the patent and licensees thereunder. Any others making, selling, importing or using them alone or in combination with other devices, infringe upon the Fleming patent and are liable to a suit for injunction, damages and profits. And they will be prosecuted.

THE AUDIOTRON AND THE LIBERTY VALVE ARE NOT LICENSED UNDER THE FLEMING PATENT

The price of the genuine Marconi V. T. delivered is $7.00 each. The standardized socket is $1.50 additional. The standard resistance, complete, costs $1.00 and is made in the following sizes: ½ megohm, 1 megohm, 2 megohms, 4 megohms, 6 megohms.

Do not take chances by making, importing, selling, purchasing or using vacuum tubes for radio purposes not licensed under the Fleming patent. By selling, purchasing or using licensed tubes for radio purposes you secure protection under the Fleming patent and avoid the risk of litigation for infringement thereof.

This warning is given so that the trade and public may know the facts and be governed accordingly.

Send all remittances with order to COMMERCIAL DEPARTMENT

RADIO CORPORATION OF AMERICA
MARCONI WIRELESS TELEGRAPH CO. OF AMERICA
233 Broadway Woolworth Building New York

Sole Distributors for De Forest Radio Telephone & Telegraph Co.
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Insurance Exch. Bldg., San Francisco, Cal.
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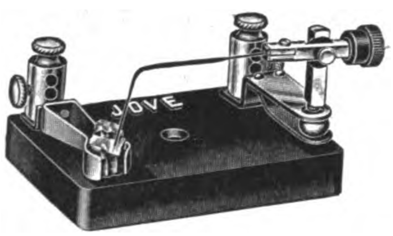

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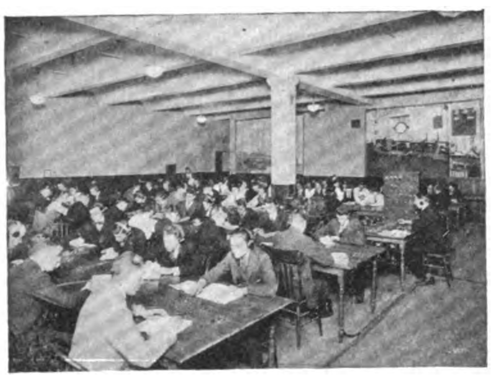

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More than 200 young men are enrolled in our classes preparing for employment in the Merchant Marine.

The demand for EXPERT WIRELESS OPERATORS is enormous. The position is most remunerative and the work is unusually pleasant.

The junior ship operator receives $100 per month, the senior $125 per month, to which is added $3.00 per day subsistence pay when the ship is in port.

You may enjoy the life of a globe-trotter and receive this salary by studying from three to four months at the Institute.

Prospective applicants are urged to investigate our course before enrolling elsewhere. Remember that by far the greatest number of assignments to the ship service are made in New York City.

The Trans-oceanic Division of the Marconi Company is in need of expert Continental Morse operators.

Write us for facts regarding the present radio situation.

We have more than 6,000 graduates to our credit.

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FOR INSTRUCTION IN

WIRELESS TELEGRAPHY

Afternoon and Evening Classes throughout the year.

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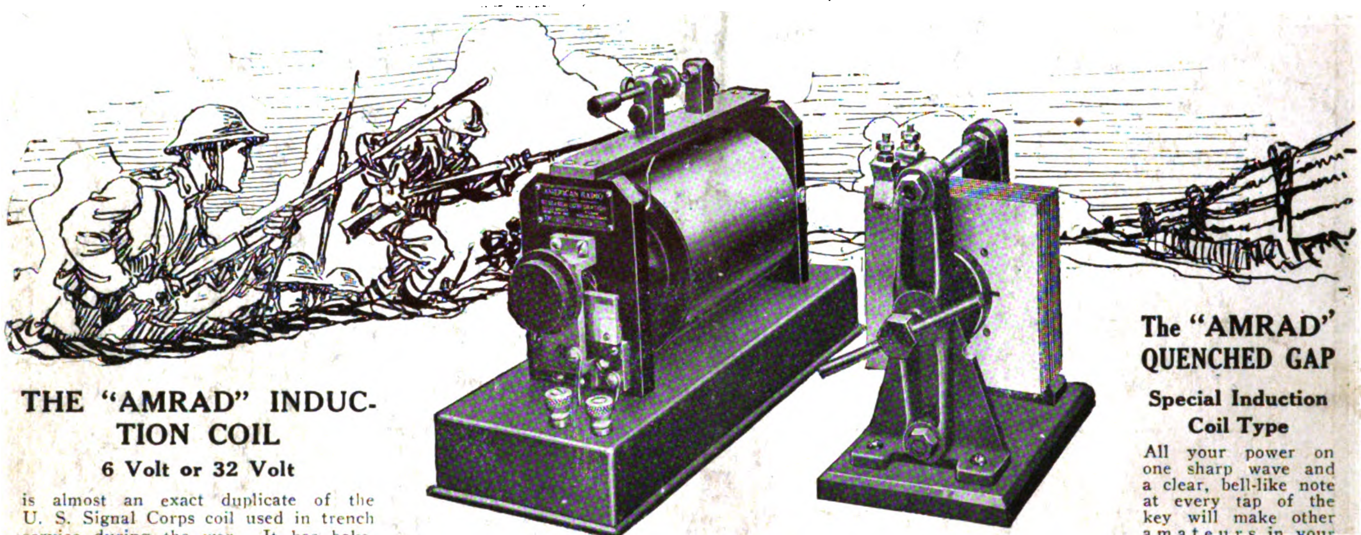

THE "AMRAD" INDUCTION COIL
6 Volt or 32 Volt

is almost an exact duplicate of the U. S. Signal Corps coil used in trench service during the war. It has bakelite insulation throughout. Its secondary, wound in 29 sections, produces 50,000 volts. Rated at 100 Watts this coil has an output about 100 per cent. greater than the average 2 inch coil. The vibrator is rugged, steady and non-sticking and designed to give a spark frequency equivalent to 100 cycles which means maximum transmitting range on short wave lengths. The 32 volt coil is intended especially for use on farm lighting circuits. When ordered separately this type is $1 extra. To get maximum results with the 6 volt coil a heavy 6 volt storage battery is the best and most economical source of current.

Price, 6-volt type............................**$28.50**

The "AMRAD" QUENCHED GAP
Special Induction Coil Type

All your power on one sharp wave and a clear, bell-like note at every tap of the key will make other amateurs in your state sit up and take notice. The Amrad Quenched Gap carefully operated, yields the secret of long range transmitting on low power. This special gap is identical in design to the heavy ½ k.w. and 1 k.w. Amrad Quenched Gaps now being installed in long distance amateur stations. Not only will this special quenched gap make your transmitter as efficient, for its power, as the more costly equipment, but you will be able to send more messages without interfering with other stations. For the first time in the history of amateur radio every induction coil transmitter can now be tuned to comply with Government decrement regulations. The Amrad Quenched Gap is the secret.

Price, Induction Coil Type....................**$12.50**

Special Introductory Offer

If you have had limited power at your disposal and inefficient apparatus or if you are waiting to be introduced to the fascination of sending radio messages over into the next county or state here is your chance to get the two most important pieces of transmitting apparatus at an actual saving of $7.50.

"Amrad" Induction Coil, regular price,		- - -	**$28.50**
"Amrad" Quenched Gap,	" "	- - -	**12.50**
			$41.00

Special Price for the Double Buy, $33.50

Either 32-volt or 6-volt coil may be chosen

How to Order Show this advertisement to your dealer and ask him to order one of these combinations for you. If you have no radio dealer in your vicinity send us check or money order for $5 and we will ship direct to you by parcel post C. O. D., the balance plus postage. Act promptly, as the standard Signal Corps parts which we secured from the Government were only sufficient to make up a limited number of sets. If you are not ready to buy and want further information send for free Bulletin P which contains complete description and operating directions.

Dealer's Opportunity Write at once for short-term trade discount on this combination. No better opportunity to introduce apparatus of such high quality at such low prices will ever be had again. The offer is made especially to introduce our rapidly growing line of "commercial type" radio apparatus.

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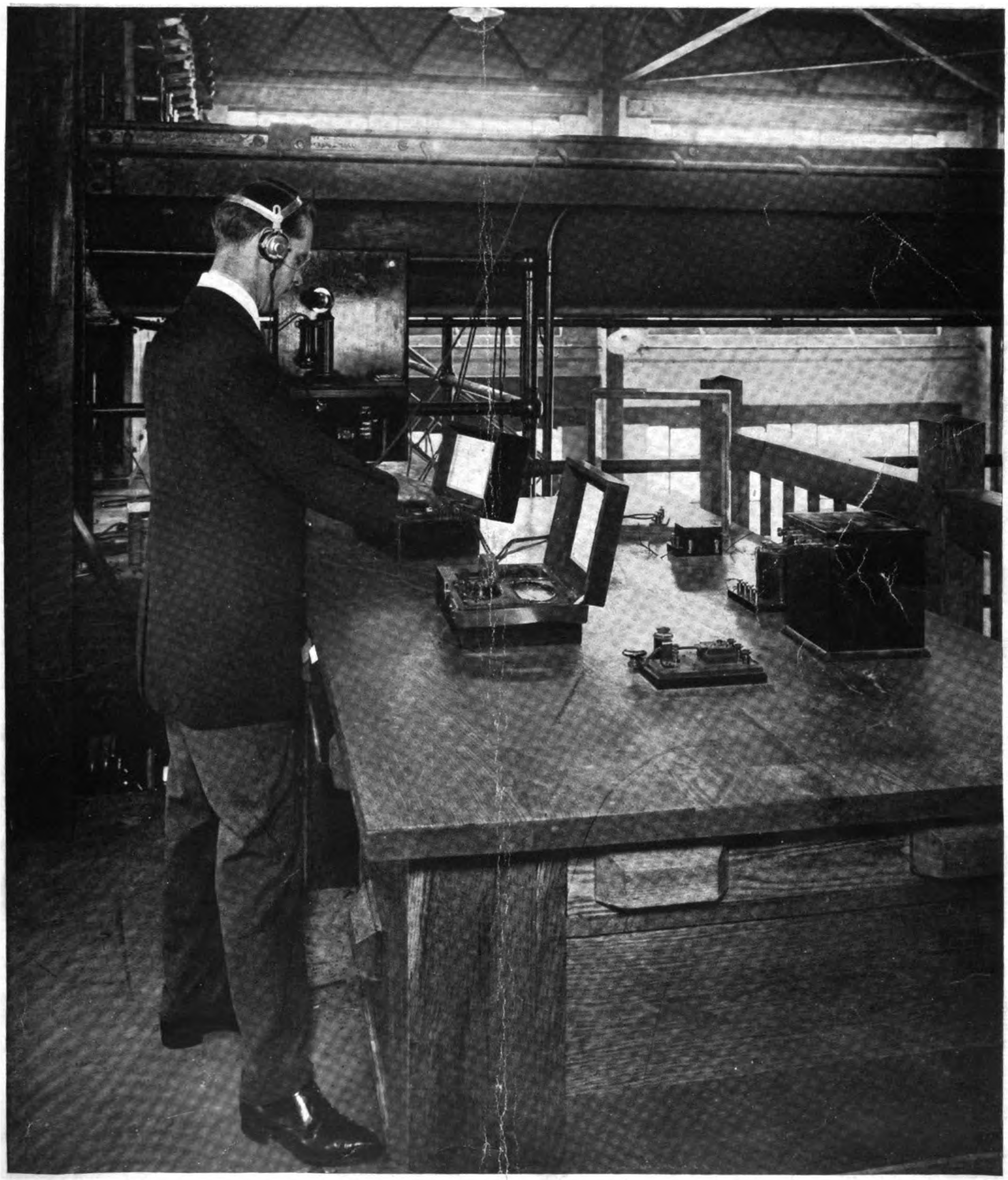
April, 1920

20 Cents

The WIRELESS AGE

Volume 7 Number 7



The Supervisor and His Instruments at a Trans-Atlantic Radio Transmitting Station

The Coil Aerial—Its Use as a Direction Finder
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for determining
Antenna Currents

Model 400

Self-contained. Front-Connected
Radio Frequency Ammeter

Weston

Model 400

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(Not a Hot-Wire Instrument)

is a Switchboard Type Instrument
7¼ inches in diameter.

Guaranteed accuracy of 1%. Equally accurate on currents of any audio or radio frequency.

Unaffected by changes in temperature. Extremely low power consumption. Can be used where bad wave form or frequency precludes the use of other forms of instruments.

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Vol. 7 Contents of **The Wireless Age** for April, 1920 No. 7

Edited by J. ANDREW WHITE

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Entered as second class matter Oct. 9, 1913, Post Office at New York, N. Y., under the Act of March 3, 1879.

THE VACUUM TUBE SITUATION

WHEN the Marconi-Deforest patent arrangement was first entered into, whereby the Moorhead - Deforest - Marconi V. T. was put on the market, the Wireless Improvement Company purchased the first large supply in order to get the pick of the limited quantity originally acquired by the Marconi Company.

We understand the above arrangement has now been terminated and only those who have still a supply of tubes in stock will be able to furnish them for the present.

We have decided to give the amateurs the benefit, for 30 days only, of the large stock we have been carrying for dealers. For the next 30 days, while they last we shall accept orders at list price $7.00 Net, Parcel Post Paid. Check or money order should accompany all orders. These are all picked tubes and are fully guaranteed.

We manufacture a full line of apparatus and accessories, all complying with Navy specifications — which are available to the High grade amateur and experimenter.

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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. 4)

Vol. 7. No. 7. April, 1920

THE WIRELESS AGE

WORLD WIDE WIRELESS

China Adopts Radiophone Between Cities

CHINA, that land of oriental apathy, which has been asleep for centuries while other nations have moved forward in the march of progress, has beaten the world in the adoption of one modern idea. Guglielmo Marconi calls attention to the fact that China is first among the nations to adopt wireless telephones to carry on communication between cities and rural districts. However, Marconi predicts that wireless phones will within a year supplant the present kind in many lands and that they will be given the widest use in the United States, which, he says, heads the list of nations in wireless inventions.

The wireless telephone has limitless possibilities and should be a great advance step over the present cumbersome system, which requires an enormous amount of work to keep up and at a tremendous expense.

Chinese Government to Establish High Power Stations

IT is reported that the English Marconi Company is making arrangements with the Chinese Government to establish high power stations in Pekin, Urga, Urumohi and Kashgar, which will be able to communicate day and night with the Indian Government station of Simla. There also are to be subsidiary stations in Uliassutai, Kobda, Sianfu and Hami. It seems evident that well informed people feel that these trade routes are of very great importance. If a railway is to be constructed from Kalgan through Urga to connect with the Trans-Siberian, and the old routes to India are to be reopened, the situation in eastern Asia will be materially affected.

Wireless Service for Mexican Border Patrol

IN order to reduce the danger of American Air Service pilots accidentally flying over Mexican territory or becoming lost while on border patrol duty, the commander of the 91st Aero Squadron stationed temporarily at Ream Field, Imperial Beach, Cal., has had every plane of the squadron equipped with a radio set with a wave length of 377 metres, which is the best wave length to dodge interference. All pilots are required to check their position every five minutes.

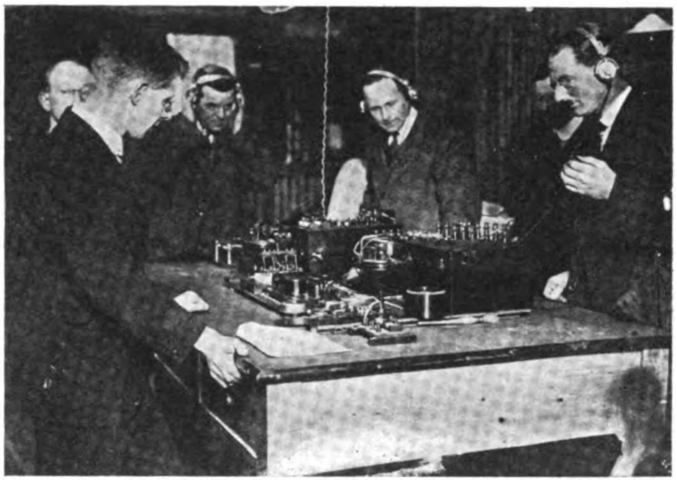
As a further precaution the radio officer of the 91st Squadron has erected at Ream Field a radio compass station by which readings are taken while planes are sending in their position reports. As the course is almost straight east from Ream Field the radio officer can tell almost instantly whether a given plane is holding to its proper air line.

Should a pilot become confused, lose or mistake his position and turn south, the radio compass would immediately show that the plane was over Mexican territory.

1500-Mile Radiophone Message at Sea a Surprise

NEWCOMB CARLTON, President of the Western Union Telegraph Company, returning from a vacation in England on the steamship Baltic, said that on the trip the wireless operator of the vessel afforded him an opportunity to hear a voice over the wireless telephone from a distance of 1,500 miles. There was some slight interference, but Mr. Carlton was greatly impressed by the experience.

Speaking of the wireless, he said it would not supplant the cables, but would be a valuable service to commerce.



(Underwood & Underwood)

Demonstrating the operation of the new wireless bell device with which it is intended to displace the S O S distress signal at sea

England Receives Wireless Offer From Marconi

THE British Government has received an offer from Guglielmo Marconi to link up the entire British Empire in a chain of wireless communication, the system to be turned over to Government ownership, if desired, at the end of thirty years.

Plan to Detect Mysterious Mars Signals

ORGANIZED tests of the mysterious signals supposed to come from some other planet will be made toward the end of April when Mars reaches the nearest point to the earth, Godfrey Isaacs, director of the English Marconi organization, has announced. All Marconi stations will be instructed to watch out for mysterious messages, he said, adding:

"We will try first to discover whether the sounds are picked up in various parts of the world in the same instant, because, if so, the theory that they are definite messages from another planet will be enormously strengthened."

New York Auto Show Has Radio Tractor

THE radio exhibit at the automobile show, New York, staged by the Signal Corps, presented many interesting features, most important of which probably was the army radio tractor, which was used extensively in the recent war. One company in each field battalion is equipped with this tractor.

The special body housing the equipment, is mounted on a two-ton chassis. The tractor is, in itself, a complete radio station of moderate power. The antenna is of the umbrella type, and is carried with the tractor, while the radio generator is operated with the transmission in neutral. While driving the generator, the speed of the engine is governed by a centrifugal governor.

Tractors of similar type were used in the campaign in Mexico, and were also in service with our forces overseas, and are now used extensively by the troops on the border.

Marquette to Have Wireless Station

THE United States Navy Department means to establish a wireless station at Marquette as a part of a general program for giving added protection to Great Lakes navigation.

A representative of the big station at Great Lakes recently visited Marquette and looked over a site on Presque Isle as a possible location for a wireless station. One acre of land on the northeastern corner of the island is owned by the government, and has been retained for lighthouse purposes. The navy man after inspecting the site said it would be the ideal spot for a wireless station.

Navy to Promote Amateur Wireless in California

PROMOTION of amateur radio plants and the study of radio operations has been undertaken on a big scale by the officers of the Twelfth Naval District, San Francisco, Calif.

Lieutenant Commander S. D. McCaughey, district communication superintendent of the Twelfth Naval District, has sent out a circular letter to all radio amateurs outlining plans for the navy co-operation with them. This will include a press service for amateurs and later a special code for reception of code messages to be broadcast for them by the navy.

Advice and assistance in development of their apparatus and ability of reception will be tendered by the navy officials.

All amateur radio stations in the district, embracing California, Utah, Nevada, Colorado, New Mexico and Arizona, are requested to obtain a "data sheet" from the district communication superintendent, U. S. N., Room 418, Sheldon building, San Francisco.

California has been divided into five leading districts, with an additional sixth district taking in all territory not included in the first five. Each of the California districts is formed by a radius of seventy-five miles from the following navy radio stations. Yerba Buena Island, San Francisco Bay; East San Pedro; Point Loma, San Diego; Table Bluff, Eureka, and Point Arguello, near Point Concepcion.

Within each district the amateurs will hold meetings and establish definite rules and regulations for communication among themselves to conform to the regulations relative to wave length restrictions, 200 meters, and power regulations, one-half of one kilowatt.

Competitive drills in communication will be sent out by the navy stations to determine rank among the amateurs.

London Wireless Inventor Hears Concerts in Italy

A LONDON inventor, H. Powell Rees, has invented a wireless telephone apparatus on which messages from Moscow and concerts in Italy have been heard, although the aerial used is only an 85-foot wire hung outside of his bedroom window, according to a Times copyright cable. The mechanism is contained in a tiny box and the cost of manufacture is said to be small. Messages from American stations are also readable.

New York Central R. R. Radiophone Tests Successful

A WIRELESS telephone conversation was recently carried on for an hour without interruption on the Harlem and Putnam divisions of the New York Central, between Elmsford and Millerton, 78 miles apart. The experiment was made by Maj.-Gen. George O. Squier, signal chief of the United States army. The direction of the waves was guided by the wires strung along the tracks. He was able to speak to and from moving trains and send a number of communications simultaneously.

Moscow Wireless Works Without Stop

THE wireless at Moscow works twenty-four hours a day and grabs practically all the wireless news from America to European countries. Each morning in Moscow bulletins containing this information are printed and distributed in the industries, in the peasant villages and among the soldiers.

Venezuelan Government to Build High Power Station

THE Venezuelan government, up to June 30, will receive bids for the erection of a powerful wireless station to be built near Caracas, which will be of sufficient power to communicate with similar stations in the United States and Europe.

U. S. Forest Service to Use Radiophone

PRELIMINARY tests of the wireless telephone by officers of the Forest Service of the Department of Agriculture, in the vicinity of Portland, Ore., lead to the belief that this invention can be utilized extensively in the national forests, especially in fire-prevention work. The results so far are pronounced satisfactory.

One of the sets in the tests was installed on Mount Hood, Ore., where the problem of providing a satisfactory support for the antennae was a difficult one, since a mast was needed which would be strong enough to resist seventy or eighty mile gales that sweep the mountains. At the same time the mast had to be light enough for the men to be able to raise and lower it before and after sleet storms. A fifty-foot bamboo pole was finally selected as the support.

In the telephone conversation between the sets, some of which were ten miles apart, the voice carried very clearly and was about as loud as over a wire line. Telegraph signals from many stations scattered over the continent were picked up. On Mount Hood they often were so loud as to be audible in any part of the cabin.

Trans-Oceanic Radiophone Service Within Six Months

WIRELESS telephonic communication between England and America has passed beyond the experimental stage.

"Within six months," says Godfrey Isaacs, Managing Director of the English Marconi Company, "we may be speaking to New York, Boston, Chicago and any other towns in the United States more quickly and easily than we are able to communicate with Birmingham or Manchester."

Mr. Isaacs said the cost would only be a few shillings for a three-minute conversation and he added: "In a year or so we hope to establish regular telephonic communication with Australia. We hope to bring every country in the world into telephonic communication with each other—not in an indefinite time, but very soon."

London and Paris Airplane Service Has Radiophone System

ON the regular airplane service now established between London and Paris a system of wireless telephony enables persons on the airships to be in speaking communication with ground stations. The voices are conveyed distinctly and can be identified as readily as if those conversing were face to face. This wireless conversation has been tested over a distance of fifty miles, which is as far as is required in the interval between stations.

Norfolk Police to Use Wireless

REAR ADMIRAL A. C. DILLINGHAM, retired, head of the Norfolk, Va., Police Department, with the title of Director of Public Safety, is working to bring the department up to a state of last-word efficiency through the establishment of an aero squadron and the equipment of the police stations with wireless outfits.

"The wireless," says Admiral Dillingham, "will enable us to get in almost instant touch with the police departments of New York and other great cities when necessity arises."

Saigon, Indo-China, to Have Powerful Station

ADVICES received at the headquarters of the Inter-church World Movement, which is making a religious, economic and social survey of the world, state that the most powerful wireless telegraphic station in the world is being installed at Saigon, Indo-China. This new station will be so powerful that communication may be had with France, Africa, Madagascar, French New Caledonia, Australia, Japan and the United States.

The report explains that the continuous wave system will be used and the electric power will be supplied by two converter groups equipped with internal combustion motors of 2,500 horse power. Aerials will be suspended from a height of 833 feet, nearly 100 feet higher than the Woolworth building, and the network of wires will be spread over nearly 180 acres.

This new station brings the world closer together by many thousands of miles, and it is expected to be of great aid to the Pacific northwest in carrying on transpacific business communications.

Italy and England Connected by Radiophone

WIRELESS telephone communication has been established between England and Rome, the Daily Mail announces.

The distance is more than 2,000 miles.

Denmark and America to Be Connected by Wireless

A DANISH radio commission is proceeding to America on April 8. The commission will negotiate with the American authorities for the linking up of a radio service between the United States and Denmark.

(Underwood & Underwood)

Kansas operator listening to music and conversation from New York transmitted by a radiophone set using a vacuum tube and one-third kw. generator

Bolivia Gets Three New Wireless Stations

THE Ministry of the Government of Bolivia recently accepted a bid made by the Bolivian engineer, Senor Humberto de Asin, to install three wireless stations in the country, to be located at Guayaramerin, Cachuela Esperanza and Trinidad. The Government will contribute the sum of 11,000 bolivianos (boliviano equal to $0.3893 U. S.) for the first, 25,000 bolivianos for the second station, and 75,686 bolivianos for the Trinidad station. These three wireless plants will connect the outlying districts of the republic with the rest of the country.

S. S. Imperator Receives Radio Messages from Scotland Across Atlantic

WITH a new wireless receiving apparatus rigged on her, the liner Imperator arrived from Liverpool recently. All the way across the Atlantic she received radio messages direct from the big station in Aberdeen, Scotland. It was the first time a vessel had been in communication with a single land station on an entire transatlantic trip. The transport George Washington, when she carried President Wilson to France the last time, was in direct communication with this side almost all the way across the Atlantic.

Sir Ernest Glover, Director of the Ship Branch of the British Ministry of Shipping, was a passenger, and was much interested in the wireless feat.

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 of Radio Division, Signal Corps, A. E. F.

and Capt. Willis H. Taylor, Jr.
Co-ordination Officer, Radio Division, Signal Corps, A. E. F.

Part IV—Listening Stations

LISTENING stations were a development of trench warfare, so it naturally followed that the credit for the first utilization of the sensitive low frequency vacuum tube in connection with grounded antenna covering a considerable area was variously claimed by the different armies engaged in the war before our entry. Documents published by the Intelligence Service of the British Army indicated that the German army used their stations against them at the first battle of the Marne. Certain it is, that at the end of the war, the Germans were as well informed regarding listening stations as were the Allies.

This listening station was located in a Vosges mountain sector and was operated jointly by the French and Americans

The information regarding German listening stations published by the British Intelligence Service consisted of captured orders and other data indicating that at the beginning the Germans realized that the effectiveness of listening stations was unlimited, if knowledge of their existence and efficiency could be kept from the enemy. They took extraordinary precautions to keep from their own men—other than those actively engaged in the operation of the stations—knowledge of the existence of these stations. This was the reason why their soldiers, when taken prisoners, could give no hint to the Allies during the usual gruelling cross examination. All the information obtainable indicated that the operators were especially selected and trained for this duty, this personnel being entirely segregated from other troops and special arrangements made for their subsistence and maintenance, making it unnecessary, and in fact, almost impossible, for them to come into contact with the general body of the combat units.

Stories were current of the early days of trench warfare, when in many places the front line trenches were separated by a strip of No Man's Land only fifty yards wide and the necessity for the telephone code was not appreciated, that many an attack came to naught because of information intercepted from telephone lines of both sides by these listening stations. Later, when their use became general in all the armies, the Germans were evidently so impressed by the effectiveness of their own stations that they greatly restricted the use of the telephone in their front lines. The instruments were sealed and their use limited to absolute emergencies; an explanation was required from the breaker of the seal as to the necessity for usage of the telephone.

The interception of T. P. S. messages naturally could not be prevented, and, as with radio, the use of code was compulsory, but even here the Germans attempted to prevent the effective use of our listening stations by employing interfering screens of audio-frequency ground currents, as will be explained later.

Toward the end of the trench warfare operations, listening stations lost a considerable part of their effectiveness because of the general knowledge of their use by all the armies. Possibly the greatest factor in limiting the results obtained by the enemy listening stations in interception of conversations on our lines, however, was the radio section listening stations which acted as monitors of our own circuits. A well insulated and balanced metallic telephone circuit is practically immune against eavesdropping, but such lines were difficult to maintain in quiet sectors and practically impossible in active sectors. Faulty conditions on our own lines were therefore immediately revealed through our listening stations, as well as the transmission of indiscreet messages over leaky or grounded telephone lines. As a result, our telephone circuits were maintained in the best possible condition through the operation of our listening stations against them as well as against those of the enemy. Many an infantry officer reading this article will realize for the first time the source of information upon which was based the reprimand he received for the transmission of an important message in plain English over a telephone.

The use of the listening station was continued in our army up to the last, even in mobile warfare, although conditions were generally unfavorable. The fact that the hastily rearranged and reconstructed telephone lines of the enemy were increasingly defective, compensated somewhat for the difficulties encountered in the operation and maintenance of our stations.

Prior to the development of the listening station, adventurous men in the Allied armies had endeavored to ascertain the enemies' plans by direct tapping of their telephone lines, signalmen crawling across No Man's Land on dark nights to bridge a telephone on the enemies' circuits. But even the advent of the listening station did little to lessen the hazards, and no activity of the Radio Section of the Signal Corps, A. E. F., was more thrilling—and more interesting—than the listening station service.

The radio intercept and radio goniometer service which has been previously described was probably the source of more information, but these stations were usually placed from five to ten kilometers back of the line, in locations of comparative safety. In quiet sectors, and during the first months of our army's operations in France, this class of stations took on to some extent the humdrum character of a commercial receiving station. But the listening stations located in dugouts in or near the front trenches were never without excitement, nor were the personnel assigned to them permitted by the enemy to forget that they were actively participating in a war.

While the function of the stations and the duties of the operators were limited in possibilities, life in a listening station never became monotonous or lost its fascination. Thus the listening service became the goal of every member of the Radio Section who craved action and adventure. However, the qualifications necessary for service in listening stations were more than ordinarily diversified. The first essential was a thorough familiarity with the German language. The operators were given a course of training to familiarize them with the military phrases they might be expected to overhear, but fundamental knowledge of German was a necessity; time did not permit the teaching of the language, and a superficial knowledge was not sufficient. Most of the men selected were of German descent and accustomed to speaking the enemy language previous to entering the army.

Our first effort to obtain suitable men took the form of a request for the Signal Corps in the United States to send over all the German-speaking radio operators available. Inasmuch as the first detachment of 40 German-speaking radio operators, which arrived about the beginning of January, 1918, apparently exhausted the supply, it was decided to make no further efforts in this direction. It was found that the ability to receive and record T. P. S. (ground telegraph) messages was secondary to the necessity of knowing German thoroughly, as T. P. S. code was sent slowly, usually not exceeding the rate of 10 or 12 words a minute. All efforts were, therefore, directed to obtain personnel by selecting men already in the A. E. F. having a knowledge of German and teaching them the T. P. S. code.

Our efforts to obtain such men from the different line organizations in the A. E. F. were productive of many laughable results. Evidently the commanding officers of many units assumed that if a man spoke any foreign language it must be German, and with the numerous nationalities represented in our army the possibilities in selection are evident. Many also reported with only a smattering of German and were promptly returned to their outfits, except for a chosen few whose cooking ability was utilized in place of alleged philological accomplishments.

The selection of German-speaking soldiers also had its less humorous side. When the first detachment of operators arrived from the United States, the men themselves had no definite idea of their prospective duties. An intelligence officer was detailed to ascertain the extent of the linguistic ability of each member, and few made any effort, for they were fearful that signs of ability coupled with German names might be prejudicial to their interests. Only after it was explained that they were intended for a duty of a particularly valuable nature did they loosen up; even then some of them did not disclose their true fluency.

Special commendation is due the men in this service for their great devotion to their duties. Above all, a listening station operator had to be observing, possess imagination and be able to visualize the possibilities within snatches of enemy conversation that came to his ears, and he had to do it quickly if his intuition was to be of any value. We were fortunate in having in our service many men possessing all the qualifications, perhaps the best of whom were those who had been newspaper reporters before the war.

Proper conception of the operation of a listening station requires an understanding of the elementary electrical phenomena which it makes use of, principles which are the same as those used in the T. P. S. (ground telegraphy) operations. Figure 1 shows a T. P. S. buzzer transmitter with its ground connections at the end of wires of approximately 100 meters length. The transmitter is an induction coil taking about 5 amperes at 10 volts in the primary, and generating in the secondary coil a high voltage alternating current of audible frequency. The secondary coil is connected direct to the grounds, the lines of current flow between which are indicated by the dotted lines in figure 1. The equipotential lines (shown in full lines in the figure) are perpendicular to the lines of current flow. If two earth connections are made at points such as 4 and 6, which are not on the same equipotential line, and if the wires leading to the earth connections are connected to a pair of telephone receivers, a current will

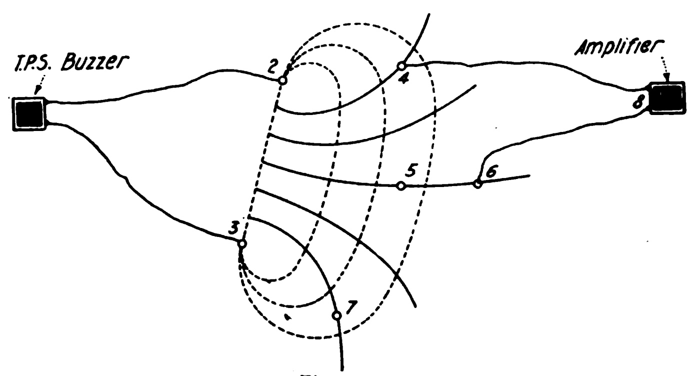


Figure 1

A T. P. S. buzzer transmitter with its ground connections at the end of wires of approximately 100 meters length

pass through the 'phones. If the current is of sufficient strength, the T. P. S. buzzer signals will be heard. If the current is weak—and it usually is—it is necessary to insert an amplifier in the wires leading to the earth connections. It was for this purpose that the vacuum tube amplifier came into use. The amplifier with the two wires and the earth connections—or "earthed antenna," as they are called—make up the essentials of a listening station. If, instead of the two earths 4 and 6, which are situated on two different equipotential lines, two earths, 5 and 6, on the same equipotential line are chosen, no current will flow and, therefore, the buzzer signals will not be heard by the listening station. For similar reasons two earths, such as 4 and 7, which are at a greater difference of potential than the earths 4 and 6, give stronger signals than the earths 4 and 6.

There is also another and lesser effect to be considered, the effect of induction. The circuit 1, 2, 3, is a closed circuit, the earth closing the circuit between 2 and 3. Similarly, 4, 6, 8, is a closed circuit. Therefore, the buzzer loop affects the amplifier loop to some extent by electromagnetic induction. Leaving out of consideration the question of phase difference, the inductive effect adds to the difference of potential effect, discussed in the preceding paragraph. In general, in a system such as shown in Figure 1, the inductive effect is much smaller than the difference of potential effect. Other effects such as the direct inductive and capacity reactions between the earthed antenna of the buzzer circuit and those of the amplifier circuit, etc., may be disregarded, because of their relatively small importance in comparison to the first two effects.

A grounded telephone system used as the source of signals may be considered in exactly the same way as has been done for the T. P. S. buzzer set; there is no difference between the two cases.

An insulated telephone system presents a slightly different case. This system influences the receiving station only by induction. This it does in two ways: first, by direct inductive action on the loop of the receiving station; and second, indirectly, by inducing earth currents which are then picked up by the earths of the receiving station. If the line wires of a well insulated metallic telephone circuit are twisted together, the resultant stray field is feeble, and hence any inductive effect is small. It is practically impossible to overhear signals on such a system.

If the two earthed antenna of the listening station (Figure 1) are entirely insulated from the ground, and if the ends, 4 and 6, are connected by a wire also insulated from the ground, we then have, instead of the earthed antenna, an insulated loop, and the station receives signals by induction only. The insulated loop system was used to some extent by the French.

Listening stations are a development of trench warfare and no activity of the Radio section was more thrilling and more interesting

A listening loop utilizes inductive principles only, and its main advantages over the grounded antenna—in which it is very similar to the radio loop—is its comparative freedom from ground static. Loops were not used extensively by us, because of the difficulties of properly maintaining and repairing them. Loops installed in trenches are too liable to injury, so we placed our reliance in grounded antenna. Several turns in the loop are necessary to obtain satisfactory results and this naturally adds to the maintenance difficulties.

It must be remembered that these listening stations can be used only where conditions are favorable and when the opposing armies are fairly close together, as in trench warfare; and also when the intervening conditions of the terrain are such as will not shunt or side-track the currents which it is desired to intercept. An intervening river or gully or metallic geological formation was found to prevent successful operation in many places.

It was necessary to get the ground plates as close to the enemy as possible, and their installation required the highest type of bravery in the men who accomplished it. The personnel operating listening stations were continuously on duty one week, then off one week, which kept them in the front lines considerably longer than was required of the infantry under ordinary conditions.

The dugouts in which the stations were located were usually a few hundred meters from the front line, and generally in the support or communication trenches; but some times they were concealed under the ruins of a demolished house or structure. One of the first stations established in the Toul Sector, where most of our troops of all services obtained their first taste of real war, was in the village of Marvoisin at the foot of the ever menacing Mt. Sec. The dugout was located under the ruins of an old stone church which had been demolished by shell fire, but it was seen that these ruins formed a fine protection for the station when an enemy shell made a direct hit, but did not penetrate into the dugout proper. The force of the concussion demolished the amplifier and threw the operator on duty off his comfortable seat; it also greatly enhanced his respect for churches.

From the dugouts the leads followed the trenches to their terminating grounds, located at intervals of several hundred meters along the front line trenches and close to the enemy lines as possible. These grounds consisted of copper mesh mats about two by ten feet, buried a few feet under ground. If it was impractical to thus install them, a group of metal stakes were driven down.

Because of the large area covered by the ground antenna these stations were more effective in receiving T. P. S. messages than the regular T. P. S. receiving stations in which grounds were usually separated by approximately 100 meters. Nearby radio stations could also be heard when the French amplifier was used, a combination apparatus providing for the rectification and amplification of radio signals in one position of its control switch, and low frequency amplifications with all three tubes, with the other position. Even when so used, it was found that radio signals could be heard in it. Investigation developed that the first low frequency transformer connected to the ground antenna showed a capacity reactance to radio frequency currents due to its distributed capacity. The inductive effects of this radio frequency current on the remainder of the amplifier wiring evidently resulted in the unintentional detection of radio stations and a demonstration of grounded radio antenna possibilities.

Because it was possible for the listening station to select different grounds, an idea of the approximate direction and distance of a transmitting station might be obtained by an operator of long experience. T. P. S. messages could be heard for as much as 4 kilometers and telephone conversations 2 kilometers. This distance of course depended on the degree of grounding of the telephone lines. The listening station shown in the accompanying photograph does not by any means represent a typical one. It will be observed that it has been located in the same place for a considerable period. This station was located in a Vosges mountain sector on the extreme right of our Toul Sector and was operated jointly by the French and ourselves. The quietness of this sector is attested by the neatness and the apparent comparative comfort.

From the station dugouts the insulated leads radiated to the grounds, which were from 500 to 1500 meters away, and distributed along the front line trenches at intervals of from 200 to 300 meters. They were often carried well over toward the enemies' trenches, for the effectiveness of the station was dependent on the distance to the source of the intercepted current, as will be appreciated from the foregoing explanation. Grounds were also installed in our own area back of the station for use when it was used as a monitor for our lines. Because of the proximity of listening stations in this work it was much easier to overhear the communication within our lines, and by the same token this drowned out much of the German communication we were trying to copy. Listening stations have more interference to contend with than a radio station, because the element of tuning is not available and because of so-called "earth static."

The principles used in listening stations are well known and have long been utilized, but only with the development of the super-sensitive vacuum tube amplifier did their possibilities become valuable for war purposes. The type 3 ter French amplifier first utilized has already been described. Later the type SCR-72 amplifier was received from the United States, and was found to be a trifle more efficient for voice and audible frequency currents. The circuit for this amplifier is the usual audio frequency amplifier utilizing two tubes as against three in the French amplifier, but it was only intended for low frequency amplification and no provision was made for rectifying radio frequency currents as in the French instrument.

Many times it seemed that the Germans were providing an electrical screen for their communication, for their motor noises came in so loud in some cases that we believed they had intentionally carried over wires from their machine and grounded them near or in our lines so as to drown out the signals from their T. P. S. stations further back. However, it was noticed that if these motor noises stopped there was an immediate increase in the T. P. S. activities so that if it was a purposely provided screen it would have also been effective in interfering with their own ground telegraphy. No doubt it was effective in protecting their defective telephone lines.

That the operators determined the efficiency of our listening service, however, is a fact that must not be lost sight of. This service could not be organized as scientifically as the radio intercept stations, in which gonio stations could locate the radio stations intercepted and wave lengths could be measured and other characteristics of the stations recorded. The listening station operator had only his ear to aid him in determining the probable distance and location of the station he overheard. T. P. S., like radio, has characteristic notes and the operator's "fist" also betrays itself, but neither of these are as pronounced as in wireless.

The listener had therefore to depend on his judgment to determine what any unusual occurrence or activity might foretell, in addition to what might be revealed by the decoding of the message he recorded. He soon learned that unusual T. P. S. activities by the enemy forecasted a military offensive or some unusual operation. For weeks his efforts might be unproductive, but his vigilance could not be relaxed. A probable change in an enemy station could be noted by a change in its note or in its intensity. A sudden change in the T. P. S. communications indicated a difference in the troops opposite or a rearrangement of their lines. The first information regarding the relief of enemy battalions opposite was usually obtained through our listening station operators noting the change in their T. P. S.; in nearly every case the operator's deduction would be later verified by a prisoner.

By diagramming the T. P. S. stations of the enemy according to loudness and the stations with which they worked, operators could quite accurately place the large and small units, their observation posts and posts of command. Just previous to the St. Mihiel operations, the operators quite accurately reported the withdrawal to the rear of the enemy T. P. S., which indicated the removal of troops from the front lines, or at least a rearrangement of the forces.

The listeners were repeatedly commended by the General Staff for their intelligent deductions, especially with regard to telephone interceptions. In this work—which could not be recorded literally—the operator had to act as an intelligence officer. One man deduced the arrival of a new division opposite him by the increased politeness used in telephone communication, and he proved to be right in his surmise. As the Germans also used code words for all places and military phrases in their telephone conversation, only the slightest clues were available for making deductions. Through hearing a certain time spoken repeatedly by the enemy and its anxious reception at the other end of the lines, the 42nd Division was warned of attacks on Ferme-le-Chamois, Village Negre and La Chapellette, and being forewarned they effectively repulsed the offensive.

The most hazardous part of the operation of the listening station was in the maintenance and installation of the ground lines. The entire effectiveness of the station obviously depended on the maintenance of the lines in good condition; they were continually broken by artillery fire and the necessity for repairs was always immediate.

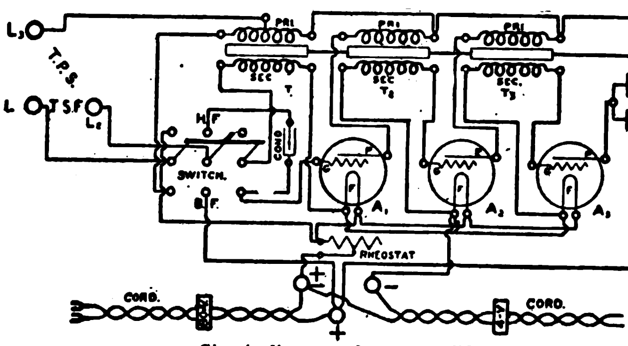
It was at these lines that the fibre of the station personnel showed at its best. Usually wearing their gas masks, the men stuck to the task, in most cases under shell fire, until they had established their circuits. In one instance all three operators of the station were wounded during an attack on our position. The majority of casualties in the Radio Section occurred in this service, and there is not one case of a man shirking his duty. If a station was not getting satisfactory results it was usually the operators who suggested the advisability of carrying the grounds over nearer the German lines, then they would volunteer to install it themselves.

Facsimile of German poster distributed amongst the German Intelligence Service for the purpose of retaining secrecy

These night excursions to bury ground mats in the enemy area showed our men's intense interest and devotion to their work. At these times they were usually accompanied by a covering patrol and it took many hours of slow arduous crawling through barbed wire entanglements and across No Man's Land to carry the wire to the desired location. Then followed the stealthy burying of the mat to accomplish the desired end. Star shells threatened to reveal their presence every few minutes and they could advance only during the intervening periods. Returning, they might be taken for an enemy raiding party by some nervous doughboy and be received accordingly. This actually occurred more than once.

The Seicheprey fight was waged all around one of the listening stations and for a time it was behind the German front. Fortunately, in the night and the confusion its existence was not realized by them and when American counter-attack recovered the ground the operators were still on the job.

Another factor that increased the effectiveness of listening stations was the possibility of connecting on to old and grounded lines running over into enemy territory. In the continual surging back and forth of their fronts both armies necessarily abandoned lines in areas which later came under enemy control. The trenches were a mass of old and abandoned wires of both sides and these were usually the bane of the telephone men of our Signal Corps in taking over sectors from the French. Their greatest ambition seemed to be to tear them all out and start over with new and better circuits, thus in many cases they de-



Circuit diagram of 3-ter amplifier

stroyed a source of information for us. In one case the allied armies were notified of a commercial underground cable, installed before the war, but lying behind both lines; this cable possibly would have been a fertile source of information to the army that could connect to it without the other's knowledge. Some of these old circuits that extended far back into our lines were certainly the source of information to the enemy, as there were reported many incidents, such as the shelling of expected relief troops or truck trains in the night, which could only have been ascertained by intercepting telephone conversations, possibly only a few minutes before the expected arrival. A typical instance was that of a Brigade headquarters which received its supply trucks every night at a regular hour, and as regularly the road was shelled. It was assumed the Germans had in some manner ascertained this hour and it was decided to change it. Arrangements were made over the line and, sure enough, the time of shelling changed also. Inasmuch as the headquarters was too far back for an ordinary listening station to be effective, it is probable that the Germans had connected to an old line running back over the intervening five or six kilometers.

One of the most daring feats in the listening service was that performed by Private 1st Class George Stroh, who volunteered to accompany a raid on the German position at Marcheville, and install a ground connection for his station inside the enemy line. He went along with the attacking party carrying his wire ground stakes and tools, and when the infantry had attained its objective he coolly proceeded to hammer in his stakes and lay his wire as he returned to his listening station in Soule.

Sergeant Carleton R. McQuown, while installing a ground at night near the enemy lines, discovered a machine gun nest, and the following night an American raiding party acting on his information succeeded in destroying it and capturing twenty-eight prisoners.

Incidents like these, indicating the bravery and resourcefulness of the listening station operators, were so numerous that only a few can be mentioned. It has repeatedly been said that the glamor has gone from war, but the experiences of these men, who in the new warfare combine somewhat the duties of both the scout and the spy give this assumption the lie. Among the men cited for their work by the General Staff were Corporal (later Lieutenant) Frank B. Fairbanks, Sergeant Braun, Corporals Floyd F. Felmick, L. V. Garner and H. T. Schoefer, and Privates 1st Class L. V. Pease, D. O. Butterfield, W. R. Hogel and Geo. J. Baum.

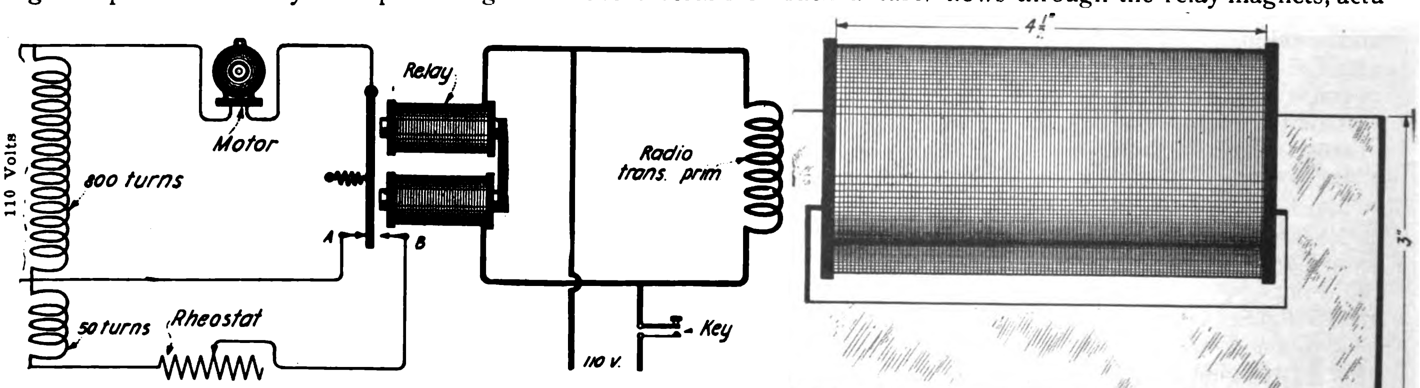
If anyone could be expected to be "fed up" on war, listening station operators certainly qualified. These men, in many cases for nearly half their term of service in France, had for their quarters dugouts the size of a packing case, with smelly pools rising in the bottom and rats and smaller but no less active intruders as constant companions. Under these conditions they worked, ate and slept—certainly they can claim to have done their bit for their country.

Constant-Speed Regulator for Series Motors

By L. A. Bartholomew

In many amateur stations where a series motor is used for the rotary spark gap, in connection with a transformer of considerable input, the voltage drop when the key is depressed is sufficient to slow down the motor somewhat resulting in a disagreeable "whine" in the spark note. Sometimes this can be remedied by increasing the size of the wiring in the station, but more often it is due to insufficient capacity of the power company's feeders which is beyond the control of the consumer.

A method which has been found to give excellent results in such a case, and which may be of value to other amateurs troubled in the same way, is to insert a small auto-transformer in the motor leads with a double contact relay connected to the key. Figure 1 shows the circuit for such a device. When the key is open, the regular line voltage flows into the motor through the contacts A. As soon as the key is pressed, however, current also flows through the relay magnets, actuating armature and closing contacts B, which connects the motor across the entire winding of the auto-transformer, and the increase in voltage will compensate for the drop due to the



Circuit diagram and dimensions of coil

(Continued on page 22)

25-Mile Radiophone Transmitter Using Marconi V.T.'s for 200-Meter Amateur Work

By Chas. R. Leutz

A GREAT many amateurs would undoubtedly like to construct a short range 200-meter radiophone transmitter, using the Marconi V.T. tubes that are available, so I am undertaking to describe in detail the plans of a set which has shown its ability to work twenty-five miles in the day time with normal conditions prevailing.

Only four V.T.'s were required for the transmitter. The antennae used at both transmitting and receiving ends consisted of four wires, spaced three feet, each 100 feet long, T-type, with an effective height of 100 feet. Capacity was approximately .0008 microfarad and the fundamental wave length about 125 to 150 meters.

A Paragon short wave regenerative receiver was used at the receiving end with marked success. Two steps of transformer coupled amplification (audio frequency) were tried, and from the resulting increase in signal audibility, it is estimated that a range of 50 miles could be covered under favorable conditions.

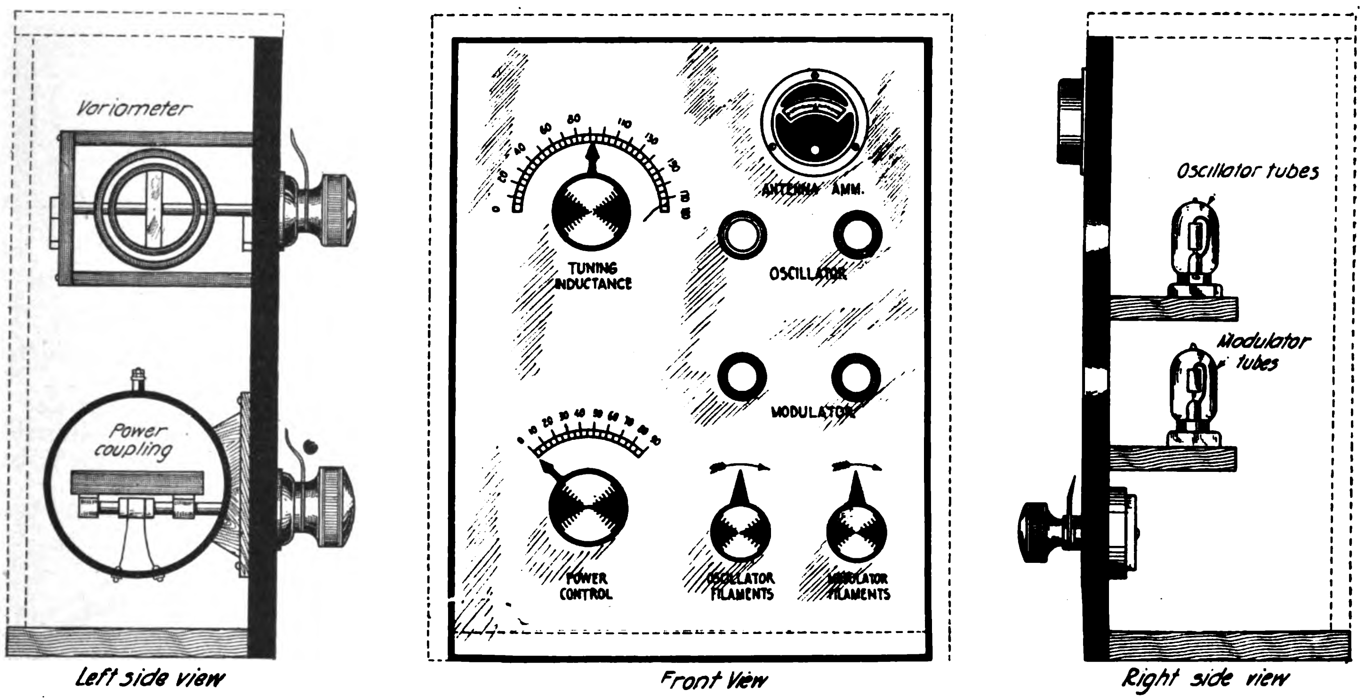
Any V.T. acting as an amplifier or "repeater" will generate oscillations if coupling is provided to transfer energy from the output circuit back to the input circuit. The period of the oscillations may reach either audio or radio frequencies, which will depend upon the natural periods of the wing and grid circuits. For practical purposes and for adjustment to any desired wave length, only one circuit should control; as the wing circuit contains the most energy, it is the most suitable controller.

A schematic diagram showing the wiring of the circuit used is given in figure 1. It may be stated in this connection that the circuit used is not the most reliable and steadiest known, but this oscillating circuit does give a much better output with a given number of tubes than with more stable circuits where output has to be sacrificed to gain reliability. However, with intelligent operation, perfectly satisfactory results can be obtained.

The construction of the individual component parts of the complete transmitter will first be taken up separately and, as a suggestion, a drawing of the complete transmitter shown.

Figure 2 gives a cross-sectional view and an end view of the microphone transformer. As the schematic diagram indicates, a telephone microphone, a four-volt dry battery and the primary of the microphone transformer are in series. Speech directed into the microphone results in electromagnetic transformations in the transformer in accordance with the pitch and volume of the speech, and, subsequently, potentials are developed across the secondary of the microphone transformer, these potentials varying in accordance with the pitch and volume of the speech. This potential is thrown on the grids of the modulating V.T. tubes and modulates the oscillating current in accordance with the speech directed into the telephone microphone. Any ordinary telephone transmitter may be used, but a little experimenting will prove that some are far superior to others.

The construction is clearly shown in the drawing. The core consists of a bundle of soft Norway iron wire, No. 22 B&S gauge, ¼" diameter, 4" long. Two end pieces of dilecto 1½" square and ¼" thick are placed on each end of the core. Two layers of .010" Manila paper are shellacked to the core for insulation and it is then ready for winding. The primary winding consists of 230 turns of



Left side view — Front View — Right side view

Figure 10—Panel assembly of the various instruments

No. 26 B&S double cotton covered wire, one layer of .010" paper between layers of wire. Over the primary winding, two layers of .010" Manila paper are wound and shellacked for primary-secondary insulation. The sec-

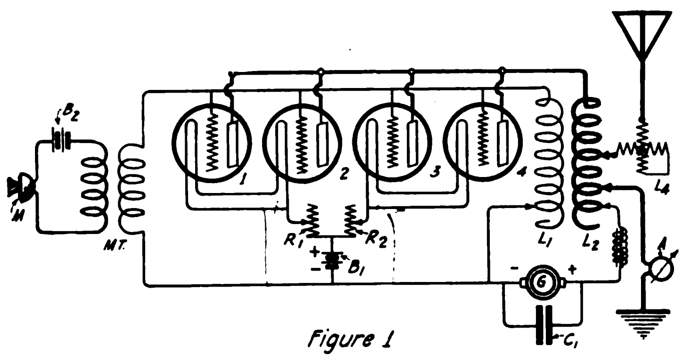


Figure 1—Schematic wiring diagram of the circuit used

ondary winding can then be placed on, consisting of 6,520 turns of No. 36 B&S enameled copper wire. A piece of Empire paper .001" should be placed between layers of the secondary winding. The start and finish of the windings should preferably be heavy flexible wire, such as lamp cord, which will allow external connections to be made safely.

Figure 3 shows, cross-sectionally, the constructional details of the audio frequency choke, shown in the schematic wiring diagram. This coil is placed in one leg of the generator line lead to prevent radio frequency oscillations from passing into the generator, or direct current supply.

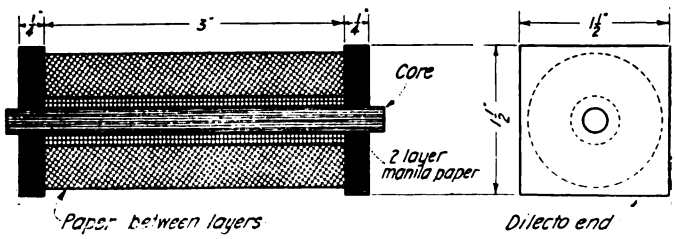


Figure 2—Cross-section and end view of the microphone transformer

The constructional details are very simple. Seventy leaves of .014 silicon steel, 6" long by 1" wide, are packed together and taped evenly with friction tape, making a core one inch square. Five layers of .010" manila paper are then shellacked on and the form is ready for winding. A total of 3,600 turns of No. 36 B&S copper enameled wire are wound on in layers, one layer of .001" Empire paper being wound between layers of wire. The winding space should only occupy 5" so that there will be space left on the core to place end pieces for support of the core by clamps, when assembling into the complete set. The start and finish of the winding should be a 6" piece of lamp cord, so as to provide substantial external connec-

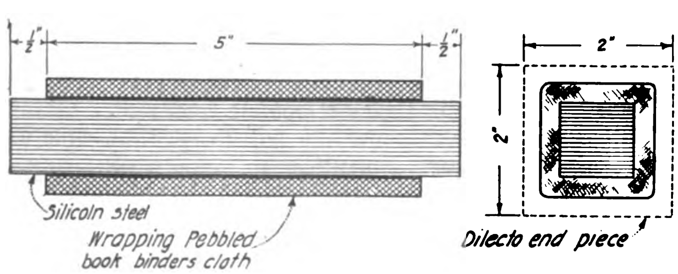


Figure 3—Constructional details of the audio frequency choke

tions. For the sake of appearance all coils may be covered with one layer of pebbled book binders' cloth.

Referring to figure 4, the method of mounting the Marconi V.T. tubes is shown clearly. The upper shelf holds the two oscillating tubes and the lower shelf holds the two modulating tubes. The tubes are mounted vertically, so that the filaments will not sag when they are heated and thus touch the grid. Observation holes may be cut into the windows so that the brilliancy of the filaments may be noted.

Figure 5 gives the assembly sketch of the filament rheostats, two of which are required. One controls the two oscillating tubes, and the other controls the two modulating tubes. A strip of fish paper, or other flexible heat resisting insulation, ½" wide by .040" thick, and 3" long, is wound with No. 24 Advance resistance wire, 26 turns

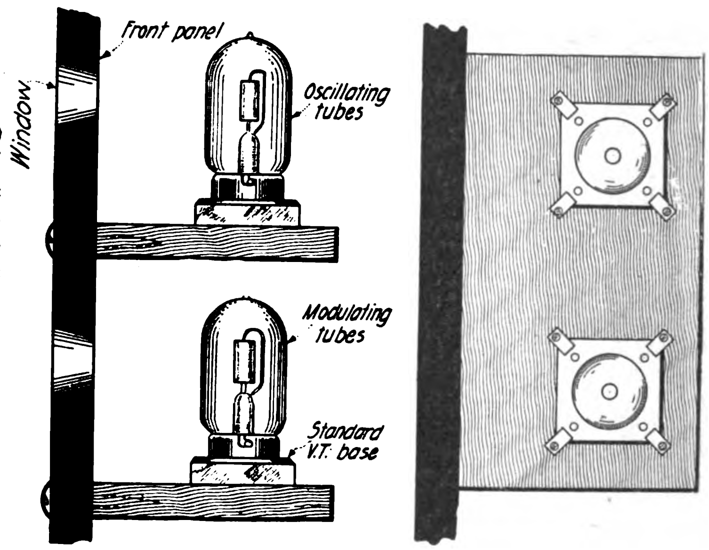


Figure 4—Method of mounting the Marconi V. T.'s

to the inch. The last few turns at each end are soldered together to prevent the winding from getting loose. After this strip is wound, it is forced into the circular slot in the dilecto base, as shown in the drawing. An adjustable contact with suitable bearings is shown so that the resist-

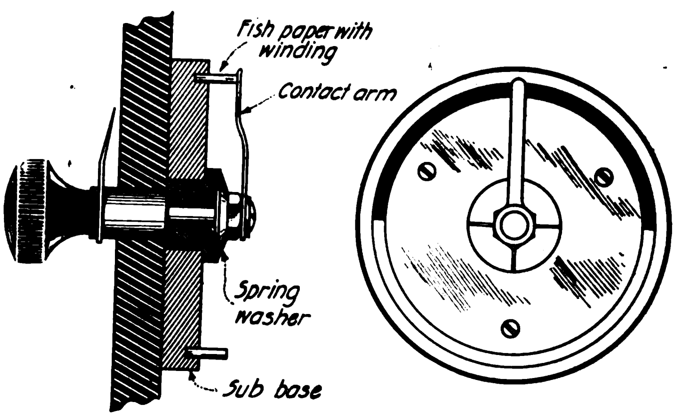


Figure 5—Assembly of the filament rheostats

ance may be varied in accordance with the value desired.

In the circuit diagram, it will be noted that a condenser is shown in shunt to the high potential generator. This should have a minimum capacity of 0.10 microfarad and should have enough dielectric strength to stand the full generator potential continuously.

A suitable 400-volt direct current generator may now be purchased on the market, or a lower voltage generator rewound and driven at a higher speed to give the necessary 400 volts. The generator should be one able to deliver about 125 milliamperes.

A description of the most important parts of the transmitter, the inductive coupler and the antenna tuning variometer, follows: For best efficiency the coils should have low distributed capacity and subsequently low high frequency resistance. For 200 meter transmission, investigations prove that solid wire will have the same or lower high frequency resistance than coils wound with Litzendraht, sometimes called high frequency cable. However, if longer wave lengths are to be used, say about 400 meters, high frequency cable may be used to advantage.

The wing inductance is wound on the stationary tube, figure 7, which is cardboard or dilecto, thickness 1/8", outside diameter 5½", and 2½" long. Upon this tube, 40 turns of 3/16 No. 38 Litzendraht, or No. 22 D.C.C. copper wire are wound. Taps are taken every three turns and brought up through the terminal block shown, so that substantial external connections may be soldered to the taps. Litzendraht may be successfully tinned by first dipping the wire in soldering acid and then heating to a cherry red, then wiping with cotton waste. Bare copper should then be dipped in a half-and-half solution of alcohol and rosin and dipped into a tin bath. After winding, all coils should be given a coat of Sterling or Ajax varnish and left to dry in an oven at about 200° F.

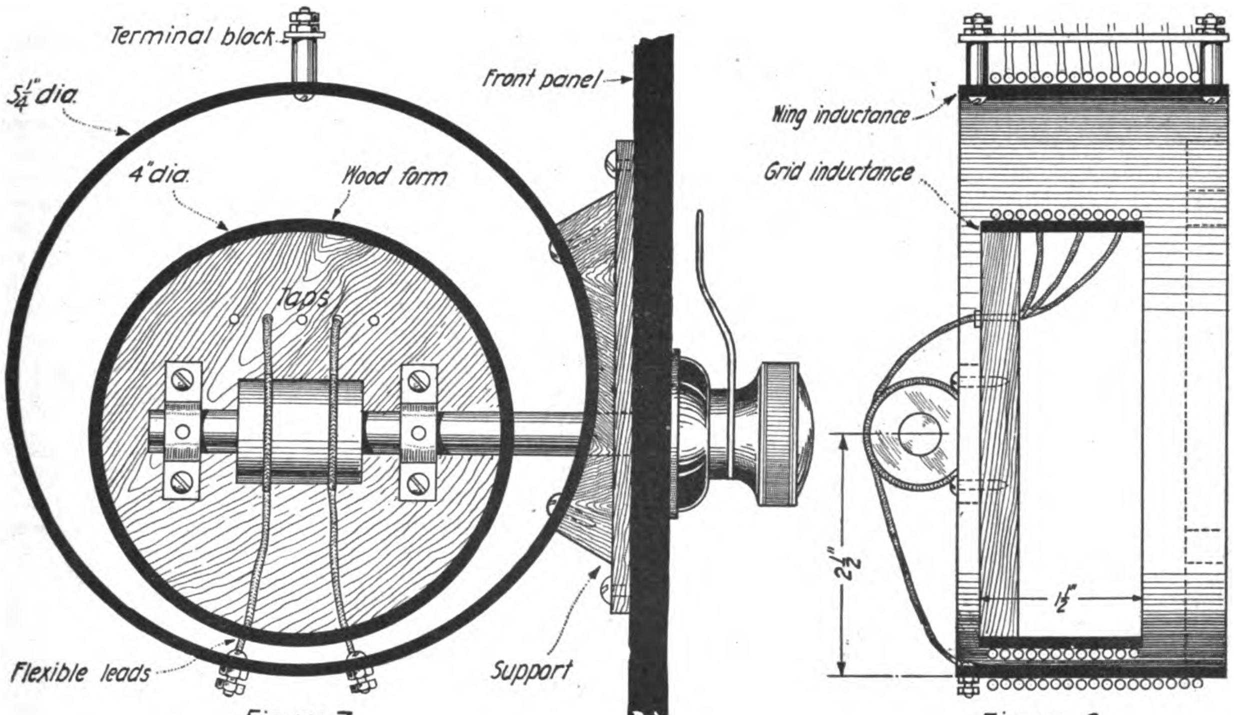


Figure 7 Figure 6

Figure 6—Front sectional view and Figure 7, side view of the construction of the coupling device

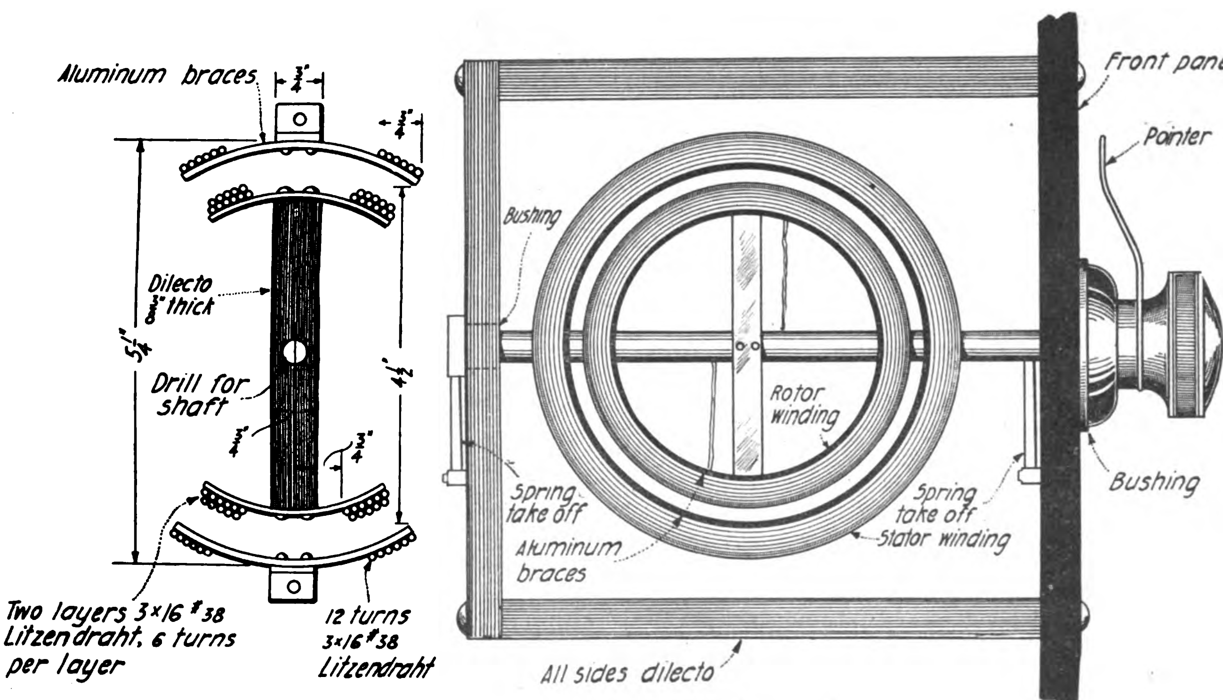


Figure 8 Figure 9

End and side views of the antenna tuning variometer

The grid or movable inductance is wound on a tube 4" outside diameter, ⅛" thick and 1½" long. This is wound with thirty turns of the same size wire as on the stationary coil. Taps are taken out every three turns and brought to brass studs, so that the two flexible leads may be connected to any of the taps as required in operation.

The constructional details of this coupling device are clearly shown in figures 6 and 7.

The antenna tuning variometer is shown in figure 8 and figure 9. Sufficient dimensions are given to allow the constructor to make wooden winding forms to wind the stator and rotor coils. The same form will do for both halves of the stator coil, and then the form may be turned down to wind the rotor coils on. Either 3-16-38 Litzendraht or No. 20 D.C.C. copper wire may be used, preferably the latter, as the coil will hold its shape better. After winding, the coils should be dipped in hard beeswax and left to dry before taking from the form.

Small aluminum brackets are made to hold the coils in their proper places and to the frames. The two rotor coils are connected together so as to produce a continuous winding in the same direction. Leads are brought to the shaft, which is split and insulated in the center. Flexible springs from which connections are taken are soldered on the shaft ends. The stator coils are also wound so that the coil is in one continuous direction. These two coils are in series and maximum inductance is obtained when the two coils add in the same direction and minimum inductance when they oppose.

Figure 10 shows a possible assembly arrangement, but this may be altered to suit the individual taste. Connections should be made with heavy wire and all joints soldered, using the alcohol and rosin flux.

The operation of the transmitter is very simple. Starting with tight coupling on the power control, connect the high potential direct current and heat the filament to normal temperature. Oscillations will be indicated by radiation, noted from the aerial ammeter. The four taps of the wing inductance and the two taps of the grid inductance will now have to be adjusted until maximum radiation is obtained, consistent with the wave length desired, final tuning being accomplished with the antenna tuning variometer. Definite connections cannot be stated for the taps as the inductance of the connecting leads of the various sets built will vary too widely, but the right selection of taps is not difficult.

The microphone battery circuit is closed after maximum radiation is obtained and the set is then ready for transmission. Good modulation will be indicated by a slight decrease in antenna current while speaking into the microphone.

The Coil Aerial

Its Use as a Direction Finder

By Leon T. Wilson

DESPITE some limitations, the coil aerial has jumped into a position of considerable importance in the last few years, and a large amount of research work has been expended in an effort to find out just what is its peculiar field. For the benefit of those who desire to take up this very interesting field of experimentation and research a description of the construction and use of the aerial as a direction finder will be sketched. There is still a great deal to be done in investigating this peculiar type of aerial, and the opportunities for the amateur to be of real constructive assistance to the art are manifold.

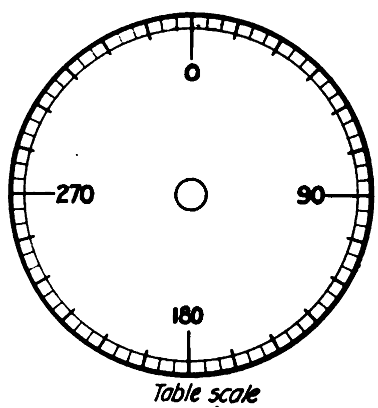
LIMITATIONS: There are only two disadvantages of the coil aerial which demand serious consideration.

FIRST: It is not suitable for long wave work, either in transmission or reception unless unusual facilities are available for the erection of a very large coil. In commercial work, of course, this limitation is almost fatal, as it bars the coil aerial from use on wave lengths over 300 meters. For the amateur this does not mean much, as he is restricted to transmit on wave lengths of 200 meters or less.

SECOND: The general bulkiness and unhandiness of this type of construction, especially in the larger sizes, makes it difficult to construct a rigid and durable frame with the facilities at hand for the average amateur. Do not think that this is an objection of any moment in making a direction finder, though, for as we shall see in the details of construction, the square coil is only about 4 feet on a side. Such a small dimension as this is perfectly easy to handle and pivot. It is only when the coil grows to 20 or 30 feet on a side, as it must be to compete with the results of a flat top antenna, 40 or 50 feet high, that we get into difficulties.

ADVANTAGES—FIRST: A coil aerial, can, in general, be made to have less resistance than an average flat top antenna. The tuning is therefore sharper, with resulting clarity and ease of reception, due to the decrease of interference.

SECOND: Besides the effect of lessened resistance on interference, there is the unmistakable effect of the directional qualities of the loop on clearness of reception. This is due to the fact that when the coil aerial is set for the best reception of any particular station, all other stations, with the exception of possibly one or two, come in at an angle to the coil, and their strength is consequently decreased. The intensity of signals decreases the nearer the line of direction is to a right angle with the plane of the coil.



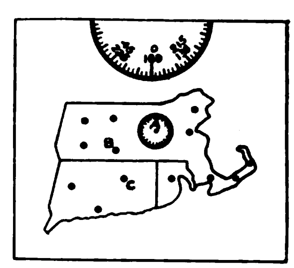


Figure 2—Compass card. Figure 3—Plotting board

THIRD: The coil aerial generally gives a smaller stray to signal ratio. That is, the intensity of the "static" coming in is smaller in comparison with the intensity of the signals, than is the case of a flat top antenna.

FOURTH: A coil aerial has the peculiar properties of being able to indicate the *line of direction* of any transmitting station. Basically, this is due to the fact that any solenoid made up of a few turns of wire on a frame that is considerably larger in the dimensions of its cross section than it is in length, gives a minimum signal when its plane is at right angles to the line of the incoming wave. An approaching wave front strikes both sides of the coil at the same time, if the coil is facing the wave, and the currents set up in opposite sides of the coil neutralize each other. If the coil is swung into any other position the wave front does not impinge on the two sides of the coil simultaneously, and consequently some part of the current is left unbalanced. This unbalanced portion produces the signal. This effect is the same from whichever side the wave comes, hence the coil will indicate the *line of direction* only.

Since the line of direction only is given, it is necessary to have at least two stations take and compare observations, if actual locations are to be determined. The point of intersection of the lines of direction is the location of the transmitting station. In general, a well constructed aerial will give directions accurate to two degrees. Best results can be obtained with reports from more than two stations, as the additional reports serve as a check on the others. The use of the minimum signal point gives much sharper definition of direction than the maximum. It is evident that the nearer the reporting stations are to 90 degrees with each other, the more accurate can the intersections be plotted.

Construction Suggestion—A size convenient for indoor operation, on 200 meters, is a square loop, 4 feet on a side. The frame may be made up of cheap wood, varnished or shellacked. Four turns of No. 18 D.C.C. copper wire will be sufficient. Space the wires ¾" apart in the form of a helix. This means that they must be laid on the edge of the frame. For experimental work with the aerial, the frame shown in figure 1 is easily constructed, and has the advantage of the corner blocks being easily removable for a change in spacing or number of turns used. Leads may be tapped out where convenient.

Mount the frame in a yoke, and arrange the yoke on a tripod or a table, so that it may be rotated about a vertical axis. Make a pointer to fix to the yoke, so that it will rotate with the coil and indicate the direction in which the axis of the coil is pointing with reference to the scale. To the tripod or table attach a compass card, or circle divided into 360°. This card should be at lease 6" in radius, 12" in diameter, with every five or ten degree mark distinctively drawn and numbered, as in figure 2.

Place the scale so that the zero point is to the north, as determined with a pocket compass. This is one point that must not be overlooked, as otherwise two or more observers will have no common zero from which to report their lines of direction. Be sure, then, that the scale reads zero when the face of the coil is due north. For permanency make the card of a thin piece of wood, or mount the drawing on a heavy back of similar nature. If a table is used, simply fasten it to the table top.

When the amateur is satisfied with his execution of these details the coil may be connected into circuit, and the desk instruments tuned.

Plotting Board—To use the coil aerial as a direction finder we must have a map and a simple form of an alidade, for plotting reports.

Secure a cheap drawing board, or mount a map of the territory you wish to cover on a table top. If a drawing board is used, paste it on with the edges of the map and board parallel. Now, using compass and protractor, lay off a semicircle of 6" radius and divide it into degrees, having the center of the semicircle at the center of the top edge of the board, see figure 3. Number every 5-degree mark so that it reads for both ends of the diameter of which it is one end. The drawing makes that clear. About the location of your home-station circumscribe a complete circle of 2" radius and divide that into degrees, every 5th degree as before, only numbered consecutively. Zero is always to the north, or top of the map.

To each of a half a dozen or more push pins attach a heavy thread with a small weight at the end. These are to insert at the locations of the home station and other reporting stations. The threads indicate the lines of direction, and their intersection point locates the unknown sending station.

The alidade is an instrument by which the angle of direction can be laid off from any point on the map. It consists of a cheap T-square, or if one is not handy, of two pieces of thin wood joined together as shown in figure 4. The blade is about 30" long—or 6" longer than

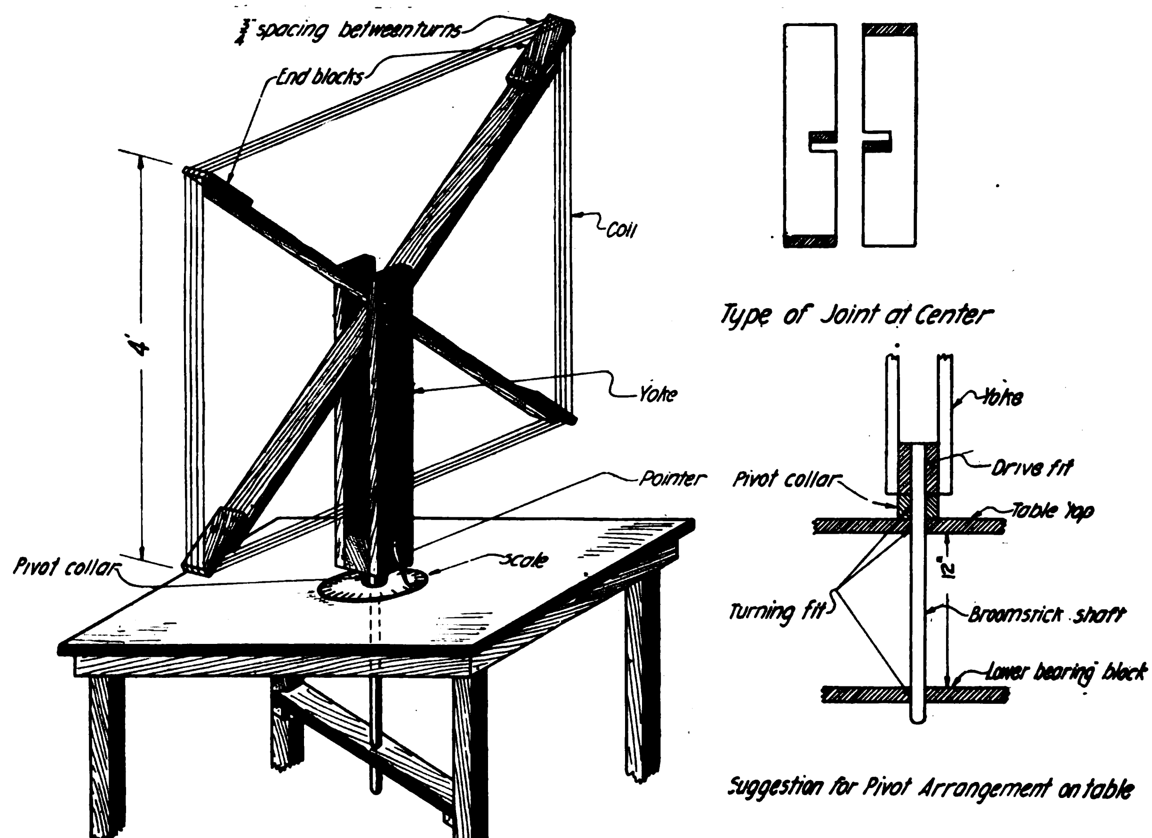


Figure 1—Detailed constructional view of the coil aerial

the width of your map board, of 1/8" x 2 1/2" stock. The head is about 8" long, of 3/8" x 2 1/2" stock. They are joined with a screw and thumb nut, so that the blade may be turned to make any desired angle with the head. If a T-square is purchased, remove the small screws which hold the blade solidly to the head, and substitute the screw and thumb nut mentioned.

This completes the construction of the accessories for direction finding.

To locate the direction of a station, ascertain the direction from the home station by reading the angle of the incoming wave on the scale of the coil. Transfer this angle to the map by inserting one push pin at the home station and laying out the thread over one of the two possible angles. That is, a station may be either 90°, or 270°—as you only know the line of direction. In most cases you can guess correctly which one, but positive check will come with the report from the station co-operating in finding the direction. When his report comes in turn the blade of the alidade to the proper angle on the large semicircular scale. Then slide the head of the ali-

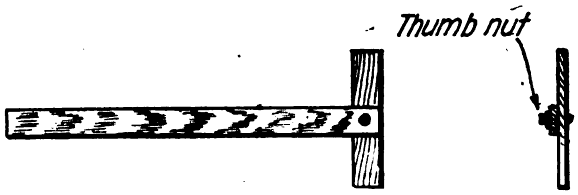


Figure 4--Method of constructing the alidade

dade along until the blade edge crosses the location of the reporting station. The intersection of this line with the line from the home station locates the transmitting station. If reports from other stations are to be obtained, insert a push pin at each station, laying out the line of direction with the thread as in the first instance. The more reports you have, the more accurately can you allocate the sending station, a result most desirable when attempting to spot a station that is jamming the ether with an obnoxious variety of wave lengths.

SOME PRECAUTIONS—In operating such a coil aerial as a direction finder some precautions are necessary. In order that a sharp setting may be obtained the grounding of any part of the receiving apparatus should be avoided.

If operated indoors the coil should be at least the length of one side of the coil away from the sides of the room to avoid undue absorption in the walls. Likewise the coil should be well away from masses of metal such as steam radiators, pipes and the like.

If operated out-of-doors, unshielded, the coil *and receiving apparatus* should be several feet off the ground, preferably as much as 7 feet.

If it is desired to operate the set closer to the ground a grounded horizontal shield placed above the loop may be used to advantage. This shield may be built of parallel wires arranged in a harp-like fashion. The wires should be long enough to extend about 6" beyond each end and wide enough to extend 6" beyond each side of the loop. A 3/4" spacing of these wires will do nicely. The shield should have its wires parallel to the top wires of the coil. They should be joined at their centers and grounded. In general such a shield will sharpen the minimum setting considerably and will also serve to decrease the ratio of strays to signals.

If the signal received on a coil aerial is weak, the minimum setting of the loop may be very broad. That is, there may be a zero signal over several degrees. In such event, the direction of the sending station may be approximated by taking the mid-point of the section of the scale over which a minimum signal occurs.

Although the direction of the incoming signal is of course perpendicular to the plane of the coil when it is set on a minimum, this is not always the true direction of the sending station, especially if the wave has passed over land for a considerable distance. This is because the waves do not necessarily radiate in straight lines. They tend to follow good ground paths such as are offered by rivers. Where a wave passes entirely over water the propagation is practically a straight line. A number of reports will get around this difficulty in most cases.

In this article only the simplest form of construction has been outlined. As in everything else pertaining to radio work, care and accuracy in detailing the various parts are sure to bring their reward in increased and more dependable results. Research and experimentation in this field will be not only fruitful but interesting, and the amateur is urged to investigate the possibilities of the device to the limit of his abilities.

Uni-Control Receiver Without a Coupled-Tuned Circuit

N an invention of Roy E. Thompson, he claims to have discovered that, in the use of two circuits in a radio receiving set, closely coupled together, a transfer of energy from the first to the second and its utilization in useful work in the second can be effected equally well at any period of the first circuit and wholly independent of the period of the second circuit, provided the second circuit be properly constructed.

Heretofore at radio receiving stations it has been customary to employ two circuits supplying the detector and telephone, these two circuits being termed the antenna circuit and the secondary circuit, and heretofore the most efficient use of the received energy has been obtained when both circuits were made resonant, and both adjusted to have the same, or substantially the same, time-period. The utility of this two-tuned-circuit arrangement was due to the fact that the secondary circuit not only received energy from the antenna, but being a resonant circuit, it permitted that energy to accumulate to the maximum and thereby efficiently operate the indicating apparatus, such as a detector and telephone, or in some cases, a telephone alone. This secondary circuit, also having the same time-period as its primary circuit, thereby permitted the two circuits to resonate harmoniously with consequent beneficial results.

This coupled-tuned circuit receiving apparatus (known as the Marconi type) proved so exceedingly useful in radio work that for many years it was not deemed possible to devise practical apparatus which was not of this type.

However, notwithstanding that this type was standard practice for many years, the art recognized that it possessed certain serious disadvantages. Attempts were made to improve the type so as to eliminate these disadvantages, but the latter proved to be inherent in the type.

The chief disadvantages were two: First, the inconvenience and delay involved in making fine adjustments in order to operate at best efficiency; and second, the inefficiency of operation due to coupling difficulties incidental to the transfer of energy from the antenna to the secondary circuit.

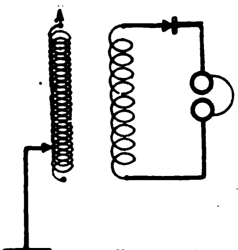


Figure 1

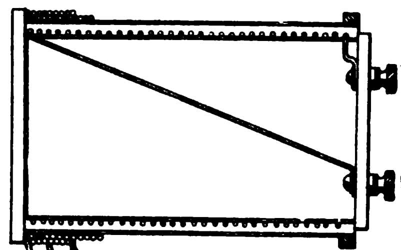


Figure 2

Figure 1—Location of the detector near an end of the secondary coil
Figure 2—Coil of the utilization circuit

The first disadvantage in the coupled-tuned circuit type was involved in the manipulative adjustments executed by the receiving operator. Each of the two circuits contained at least one frequency-determining element, such as a variable coil or a condenser, and generally both of such elements, and such elements in both circuits, were required to be accurately adjusted, in order to obtain the efficiency of the type, each time that a message at a different wave length came in from a distant transmitter. In fact, the highest efficiency of which this type was capable could not be obtained unless the operator first by trial adjustments put the two circuits into the same tune. This usually involved, first, an adjustment of the antenna circuit; then an adjustment of the secondary circuit; then a re-adjustment of the antenna circuit; then a re-adjustment of the secondary circuit, etc., sometimes including an adjustment of two or more elements in each circuit, so that, at best, it took a substantial length of time to put the apparatus into best condition. All this was a very serious disadvantage in practice, on account of the great importance of quick service. But this disadvantage was borne with, because it was inseparable from the efficiency of this type.

Thompson claims that in his arrangement there is equal efficiency with the coupled-tuned-circuit type without the necessity for any adjustments of a secondary circuit.

The second disadvantage in the coupled-tuned-circuit type involved difficulties in the coupling between the two resonant circuits. If this coupling was too close some of the energy accumulating and persistently oscillating in the secondary, was transferred back to the antenna, and re-radiated and wasted, instead of going forward to do useful work on the indicating apparatus—for the very fact that harmonious persistent oscillation of the two circuits facilitated the transfer of energy from primary to secondary, likewise facilitated the re-transfer of energy back from secondary to primary. On the other hand, if the coupling were then loosened in order to prevent such re-transfer, then that resulted in a decrease of the efficiency of energy-transfer from the antenna to the secondary. In practice a compromise was made by having the coupling neither very close nor very loose, *i.e.*, not so close as to cause a re-transfer of considerable energy back to the antenna, and not so loose as to prevent the transfer of a substantial amount of energy from antenna to secondary. This, however, did not remove, but merely alleviated, the difficulty, and there yet remained a substantial loss of efficiency because the compromise coupling was not close enough to transfer to the secondary all the energy supplied to the receiving antenna.

In the scheme here shown, there are no coupling difficulties because the accumulative action of the circuit supplied from the antenna is eliminated entirely, so that instead of a re-transfer of energy back to the antenna, the entire energy, transferred to the utilization circuit, is instantly consumed therein, and doing useful work in operating the detector.

In the best form of the coupled-tuned-circuit type, the secondary circuit included the secondary coil of an oscillation transformer, and a condenser, in series with each other; the condenser was in shunt or parallel between the detector and the secondary coil, the coil and condenser constituting a resonant cumulative circuit, this condenser being preferably variable to adjust the period of the secondary to that of the antenna; or else the inductance in the secondary was variable; or both the condenser and inductance in the secondary were variable, in order to obtain the best tuning.

In other forms of this coupled-tuned-circuit type, in order to reduce the manipulative operations of the receiving operator, the condenser has been omitted, and then the secondary coil was the only adjustable element in the secondary circuit. Of course, in all cases, the antenna is adjusted to be put in tune with the received waves.

In yet other forms of this type, no adjustment has been provided for the secondary circuit, but it has been given a fixed period approximating the range of commercial frequencies received on the antenna (no variability being provided for any reactance in the secondary circuit), the idea having been to eliminate all the troublesome secondary adjustments, but yet to retain the advantage of having the secondary more or less closely or broadly tuned to the antenna. This form has been termed the non-adjustable or "untuned" form, although the fact is that the secondary did have a "tune," as various investigators have shown. The difficulty with such attempted simplified form, however, was that the efficiency was reduced in proportion as the fixed period of the secondary was different from that of received signals to which the antenna was tuned. That is, although such a modified receiving set of the coupled-tuned-circuit type might be very efficient when the incoming waves at a period which happened to be the same or

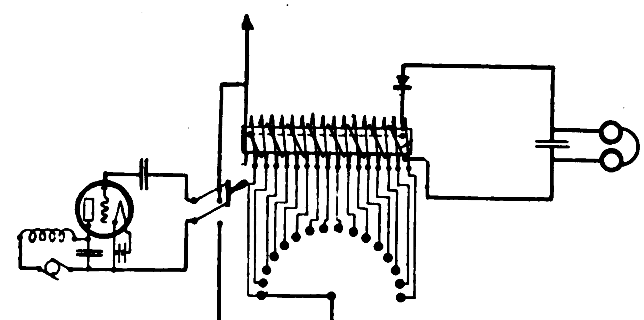


Figure 3

Figure 3—Showing arrangement whereby a vacuum tube produces oscillations to produce beats with an incoming signal

nearly the same as the fixed period of the secondary, yet the efficiency for receiving wave lengths higher or lower than the period of the secondary, was proportionately less, and the efficiency fell off rapidly for increases of difference in periods of secondary and received waves.

Thompson states that the inefficiency of the non-adjustable (so called "untuned") secondaries was due to the presence of distributive capacity yet existing in the circuit, even in cases where no condenser (lump capacity) was used in shunt to the detector and coil; that this distributive capacity was acting to make the circuit cumulative to a certain degree so that when it was attempted to simplify the operation by omitting an adjustable condenser paralleling the detector (in addition to the omission of adjustable inductances) such omission alone did not make the secondary circuit a non-resonant circuit, but simply deprived it of the mechanical advantage of being adjusted to have identically the period as that to which the antenna was adjusted. It possessed the disadvantages of a condition of resonance in the secondary without the ability to take advantage thereof. It, therefore, was nothing else than an inferior form of the coupled-tuned-circuit type, notwithstanding that this modification has been termed an "untuned secondary" type by many writers, simply because no adjustable condenser for exact tuning was provided in the secondary. The secondary was in fact tuned, although not to the exactitude required for the highest efficiency of the type.

In the practice of making secondary circuits without a condenser in parallel to the detector and secondary coil, it has been assumed, apparently, that the omission of this condenser removed from the circuit all capacity which was acting to make it a tuned cumulative circuit. The fact apparently has been overlooked that the circuit always possessed substantial capacity other than that of the omitted condenser—especially that capacity which is resident in the secondary coil.

It is Thompson's claim that the reason why the so-called "untuned," i.e., non-adjustable secondary, did not respond efficiently to the various wave lengths, was the existence of such distributed capacity. This distributed capacity of the coil provided it with ability to accumulate enough energy to be effective in re-acting on the driving circuit to such a degree as to make necessary the adjustment to the same period in order to eliminate such re-action effect.

It has been demonstrated that if the secondary circuit be constructed to have so little capacity (in parallel to the detector and secondary coil) as to be substantially non-effective in making the secondary a tuned circuit, then it is possible to operate a receiving station at maximum efficiency for all possible period of transmitted waves, without any reactance adjustments of the secondary whatsoever.

Under practical conditions, and with such minimum capacity in the secondary as the fundamental condition for substantial aperiodicity of the secondary, it is claimed that the same efficiency of reception at all present commercial wave lengths is obtained without any adjustment whatsoever of the secondary circuit. The coupling between the antenna and the utilization circuit should be sufficiently close to cause an instantaneous and complete transfer of energy from the antenna, and thereby cause the creation of maximum potential in the utilization circuit, without any necessity for (or any actual) substantial accumulation of energy, as in the coupled-tuned-circuit type; yet without any substantial loss of energy, and without any substantial re-transfer of energy back from the detector circuit to the antenna. This instantaneous maximum potential is created across the detector, and the resulting effect is passed directly, via the detector, to the telephone. Under these circumstances, the utilization circuit being actually aperiodic, and no energy being accumulated therein, there is none of the coupling troubles which existed in the couple-tuned-circuit type, for there is no re-transfer of energy back from the utilization circuit to the antenna, all the energy which was instantaneously transferred from antenna to utilization circuit being instantly employed in causing the indication of the signal. In all cases the non-adjustable utilization circuit has the same efficiency irrespective of the frequency of the transmitted waves. All this is particularly true when the natural period of the aperiodic non-accumulative utilization circuit is far below 300 meters—the shortest commercially used wave length—and when the antenna is adjusted above 300 meters.

In brief, the construction is such that substantially all of the energy received on the antenna is instantly passed on to its place of utilization without any interval of accumulation in the utilization circuit.

In putting his discovery into practice, Thompson reduces, so far as possible, the distributed capacity of the coil itself, and by so locating the detector in the circuit that any capacity which may exist in the circuit connections acts as in series with the detector and not in parallel thereto; that is, the detector is located as near as possible to an end of the secondary coil, as is illustrated in figure 1. In figure 2 is shown a coil of the utilization circuit especially adapted for an antenna coil of a given range of wave lengths; i.e., in this example 100 to 3,600 meters. For a receiver, the antenna and primary of which is to have a range of 100 to 3,600 when connected to an average ship's antenna, the following dimensions are suitable in connection with this scheme.

Around the primary core (see figure 2) of suitable insulating material, 4" in diameter and 7" long, is wound a primary coil consisting of 280 turns of wire, having a diameter over the insulation of approximately .05". This primary is "banked" in two layers. Suitable taps may be taken off as desired for purposes of adjustment of the wave length of the antenna circuit. Provided with means for sliding all the way inside of the primary core is the secondary cylinder, which is 3½" diameter and 7" long. Around this cylinder is wound a single layer secondary coil, consisting of 70 turns, having a diameter outside of insulation of .05", each turn being separated from each adjacent turn by a distance equal to the thickness of the wire. The extreme ends of the winding are connected to binding posts which in turn are connected to the detector and telephone (figure 1). The novel feature of figure 2 is, according to Thompson, that a high inductance is had here without the capacity normally corresponding thereto.

In figure 3, an arrangement is shown whereby a vacuum tube may be connected for the production of oscillations which are to produce beats with any incoming signal. Here the antenna circuit controls the frequency of the oscillations of the vacuum tube and also, as before, the frequency to which the antenna circuit is tuned.

Many efforts have been made during the past few years to simplify the operation of a receiving device. The foregoing is a very good example of the trend that these efforts have taken. A solution such as this, however, would not seem to be the final solution.

Constant Speed Regulator for Series Motor

(Continued from page 14)

wireless transformer, providing the auto-transformer is correctly designed. A ten-ohm rheostat is also included in the circuit to the motor for close regulation of the compensating voltage in each case.

The auto-transformer, for the usual type of high-speed series motor using about 50 watts, consists of a laminated iron core one inch square in cross-section and three by seven inches outside dimensions, as shown in figure 2. On one leg of this core are wound 800 turns of No. 22 D.C.C. wire, a tap brought off, and an additional 50 turns on top of this. In some cases, with larger motors or where the voltage drop is already excessive it may be necessary to use more than 50 additional turns, but these can readily be added after the device is completed. The line voltage is connected to the 800 turns and the motor is normally connected to these also giving it the regular line voltage, but when the key is pressed the compensating winding is connected in circuit.

The double contact relay can be made from any available parts the experimenter may possess. The magnets should be of about 200 ohms resistance and have laminated cores if possible. The contacts need not be very large as only one-half ampere of current is carried by them.

The whole device is so simple and inexpensive that it is recommended to any amateur who desires a constant, readable, spark note.

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

An Original Aerial Switch

By Thos. W. Benson

FIRST PRIZE, $10.00

THE writer has had occasion to handle many types of aerial switches, from the ceiling type operated with cords to the foot operated switch, and few, indeed, are really satisfactory. The usual D. P. D. T. switch operating through an arc of about 60°, in common use, makes a fine appearance but it is unhandy to throw upward, requiring some effort when the clips are tight.

To overcome these defects the switch described was designed and worked splendidly. There are several advantages, the most important being that either a downward or upward thrust of the hand will throw the switch either way. The switch, when mounted over the key is remarkably easy to throw. When reaching for the key, the hand naturally throws the switch with the minimum effort.

It includes a device for closing the primary circuit and starting the rotary gap. Other attachments are not advised as they lead to induction currents in the receiving set. A convenient place to mount the thermo-ammeter is over the switch. A special arrangement of contacts allows this meter to be up in the circuit when desired. This eliminates an extra switch used for short circuiting the meter. The circuit used is rather novel, the problem of insultation is solved by receiving through the secondary of the oscillation transformer. Though not exactly new, the method is not used as extensively as it deserves to be.

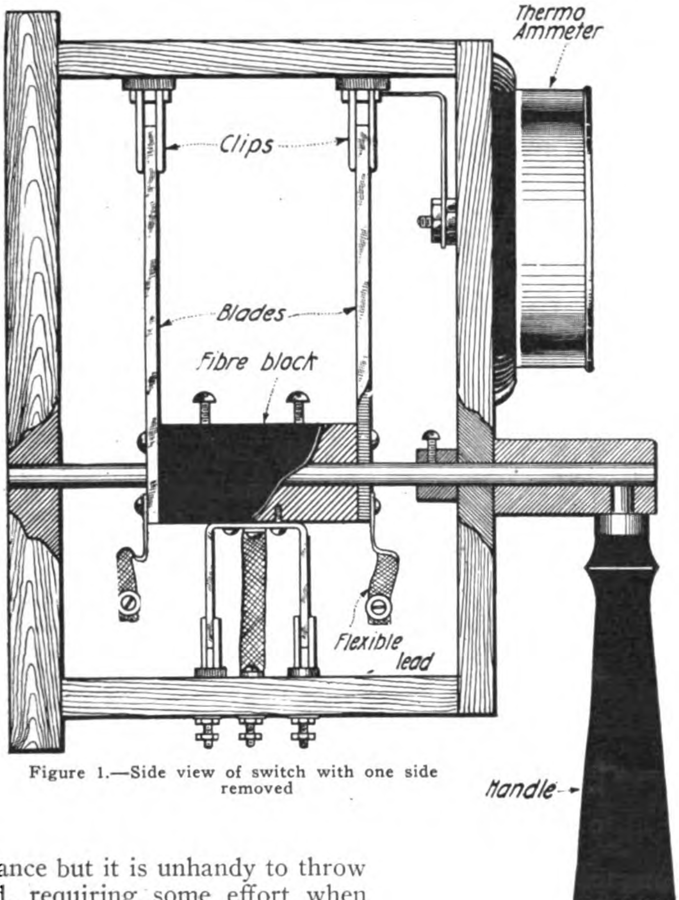


Figure 1.—Side view of switch with one side removed

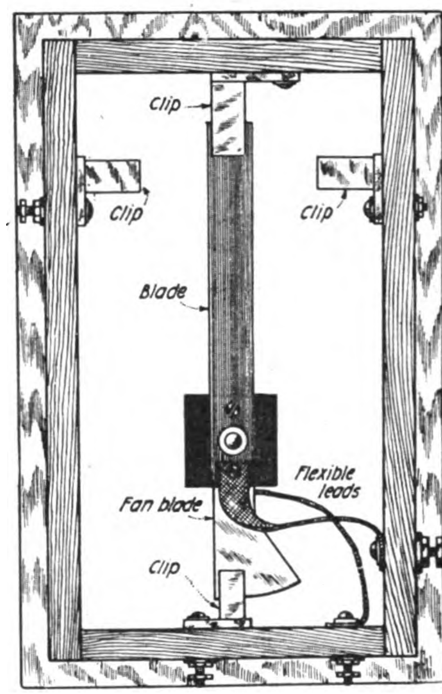


Figure 2.—Sectional end view of switch showing arrangement of clips

The constructional details of the switch are given in the attached illustrations and due to its simplicity requires little, if any, explanation. The dimensions will vary slightly with the apparatus available, hence only general data is of any practical value.

The switch blades are made from copper strips 4" long ⅛ x ½". These are held 2" apart by a block of bakelite or fibre. A hole drilled through the fibre passes a brass rod to actuate the switch. A hole larger than the rod drilled in the copper blades prevents them making contact with the brass rod. The insulating block is fastened to the rod by two machine screws running through the block.

Two copper Ls attached to the lower side of the block, act as blades for controlling the primary supply current and the rotary gap motor. Connections are made to all the blades by heavy stranded wire, No. 14 serving for the smaller blades, a braided ribbon for the aerial circuit blades. These are clamped under the screws and soldered securely in place. Three binding posts on the bottom of the box allow of connections to the small clips. A heavy pair on the lower right hand side is for connection in the aerial circuit.

The arrangement of the clips is shown in Fig. 2. The box is 4" wide; two switch clips being mounted on both sides of the box 2" apart to receive the blades, the clips on the right being short circuited by a copper strip, those on the left having binding posts on the outside for connecting to the receiving set. Midway on the top of

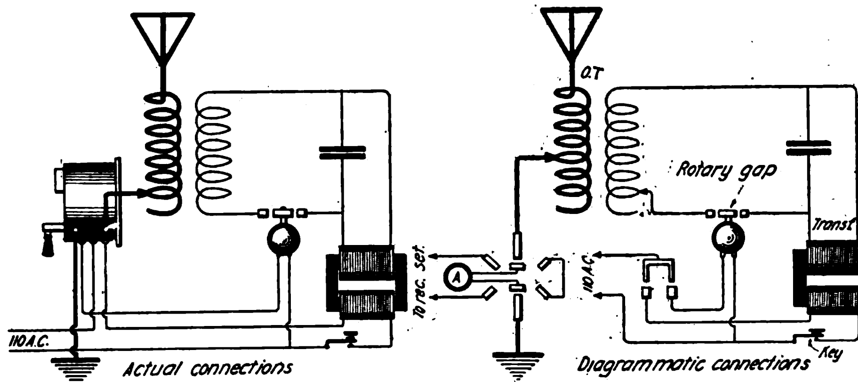


Figure 3.—Wiring diagrams showing how the circuits are controlled

the box, and arranged so as to make contact with the blades, are mounted two other clips. These are shaped so the blades will enter easily from either side. Heavy leads are run from these posts to the thermo-ammeter on the front panel.

The actuating handle may take different forms depending on the desire of the builder. A small hand wheel may be used or either of the ideas shown. In one form a round block of fibre is drilled to pass the rod and tapped to take a switch handle projecting downward. The thread in the switch handle clamps again a flat side field on the brass rods. or two switch handles may be threaded into the fibre cylinder projecting on either side.

The switch is mounted on the wall or back of the operating table, six inches above the top. With the single form of handle a sweep of the hand will throw the switch. The double handle requires downward pressure on the proper side to operate the switch. By setting the blades in the centre a reading can be taken on the ammeter, the width of the primary and gap circuit blades permitting the circuit to remain closed.

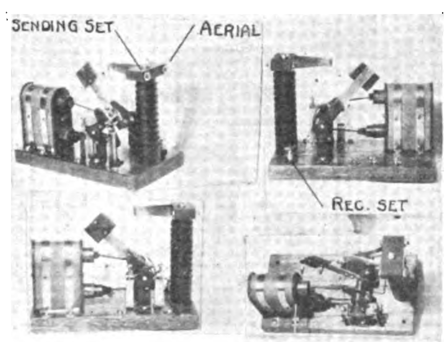
The wiring diagram in figure 3 shows how the circuits are controlled. The switch acts to open the aerial circuit and connects in the receiving set thus receiving through the secondary of the O. T. Leakage of the sending current is impossible. The switch is connected in the ground lead of the set so the lead can be run directly to the O. T. simplifying the wiring. The thermo-ammeter is connected in the ground lead, the proper place for this instrument.

A Remote Control Antenna Switch

By Omer E. Cote

SECOND PRIZE, $5.00

A GREAT many amateurs will find it possible to increase the efficiency of their transmitters considerably if they locate the transmitting apparatus at a point which is remote from their receiving apparatus. The amateur is not always able to choose the loca ion for his apparatus, and is usually allotted a room somewhere in the garret. Those who have had experience with the transmitter located in the garret have learned that they do not function as well in such a location as they would near the ground. The design of a remote control antenna switch which may suggest possibilities in this direction, is therefore offered. This switch, as constructed, is suitable for powers to ½ KW. For higher power a longer strip on the switch blade will be required. The switch, as designed, merely changes the aerial connections from "receive" to "send" and vice versa, the ground connection being on both transmitter and receiver at all times. It is necessary, however, to disconnect the ground from the receiving set when transmitting. This may be accomplished by having a small porcelain base single pole switch near the receiving apparatus which is to be open when the transmitter is in operation. This method simplifies the construction of the antenna switch itself, although the ingenious amateur will be able to so al-



Various views of the switch

ter the design as to meet any of his requirements.

Figure 1 shows the base which may be made of mahogany or any wood.

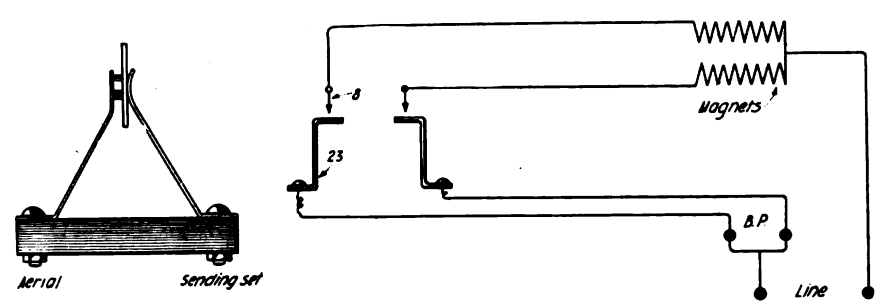
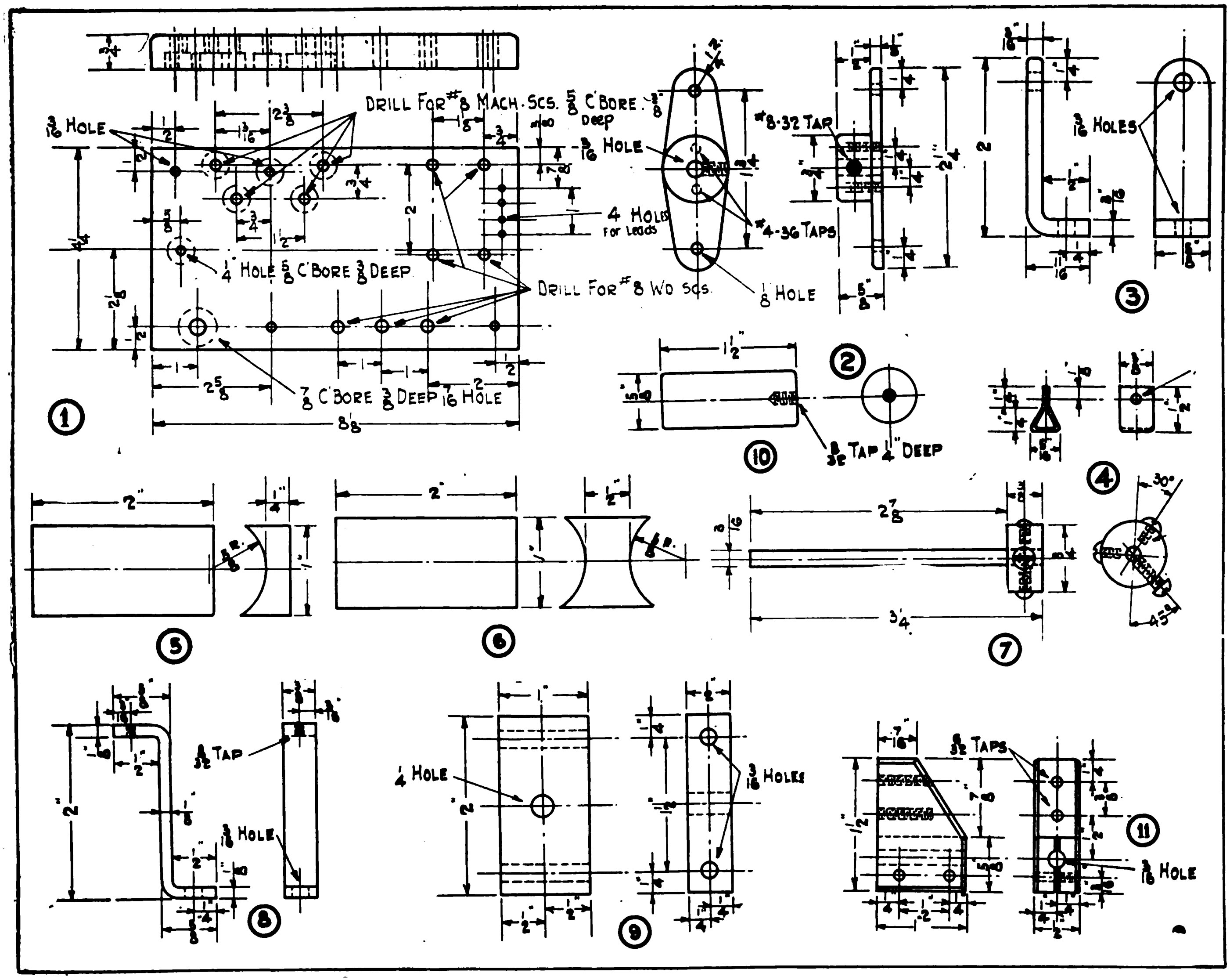


Figure 25.—Circuit diagram showing connections

Bakelite or hard rubber is not necessary, since all the high voltage terminals as well as the receiver terminals may be mounted individually on hard rubber or bakelite. This method will save considerable expense. Dimensions are clearly shown on the base drawing. Standard binding posts may be substituted for the three No. 8 machine screws which are called for in connection with this base. Machine screws will serve every purpose, however, since, once the connections are made, they are never changed.

Figure 3 shows the standards for the shafts. These may be made of iron or cold rolled steel. Two are required. A coat of dull black enamel will furnish a neat appearance. Figure 2 is the magnet rotator arm. The hub may be made of either cold rolled steel or of brass and is fastened to the long fibre piece with two No. 4-36



Figures 1 to 11.—Constructional details of various parts

round head machine screws. An 8-32 machine screw in the hub itself is used for a set screw in holding the arm to the shaft. One arm is required.

The shaft shown, figure 7, is either brass or cold rolled steel and at one end is fastened the magnet current breaking attachment. The cam is made of hard rubber or bakelite and the two 4-36 screws are ¼ inch long, as they should not touch the rod. The other screw can be a 6-32 machine screw to hold the cam to the rod. It is important that the point of this set screw fit on a flat spot on the shaft to keep it located at all time; otherwise the shifting of the magnet would soon twist the cam out of alignment.

Figure 4 is the clip fastened by a machine screw to the magnet core, figure 10. The ⅛-inch hole is for the connector arms, figure 15. The arms are made of iron wire to the sizes shown. Figures 5 and 6 are made of wood and are the support for the magnets. Figure 5 goes on the base, then the first magnet, then figure 6, then the second magnet.

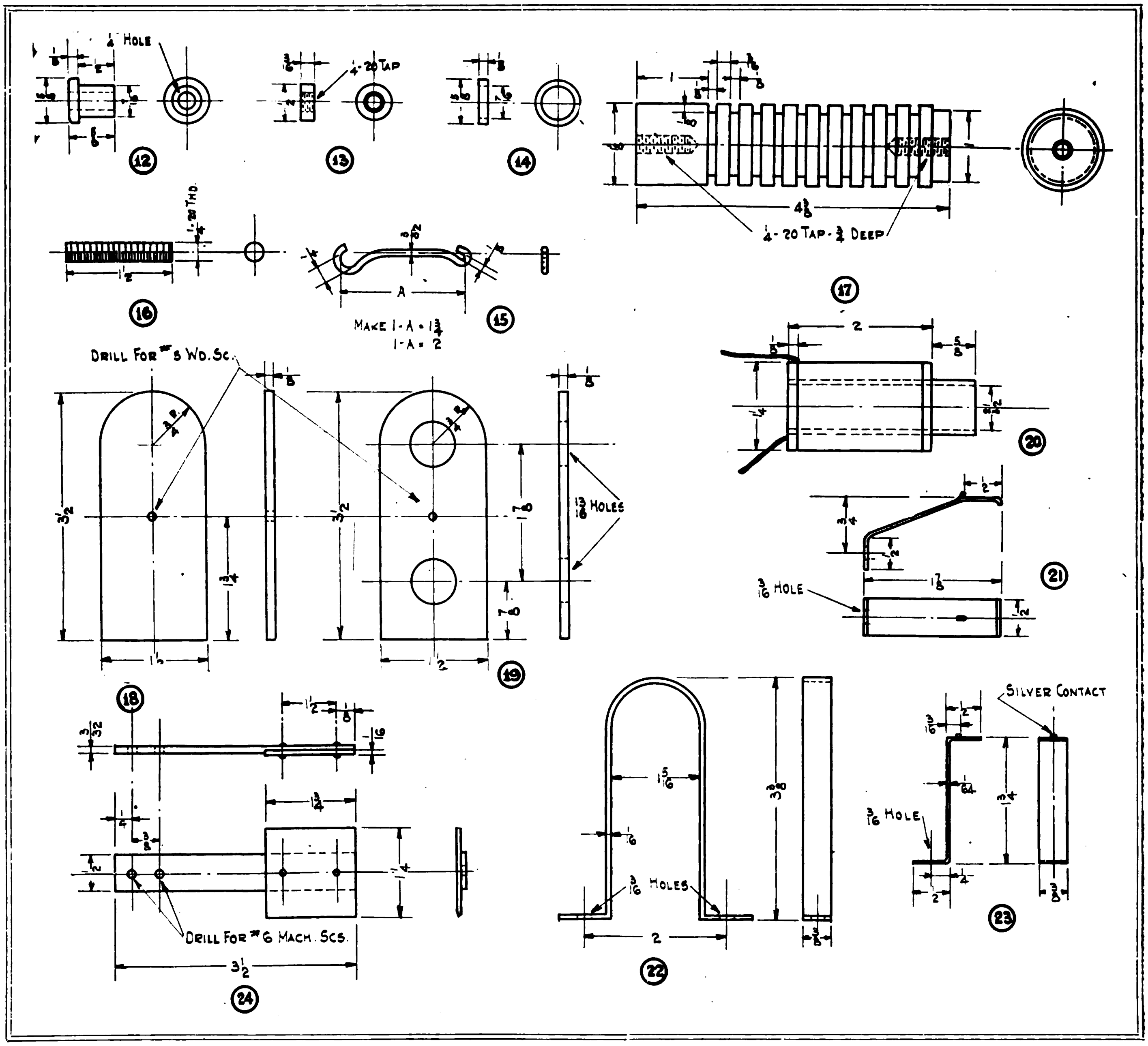
The magnets are shown in figure 20. The solenoid is a piece of brass tubing which is covered with varnished linen before winding the wire. The magnets are wound each with 1500 turns of No. 27 enamel wire which gives a resistance of about 20 ohms. The ends are of fibre.

These magnets are fastened in place in the following manner. The blocks 5 and 6, having been placed between the magnets, a piece of fibre about 1/32 inch thick and cut 2⅛ inch wide, is put around the magnets before putting on the straps, figure 22.

If it happens that these straps do not hold the magnets good, the latter are wound with a few wraps of tape to increase their size; it is important that they be fastened very tight so that they will not move when working. The magnets being 2 inches long and the fibre covering 2⅛ inches, leaves at the outer end a space of ⅛ inch for bringing the leads down and through the base. At both ends are the parts 18 and 19, which are made of fibre and held in place by wood screws fastened into part 6.

Figure 11 is made of bakelite and holds the knife blade. As can be seen in the photos, this blade is entirely insulated from the shaft. A connecting wire made of many strands of fine wire, to be flexible, is fastened to the knife blade at one end and the other end is fastened to the insulated terminal on the base.

This terminal is shown in figures 12, 13, 14 and 16. Figures 12 and 14 are made of hard rubber or bakelite, while 13 and 16 are made of brass. A knurled nut is used to connect the lead wire. Figure 17 is the insulating support and is made of either hard rubber or bakelite, while part 9, which is fastened on top with a ½-20 round head brass machine screw, is also made of the same material. The 3/16-inch holes in part 9 are for 10-32 round head machine screws., 1¼ inches long, which hold the springs, part 21, in place. Part 17 is fastened to the base with a ½-20 machine screw.



Figures 12 to 24.—Additional constructional detail

Part 21, two of which are required, is made of spring brass or copper.

Figure 8 is a brass standard which holds the contact screw. Two of these standards are required. The contact screws are 8-32 round head brass machine ½ inch long with a silver or platinum contact at the end. Two check nuts are also used with these screws.

Figure 23 is the spring standard, two of which are required, and is actuated by the cam at end of shaft.

The switch blade, figure 24, is made of copper and the insulating strip at the end is of bakelite held by two brass pins.

Figure 25 shows the connections.

1 KW. Antenna Switch

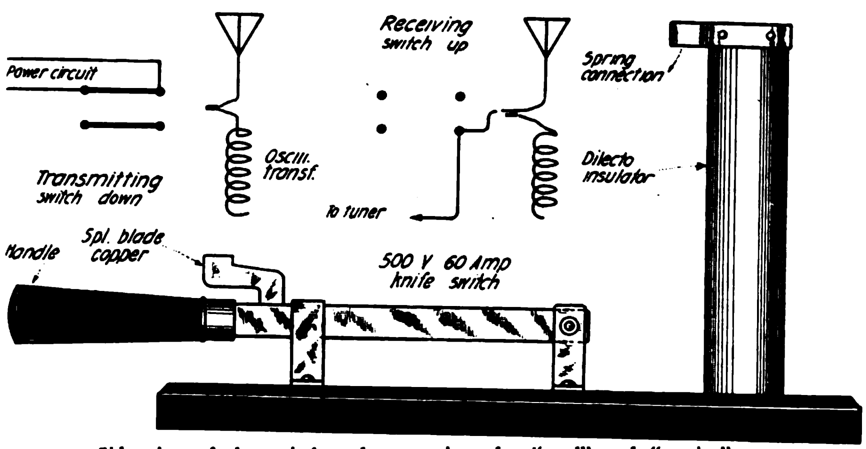
By M. P. Koopman

THIRD PRIZE, $3.00

The design of the following described switch has been worked out with the idea of reducing the machine work to a minimum, as most amateurs have not the facilities of good tools.

The sketch shows the connections for the "send" position and "receive" position and side view of the switch. The main part of the switch can be bought new or secured second hand and is a 500-volt 60-ampere knife switch with high jaws, front connected. This switch is then mounted on a slate base of suitable size. Also on the same base a dilecto rod insulator is mounted as shown. In a 1-kw. set the rod should be about 8 inches high, and for a ½-kw. set about 5½ inches high.

At the top of this rod insulator, two contact springs are placed, and so adjusted that they touch each other with good contact at all times that the special blade contact is not between them. One of these contacts is connected to the antenna and the other to the transmitting loading inductance or oscillation transformer. When the switch is down, the special blade is not between



Side view of the switch and connections for "send" and "receive"

these two contacts and direct connection from the antenna to transmitter is made. At the same time, the auxiliary contacts on the knife switch may be used to start the rotary gap and close the primary of the transformer circuit.

It is noticed on the drawing that the special blade on the switch is insulated on one side. Then when the switch is up, the transmitter is insulated from the antenna, and connection from the antenna is made through the special blade down through the switch blade to the switch hinge on one side.

Such a switch is very simple, very easily constructed and will give excellent operation.

70-Foot Mast for Umbrella Antenna

By M. P. Koopman

FIRST PRIZE, $10.00

THE mast and antenna described was erected some time ago (before the war) for 200-meter transmission, and it gives very good results. Many people claim that the umbrella type antenna is the best for transmitting, especially on low wave lengths.

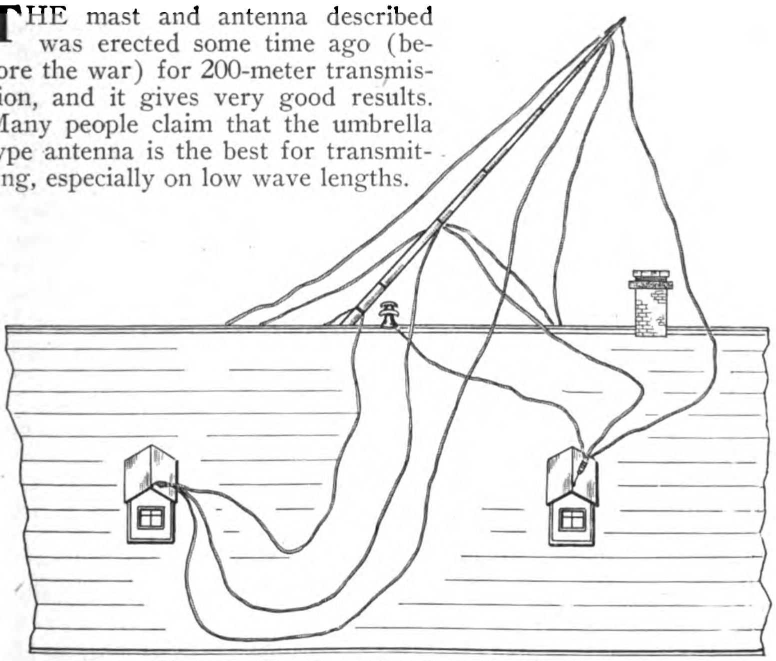


Figure 2.—Showing method of erecting the mast.

Inasmuch as the amateur has to pay quite a little money for his mast and then an additional sum for the antenna, by incorporating the antenna and mast together, this total is reduced considerably. Furthermore, this type, besides being efficient for transmitting, occupies very little space and may be erected on one's premises where the amateur is confined to his own residence.

The material necessary is itemized as follows: Eight 10-foot lengths of conductor pipe 3 inches diameter, No. 26 standard gauge, extra heavy galvanized; one petticoat insulator, porcelain, glazed, should be rated for at least 80,000 volts for wooden roofs and 120,000 volts for tin roofs; four large strain insulators, voltage will depend upon the power and wave-length that the set is to be worked at; four heavy screw eyes for anchors, screw should be about ⅞-inch thick and 3 inches to 4 inches long; antenna wire, seven strands of No. 22 B. & S. gauge silicon bronze, preferably tinned. Quantity can be figured out for the particular installation. Muriatic acid for soldering, solder (half tin, half

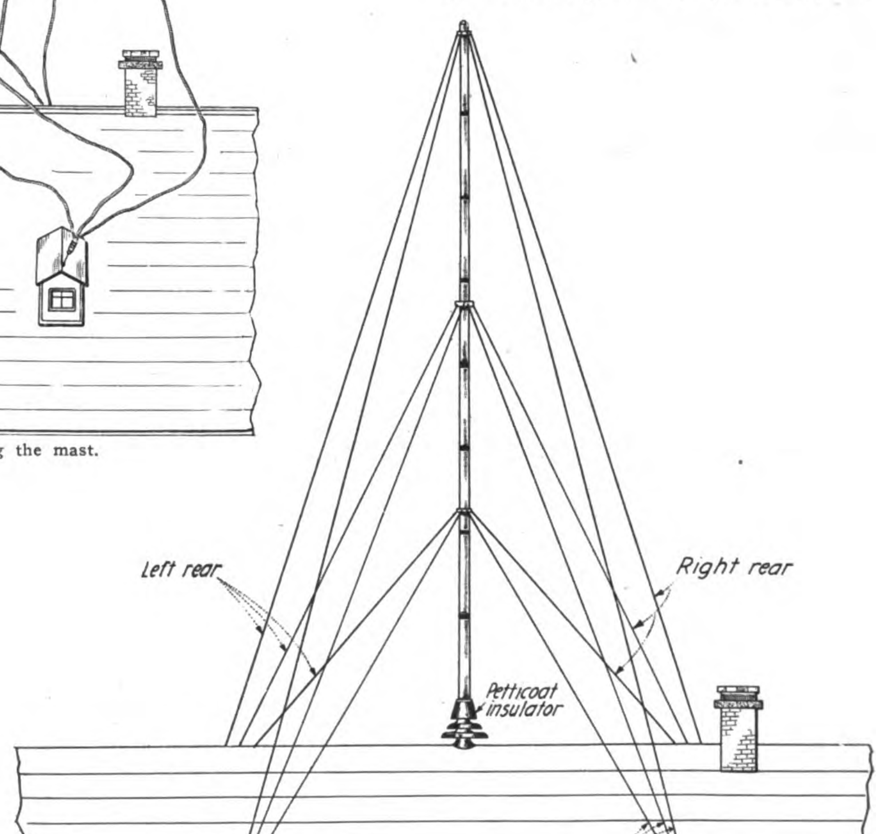


Figure 1.—Showing mast in position and location of the guy wires and lead-in wire

lead), cotton waste and rubber tape, little shellac or varnish, some asphaltum.

The third sketch shows the details of the petticoat insulator. This should be installed first, in the center of the four anchor posts that will be selected. As shown, the pin that screws into the insulator, is one that has a large wood screw at the other end. This wood screw is screwed deep into the ridge pole. It will be found that the ridge pole is a heavy beam and a hole will have to be drilled for the wood screw. Before screwing it in, the hole should be filled with asphaltum and later asphaltum spread all around the hole to prevent the roof from leaking. The four anchor wood eye screws are then screwed in their respective places in a like manner. It must be ascertained that the anchor wood eye screws are fastened into beams and not into the roof, which is only ½-inch stock.

Conductor pipe comes small at one end and large at the other and in 10-foot lengths. There are eight sections in all. While on the ground, these sections should be placed inside each other for 18 inches, making a total length of about 70 feet. It will be found that they will have to be forced in order to go in that 18-inch and that they will not go in much further without undue effort. Now that the sections are fitted together, these joints should be very thoroughly soldered, using a gasoline blow torch, muriatic acid diluted with water for soldering flux, and good solder. It may be advisable to tin the joints before forcing them together and then heating with the blow torch, making the soldering operation easier. At the top section,

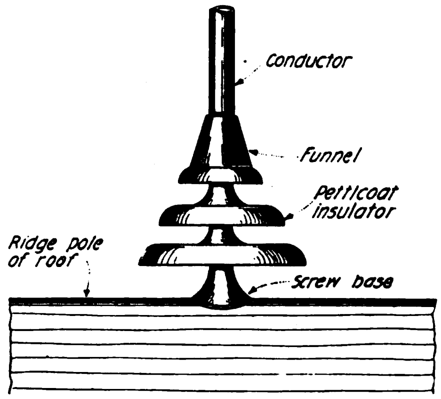


Figure 3.—Details of the petticoat insulator installed in the center of the anchor posts

the end is hammered over to prevent water running down the inside. This should also be soldered to make it water proof.

At the end of the bottom section, an ordinary 8-inch heavy gauge gasoline funnel is inverted. This gives a means of evenly distributing the weight of the mast on the petticoat insulator. This funnel need not be soldered to the bottom section as it will center itself.

The antenna wires should be cut about 10 feet longer than the exact size required in order to have a working margin. The lower antenna wires are placed 25 feet up the mast, the center wires 50 feet up the mast, and the upper wires at the top. At that place where the wires are fastened to the mast, they should be wrapped around very securely and soldered carefully. After feeling that they have been soldered properly they should be covered with asphaltum as far as they are soldered and all over the mast where there is soldering. This will prevent corrosion, at a later part of the season.

After the wires are cut to size and soldered to the masts, they should be so placed that they will not cross when the mast is lifted up alongside the house. Figure 2 shows the first erection operation. Most houses are from 30 to 40 feet high, and when the mast is hoisted along side the house, it will stick about thirty feet above the roof. The best way to raise the mast is to fasten long ropes to the end of each set of three wires and have a man hold each set. A block and tackle can then raise the bottom of the mast to the top of the roof and be placed on the petticoat insulator, while the four men steady the mast by holding the guy wires. Afterwards, one set of wires can be fastened to its anchor screw eye and the others following.

The whole outfit does not weigh more than sixty to one hundred pounds and no difficulty will be experienced in raising if there are five men available. Larger masts of the same type could be built, but the natural wavelength would be too great for 200 meter transmission without a series condenser which is not desirable.

100-Foot Radio Mast

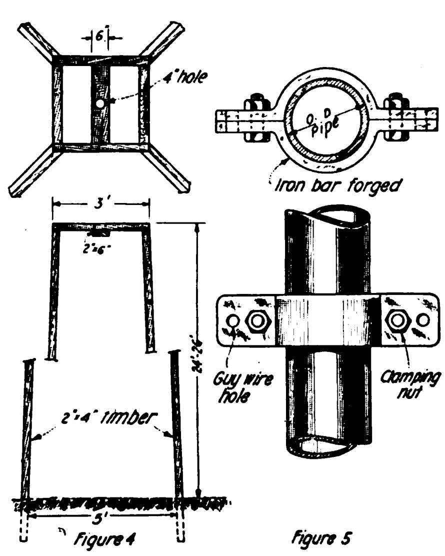
By L. D. Dillenback

SECOND PRIZE, $5.00

A YEAR before the war, an excellent mast was put up in New England by a few amateurs, 100 feet high, made of second hand iron pipe and second hand guy wire that was purchased very reasonably. Of course, prices have gone up about 200 per cent in iron pipe and wire, but even now a good mast could be put up reasonably.

This particular mast, figure 1, was used to support one end of an aerial, the other end being supported by a 130-foot pine tree which was located about 100 feet away. The antenna was strung between these two points, made T type and the fundamental was about 170 meters.

The technical data at the end of this article show the hardware that will be necessary, with the exception of the pivot, guy clamps and anchors, or "deadmen" as they are called in telegraph practice. When purchasing the pipe, new or second hand, look for the manufacturer's mark. The year is also



Figures 4 and 5.—Frame for concrete foundation and details of guy clamps, respectively

there and either a B or an L after the year it is manufactured in. B means butt welded and L means lap welded. Lap weld should be secured if possible as this will not buckle so easy and is much stronger. Furthermore, galvanized pipe should be secured. After buying second hand pipe, test the pieces by dipping them into a saturated solution of sulphate of copper and watch for defects in galvanizing, or spots where the galvanizing is disappearing. Black spots show where the galvanizing is weak or incomplete. In case the defects show up, it will be best to paint the pipe with black asphaltum or a graphite paint which will last some years.

The guy wire should also be bought galvanized or it will not last any length of time at all. In case it is bought second hand, it should be tested by stretching out and inspecting closely. Both new and second hand wire should be greased thoroughly with a good graphite grease before being erected. Care should be taken at all times to see that no kinks are made in the wire, for when these are pulled taut the wire will break easily.

The first operation is to carefully select the location of the mast, or the masts if there are two. The position of the pivot should be marked with a stake, and the position of the anchors should be laid out and marked with stakes. The pivot is then set in concrete, figure 2, and allowed to stand at least a week. During that time the anchors can be put down, figure 3, guy wires cut to length and other material all put in accessible places. A light frame of wood timbers, 2 x 4 inches, should then be erected at the pivot foundation, about 24 to 26 feet high, figure 4.

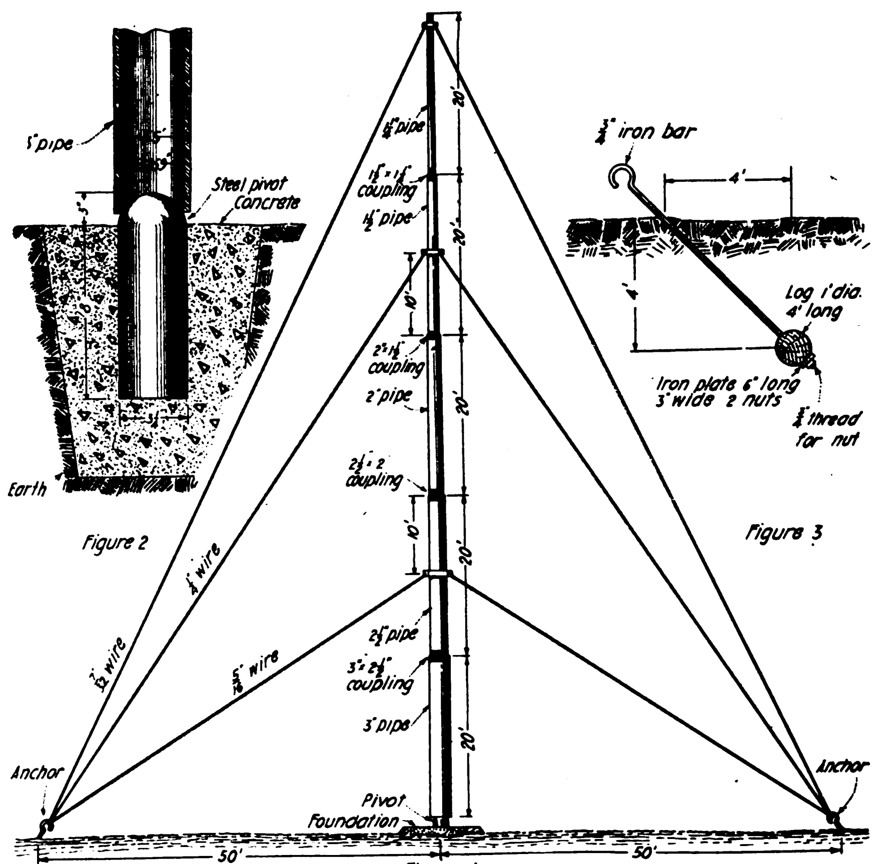
After the concrete around the pivot is dry and hard and the deadmen are laid and all the wires cut to size, etc., erection may start. It is suggested that six men be available and that they start in the morning. Then, in case things go slowly for some unforeseen reason, the work may be completed in a day and will not have to be left unfinished during the night with chances of a storm coming up to wreck the mast.

The 1¼-inch pipe is first lifted through the hole in frame and the upper guy wires fastened to the guy clamp, figure 5, for that pipe. The 1½-inch pipe is then joined to the first section by the reducing coupling. The 1½-inch section is then lifted ten feet, its guy clamp and the middle guy wires attached. That section is then lifted ten more feet and the 2-inch pipe coupled on with the reduction coupling. During this time, one man at each of the four anchors is paying out the guy wires. It may now be necessary to put a block and tackle on the pipe to hoist it, as the total weight without guy wires is about 450 pounds. The two-inch pipe is raised and coupled to the 2½-inch pipe and that raised ten feet more and its guy clamp and the lower guys fastened on. The 2½-inch pipe is then raised ten feet and coupled to the last section, the three-inch pipe. The three-inch pipe is then settled on the pivot and full attention given to the guys.

If the guys are kept steady when the sections are raised, it will be found that no trouble will be experienced. However, jerks or unsteadiness increases the possibility of trouble. In those spots where the guy clamps are fastened to the pipes, the pipe should be knurled with a center punch and hammer, to prevent slipping when strains are placed on them.

The guys should then be taken up temporarily by hand by each man. Later, one man should go some distance away and signal each man at the different anchors to take his guy in or out the proper amount to get the mast exactly perpendicular. Then two or three men should go around each anchor and draw the guys as tight as possible.

Of course, before the mast is put up, a tackle and rope should be fastened on the first 1¼-inch section to hoist the antenna on. After the antenna is raised, further adjustments on the guys will be necessary to compensate for certain unusual strains that may be encountered according to the height of the other supporting end of the antenna.



Figures 1, 2, 3.—Mast erected, concrete for pivot and anchor fastening, respectively

Exclusive of the labor, this mast could be put up for about $75 to $100 and would not have to be overhauled for at least three years, so it would cost about $30 a year.

HARDWARE REQUIRED—TECHNICAL DATA

Wrought Iron Pipe, Galvanized, Standard Lap Weld

Length	Size	List Price per Foot	O. Dia.	I. Dia.	Lbs. per Ft.	Wght. 20 ft., Approx.
20	1¼	.23	1.660	1.363	2.272	44
20	1½	.275	1.900	1.604	2.717	54
20	2	.37	2.375	2.060	3.652	72
20	2½	.585	2.875	2.460	5.793	114
20	3	.76½	3.500	3.059	7.575	150

Total weight of pipe (lbs. approx.)....450

REDUCING COUPLINGS:

Size	Approx. Length	Approx. Weight
3 -2½	3"	3 lbs.
2½-2	3"	2.2 "
2 -1½	2½"	1.3 "
1½-1¼	2¼"	.8 "

1-1¼" End Cap.

Upper Wires: Four 115 ft. long; each 7 strand; 7/32" dia. total: .095 lbs. per ft., 1,800 lbs. breaking strength.

Middle Wires: Four 86 ft. long; each 7 strand; ¼" dia. total; .012 lbs. per ft., 2,300 breaking strength.

Lower Wires: Four 59 ft. long; each 7 strand; 5/16" dia. total; .210 lbs. per ft., 3,800 breaking strength.

See details of pivot, guy clamps, and anchor for other material required.

An Easily Constructed Mast

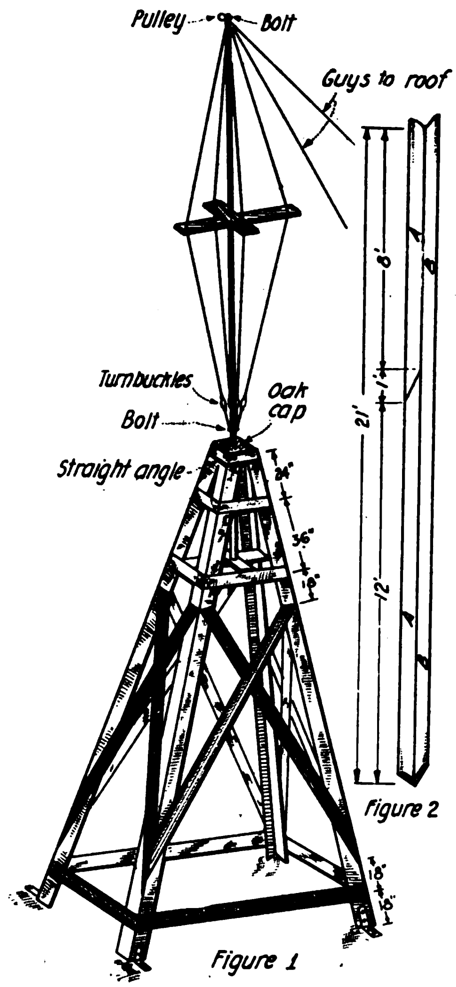
By Frank H. Mulcahy

THIRD PRIZE, $3.00

THE following is the description of the mast which I use at my station, formerly 2AIL, now 2NG, located at Park Avenue and 169th Street, New York City.

The material required for this type of mast consists of three bundles of furring strips, one twenty-foot length of ¾-inch galvanized iron pipe, four iron straps 2 feet x 1½ inches x ¼ inch each, four 4-inch straight angles, six dozen 2½-inch round head bolts, twelve dozen washers, one dozen 2-inch wood screws, two pounds of 2-inch nails, a galvanized iron pulley, four turn buckles (small), and about 200 feet of steel guy-wire. When I built the tower the material cost me about eight dollars.

To begin with, the corner members are formed as shown in figure 2. Two furring strips are prepared as A, and two as B. These are nailed to form an "L", placing a small section at each end so as to bring the joint at different places in the member. Two corner members are laid on the ground, touching at one end and eight feet apart at the other. Eighteen inches from the open end a piece of furring is bolted to each corner member, and a few inches from the top a four-inch straight angle of iron is fastened. Two feet and five feet respectively from the top two more pieces of furring are bolted. Then six and one-half feet from the top and three feet from the bottom two pieces of furring are bolted forming an X. This complete operation is repeated and a second side is formed. Then placing these sides so they meet at the top and are eight feet apart at the base, the remaining sides are bolted to correspond to the two already formed. A 4-inch x 4-inch x 1-inch oak cap is nailed on the top and a hole drilled to fit the outside diameter of the pipe. Connecting the mid-points of the opposite cross-bars that are five feet from the top, a strong cross is nailed, at the intersection of which a hole is drilled part way in the upper piece to form a socket for the pipe to rest in. A washer is placed under the head and nut of each bolt.



Figures 1, 2.—Constructional view of mast and details of corner members

A hole is drilled in the pipe two inches from one end and six feet from the other end. A bolt is placed through each hole as a fastening for the ends of the guy-wires. Two three-foot pieces of strong wood are nailed to form a cross as indicated in figure 1, a hole drilled at the intersection for the pipe and a small hole at each end for the guy-wires. The guy-wires are made tight to the bolts and through the holes in the cross by turn-buckles placed in each guy near the bottom. To the top of the mast a galvanized iron pulley is fastened and from the same point guy-wires go down to the roof to compensate for the pull of the aerial wires.

Four iron straps, 2 feet x 1½ inches x ¼ inch are bent to the angle which the foot of the tower makes with the roof, and three bolts fasten one leg of the angle to the tower and three 2-inch wood screws fasten the other leg to the roof. Roof cement packed around this strap will prevent rain from leaking through.

The tower can be built on the ground, disassembled and reassembled on the roof. As my roof space did not

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permit the placing of the mast in the tower before standing it upright it was necessary to bolt the tower in place first, leaving the mast rest on the roof in the center of the tower with the top end passing through the hole in the top of the tower. Before placing the mast in the tower the guy-wires are loosened and the cross pushed to the top of the mast. Two men now climb up the tower, which is strong enough to support them, and raise the mast until it rests in the socket on the cross-arm five feet below the top of the tower. While raising the mast the cross should be brought down from the top of the mast until it is seven feet from the top and then left there. After the mast is set in place the guy-wires are again fastened and the construction of the tower is completed. A coat of light gray paint gives a steel-like effect.

This tower has supported one end of a four-wire 150-foot span, without giving way under the severe storms to which it has been subjected.

X-Ray Tube Holder and Shield

HARRY F. WAITE has devised a novel combination X-Ray tube holder and shield shown in the accompanying figures. at the same time acts as a shield enabling the rays of the tube to be projected only through the end of the shield, and thus protecting at the same

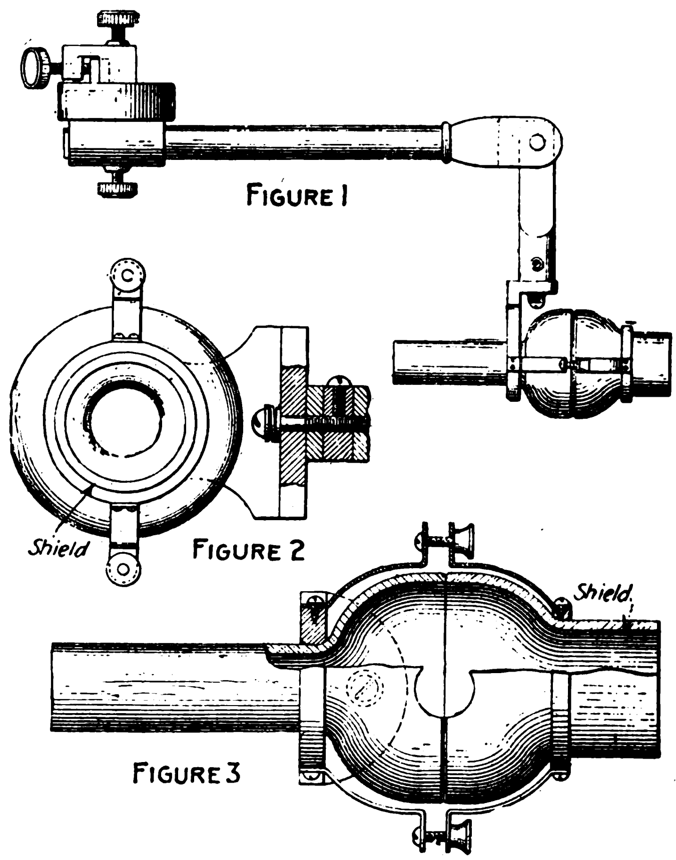

Figure 1.—Side view. Figure 2.—End view. Figure 3.—Top view.

The purpose of this device is to provide an X-ray tube holder which is adjustable to all positions and which time the patient and the operator from ill effects resulting from undue exposure to the rays.

Explanation—January "Age" Article

WITH reference to the article by Chas. R. Leutz in the January issue, covering the construction of a VT detector and 4-stage resistance coupled amplifier, the circuit diagram shown in Fig. 8 should be altered to include a connection joining the terminal marked "wing" to the positive terminal of the common B battery.

With reference to figures 11 and 12, it is understood, of course, that in order to get proper action when the circuits shown in above figures are connected to the amplifier, it will be necessary to provide some means of coupling the detector circuit to the amplifier. This may be effected most easily, perhaps, by connecting a pair of telephones, or, a single telephone piece across the grid-filament terminals of the amplifier.

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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Getting Results

By P. F. Geagan

WHENEVER and wherever radio operators, amateur or professional, congregate, the conversation will nearly always swing around to a discussion of the merits of different appliances. Apparatus, circuits, antennae, etc., are discussed pro and con, and each one of the participants holds decided convictions as to what is good, fair, and bad, among them. Of course, each boasts the particular arrangement which has given in actual use the best satisfaction to him, and invariably condemns whatever has failed in his case to deliver the goods.

There is always an arrangement of circuits which one enthusiast boasts to the skies, giving instances of long distance work, unbelievably loud signals, or great selectivity of tuning. His claims are ridiculed by another for the reason that he has given it a thorough trial himself, and being unable to get anything out of it, returned to his own pet hook-up, the only one in captivity, all others being base imitations. A third member of the group pities both of them, since he knows from actual experience that neither one of the layouts they are arguing over can compete with his lashup, which, take it from him, is the only one extant that will . . . etc., etc., etc. And so on to the end of the meeting.

The reason for the widely different results obtained from any method of connection among a number of experimenters, is carelessness or a lack of knowledge. Obviously, what works well at one station should work well at another, under the same conditions. But it is not generally understood that, "under the same conditions," covers a multitude of sins of commission and omission. Utter disregard of a few thousand ohms resistance, more or less, due to square knot splices, dirty corroded contacts, and wires hanging perilously by one strand (the other seventy-nine having parted company with a disreputable binding

post) is the probable cause for the government inspector who views the quivering remains wondering whether it is an exhibition of lightning arresters or a miniature reproduction of No Man's Land.

Experimenters who spend a number of perfectly good and healthy dollars in the purchase of Litz wire in order to reduce the high frequency resistance of their circuits, connect it carelessly and loosely to what should be termed a "subterranean binding post"—that is, one which requires extensive excavation of dust and disturbing the clutter of cigarette ashes and the other things around it in order to correctly place an inoffensive and long suffering wire. Then the wire is carefully draped around the table in imitation of the course of the Mississippi River, the remainder which the small fifteen foot table will not accommodate being looped up on a gas jet. The experimenter then pounces upon the helpless apparatus which has endured much, and proceeds to prove that Litz wire is a snare and a delusion. He spent his good money for it and imagines that he has given it a fair trial. Results? Nothing from nothing equals their numerical value. And so, when later on, he meets with station owners or operators who extol Litz wire, he opens wide his face and shames the hyena with his mirth. You've met the type!

The number of weird schemes and queries submitted to the editorial staffs of the magazines devoted to radio, indicate how far in advance of the scientists are some of our amateur station owners. At the moment I have in mind—with apologies to Wool Soap Eddie—one who sent in a letter with a sketch of a row of trees standing beside a house with a wire running from tree to tree and into the house. The height of the trees, the distance apart, the height and length of the wires, were all carefully set forth, even the information that the trees were descendants of the maple family, was included. It was requested that the wave length of this multiple tree antenna be furnished.

As the writer neglected to supply information as to the number of pickets in the fence surrounding the house, the editors were unable to answer the question.

Much of the hit or miss trust to luck method of assembling and handling the transmitter also naturally results in as many different degrees of failure. Transformers are often connected to a condenser capacity of a greater value than they are able to supply. Loose connections, carelessly arranged power circuits, and indifferent antenna and ground connections, all contribute to negative results.

If a few simple rules are followed

increased efficiency will be produced in many cases. First comes cleanliness. All apparatus and the operating table should be cleaned often. Do not allow dust to accumulate, or the binding posts or switch contacts to become corroded or dirty. Run all leads as directly as possible and do not allow loose ends to wander at will about the table. It is preferable also to solder a terminal on each wire. Arrange the circuits as far as possible so that the coupling between circuits is confined to the coils designed for this purpose. Very often poor results are obtained as a result of a system of wiring which resembles the freight yards of a railroad terminal. Especially in circuits designed for undamped reception, cleanliness and arrangement of wires plays an important role. A little resistance may make the whole difference between success and failure. Make soldered connection wherever possible. See that all binding posts are kept clean and tight. Keep switches clean and making good contact, and a great many troubles will disappear.

For reception of undamped waves, the condenser values should be relatively small compared with those which would ordinarily be used for spark reception. If an amplifier be used, reversing input leads or tickler leads may make all the difference between success and failure. Correct polarity of both batteries is necessary also, as well as the proper amount of voltage. Less precaution is necessary when using the crystal detector, but when it is considered how small is the amount of energy being handled, it should be realized that too much precaution cannot be taken.

On the transmitter, use leads of sufficient circular mil area to prevent a high impedance and consequent low power factor. It does not avail much to have 1,000 apparent watts flowing and only 0.3 kw. in the transformer. If the transformer is rated at 7,000 volts, do not use a spark gap of such a length that the condenser voltage must rise to 15,000 volts to break it down. If the outfit boasts a motor generator, see that the bearings get clean lubricating oil. It may not seem necessary for two surfaces rubbing against each other at a high speed to have any lubrication, but years ago somebody established the custom of looking at motor generator bearings once in a while to see that they were getting oil. We might as well cater to custom as long as it saves the delay and expense incident to getting new bearings.

The best commutator advice ever printed for the inexperienced is "let it alone." If the temptation to fix it becomes too great to be overcome, however, take the precaution to throw overboard all the cold chisels, files,

Prize Contest Announcement

Articles submitted to be printed in July issue on the subject.

"A Sensitive and Compact Portable Receiver."

Closing date, May 10, 1920.

Summer, with its vacations and days when one loves to be out of doors, is on its way, and many will begin to plan the construction of apparatus which is sufficiently portable to permit its inclusion in the camp kit, or the holiday trunk. There have been a great many developments since the last holiday season when Government regulations permitted the use of radio apparatus, as a result of which portable devices now in existence will have become, perhaps, more or less obsolete. The portable receiver should, if possible, include a vacuum tube detector. The great objection to the use of this detector in a portable receiver lies, of course, in the necessity for a heavy battery for filament current supply.

In the case of the outfit being taken on a cross-country hike, dry batteries or a low ampere-hour capacity storage cell may be substituted. In the case of the camp outfit where no supply current is available, the crystal detector has to be depended upon, but in the case of one who goes to the sea-shore or to some summer resort, it should either be possible to rent a storage battery from some handy garage or to devise a means whereby the detector tube may be supplied from the lamp socket in one's room.

PRIZE CONTEST CONDITIONS—Manuscripts on the subject announced above are judged by the Editors of THE WIRELESS AGE from the viewpoint of the ingeniousness of the idea presented, its practicability and general utility, originality, and clearness in the description. Literary ability is not needed, but neatness in manuscript and drawing is taken into account. Finished drawings are not required, sketches will do. The contest is open to everybody. The closing date is given in the above announcement. THE WIRELESS AGE will award the following prizes: First Prize, $10.00; Second Prize, $5.00; Third Prize, $3.00, *in addition to the regular space rates paid for technical articles.*

All manuscripts should be addressed to the Contest Editor of THE WIRELESS AGE

hammers, and sledges at hand before attacking it. Give the unfortunate repair man a chance.

Much may be said about storage batteries and their care, but the main points are: keep the battery clean; watch for acid creeping and corrosion; keep the plates covered with solution. Many operators have discovered that it is easier and quicker to bring the solution up to the proper specific gravity by adding acid than by charging. This is a tremendously clever idea and a great saver of time, but such is the perversity of storage batteries that they persistently refuse to accept this innovation. Wise men prefer the old established methods and keep off this method of raising the "speegee." Do not discharge beyond the point given by the maker, and do not allow the battery to stand idle when low. Place it on charge as soon as possible. Contrary to opinion in some quarters, 100 A.H. stamped on a cell does not mean that it may be left on short circuit for one hundred actual hours!

Too much antenna insulation is a valuable fault in any installation. Too, no one has ever yet succeeded in making the ground lead too short. Keep the antenna resistance as low as possible. A circuit as stiff as a bar of iron will have difficulty in oscillating even though its intentions are the best in the world.

In the oscillating circuit use strip or tubing if procurable, and, as in the case of the receiver, try and arrange so that all the coupling takes place in the oscillation transformer.

While it is possible that the people who put up the money for wireless equipment may go to the trouble and expense of installing some appliance that they do not intend shall be used by the operator, still in the main, this is not the case, and such scintillating schemes as tying or jamming in a circuit breaker so that it cannot open, or replacing a fuse with an enormous piece of wire, will never set the world of science afire. Innovations of this character, too, are not overwhelmingly popular with the people who have to effect the repairs to the outfit as a result of such blacksmith methods of handling.

While meters will read higher without their shunts and resistances, it is customary to allow these to remain connected to their respective meters, if only because of the mental attitude of the makers that these are essential if the meters are to function properly.

Due to the slow rate of progress made by our inventors and manufacturers, the elastic telephone cord has not yet arrived, and it is better to remove the head set when wandering from room to room. Such cords as we are offered have a disagreeable habit of breaking when we attempt to stretch them more than a yard, and this causes the receiver to function poorly, due, of course, to the unmentionable detector.

Try to confine sparking to the spark gap. Several sparks operating simultaneously at different parts of the wiring or switchboard are unnecessary. The one furnished with the set is sufficient.

Before proceeding to disembowel your receiver, have a clear idea of what you propose to prove. It does not pay to cut, slash, and short circuit indiscriminately and then be able to re-assemble after the new hook-up has proved a failure. In case this happens, and you give the repair man a chance, admit at once that you have perpetrated improvements. The inside of the box may contain connections fearful and wonderful to behold, but unless he has reason to suspect it has undergone something of an ordeal, he will probably spend considerable time looking elsewhere for the trouble.

A motor generator or transformer name plate marked 1, does not imply that this is the minimum power at which it may be worked; when increasing power, it is better not to wait until the apparatus bursts into flames before deciding that perhaps the allowable increase in temperature is being exceeded. Horsepower is horsepower, much the same as "pigs is pigs," but if your motor, marked for instance, 3 HP, shows a tendency to slow down when you attempt to pile on the load, do not decide at once that the particular three horses that the manufacturer of your motor had in mind must have been emaciated, underfed, and on the point of death.

Of course all this has been written many times before. The only reason we keep on writing the same stuff is that we live in hopes that some of those who know better will come to think there is something to it.

Albany Radio Club

THE meeting night of the Albany Radio Club has been changed to Monday evenings, instead of every second Tuesday, and hereafter the weekly sessions will be held in the Y. M. C. A. building, Albany New York.

This club has installed a modern receiving set and a number of distant stations have been heard. Temporarily, a six-inch coil is to be used for transmitting, but it is expected that this will be replaced by a transformer in the near future. Other equipment includes a number of buzzer sets which have been installed to help the younger members to master the code.

E. C. Tasolett, president of this club, has a private radiophone set and is giving concerts every Saturday evening which are enjoyed by amateurs within a radius of fifteen to twenty miles.

The members of the Albany Radio Club would like to hear from amateur organizations and a wide-open invitation to this end is extended by Herbert Ammenheuser, corresponding secretary.

Clean English in Wireless

HAS it ever occurred to those operators of radio telephone stations in the vicinity of metropolitan centers and elsewhere that what is being said by them is being heard by hundreds and perhaps thousands of ears?

Has it ever occurred to those experimenting with radiophones that they may be "getting out" when they think they are *not* being heard?

In asking these questions, we have in mind a radiophone conversation carried on between two amateur stations in the vicinity of New York City on a recent date, when the ether was thoroughly contaminated with foul and profane language.

This wireless game is a great game, and those of us who are interested in it should do all we can to foster interest on the part of others. We can think of nothing which will so quickly kill the game as thoughtlessness in the respect just mentioned. In the old days when all amateur radio was strictly telegraph, we presume that those who were unable to express themselves in *clean* English gave little thought as to *what* they might say, since there was always a feeling that only the initiated few would be able to understand them, but with amateur phones coming into general use, unless we are mistaken, the entire family "sits in" for the evening concert. After reading the above may we suggest the use of a little imagination?

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.

H. A. T., Brooklyn, N. Y.:

In reply to your several queries; prior to the assignment of WSE to the Sea Gate Station, their call was "SE." Sea Gate abandoned the magnetic detector in 1912. This station rated 3½KW, and used a non-synchronous spark gap.

The call for the Manhattan Beach Station was "DF" (Dreamland, Coney Island). There is no data available as to the date on which the Manhattan Beach Station was opened. A straight gap was used.

The United Wireless Co. was absorbed by the Marconi Company in 1912.

The range of the station at 42 Broadway, New York, "NY," which was shut down in August of 1912, was about 300 to 400 miles day time. It was very common, however, for "NY" to work distances of several thousand miles.

The station at Bush Terminal, Brooklyn, "WCG" has always been owned by the National Electric Signaling Co., now the International Radio Co.

We are uncertain as to when the Cape Hatteras station, "HA," opened up, but it was probably in the fall or winter of 1907. This station was closed April 7, 1917.

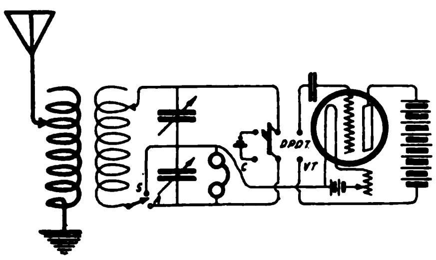
We are unable to say definitely as to when the first time signals were sent out by radio. The regular transmission of time signals in the U. S. commenced, however, directly after the completion of the Arlington station in the late fall of 1912.

At the time when Jack Binns sent out the first "SOS" from the S. S. Republic there were about 400 vessels which carried radio.

The Marconi Service News has been changed to "World Wide Wireless," and we suggest that you communicate with the Radio Corp. of America, Woolworth Bldg., N. Y.

M. K., Oakland, Calif.:

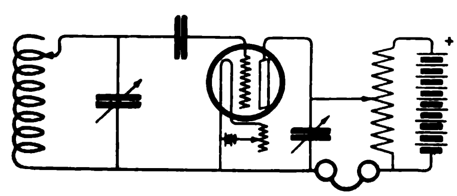
With reference to the circuit diagram on page 34 of the September issue, the reception of arc signals and of spark signals at their natural tone is effected by adjustment of the switch marked "tickler" and the bridging condenser. It is only possible conveniently to switch from spark connection to continuous wave connection when a circuit is used wherein the "back coupling" is capacitive. Such a circuit is shown below, wherein a switch has been incorporated for change from crystal to audion detector.



The 110 volt house lighting current may be used to light the filament of the audion and to supply the plate battery. This scheme cannot be made to operate quietly without considerable difficulty, the 60 cycle hum being heard in the telephones continually. It is needless to point out that this may become quite troublesome in cases where extremely weak signals are to be received.

Iron core amplifier transformers have proven to be the most satisfactory. We hope to be able to publish in the near future an article on how to construct them. The construction of an efficient amplifier transformer is not a very easy problem for the amateur inasmuch as the windings consist of many thousands of turns of No. 44 wire.

It is suggested that you use a switch for the regulation of your B battery in preference to a potentiometer. The battery will last longer since there is a continuous leak through the potentiometer when connected to the battery. A diagram showing connection for potentiometer is given below.



We regret that we have no data available concerning the construction of De Forest Company's radiophone outfit.

* * *

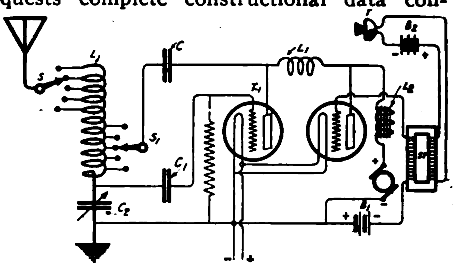
A. E. H., Toronto, Canada:

Asks for information concerning the schedule and wavelengths of radio telephone stations. Perhaps some of the readers of the WIRELESS AGE will be glad to submit any information concerning the wavelength and schedules of radio telephone stations within their receiving range.

There are several amateurs within the vicinity of New York City who are operating radio telephone outfits on wavelengths between 200 and 400 meters. Several of these have been able to communicate with points as far west as Ohio, and if you have an outfit which is particularly efficient on short wavelengths, you should be able to pick these up. In addition to this, the Western Electric Co. has been carrying on experiments with radiophone outfits at wavelengths in the vicinity of 1500 meters. As far as we know, none of the stations mentioned have regular schedules, and in fact, we know of no other stations which do have, inasmuch as all of the work is purely experimental.

H. R. W., Lansing, Mich.:

Encloses a circuit diagram of the "SCR 67" which is reproduced herewith, and requests complete constructional data con-

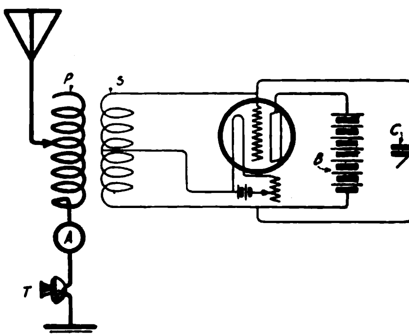


cerning the radio frequency inductance L, its taps, etc.; the condensers and the radio frequency choke coils L_1 and L_2, as well as the voltage of the generator used in connection with this outfit. Perhaps some of the readers of the Wireless Age will be able to supply this information.

* * *

C. R. L., Winnetka, Ill.:

A diagram suitable for use in connection with the laboratory radiophone described by J. Pignone in the November issue, is printed herewith.



The wavelength range will be over about 200 to 400 meters, and the transmitting range with such a set, using a Marconi vacuum tube and, say, 350 volts on the plate circuit, should be in the neighborhood of 6 to 30 miles depending on the type of receiver used.

* * *

A. V. M., Penn Yan, N. Y.

There is considerable difference between a radio telegraph and radio telephone transmitter as the average amateur thinks of them. For radio telegraphic purposes the alternating current supply which is available in every town of any size may be passed through a transformer, the voltage thus being raised to 15 or 20 times its original value and then utilized to charge a high tension condenser which upon discharging across a suitable spark gap, sets up high frequency oscillations in the discharge circuit. The discharge circuit is so associated with the antenna circuit that oscillations are induced into and radiated by the antenna. With a spark transmitter these oscillations are radiated in groups at group-frequencies depending upon the frequency at which the condenser becomes completely charged and discharged; or, if a rotary spark gap or discharger is used, the frequency of the groups of oscillations will depend upon the number of times the rotating electrodes pass the fixed electrodes. Present day radiophone practice on the other hand, requires a generator capable of supplying oscillations continuously, that is, oscillations which are not radiated in groups. This is accomplished now-a-days by the use of electron discharge devices such as the three element vacuum tube. For the theory and operation of the three element tube, you are referred to "Practical Wireless Telegraphy" by E. E. Bucher, Wireless Press, Inc., N. Y. C.

While there is considerable difference between a radio telegraph and radio telephone transmitter, the same receiver may be used for both.

We regret that we are unable to tell you where you may purchase a steel mast. You need not necessarily use steel, neither is it necessary to use more than one, although the mean height of the antenna will be considerably increased if it is supported by two masts, and you understand, of course, that the higher the antenna the greater the strength of the received signal and the greater the range of the transmitting station. It is possible to construct your own mast from gas pipe or to build yourself a wooden lattice mast. Suggestions along this line are being printed in current issues of this magazine. If you are desirous of doing transmitting at amateur wavelengths, we suggest that you make your masts about 70 ft. high, set them about 125 ft. apart, and take your lead-in from the middle of the horizontal wires. If you wish to use only one mast, we suggest that this be made as nearly 100 ft. as possible, the wires being brought down from the top of the mast to the station so as to form an angle of about 45 degrees with the mast. In the case of the two masts, it makes no particular difference whether they are in an east to west, or north to south line.

* * *

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

Of the Wireless Age, published monthly at New York, N. Y., for April 1st, 1920.
County of New York,
State of New York, ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared E. J. Nally, who, having been duly sworn according to law, deposes and says that he is the President of the Wireless Press, Inc., Publisher of The Wireless Age, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:
Publisher, Wireless Press, Inc., 68 Broad St., New York, N. Y.
Editor, J. Andrew White, 68 Broad St., New York, N. Y.
Managing Editor, none.
Business Manager, J. D. Conmee, 68 Broad St., New York, N. Y.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)
Wireless Press, Inc., 68 Broad St., New York City, N. Y.
E. J. Nally (850 shares), 233 Broadway, New York City, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)
None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

E. J. NALLY,
President.

Sworn to and subscribed before me this 19th day of March, 1920.
(Seal.) M. H. PAYNE.
(My commission expires March 30, 1920.)

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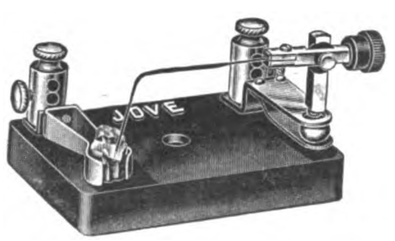

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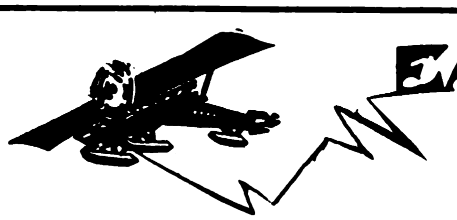

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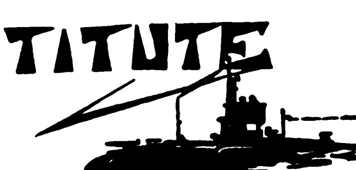

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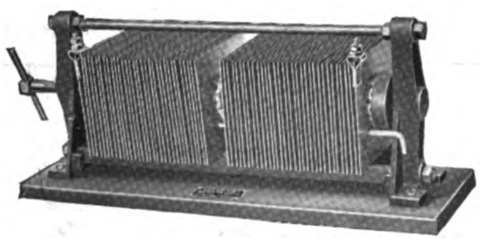
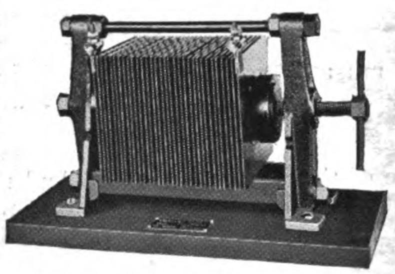


TYPE G-1—This gap is built to control the energy necessary to do real long distance work, 1,000 miles and over. It has 32 sparking chambers. Designed for use with transformers delivering 20,000 volts up. Maximum power 1,000 watts. Price, **$26.50.**

TYPE G-2 — Our first gap. Out only four months, it is now in operation in every U. S. A. radio district and in Canada. No inducements offered to introduce this gap; every user a voluntary purchaser. Enthusiastic reports on file in our office. Intended for moderately long distance work, 500-900 miles. It has 16 sparking chambers and is designed for use with transformers delivering over 10,000 volts. Maximum power 500 watts. Price, **$17.50**



TYPE G-3—Especially designed for use with the Amrad 100 watt induction coil, but is suitable also for use with ordinary spark coils or small transformers delivering over 7,500 volts. This gap will increase the range of any induction coil set and at the same time will permit the operator to comply with the Federal law regulating decrement. It offers the only practical solution to the QRM problem in congested districts. Seven sparking chambers. Maximum capacity 250 watts. **Price, $12.50**

Adjustable Resistances: To operate quenched gaps efficiently on 60 cycles a. c. an adjustable resistance must be used. We furnish three types of adjustable resistances. Prices and description of complete mounted units and parts contained in Bulletin Q.

Why You Should Use The Amrad Quenched Gap

1. Correctly operated, it will radiate more *effective* energy on a given power input than any other type gap. This absolutely assures consistent long distance work.
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3. The Amrad Quenched Gap is silent. No longer need your radio station be a nuisance to your family or neighbors.
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5. It is reliable. When using the Amrad Quenched Gap there is no danger of your station suddenly being put out of commission by a kick-back burning out motor windings.
6. It is economical. It reduces electric current bills. No moving parts to wear out, break or get out of balance. With careful use the quenched gap gaskets need be renewed only occasionally and then at a trifling cost.
7. It is efficient on 60-cycle supply circuits. Two spark frequencies may be obtained, either 120 or 240 sparks per second. When adjustments are correctly set, both notes are clear, snappy and wonderfully uniform. The gap is equally efficient when used with induction coils.
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Coil and Gap Combination: The Type G-3 Gap and our 100 watt Amrad Induction Coil, 6 or 32-volt type, will be sold for a limited time at the special price of $33.50. See page 33. Described in Bulletin P.

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DUPLEX

$4.50

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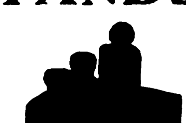

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May, 1920 20 Cents

The WIRELESS AGE

Volume 7 Number 8

Members of Congress Sitting as a Committee on Army Appropriations Get Their Data by Radio 'Phone

Instructing Wireless Students by the Movie Screen

The Design of Multi-Stage Vacuum Tube Receiving Circuits

And a Dozen Exclusive Features in This Issue

Vol. 7 Contents of The Wireless Age for May, 1920 No. 8

Edited by J. ANDREW WHITE

Advertisements

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AUSTRALIA, 97 Clarence St., Sydney, N. S. W.

Yearly Subscriptions in U. S., $2.00 Outside U. S., $2.48; Single Copies, 20 cents

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Reliability, Quality and Efficiency
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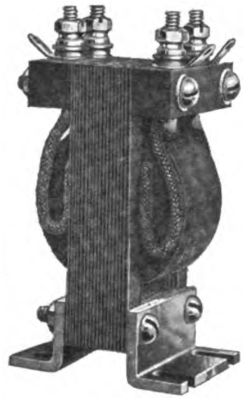
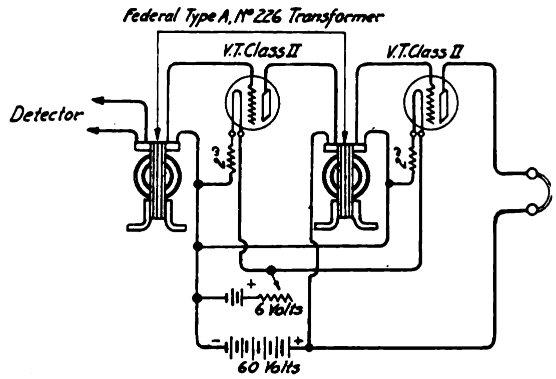


No. 226-W Type A

AUDIO FREQUENCY
Transformer
$7.10 each



CIRCUIT WITH TWO STAGE AMPLIFIER

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LIBERTY HEAD SET
$12.50 per set

One 226-W Transformer with one Marconi V. T. gives an energy amplification of 400 times. (Audibility amplification of 20 times.)

Two 226-W Transformers with two Marconi V. T.'s give an energy amplification of 160,000 times. (Audibility amplification of 400 times.)

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Whether it is a Transformer, Condenser, Quenched Gap, Radiophone or Vacuum Tube you are assured that we carry it in stock.

And so—the next time you find it necessary to add to your equipment, why not write us for price and description of the particular piece of apparatus you require?

Bulletin 14 will be sent upon receipt of 10 cents—
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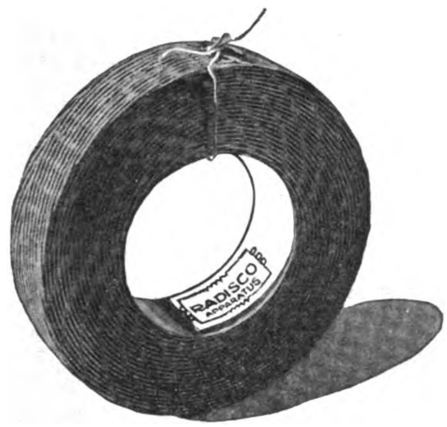

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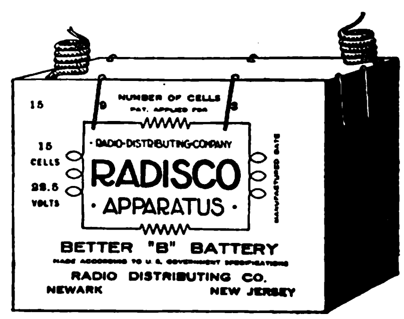
RADISCO AGENTS carry only apparatus of proven merit. Look for the Radisco trade mark on all parts you buy and be sure of getting efficient apparatus.



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If none of the above agencies are in your vicinity, communicate with

RADIO DISTRIBUTING COMPANY : : Newark, New Jersey

Vol. 7. No. 8. MAY, 1920

THE WIRELESS AGE

WORLD WIDE WIRELESS

Marconi Leaves On Testing Trip in Mediterranean

GUGLIELMO MARCONI is working out the details of an invention which will enable wireless stations to tell the exact location of any ship that reports herself in distress. Mr. Marconi has begun a cruise in the Mediterranean to make tests.

Mr. Marconi was asked if he would attempt to communicate with Mars, as was recently reported. He replied:

"No effort will be made to send wireless communications to Mars or receive them. Our vessel will be equipped with sending apparatus having a radius of 3,000 miles only. We are taking two sets for experimental purposes. One is of ½ a kilowatt strength, with a radius of 300 miles for telephone and 500 miles for telegraph. The second is of 3 kilowatts strength, with a radius of 1,000 miles for telephone and 3,000 miles for telegraph.

"I am more interested at this time in practical development of the wireless telephone than vague electrical impulses which may come from wireless apparatus on some other planet. However, the experimental laboratory is keeping in close touch with such phenomena, and when it occurs notes are being taken, in an effort to determine the source and meaning of the wireless waves.

"We hope that soon lighthouses and ships can be equipped with instruments that will enable them to tell precisely the location of any ship at sea that reports herself helpless."

Radiophone an Aid to Legislation at Washington

A RADIO telephone was used to gather information for members of Congress at Washington when the hearings were held on the Army Appropriation bill before the House Military Affairs Committee. It was the first time on record that the new invention was used for such a purpose.

Whenever a question arose on which the committee desired information Major General Lord, Chief Finance Officer of the Army, was called on the radiophone. Headgear was provided for all members of the committee so they could hear the questions and answers.

Music by Radiophone From San Francisco to Victoria, B. C.

E. A. HAUGHTON, radio superintendent of the Canadian Government, reports that he was recently working on a long wave length in his wireless station in Victoria, British Columbia, when he heard the following conversation:

"Hello, Point Arguello. This is San Francisco. Wait a moment and I'll play you a record."

Haughton then heard a record of "The Star-Spangled Banner" played.

Radiophone Service Between England and Holland

WIRELESS telephone communication between England and Holland is about to be opened. Results with test calls have been excellent, it is announced, conversations having been carried on up to a distance of 1,200 miles.

Radio Service for Wanamaker Stores

AFTER being out of operation since April, 1917, the wireless station on the roof of the John Wanamaker store in Philadelphia has been restored and is ready for regular communication with the New York store.

All the hurry-up messages necessary between the two stores will be sent regularly by wireless instead of by telegraph. The antennae for the receiving of messages are 350 feet from the the ground, the poles being 130 feet high from the roof of the building. The wireless equipment installed is largely that which was dismantled at the beginning of the war. Testing or "tuning up" was done under the direction of E. M. Hartley, district manager for the Radio Corporation of America.

Rogers Honored by Maryland Assembly

DR. J. HARRIS ROGERS, of Hyattsville, Md., developer of underground and underwater radio, has been extended a vote of thanks in a joint resolution unanimously adopted by the Maryland State Assembly. The resolution was introduced in the Senate by Oliver Metzerott and in the House by Clarence Roberts.

General Electric Company's Radio Report

THE pamphlet report of the General Electric Company for 1919, which has just been issued, contains the following statement by C. A. Coffin, Chairman of the Board:

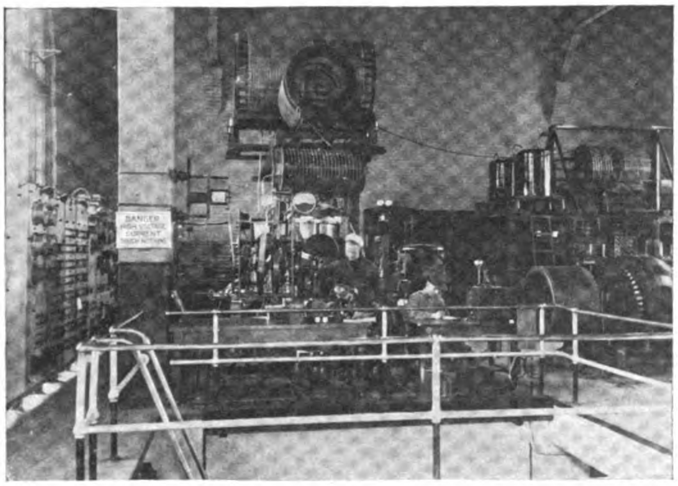
"Your company has for several years been engaged in its research laboratories and factories in the development and manufacture of apparatus and devices essential to the transmission and reception of wireless communications. Its inventions have had a far-reaching effect on the entire radio art. The Marconi Wireless Telegraph Company of America is also the owner of valuable patents, rights and licenses, and it has seemed wise to the Boards of Directors of both companies that their research and engineering resources should hereafter be used in closest co-operation. To this end, and in order to secure the benefits of the long and varied electrical manufacturing experience of the General Company on the one hand and the operating experience of the Marconi Company on the other, a new company has been formed, known as the Radio Corporation of America, in which both your company and the Marconi Company have accepted a considerable participation."

Wireless Operators Needed for Alaska

LIEUT. COL. F. B. SHAW, chief of Army recruiting in Boston, has been urged by the War Department to recruit radio and telegraph operators for the Signal Corps, for service in Alaska. Men accepted in New England will be instructed at Camp Alfred Vail, Little Silver, N. J., and sent to Alaska promptly.

Oriental Radio Rates Reduced

THE Radio Corporation of America announces that the rate for wireless dispatches between San Francisco and Japan were reduced from 80 to 72 cents a word, beginning April 1.



General view of the power room of the Arlington station showing switchboards at left and the 30 kw. arc transmitter at top

Japan Erects Tall Concrete Wireless Masts

THE highest concrete poles in the world (650 feet) are being erected at Tomioka-cho, in Fukushima Prefecture, Japan, for the new wireless stations which will be opened soon, especially for communication between Japan and the United States. One station will receive and the other will send. The capacity each way is about 8,000 words a day.

Vancouver-Victoria, B. C., Radiophone Service Opens

THE Marconi Company of Canada has installed a wireless telephone apparatus at Vancouver, B. C. and at Victoria and will open a service within a few days. The plant has a radius of over 500 miles. It is planned to place stations throughout Canada. The success of the Montreal Rimouski experiment has led to the present development in this branch of utility.

Resumption of Radio Service Pleases San Francisco Business Men

SHIPPING men, operators, exporters and importers announce that the resumption of the wireless service by the Radio Corporation of America will prove an advantage to all concerned and that it will be possible to get messages through between this country and the Far East with the same degree of regularity that obtained before the war. Instead of waiting three weeks for replies, it will be possible to get returns in two and three days at most. This will have a beneficial effect upon all overseas shipping and will stimulate the movement of commerce and the sale of merchandise.

Wireless on Chinese Wall Unite Ancient and Modern Wonders

A REINFORCED concrete wireless mast of large dimensions has been erected upon the Chinese wall for the use of the American navy. It is 164 feet in height. The original program called for the making of the mast by the precast method in two parts, and then erecting them by means of derricks, but an accident occurred while the erection was taking place and an American engineer and four coolies were killed. The method of forming in molds was then tried, and although it was much more expensive than the other, it was successfully carried out.

English Use Wireless for Police in Ireland

IN consequence of the frequency with which telephone and telegraph wires in Ireland are being cut out, the government has decided on an extensive use of wireless telephony there, says the Daily Mail, London.

Naval signal men are being employed to start the system, and the newspaper intimates that portable telephones with a radius of about thirty miles are being employed in transmitting messages from one police station to another or between adjacent towns. It is asserted that the system has proved satisfactory.

Oregon Pilot Commissioners Want Wireless Service

THE Oregon State Board of Pilot Commissioners voted at a meeting to ask the Port of Portland Commission to restore the radio apparatus and service of the bar tug Oneonta. The bar tug's radio set, which was of considerable assistance in receiving reports of vessels in distress off the Oregon coast or reaching the mouth of the Columbia in need of a pilot, was dismantled with the outbreak of the war and has not been replaced.

As the radio station at North Head is operated by the United States navy, all messages received by it are relayed to the Bremerton navy yard before they are placed on a commercial wire, and some complaint has been made that the service thus is not so rapid as it might be. The board of pilot commissioners, acting on this matter, joined the Astoria port commission in asking the navy department that some change be made to facilitate the radio service.

Wireless Withstands Effects of Aurora Borealis in New York

THE Aurora Borealis, or Northern lights, made a brilliant display in the heavens in New York recently and up to 2 o'clock in the morning the wonderful streamers danced, shivered and waved over nearly the whole visible sky. The display appeared more vivid and strong in the north and northwest, but the banners of mystic light repeatedly shot up to the zenith, or uppermost part of the celestial sphere, where they met in an apex or hub.

As usual, the effects of the aurora was promptly felt in the offices of cable, telephone and telegraph companies, communication being seriously interfered with. Wireless service was also affected, but in a less degree.

The aurora, which is seldom visible in New York skies, is a common spectacle in Arctic regions.

Scientists have little to say in explanation of its occurrence, except that it is the result of magnetic activity in the upper region of the earth's atmosphere, these disturbances, in turn, being mysteriously associated with the frequency of sun spots.

Wireless Concert Aboard the Mauretania

W. S. TODD, of Hartford, Conn., who has just returned from a trip to England and Scotland, says that the Steamship Mauretania had a unique experience before leaving Southampton on her last voyage. A wireless message was received by her captain from the Marconi works at Chelmsford, Essex, as follows: "Hear demonstration of wireless telephone from the Marconi works, Chelmsford."

The Cunard Bulletin, issued while the Mauretania was en route for New York, contained the following description of that concert.

"There followed immediately a summary of the day's news and the listeners on board the ship were asked to 'wait a minute.' Suddenly, the voice of a soprano singing 'Land of Hope and Glory' was heard distinctly, followed by a rich baritone who rendered 'The Trumpeter.' A violin solo was clear and resonant, as was the voice of the lady who sang 'There's an Old-Fashioned House in an Old-Fashioned Town.' The little concert closed with the national anthem played on the cornet. Then the call: 'How did you enjoy the concert? The Marconi works are closing for the night but another demonstration will be concluded to-morrow morning at 11:15, Greenwich time. Good night!'

"Although only six ear pieces were used in the cabin on board the ship, it was possible for six other persons to overhear the demonstration distinctly. The voices were almost too loud, but that may have been due to the extreme sensitiveness of the ship's installation.

"At the time the concert was held, the Mauretania was 100 miles away from the works."

Charlestown Navy Yard to Use Radiophone

IN order to expedite conversations between naval ships coming in and going out a wireless telephone has been established at the Charlestown navy yard. It frequently happens that commanding officers of ships desire to talk with the commandant of the yard and they have to resort to the wireless. The telephone will have a speaking radius of 10 miles during the day time.

Destitute Austrian Operators Appeal for Aid

AN appeal to brother wireless operators has been received from the Austrians at the Deutschenburg Station and the following radiogram sent via Lyons, France, to the Ottercliff Station:

> "In sorrowful condition of nourishment in Austria we beg the American wireless operators as commands to help us with Dollapackets. None of us have relations in the United States, but each of us has been very often with the ex-Austrian steamers as wireless operators. The number of members of this wireless station is sixteen. With foremost thanks,
>
> THE WIRELESS OPERATORS OF THE AUSTRIAN STATION DEUTSCHENBURG."

This is a humane appeal which many of the wireless operators are going to answer. A substantial fund has already been collected. All readers of The Wireless Age are invited to help out.

The "Dollapackets" contain a dollar's worth of food—and the Austrian operators need food badly. Further comments are unnecessary.

Let us show them by quick action that the American radio men are really and truly the foremost members of the great fraternity of men who never fail—especially where an S.O.S. call of distress commands their action. This is obviously a call of distress.

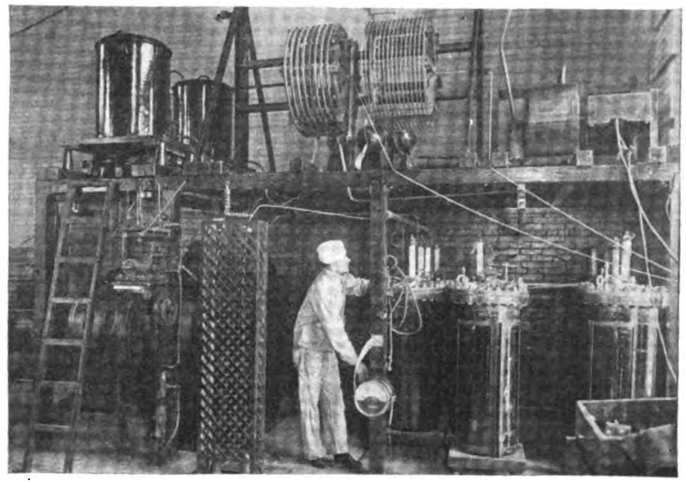
Those who would like to be of some service to the suffering radioists abroad are invited to send their contributions to the "Dollapacket Fund," c/o The Wireless Age.

Senate Passes Radio Bill

SENATOR POINDEXTER'S bill authorizing the Navy Department to operate certain radio stations for transmission of press and commercial messages was passed by the Senate March 10 without a record vote after it had been amended to provide that private business should not be handled at less than cost.

Senator Phelan, Democrat, California, put into the record a letter from Secretary Daniels urging some such legislation, and one from V. S. McClatchy, of the Sacramento Bee, declaring that provision for transmission of news to the Orient at a low rate would be a powerful factor in promoting good relations with Japan.

The bill expressly provides, Senator Poindexter pointed out, that special low rates be established for press dispatches.



Section of the power room showing 100 kw. spark transmitter of the U. S. naval high power station at Arlington

American Marconi Company Dissolved

STOCKHOLDERS of the Marconi Wireless Telegraph Co. of America at a special meeting held April 6, voted to dissolve the company. This action finally concludes a plan whereby the assets of the Marconi Wireless Telegraph Co. with certain exceptions, are to be taken over by the Radio Corporation of America. Henceforth the business of the company will be conducted under the latter name.

President Wilson's Wireless to Open Air Meet

PRESIDENT WILSON will officially open the third Pan-American Aeronautical Congress on the Steel Pier, Atlantic City, N. J., and at the Airport beginning May 20.

A wireless plant is being installed on the end of the pier, where the flash from the White House will be received at 3 P. M. on the opening day. Wireless greetings also will come from government heads of several South American republics, where aviation now is popular.

Legion's Radio Intelligence Post Making Progress

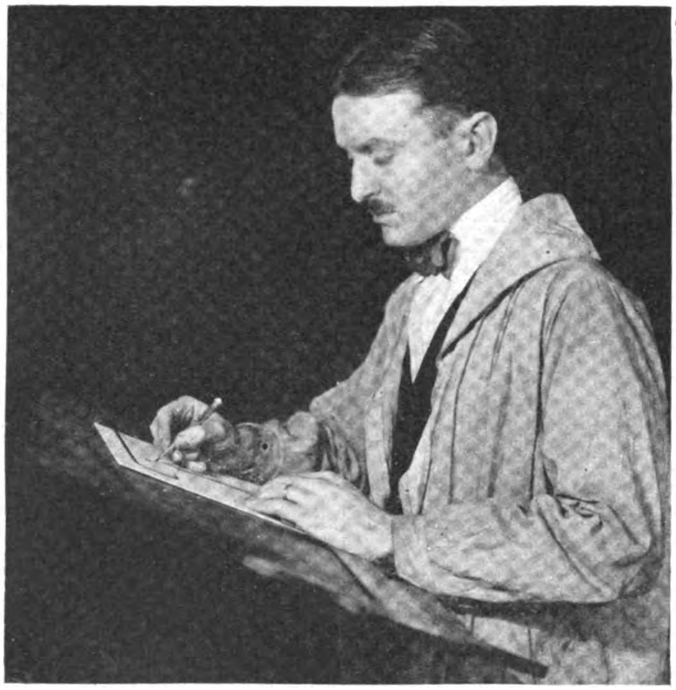
THE third meeting of the Radio Intelligence Post of the American Legion was held in New York City. Men were present who had traveled many miles to attend, but all agreed that it was worth it.

All former members of the Radio Intelligence Department, either in service abroad or at home, and who wish to get in touch with their former pals are cordially urged to communicate with the acting secretary of the post, Arthur L. Bernhard, 1679 42d Street, Brooklyn, New York.

Visualizing the Unseen

By Jerome Lachenbruch

A FEW hundred feet of film, a motion picture camera and an artist with imagination and ingenuity are solving the intricate problems of electricity for the beginner. The various phases of electricity have been visualized on the motion picture screen so that any one may understand them. The principle of induction, the working of the wireless telegraph and telephone, and many other phases of the subject are now being shown to the general public; also they form part of the curriculum of instruction in many elementary and secondary schools.



E. Lyle Goldman, of the Bray studios drawing the background for one of the electrical animated drawings

Strange as it may seem, the visualization of electrical topics is a direct development of the process by which the animated cartoon is made. A few years ago John R. Bray, a Brooklyn newspaper cartoonist, discovered that by making a series of cartoon drawings and photographing them on a motion picture film, he could produce the appearance of cartoons in motion. In his first attempt he drew about 10,000 individual pictures, worked for about ten months and then saw his arduous work reeled off in about ten minutes. He realized that the work was impractical if done in this way and began to study ways to simplify the method. After several weeks of analytical study, Mr. Bray discovered that many different motions may be represented by the same bodily action. For instance, the delivery of a blow, represented by the arm drawn back, is very similar to the motion executed in throwing a baseball. Consequently, when these two motions are to be shown in the same picture, the drawings are not duplicated. They are simply photographed on the motion picture film in their proper order. Furthermore, it was learned that many motions require only a change in part of the figure, say the arms or the legs. And so a cartoon figure may go through several movements without changing the position of the body. In utilizing this fact, Mr. Bray drew a man's body, then on another sheet of paper his legs, and when the legs changed position he drew them in the new position. By superimposing the second drawing over the first picture of the body, a new complete figure appeared. This eliminated the drawing of thousands of lines and avoided immeasurable duplication in the making of the original drawings. Now, only about 1,500 drawings are necessary to make an animated cartoon.

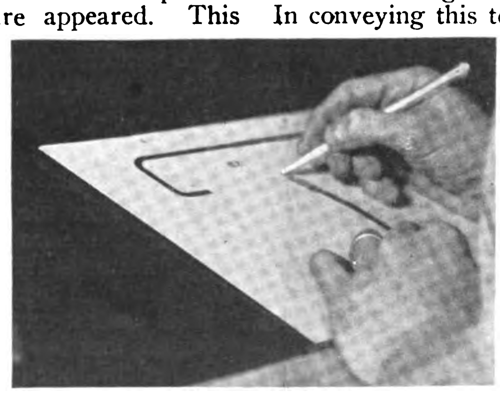
The original drawings are made on transparent paper and are traced on transparent composition plates which are then photographed by an inverted motion picture camera set up on a rigid frame above a table. An ingenious arrangement of gears and small linked chains carries the control of the motion picture camera to a pedal beneath the photographing table which the photographer operates with his foot. At every pressure of the pedal the shutter opens for a measured length of time. Of course, on the table is a frame to which Cooper Hewitt lights are fastened.

Every drawing is numbered and when each is photographed a little indicator, similar to a speedometer in its action, records the number of drawings that have been thus far photographed. The developing and printing of the negative follows the same process undergone by films taken from living figures.

The accompanying photographic diagrams give an idea of the method by which the animated technical drawings are made. Figure 1 shows a battery, upon which is mounted an iron core wound with two coils of wire of different thicknesses. It will be observed that the heavier wire has fewer turns than the finer coil.

The action indicated is an excerpt from the way in which the principle of induction is taught by the "movies." When the connection is made at A, the current flows through the heavy wire, or, technically, the primary winding. In showing this on the screen, figure 1, which is a drawing made on a dark grey cardboard and used as a background for the succeeding pictures, is photographed first.

The phenomenon resulting from the closing of the circuit is twofold. First, a current is set up in the primary winding; secondly, a magnetic field is built up about the core. This fact is conveyed in a title, and is followed on the screen by figure 2, showing the current passing through the primary, then figure 3, showing a magnetic field and the apparent "flow" of the magnetic lines of force. Here the relationship between magnetism and electricity is explained. In the diagram, the lines of force are shown to "flow" all about the core; and the direction of the course of the magnetic lines from north to south through the air is indicated by moving arrows. In conveying this to the screen, the artist who made the drawings made several similar drawings showing the arrows in slightly different positions. When these were photographed on the motion picture film the effect was similar to the flickering which we are all familiar with, securing an effect on the screen of the constant activity of the electro-magnetic field. The diagram of the electro-magnetic field is a photograph of the original background with two transparent plates superimposed upon it.



Close-up showing the background of an animated technical drawing

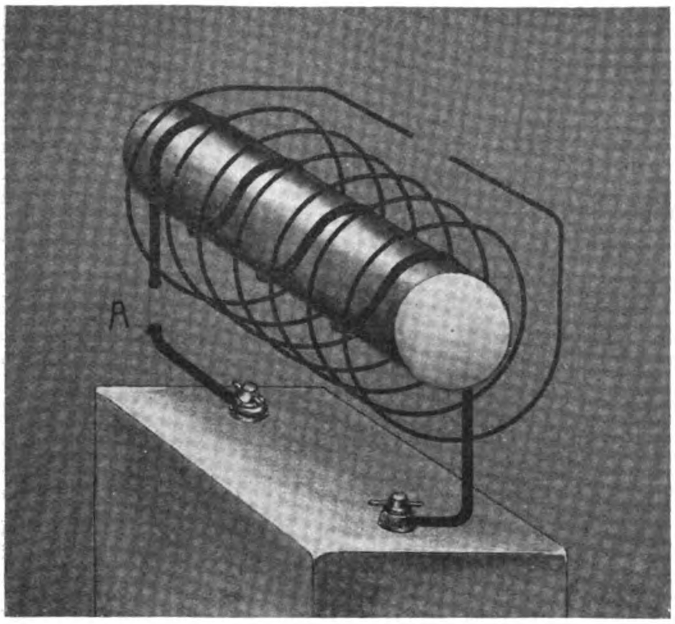


Figure 1—Iron core wound with two sizes of wire mounted upon a battery

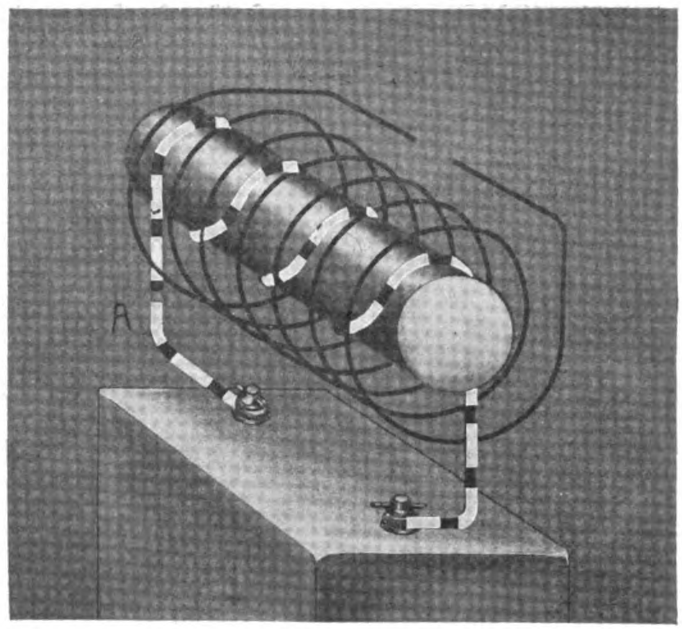


Figure 2—The battery or primary current passing through the primary coil

In following the electrical action further, the contact at A is broken and the electro-magnetic field immediately collapses. What happens now is told in another title that explains, in a few words, the principle of induced currents. The building up and breaking down of magnetic fields constantly results in currents being induced from the primary winding to the secondary. In the motion picture portraying this phenomenon, the current is seen now in the coil of fine wire, the secondary winding. Figure 4 shows this clearly.

It is an electrical fact that a current induced as shown in the figure has its voltage increased and its amperage reduced. This is a principle that has made wireless telegraphy possible, because it permits of the creation of high frequency currents.

But to return to our diagram. The voltage in the secondary is now much greater than it was in the primary winding. This is proved by the fact that it has a potential, or electrical, pressure sufficiently great to enable it to jump the gap and make a completed circuit. The gap, of course, is a familiar contrivance in wireless hook-ups. And here, in the animated technical drawing, its fundamental uses are explained.

Another most important elementary principle of electricity elucidated by the animated technical drawing is the action of the condenser as used in connection with a circuit breaker. This is of particular interest to the student of wireless telegraphy, for the condenser is a storehouse of electrical energy, and in the wireless set is indispensable. The circuit breaker acts as a danger signal by flying open and breaking the flow of the current in case anything goes wrong in the circuit.

To apply the action of the condenser to the screen, the flow of the current in an electrical circuit is shown by means of a series of individual drawings, each differing very slightly from the other. This produces the effect of movement. As a background, a fundamental diagram of a condenser is shown connected with a circuit breaker. The circuit breaker is not drawn on the background, but is a cardboard cutout attached to the background by pins. The various positions of the circuit breaker in opening the line are obtained by moving the dummy by hand and

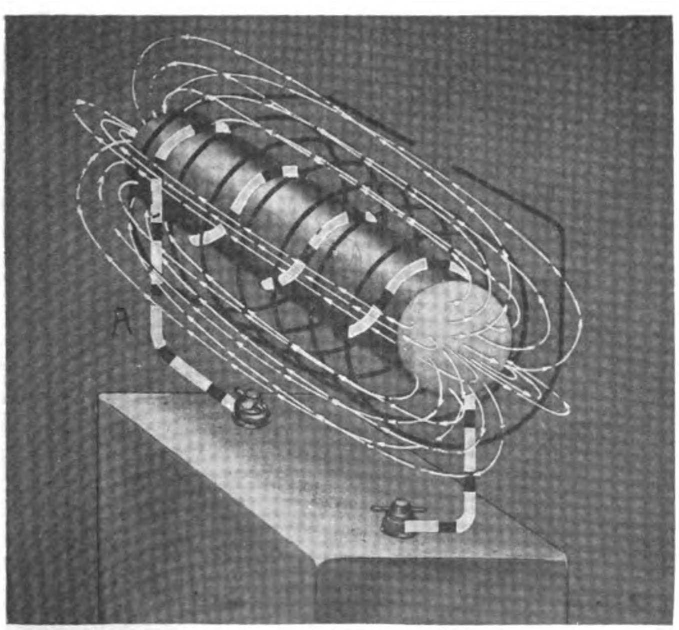


Figure 3—The magnetic field produced by the flow of primary current

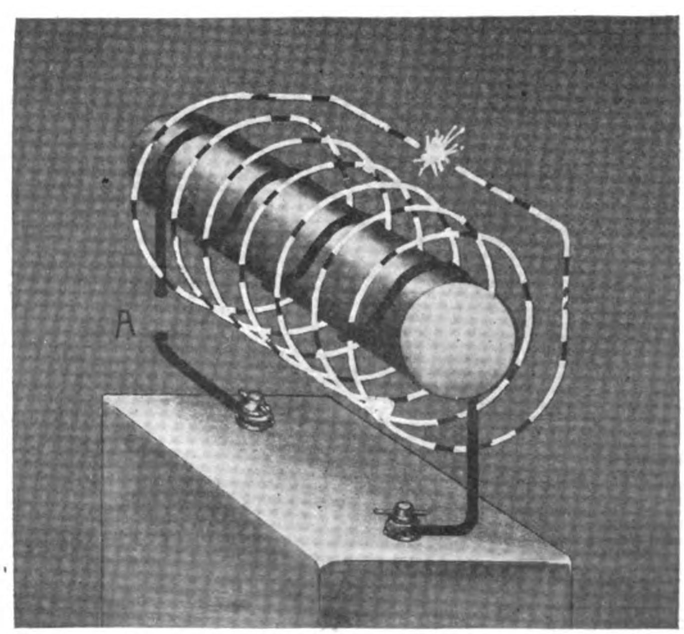


Figure 4—Primary broken at A and induced current in secondary jumping the spark gap

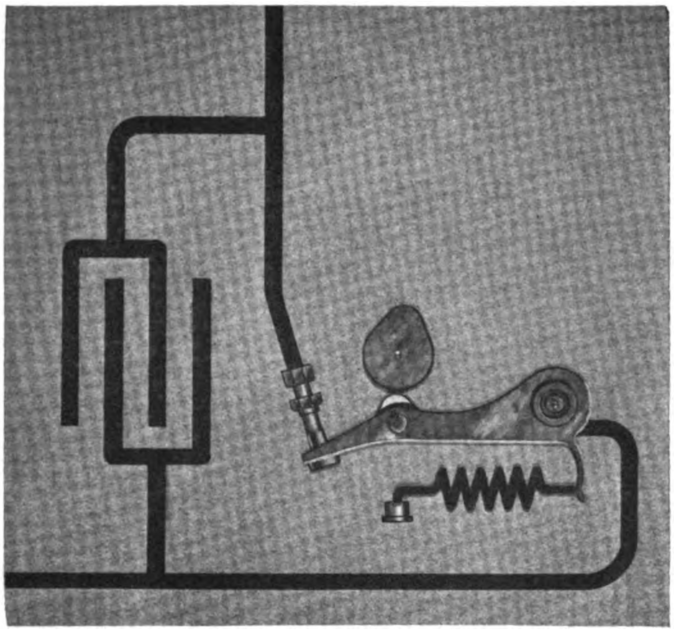


Figure 5—Electrical circuit with circuit breaker and condenser connected

photographing it during the different stages of its action.

The circuit breaker is shown to operate by means of a spring; but to represent the spring in the act of springing many individual drawings of the spring had to be made, otherwise the action as shown on the screen would appear as a jerk. In order to obtain smoothness, the various parts of the diagram that are supposed to move must be drawn in their different positions while the circuit is breaking, and each drawing then photographed on the motion picture film.

Let us assume that the current is running smoothly through the line. In this arrangement the circuit breaker is closed. The dashes in the photographic diagram suggest the course of the current flow. It will be seen that the condenser is not in use, and the point of the cam, which operates the circuit breaker, is turned upward. To obtain this effect on the screen, three drawings were necessary. The first was a background showing the dummy circuit breaker and the general outline of the electrical circuit, together with the condenser. Then a drawing of the spring was made, traced on a transparent composition plate and laid on top of the background, with the

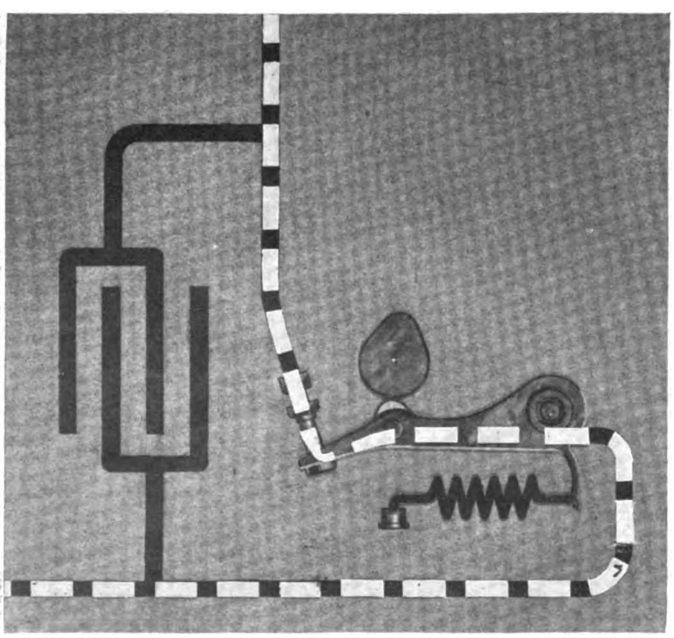


Figure 6—Circuit breaker closed, permitting flow of current

result shown in figure 5. Finally, the dashes representing the current were drawn, and the three photographed together, the completed picture being shown in the diagram, figure 6. Now, to make the lesson move on the screen, the plate showing the spring when the circuit breaker is closed is removed as well as the plate indicating the course of the electric current.

For the next series of drawings, the same background is used. But instead of the first drawing of a spring, another, in a slightly different state of tension, is drawn and placed over the background. Then the cam of the dummy circuit breaker is moved by hand, so that the breaker opens the line and the current flow is seen to be interrupted. See figure 7. Here a title is inserted to state that when the line is open the current flows into the condenser. In order to show this, another drawing of dashes is made to fit over the condenser drawing of the background. What would happen if the line opened and there was no condenser to catch the surplus current is shown by a spark jumping across the opened circuit. This involves several other drawings.

This elementary electrical instruction is invaluable in the teaching of wireless telegraphy. From such funda-

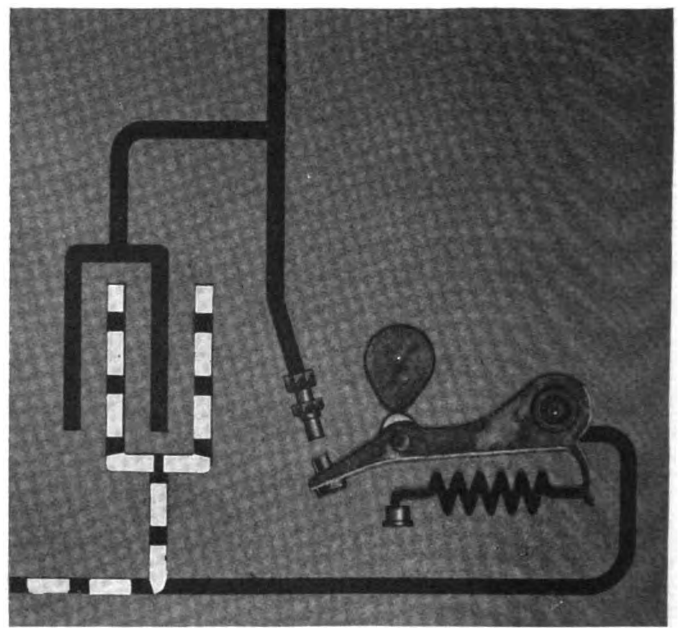


Figure 7—Circuit breaker open and interrupted current flowing into the condenser

mentals, the Bray Studios have progressed to the point of teaching how the wireless telegraph operates. For example, most students who are interested in this phase of electricity know that electro-magnetic waves radiate in all directions, yet follow the general course of the earth's surface. Now, the best way to teach an unknown thing is to compare it to a known one and then to show in what particulars the new fact to be taught differs from the thing known. So, in animating the principle of wireless telegraphy, the movie artists have gone back to two known facts: one, the electric bell and the action of sound waves; and two, the ripples on the surface of a lake made by a stone being thrown into the water. This natural phenomenon is understood by everybody; so the comparison between the ever-widening circles on the surface of the water and the electric-magnetic waves of the wireless brings the general principle to the understanding of the masses. Coming closer to the subject, the electric bell comparison tells a similar story, but adds to it by showing that sound waves act like water ripples and also like electro-magnetic waves. In visualizing this, an electric bell in the act of striking is seen to send off waves in ever-widening concentric circles.

But to amplify on the examples, the difference between sound and electro-magnetic waves must be emphasized. This is done by showing a boy shouting, and flashing the fact, in a title, that his voice carries only about a quarter of a mile under the best conditions. The sound waves emanating from his mouth are represented in the form of very short waves. Now the far greater length of the electro-magnetic wave is shown in animated form, and the fact stated that these waves are carried by the ether for thousands of miles. When the possibility of transporting electro-magnetic waves has been established, the construction of various pieces of apparatus is taken up in detail.

The generation of high frequency currents, and their oscillation in the closed circuit until they jump the gap (see figure 4) and pass into the ether; the apprehending of the electro-magnetic waves by the antennae of some receiving station many miles away, and the passing of the current through the receiving set; and finally the "ironing out" or reduction of the current to audible frequency are all shown in a graphic manner.

In all subjects relating to electricity, the screen offers teaching opportunities scarcely realized at present. In the naval wireless school, the schools for general electricians, and for instruction aboard ship, not to mention the many private institutions for the teaching of electrical subjects, the animated technical drawing offers a new way to impart the intricacies of the subjects in an intensely entertaining and practical way.

The Design of Multi-Stage Vacuum Tube Receiving Circuits

By John Scott-Taggart

(*Continued from the December,* 1919, *issue*)

WE NOW come to the usual aperiodic air-core oscillation transformers as a means of coupling the output circuit of a vacuum tube to the input circuit of the succeeding tube.

A two-tube receiving circuit employing this method of coupling is shown in figure 3. An aperiodic inductance coil L_3 is included in the plate circuit of the first tube, a

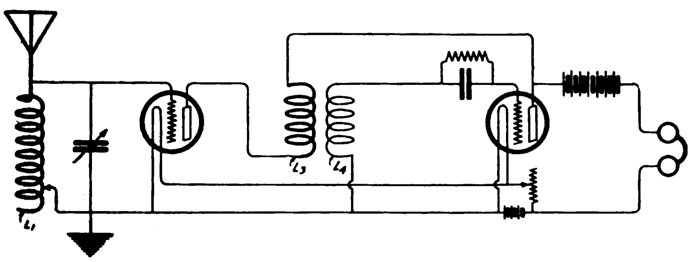
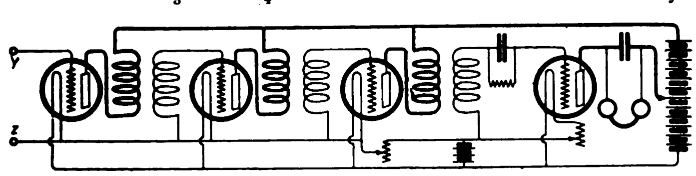


Figure 3—Two-tube receiving circuit coupling the output circuit of one to the input circuit of the other

second aperiodic inductance L_4 being placed across grid and filament of the second tube. A leaky grid condenser is included in the grid circuit of the second tube for the purpose of rectifying the high frequency current and producing audible signals in the telephones T. The two inductances L_3 and L_4 may very conveniently be wound together at the same time, or if desired, one of the inductances may be wound directly over the other. This type of amplifier will respond over a wide range of wave lengths, which range may be greatly increased by using resistance wire in place of ordinary copper wire for the inductances L_3 and L_4. The value of the resistance may



Figue 4—Four-tube amplifier-detector for oscillatory circuit

be made as high as about 20,000 ohms. Obviously, a certain loss in efficiency is unavoidable, but this disadvantage is outweighed by the greater usefulness of the amplifier.

Figure 4 shows a 4-tube amplifier-detector which may be applied to any oscillatory circuit for the purpose of receiving wireless signals. As will be seen, the arrangement is merely an elaboration of the circuit of figure 3, the coupling between the tubes taking the form of aperiodic air-core transformers. The terminals YZ are connected across the oscillatory circuit, in which the received oscillations are taking place.

An improved arrangement would consist in tuning the grid circuits of the various vacuum tubes in the series. This arrangement somewhat increases the efficiency of

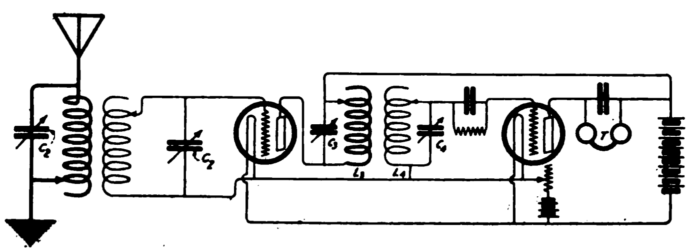


Figure 5—Two-tube receiving circuit which permits very fine tuning

the amplifier and also improves its selectivity. The number of adjustments required, however, make the circuits somewhat unwieldy. It will be realized that a certain step-up effect is obtainable by arranging that the inductances of the plate circuits will have fewer turns than the inductances of the grid circuits. If the grid circuits be tuned, it may be an advantage to have the coupling between the plate and grid oscillatory circuits variable in order to increase the selectivity. If, however, we are aiming to produce a highly efficient circuit which is exceedingly selective, it will be preferable to tune both the plate

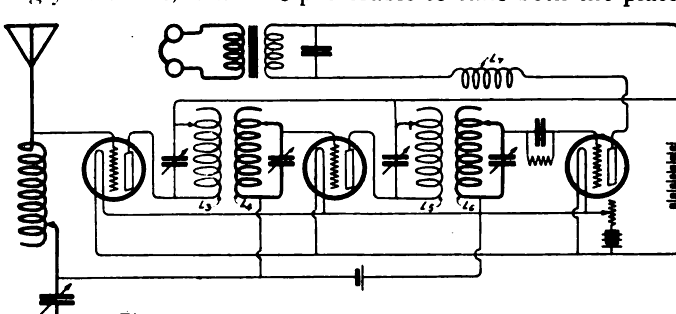


Figure 6—Three-tube circuit which provides for reception of continuous waves

and grid circuits by means of variable condensers. Figure 5 shows a useful 2-tube receiving circuit which is capable of giving excellent signals and at the same time very fine tuning. All circuits are now accurately tuned to the incoming frequency and the degree of selectivity may be varied by altering the coupling between L_3 and L_4. The second tube of this circuit acts as detector, the signals being obtained in the telephones T. Figure 6 shows a 3-tube receiving circuit which is a development of the 2-tube circuit, and which also provides for the reception of continuous waves. In the plate circuit of the last tube is included an aperiodic coil L_7 which may be coupled to any of the foregoing inductances in order to amplify spark signals on the regenerative principle or to produce self-oscillation, and so enable us to receive continuous waves. This class of circuit is especially useful when it is desired to receive within a fairly narrow range of wave length, or on a definite fixed wave length. As a general statement, in amplifiers utilizing air-core transformers an aperiodic coil for producing regeneration may always be placed in the plate circuit of one or other of the tubes and coupled to one of the circuits of a previous tube. If grid current rectification in the last tube is being used, self-oscillation may be produced by the use of an oscillator coil. If, however, the last tube is made to operate as a detector by utilizing one of the bends on the plate current curve, it is not possible to produce self-oscillation. If this form of detection is employed and we desire to produce self-oscillation, an oscillator coil may conveniently be included in the plate circuit of the vacuum tube next to the last. It is to be noted that a condenser of about 0.001 mfd. is invariably connected across the telephones. This condenser, among other things, allows self-oscillation to take place more readily. Incidentally, when a suitable number of tubes are used for amplifying high frequency oscillations, the radio-frequency component in the plate circuit of the detecting tube may be very considerably increased and is liable to cause arcing in the telephone windings, unless a shunt condenser is provided.

Except for special purposes, it will not usually be desirable to employ more than 3 tubes with tuned inter-tube transformers. The circuits become expensive and difficult to adjust, although this latter disadvantage may be largely overcome by employing a switch which changes the values of the inductances L_3, L_4, L_5, L_6, simultaneously.

We now come to the use of coupling resistances in vacuum tube amplifiers. This class of coupling is aperiodic, and after a certain wave length, is usually efficient for all wave lengths. A simple resistance coupled circuit is shown in figure 7, where two vacuum tubes are shown in use. The first one acts as a high frequency amplifier and the second one as a detector. The resistance R_1 has a value of about 80,000 ohms, and should have neither capacity nor inductance. It may be constructed by cutting two or three parallel grooves 2" long on a sheet of ebonite and rubbing the point of a lead pencil across them. Suitable terminal connections are made at the ends of the conducting grooves. A more suitable type of resistance may be constructed by using strips of paper on which heavy India ink lines have been ruled. Various commercial types of resistances have been placed on the market. Care should be taken to see that the terminal connections do not form a small condenser in parallel with the resistances.

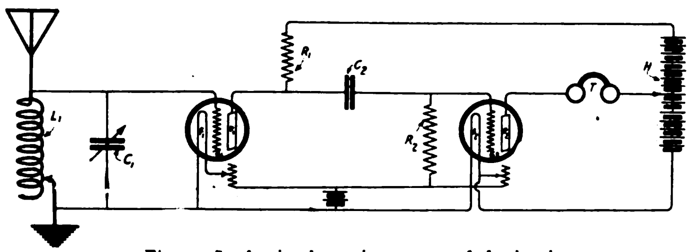


Figure 7—A simple resistance-coupled circuit

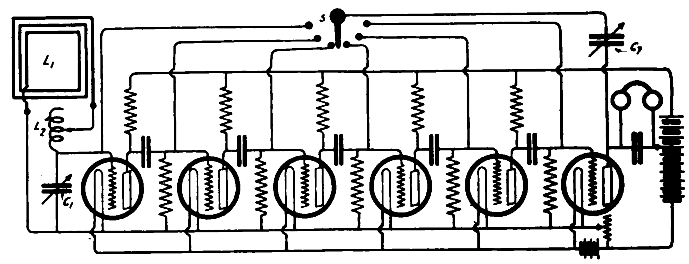


Figure 9—Six-tube amplifier for use with a frame aerial

A condenser C_2 of about 0.0003 mfd. which is connected between the foot of R_1 and the grid G_2 of the second vacuum tube insulates G_2 from the battery H, which would otherwise give the grid a very high potential. When the grid G_1 of the first tube becomes positive, the electron current through R_1 increases; consequently, a momentary negative pulse is communicated through C_2 to the grid G_2 of the second tube. Similarly, when G_1 is made negative, the electron current through R_1 is decreased and a positive pulse is impressed on G_2. In this manner the high frequency potentials across R_1 are passed on the second tube, which rectifies the radio frequency EMFs. Owing to the drop in potential across R_1 the plate battery H will have to be of considerably greater voltage than is the case in an ordinary amplifier. The value of H may conveniently be from 70 to 100 volts. Each tube is shown as having a separate rheostat of about 10 ohms resistance. These rheostats may frequently be dispensed with. Such minor variations in the circuits given here are left to the experimenter. To prevent excessive negative charges building up on the grid G_2 of the second vacuum tube a leak R_2 of about 3 megohms resistance may be connected directly across grid and filament. In place of the telephones T a step-down transformer may be used. A high resistance winding may be included in the plate circuit and a low resistance winding connected across a pair of low resistance telephones. This applies to all tube circuits and the use of such a transformer possesses considerable advantage.

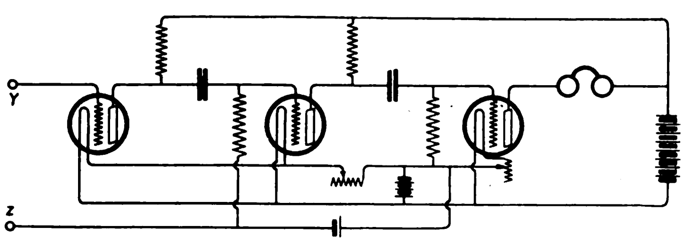


Figure 8—Three-tube resistance-coupled amplifier suitable for general reception

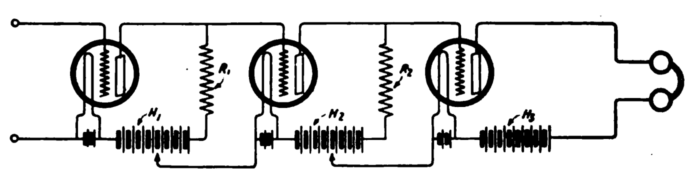


Figure 10—Marconi resistance amplifier circuit containing three tubes

Figure 8 shows a three-tube resistance coupled amplifier suitable for general reception. This circuit is simply an elaboration of the previous circuit and no comment is necessary. The values of the resistances are the same as before. The terminals YZ are connected across the oscillatory circuit in which the incoming oscillations are flowing. The important point to notice in connection with resistance coupled amplifiers is that they are not suitable for reception of short wave lengths. This is due largely to the capacity effect, which is invariably in parallel with the plate circuit resistances. This capacity effect may be chiefly due to the capacity of the electrodes in the tube and is also due to the capacity of leads and connections. This capacity acts as a resistance, or rather, reactance, in parallel with the resistances R. Since the condenser acts

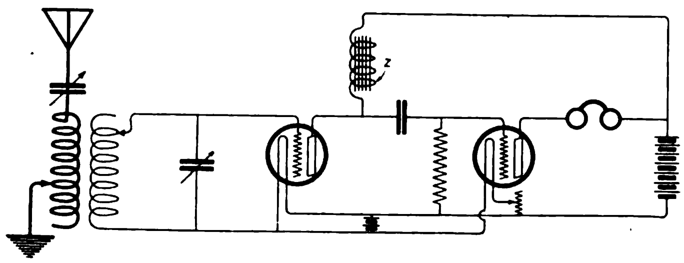


Figure 11—Two-tube impedance circuit for short waves

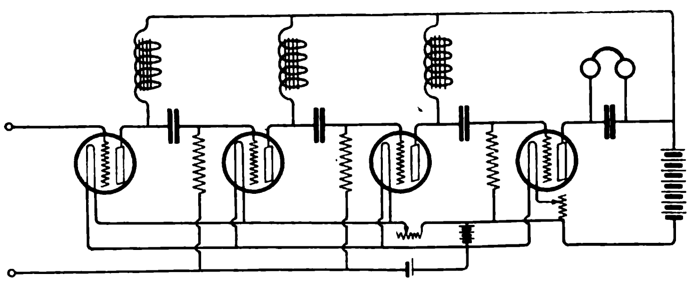


Figure 12—Four-stage amplifier for short waves

as a detector towards oscillatory current, the higher the wave length received, the greater will be its frequency and the more readily will the unintended shunt capacity act as a by-path to the oscillations, and so reduce the impedance of the resistances R. The resistance amplifier is consequently most useful for wave lengths exceeding 1,000 meters. In any case, every precaution should be taken to avoid capacity effects in resistance amplifiers.

Figure 9 shows a 6-tube amplifier being used to receive signals picked up on a frame aerial L_1, which consists of a number of turns of insulated wire on a large frame several feet square. The loading inductance L_2 and the condenser C_1 is for tuning purposes. The amplifier calls for no special comment except that a small condenser C_7 is used for obtaining regenerative amplification. By means of a switch S this condenser may be connected

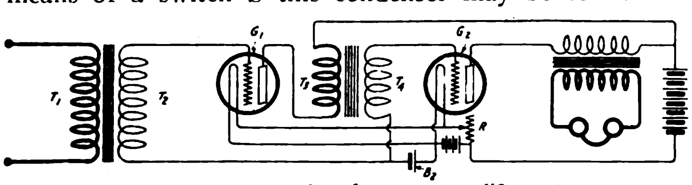


Figure 13—A simple two-stage low frequency amplifier using a step-up transformer

across the plate of the last tube and the grid of another of the preceding tubes. This condenser should have a very small capacity. By gradually increasing this capacity the circuits may be made to pass through the various stages prior to self-oscillation, thus enabling us to obtain regenerative amplification of spark signals, or to receive continuous waves.

In a resistance amplifier, the grids are alternately positive and negative at any given moment. For example, if the first grid is positive, the first plate will be negative, the second grid negative, the second plate positive, the third grid positive, the third plate negative, and so on. To obtain regeneration, the condenser C_7 should be connected across two electrodes of similar sign. Regenerative amplification may be obtained not only by coupling the plate of the last tube to the grid of the first, but by making suitable connections between any of the intermediate tubes. The condition for regenerative amplification is that when the potential of the plate increases, the grid of the preceding tube chosen should also increase, and vice versa. If the condenser is now connected across the plate and grid, regeneration is obtained and if the condenser is of sufficient capacity self-oscillation is set up.

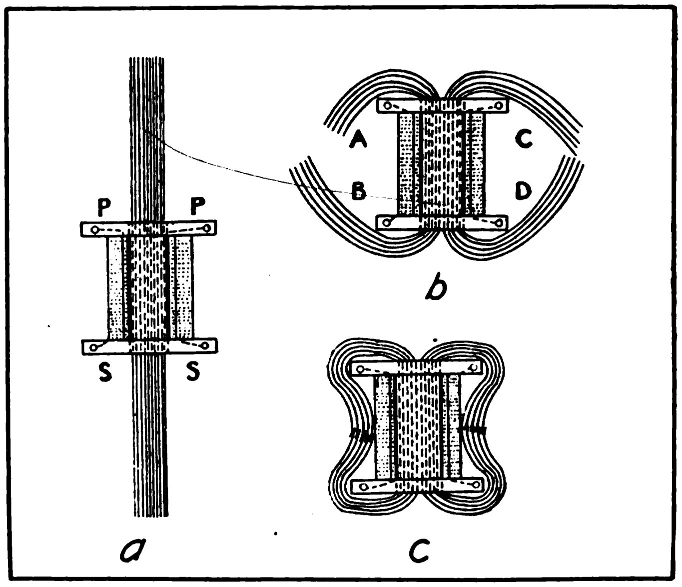


Figure 14—Detailed construction of a transformer

For example, regeneration may be obtained by connecting the last plate to the first grid of an amplifier possessing 2, 4, 6 or, in short, an even number of tubes. If an odd number of tubes were used, absorption—the opposite to amplification—would take place, and the greater the capacity, the less would be the amplification and the less the tendency to oscillate. We can see that regenerative oscillation is obtained when the coupling condenser connects the plate and grid of tubes adjacent to each other, or separated by an even number of tubes. Obviously, the greater the number of tubes in between, the more critical is the adjustment of the coupling condenser, which thus requires to be of very small dimensions. Owing to the difficulty of insuring regular working, it is desirable to arrange the coupling between the plate of one tube and the plate of a previous tube in the series. Rectification is

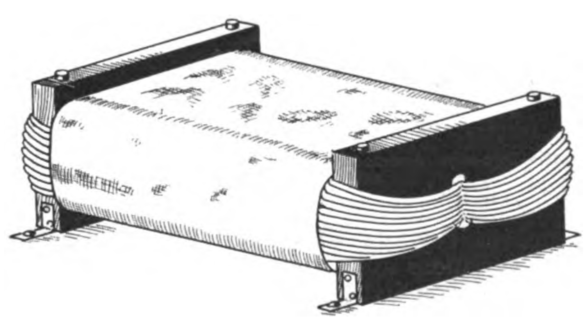


Figure 15—The completed amplifier transformer

now weak and allows of a more gradual adjustment. The coupling condenser should now be connected across any two plates which are undergoing potential changes of the same sign as, for example, 1st and 3rd, 3rd and 5th, 1st and 7th, and so on. Instead of using a condenser, a high resistance of the order of about 10 megohms may be connected across the plate of one tube and the grid of a previous tube, or the plate of one tube and the plate of another. These general remarks will explain the conditions under which regeneration is obtainable in a resistance amplifier. The present regeneration is obtainable in a resistance amplifier.

However, the writer is not inclined to recommend the use of methods for obtaining self-oscillation in an amplifier, although regeneration is frequently desirable. It will almost invariably be preferable to use an external heterodyning oscillator when it is desired to receive continuous waves.

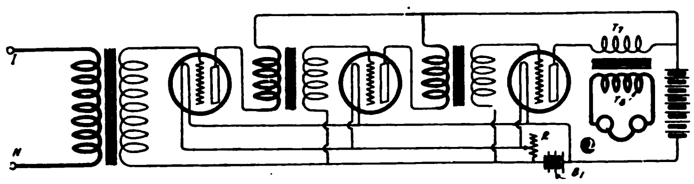


Figure 16—Three-tube low frequency amplifier circuit

An interesting resistance amplifier has been patented by the Marconi Company, which is illustrated in figure 10. In the plate circuit of the first tube is included a high resistance R_1 and a plate battery H_1. If connections were taken from the ends of R_1 across the grid and filament of the second Marconi tube there would normally be a negative potential on the grid of the second tube. This potential would be equal to half the emf. of H_1, if the resistance R_1 equalled the internal resistance of the tube between filament and plate.

It is to be noted that it is usually desirable to make the plate circuit resistance equal to the internal resistance of the tube. To overcome the potential drop across the high resistance in the plate circuit, we have seen that usually a stopping condenser has been used. The Marconi circuit, however, achieves the same object by taking the connections from the top of R_1 and the mid-way point along H_1. It will be seen that the emf. across R_1 is balanced by half the emf. of H_1 acting in the opposite direction. If R_1 does not equal the internal resistance of the tube a suitable point is readily found on H_1 so that the potential difference between that point and the top end of R_1 is zero. When a varying potential is placed on the grid of the first tube, the potential across R_1 also varies whereas the potential across the half of H_1 involved does not vary, at least, not to any appreciable extent. The magnified potential variations are consequently applied to the grid of the second amplifying tube, and the same process is repeated in the case of the second tube, the magnified variations in R_2 being applied across the grid and filament of the third vacuum tube. This last tube may, if desired, be arranged to act as a detector.

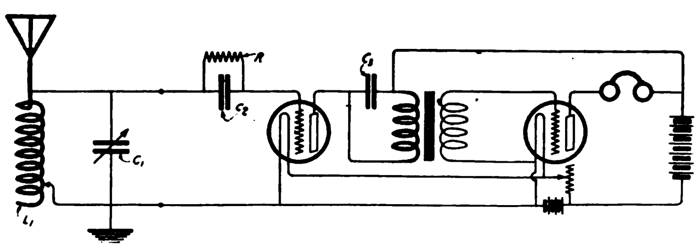


Figure 17—Two-tube detector amplifier circuit in which the first tube acts as a detector

This circuit requires separate plate batteries and filament accumulators. Moreover, it will be seen that any low frequency variations of plate current in the first tube will be passed on throughout the series; consequently, any undesired current variations such as those due to variations in filament temperature or leakage in the circuits are liable to be magnified by the amplifier and produce undesirable noises. In the case of those amplifiers in which stopping condensers are used, these condensers, if of small enough capacity, will only pass on high frequency current variations, and will filter out any audio-frequency effects. The Marconi circuit, however, is capable of being used as an amplifier of steady, maintained, direct current potentials, whereas the other type of amplifier is unsuitable. The principle of taking a tapping from the plate battery to avoid the potential drop across the plate circuit resistance is one of considerable value and may be applied in many vacuum tube circuits with advantage.

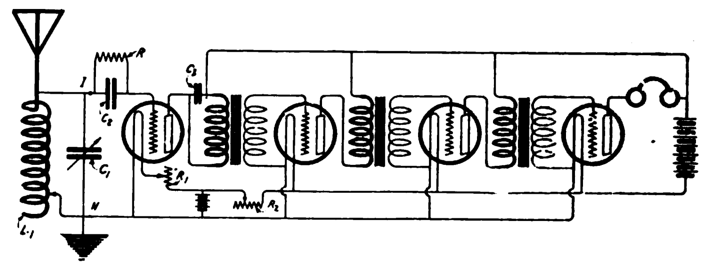


Figure 18—Four-tube detector-amplifier circuit with three tubes for amplification

We have seen that owing to the capacity of the vacuum tube and various strong capacity effects in a *resistance* coupled amplifier, the arrangement is not suitable for the efficient reception of waves less than about 1,000 meters. For the higher wave lengths we can use an impedance coil in place of a high resistance. The impedance offered by such a coil increases with the frequency of the oscillations. It will thus be seen that an amplifier employing impedances will be very efficient for the reception of short waves. Wave lengths as small as 100 meters may be very effectively received on an amplifier of the type shown in figure 11. Two vacuum tubes are here shown in use, the first one acting as a high frequency amplifier and the second one as a detector. The impedance coil Z may conveniently consist of about 10,000 turns of No. 40 silk covered wire, wound on an iron wire core 2½" x ½". An elaboration of this simple circuit is shown in figure 12. which illustrates a 4-stage amplifier which may be applied to any oscillatory circuit receiving short waves. As in the case of resistance amplifiers, regenerative amplification may be obtained by connecting a high resistance of about 12 megohms, or a very small condenser across the plate of the last tube and the grid of say the first tube.

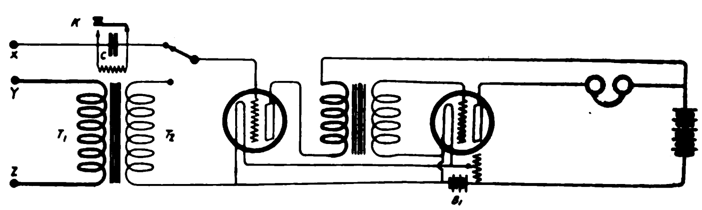


Figure 19—Circuit for use as low frequency amplifier or receiver

Obviously, in a tube of this nature, we can obtain regenerative amplification or self-oscillations by connecting an aperiodic oscillatory circuit consisting of an inductance in the plate circuit of the last tube and coupling this coil to the input oscillatory circuit. In this class of amplifier and also in any other type in which an impedance, such as a telephone transformer winding, is included in the plate circuit of the last tube, the oscillatory regenerative circuit may be connected in *parallel* with the impedance. In this case, one end of the coil is connected to one end of the impedance, while the other end of the coil is connected through a fixed or, if desired, variable condenser to the other end of the impedance.

We now come to the design of amplifiers employing several vacuum tubes coupled by means of iron-core transformers. Of these the most important are probably those employing transformers having primary and secondary, the primary being included in the output circuit of one tube and the secondary in the input circuit of the following tube. A simple two-stage low frequency amplifier is illustrated in figure 13, in which an initial step-up

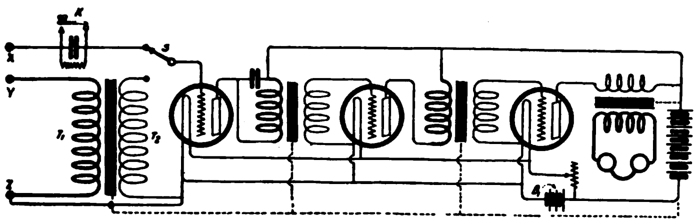


Figure 20—A three-stage amplifier used during the war

transformer T_1 T_2 is provided. This step-up ratio may conveniently be 1 to 5. The winding T_1 should have a resistance approximating to the resistance of the circuit to which the amplifier is to be applied. In nearly all cases, the winding T_1 will be included in the plate circuit of a tube being used as a detector, consequently the resistance of T_1 should be fairly high. In most British commercial amplifiers the winding T_1 has a resistance of from 300 to 2,000 ohms, or even more. Suitable windings for an initial transformer for general work are: primary—44 gauge single silk covered copper wire, 300 ft.; secondary—44 gauge single silk covered copper wire, 3,000 ft.

Although a little outside the scope of the present article, the design of a transformer shown in figures 14 and 15 may appeal to experimenters. These diagrams are taken from an article by the author which appeared in the November, 1919, issue of The Wireless World. Figure 14 shows stages in the manufacture of a simple transformer. A hard rubber tube about ½" external diameter and 2" long is fitted at each end of a square rubber cheek, 2" x 2", through which a ½" hole has been drilled. Wooden cheeks and a paper tube soaked in paraffin wax could be substituted for this. On this tube is wound the primary winding. This can best be accomplished by rotating the tube on the shaft of a small electric motor. The two ends of the winding should then be brought to two small terminals fixed on one of the cheeks. The secondary

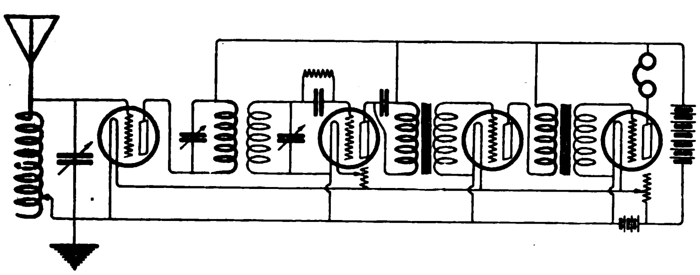


Figure 21—Circuit for high-frequency and low-frequency amplification

winding may be wound in the same direction in a similar manner, the two ends being brought out to terminals fixed on the other cheek. The greatest care should be taken to insulate the windings, which should be separated by one or two layers of varnished cloth. The iron-core consists of a bundle of iron wires 7" long which fit into the hard rubber tube and project about 2½" beyond the cheeks. The wires at each end should be parted, each half being bent round the side of the cheek. Figure 14b shows how the ends A and B and C and D have been bent round the sides of the cheeks. The ends A and B, and C and D are now worked into each other so that the core appears as two rectangular rings as shown in figure 14c. The finished appearance of the transformer is illustrated in figure 15.

A second transformer T_3 T_4 is shown in figure 13. This inter-tube transformer is of the step-up type, a suitable ratio being 1 to 5. The transformer may be constructed in the manner just described, the winding T_3 containing about 3,000 ft. of wire and the secondary about 15,000 ft. These values give excellent results, but there

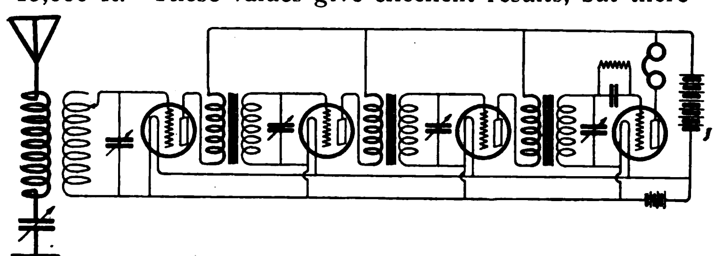


Figure 22—La Tour radio-frequency amplifier

is no reason why they should be too closely followed. Different commercial types of amplifiers vary very much indeed in the resistances of their transformer winding. Instead of connecting high resistance telephones in the plate circuit of the second tube, we conveniently use a step-down telephone transformer and low resistance receivers. It will be noted that a single cell B_2 is connected in such a position as to give the grids G_1 and G_2 a small negative potential with respect to the filament. This largely prevents any grid currents and the loss of efficiency which would otherwise result. A rheostat R of about 10 ohms resistance varies the filament currents of the two tubes simultaneously.

Our next figure (figure 16) shows a useful form of low frequency amplifier which can be applied to any circuit in which low frequency current variations are taking place. The terminals I N are simply connected where the telephone receivers would normally be placed in the circuit. A special point to notice is that the author has connected the grids of the tubes to the negative side of the filament heating accumulator B_1, and so placed the rheostat R that the grids will always be slightly negative with respect to the negative end of the filament, on account of the voltage drop across the used portion of R. This arrangement is technically preferable to the use of a small cell, although an accumulator of higher emf. may be required.

A telephone step-down transformer T_7 T_8 is now shown in use. The winding T_7 may conveniently have a

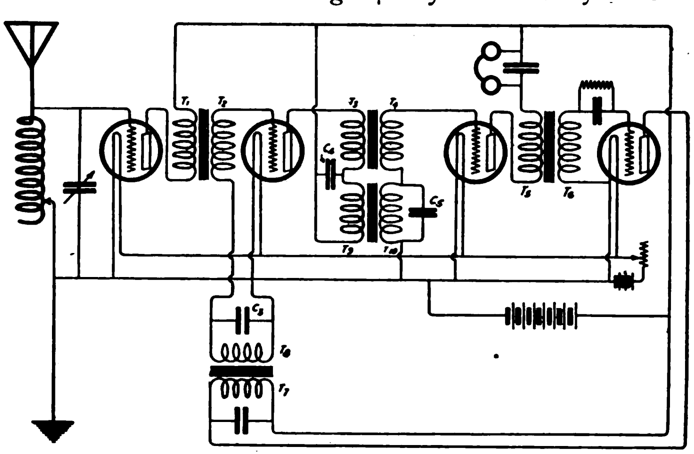


Figure 23—Four-stage amplifier designed by La Tour

resistance of about 5,000 ohms and should consist of about 5,000 ft. of wire. The low resistance winding may be wound with the same wire to a resistance equal to that of the phones to be used.

Figure 17 shows a very convenient form of detector amplifier in which the first tube acts as a detector; only two tubes are shown. The input terminals are connected across the receiving circuit L_1 C_1, but it is to be understood that the terminals could be connected across *any* oscillatory circuit in which incoming oscillations are taking place. It will be noticed that a leaky grid condenser C_2 of about 0.0003 mfd. shunted by a resistance R of 3 megohms is included in the plate circuit of the first vacuum tube. Across the winding T_1 of the inter-tube transformer is connected a condenser C_8 of about 0.01 mfd., which is intended to by-pass the high frequency component of the plate current of the first tube. An obvious but very useful development of this circuit is shown in figure 18. The condenser C_2 is shown having a value of 0.00005 mfd. and R as having a resistance of 4 megohms, but these figures depend very largely on the type of tube used. The author has shown the filament current of the first tube variable by means of a separate rheostat R_1. A similar rheostat R_2 may be made to regulate the filament current supplied to the second, third, and fourth tubes, although with suitable tubes this rheostat may frequently be dispensed with.

Figure 19 shows a design of amplifier which may be used either for low frequency amplification or for the reception of wireless signals. Three terminals X Y Z are now provided. The terminals Y Z are used when low frequency amplification is desired, the switch S being placed on the stud A. When, however, it is desired to receive wireless signals, connections are made to the terminals X and Z and the switch S is placed on the stud D; the input transformer T_1 T_2 is now entirely cut out and wireless signals are rectified by the aid of the leaky grid condenser C. This condenser may be shorted by the switch K. To avoid using four terminals and also to improve the effectiveness of the amplifier for low frequency amplification, the terminal Z is connected to the negative side of the filament accumulator B_1.

A three-stage amplifier which proved very successful during the war is shown in figure 20, which is a similar circuit to figure 19, but possesses three tubes. In all these low frequency amplifiers it is almost invariably desirable to connect the iron-core of the transformers to the positive side of the plate battery H, as shown in figure 20 by the dotted lines. This steadies the action of the amplifier and lessens undesirable noises which are otherwise usually heard. Most of the improvements in these types of amplifiers are due to Marius LaTour.

If it is desired to resonate low frequency transformers used in amplifiers, large variable condensers may be connected across the windings, but such resonated circuits have not found very much favor in Great Britain and France for low frequency amplification.

Figure 21 illustrates a typical example of a circuit in which high frequency and low frequency amplification is obtained in a single amplifier employing a single filament accumulator and plate battery. The first tube acts purely as a radio-frequency amplifier, the second acts as a detector, while the third and fourth act as audio-frequency amplifiers. There are obviously very many modifications of circuits of this type, but the one given will, no doubt, be sufficient to indicate the general principle of employing single batteries and the combining of the various functions of a vacuum tube in the single amplifier. The author, however, recommends that for general experimental work it is preferable to employ a separate three-stage low frequency amplifier independently arranged, but which could be applied to any experimental circuit.

Iron-core transformers have been very largely used by Marius LaTour in France for the purpose of coupling the various vacuum tubes in a multi-stage radio-frequency amplifier used for the reception of long waves. He has used both resonated and aperiodic windings and obtains a step-up effect which is not obtainable to the same extent in the case of an air-core transformer. Figure 22 shows an arrangement of vacuum tubes used by LaTour for radio-frequency amplification. The disadvantage of this class of amplifier is that it does not lend itself to reception over wide ranges of wave lengths and is, moreover, difficult to design. LaTour has also devised an amplifier which is shown in figure 23. Four stages of amplification are shown, the last tube acting as a detector. The transformers T_1 T_2 T_3 T_4 and T_5 T_6 are designed for radio-frequency amplification. The last tube acts as a detector and the rectified pulses in the plate circuit are passed into the primary step-up transformer T_7 T_8, the winding T_8 being included in the plate circuit of the second tube. A condenser C_8 is shunted across T_8 to allow the passage of radio frequency current. The second tube now amplifies the low frequency pulses at the same time as it is amplifying the high frequency energy supplied by T_1 T_2. The low frequency amplified pulses pass through the primary T_9 of a step-up transformer T_9 T_{10} which is included in the plate circuit of the second tube and in series with the winding T_3. The secondary T_{10} is included in the grid circuit of the third tube and is in series with the winding T_4. Condenser C_4 and C_5 are connected across T_9 and T_{10} to by-pass the radio-frequency current in these circuits. The telephones T are included in the plate circuit of the third tube. The type of amplifier shown does not seem to have achieved the success that might have been expected from a double magnification circuit of this kind.

From the foregoing remarks it will be seen that a very large number of amplifier circuits may be devised. As a rule, it is preferable to aim at high selectivity and the reception of very weak signals rather than merely to obtain a very loud response in the telephones; consequently, attention is to be called chiefly to those circuits employing radio-frequency amplification.

An Oriental Radio Set

By Howard S. Pyle

WE are hearing considerable discussion of various new radio apparatus brought out during the period of hostilities, but very little has appeared in print descriptive of the marine apparatus in use by the Japanese vessels.

This equipment has remained substantially the same for some years. It has, and is, proving very efficient and satisfactory in the long voyages in the trans-Pacific trade. A Japanese operator is often able to clear with a Japanese station and one in North America on the same night. This means spanning two thousand miles of water each way, and in spite of the many records made in both transmission and reception during the war, the almost nightly long distance work of the Japs is not to be scoffed at.

The writer, shortly after our entry into the war, had the good fortune to be assigned to a large steel freighter which the United States had purchased from the Japanese government, and which was equipped with the "Annaka" type of apparatus. We were to sail for South America and then the east coast, to enter into the trans-atlantic transport service. Having a civilian crew, although we were all naval operators, we saw a splendid opportunity for experimentation with the Japanese apparatus, and we were left entirely alone, having absolute control of the radio.

Reporting aboard our vessel, formerly the *Yoshida Maru 3d* but renamed the *Eastern Chief*, we were agreeably surprised at the excellent appearance of the apparatus. It was mounted entirely on marble, all the metal parts being nickel plated. Even the smaller instruments, such as starting boxes and field rheostats, had individual marble panel mountings. The receiver was very elaborate and enclosed in a mahogany cabinet with a heavy hard rubber top, all the controls and metal parts being silver plated. A solid oak operating table with drawers and files was installed, and a built-in settee of oak with green plush cushion added to the operator's comfort.

Our stateroom was connected by a door with the operating room, and a speaking tube connected us with the chart house. The location in the starboard wing of the bridge was also desirable.

Starting box and power panel for main 3 kw. set

Loading coil panel and antenna switch

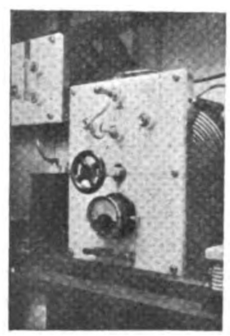
As to the apparatus itself: the transmitter was of three kilowatt capacity for the main set, with an auxiliary generator and transformer of half-kilowatt size, which, when cut in, used the same oscillating and open circuits as the main set, the change being effected by merely shifting transformers and starting the small generator. A separate power control panel was provided for both motor generator units, and contained all the controlling appliances with the exception of starting boxes and field rheostats which were mounted individually, convenient to the operator's hand. The auxiliary motor generator was powered by a fifty-volt storage battery, contained in a suitable housing on the bridge. Circuit breakers and the necessary controls for charging were contained on the power panel. The ship's mains, of course, furnished current for the operation of the main transmitter. The generator sets, while bearing Japanese nameplates, were evidently of General Electric type, and consisted of the usual DC motors, coupled to the generators with flexible couplings. The generators were of the solid rotor type, the main set being of 600-cycle frequency and the auxiliary of 500 cycles.

The transformers were of low secondary potential and of closed core design, immersed in oil. A removable plate on the top of the cases permitted of easy access, by means of a small forked wire, to single-pole-double-throw switches immersed in the oil, and which controlled the secondary potentials. Leads from the transformer were connected directly across the condenser, consisting of two large units of glass plates and copper foil, embedded in beeswax, and contained in a suitable case. A heavy single-pole-single-throw switch, permitted of change in capacity, which was necessary for operation at the 300-meter wave length. This switch was mounted on a marble panel which formed the cover of the condenser case.

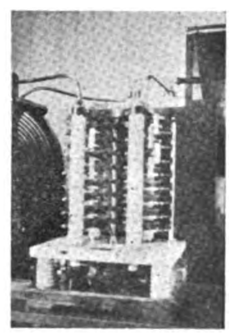
The quenched gap, which appears in one of the illustrations, is probably the most unique instrument in the transmitting equipment. This consisted of sixteen plates, mounted vertically in two rows, and having a geared edge on one plate of each gap. A series of fiber gear wheels moving on a shaft passing between the two sets of plates, engaged the teeth in the gap plates. A small tube led from the sparking surface of each gap to a larger feed pipe, and thence by a rubber tube to an alcohol chamber. A motor actuated bellows, forced the alcohol vapor onto the sparking surfaces, assisting in the quenching. The blower motor, by means of a system of chains and gears, also caused the plates to slowly revolve while the alcohol was forced onto the plates. By this means the whole surface of the gap was presented to the alcohol blast. The mica rings separating the sparking surfaces gave trouble for a while by leaking, but after a little experimenting we remedied this.

In series with the gap and condenser was the primary of an auto transformer, the almost perfect quenching of the gap permitting the use of this type of inductance in place of the customary oscillation transformer and still insuring a pure wave. The inductance was variable by means of a large wheel fronting on the marble panel which supported the auto transformer, and which may be plainly seen in one of the accompanying photographs. On this panel was also mounted the hot wire ammeter and the wave changing switch, which latter consisted of three plug sockets for the insertion of a plug connected by flexible cable to the circuits. A similar plug arrangement was in use on the loading coil panel. The loading coils themselves, were, as was the auto transformer, wound in the well known pancake style. As the Japs work their own stations on a wave length of 1,700 meters when interference is heavy on the 600 meter wave, several loading coils were installed, but ours had been connected in circuit to permit a range of waves from 300 to but 952 meters, hence several coils were removed. A heavy single-pole switch on the front of the loading coil panel provided for short-circuiting the loading coils at will.

From the loading inductance, the circuit went to the antenna switch, which was a single-bladed affair with a throw of 60 degrees. The primary power circuits and the blower motor for the gap were controlled by this



Auto transformer and control panel showing wave changer switch

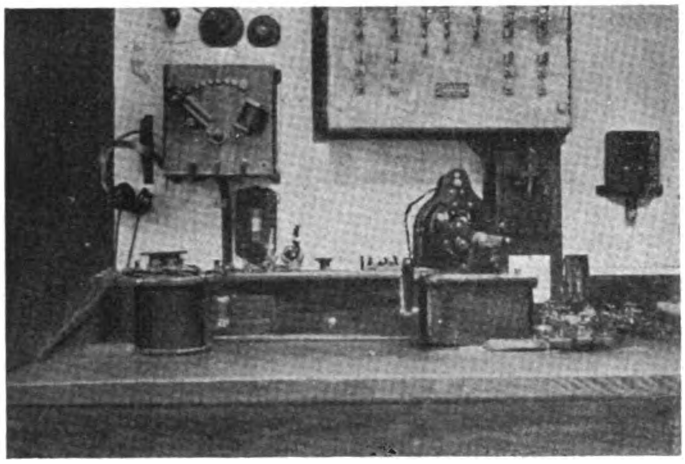


Sparkgap of novel design and unique operation

switch as well as the high frequency circuits. A deck insulator of massive dimensions and heavy porcelain construction carried the lead to the antenna. Contrary to the usual United States custom of using 7/22 phosphor bronze for the antenna, the Japanese use a cable of seven strands of number 14 phosphor bronze, which makes a very heavy, but at the same time, efficient high frequency conductor. In place of our usual Electrose insulators, two heavy 10-inch ribbed porcelain insulators, heavily glazed were in tandem at both ends of each strand. The lead in was brought from the middle and was not bunched until reaching the deck insulator. Our antenna had a natural period of 310 meters, which made a series condenser necessary for transmission on 300 meters.

Two hand keys of massive dimensions were provided, and as these were of the old massive pump handle type, we pulled them out and installed a smaller navy key.

As has been stated, the receiving set was elaborate. Of the older cabinet type rather than the more recent panel design, it was a marvel of intricacy. A bird's-eye view of the top of the cabinet had the appearance of the letter E with the middle leg left out. In the narrow part, a small drawer was set, which served to hold spare crystals, etc. A loose coupler of about 3,000 meters held the right hand side and provided for the inductive transfer. The primary was varied by a slider moving on a rubber strip which carried thirty switch points. A similar slider, but working on a worm gear from the inside of the coil, varied the secondary inductance. This was controlled by a small crank projecting from the secondary head. A loading inductance was mounted within the cabinet, controlled by the usual dial switch on the panel, and was used for considerable of the rough tuning. A fixed condenser, made up similar to a variable by using spaced aluminum plates, but stationary rather than movable, was controlled by a five point plug switch on the panel. A similar plug switch controlled a smaller paper and tinfoil condenser across each variable and the telephones. A variable was connected in shunt to the secondary and a primary variable was thrown in shunt, series or short circuit by another plug switch. A dial switch controlled a non-inductive potentiometer, which could be used with either of three crystal detectors, using foreign minerals which we couldn't analyze. Binding posts were provided for connection of the wing, grid and filament circuits of a vacuum tube detector, but none was provided, so we arranged our own tube. An extremely intricate switch contained within the cabinet and controlled by a handle on the outside, served to change the hookup for crystal or vacuum tube work. We found it to be poorly arranged for tube reception but very efficient on crystal.



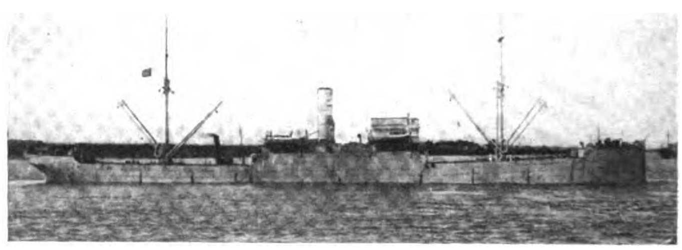
The receiving set showing a compact arrangement of instruments

In making the diagram of the connections of the receiver, two whole evenings and several choice bits of temper were used up in tracing the circuits. The wires connecting the various instruments in the cabinet made a bundle the size of a man's wrist, and we thought a considerable loss of energy in vacuum tube work was due to the presence of so much useless inductance. The telephones were probably the one real discredit to the outfit, and they were as good as worthless. Single pole construction, apparently of a low resistance and cheaply constructed, we had trouble with them continuously until we substituted a pair of navy 'phones.

We made several noteworthy transmissions, but I believe our record was hung up, when, by some freak or other, we communicated with San Diego, California, at 2,000 miles in daylight, and during July, when we were somewhere around the equator. This was purely freak work, but our night transmissions of ordinary occurrence gave clear signals easily readable at from 1,400 to 1,800 miles regularly.

The hot wire ammeter showed only about 14 amps. on our highest power, which only serves to show that the hot wire ammeter is really very much of a liar, for it has been proven time and again, that a high reading at the meter does not necessarily mean great energy from the antenna. I have done far less distance with ammeters showing as high as 20 and 22 amperes, and have come to take the meter reading as merely an indication of what you are really getting in the circuits, not what is hopping off into space.

On the whole, we were well satisfied with the performance of our Oriental outfit, but were relieved to exchange it for a navy set. Its complicated construction kept both myself and my two assistants constantly on the job to keep it going right, and often when high power work was attempted, two or three of us would have to stand by for emergency breakdowns. Nevertheless, we take off our hats to our little yellow brothers for their remarkably fine workmanship and attention to detail and to the results



U. S. S. Easternchief, formerly Yoshida Maru 3d, in Scheldt River near Antwerp, Belgium

they succeeded in getting as a regular occurrence—not as freak work. We were handicapped in having to trace all our circuits, as everything was lettered with nameplates in Japanese, and next time, we hope to have the pleasure of accepting a Japanese set lettered in English—or at least with a blueprint under the mattress.

Radio Frequency Inductance Coils

By M. K. Zinn

SUMMARY: The purpose of this paper is to discuss some of the practical considerations which enter into the design of inductance coils for radio frequencies, with particular reference to their application in circuits intended for the reception of long undamped waves. The theoretical behavior of coils at high frequencies is reviewed, and for illustration, impedance measurements on a typical antenna load coil are presented.

GENERAL THEORY: The problem of designing a coil to function within a particular band of frequencies usually presents itself in this form:

To design a coil which will have a given inductance with the smallest possible resistance consistent with cost.

At relatively low frequencies, the impedance of a coil approaches $R + jpL$ where R and L are respectively its direct current resistance and inductance and $p = 2\pi f$.

At radio frequencies, however, the impedance departs from this ideal value chiefly by reason of two influences:

1. Distributed capacity.
2. Skin effect.

DISTRIBUTED CAPACITY: For practical purposes, the distributed capacity of a coil may be represented by a fictitious lumped capacity, C, shunted across its terminals. The magnitude of C may be found experimentally by measuring the self-resonant frequency of the coil when excited by a wavemeter very loosely coupled to the same. A better method is to measure the impedance of the coil with an impedance bridge properly shielded and arranged to give accurate results at high frequencies. C may then be computed from the frequency at which the angle of the impedance reverses its sign, knowing the low frequency inductance of the coil

Tests indicate that this equivalent capacity is independent of the frequency for ordinary types of coils. We may represent an inductance coil, then, by the schematic circuit of figure 1, where R and L are the direct current resistance and inductance, respectively, and C is the equivalent capacity defined above.

At this point it becomes necessary to differentiate between two methods of connecting the coil in the circuit, viz.: (1) whether the acting voltage is applied externally, or (2) induced internally, with respect to the coil. The use of a coil as an antenna load inductance is representative of the first case. The secondary coil of a coupling transformer is representative of the second case. Figure 1a shows the circuit that must be considered in finding the impedance offered to an external e. m. f. Figure 1b shows the circuit that must be considered in finding the impedance offered to an internal e. m. f.

In the first instance, the impedance $Z = \frac{e}{j}$ is

$$\frac{R + jpL}{jp\,RC + (1 - p^2 LC)}$$

Separating this expression into its real and imaginary components we find respectively the effective resistance and reactance:

$$R_{eff} = \frac{R}{(pRC)^2 + (1-p^2 LC)^2}$$

$$X_{eff} = \frac{pL\,(1-p^2LC) - p\,R^2 C}{(pRC)^2 + (1-p^2 LC)^2}$$

For coils of the type used in radio work, the terms pRC and $pR^2 C$ are very small and negligible in comparison with $(1-p^2 LC)$ at all frequencies except those very near the self-resonant frequency, or "critical" frequency, of the coil (i.e. where $1-p^2 LC = 0$); so that the effective resistance and reactance are approximated very closely by the following:

$$R_{eff} = \frac{R}{(1-p^2 LC)^2}$$

$$X_{eff} = \frac{pL}{1-p^2 LC}.$$

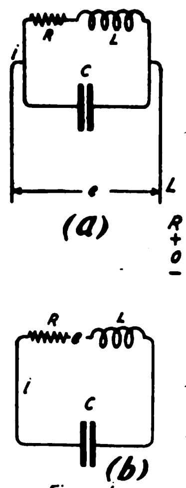


Figure 1

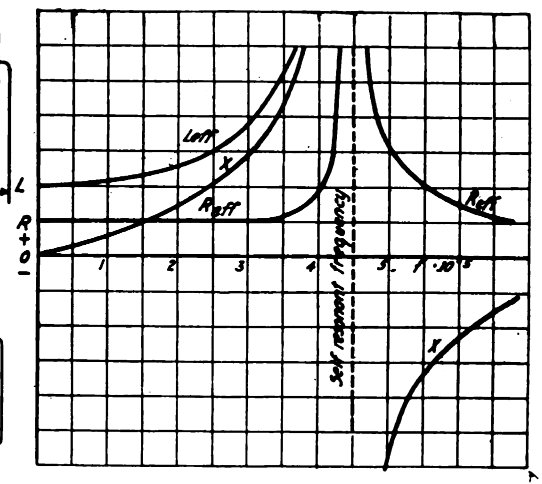


Figure 2

Figure 1—Schematic circuit of an inductance coil. Figure 2—Theoretical curves showing the action of a coil when the acting e. m. f. is applied externally

The effective inductance is then,

$$L_{eff} = \frac{L}{1-p^2 LC}$$

The effective resistance of a coil is a measure of its efficiency since it determines the current that will flow at resonance when the coil is used in a series resonant circuit. From the above relation we see that this effective resistance is increased over the d.c. resistance by the factor $\frac{1}{(1-p^2 LC)^2}$. This increase is attributable to the capacity of the coil alone, and is quite independent of the increase in resistance due to skin effect.

The effective inductance of the coil in like manner has been increased by the factor $\frac{1}{1-p^2 LC}$. For practical purposes, we are interested only in the frequency range below the critical frequency of the coil. At higher frequencies the coil has negative reactance, that is, it no longer functions as an inductance.

The behavior of a coil when the acting e.m.f. is applied externally is illustrated in the theoretical curves of figure 2.

It may be of interest to note in passing that the capacity of a load coil may indeed have quite a beneficial effect in eliminating short wave interference. For example, the writer has a long wave receiver employing several load coils immediately beneath the antenna. These coils quite accidentally have different self-resonant frequencies pretty well distributed over the short-wave spark range. The result is that neighboring spark station interference is very completely choked out, while otherwise these short wave signals would come in through the coupling capacities and cause trouble, even if the secondary circuit were tuned to 10,000 meters or more.

In the second instance (figure 1b), where the coil is so located that the acting e.m.f is internally applied, the distributed capacity effect does not increase the effective resistance of the coil. The effective inductance is changed by a small amount depending upon the dimensions of the remainder of the circuit. In fact, in this case, the effect of the coil capacity is unimportant and entirely negligible, at least if the tuning condenser associated with the coil is sufficiently large in comparison.

Skin Effect: The second influence which causes the effective resistance of a coil to depart from its ideal d.c. value is the well-known "skin effect."

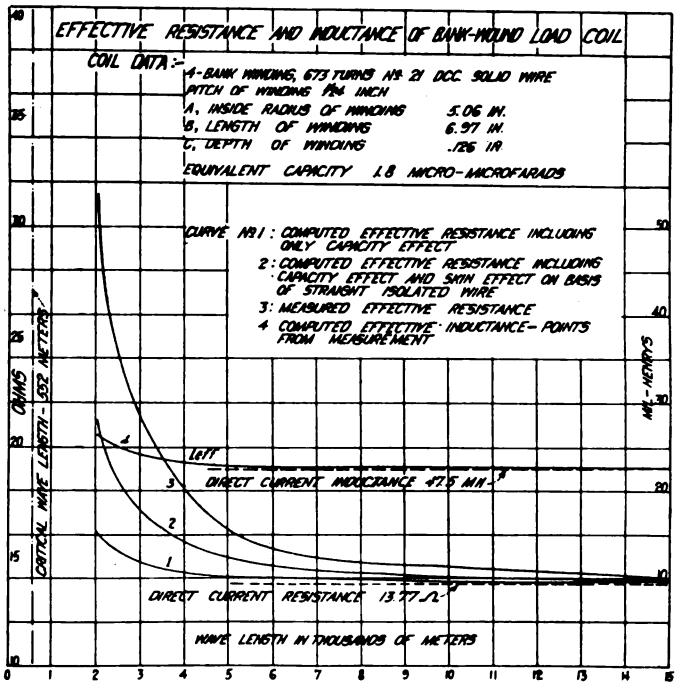


Figure 3—Graphic curves giving the results of calculation and measurement on a sample coil

Unfortunately, the magnitude of this effect cannot be accurately predicted when the conductor is wound into any form of multilayer coil. In general, however, the skin effect appears to be considerably greater in a multilayer or bank-wound coil than in a single layer coil, the skin effect in the latter being in turn greater than that in a straight wire remote from other portions of the circuit.

In default of an accurate formula for predetermining the skin effect in multilayer coils, the designer must resort to his accumulation of test data on coils of various dimensions. The results of impedance measurements on a four-bank load coil are presented below and may serve as a rough guide in estimating the increase in effective resistance due to skin effect for coils of similar construction.

Example: Table I and the curves of figure 3 present the results of calculation and measurement on a sample coil. This coil consisted of a four-bank winding of No. 21 D.C.C. solid wire on a threaded bakelite tube 6 inches in diameter. Specific dimensions are given on figure 3.

As a basis for calculation, the self-resonant frequency of the coil was first determined by the simple wavemeter arrangement sketched in figure 4. This measurement gave the equivalent lumped capacity, C. The D.C. inductance of the coil was computed from Brooks and Turner's data offered in bulletin 53 of the University of Illinois.

From these data it was possible to compute the effective resistance including the increment due to the capacity effect but exclusive of that due to skin effect, from

$$\frac{R}{(1 - p^2 LC)^2} \text{ (Curve 1).}$$

For purposes of comparison, the effective resistance was again computed taking also the skin effect into account on the basis of a straight isolated wire—from

$$\frac{RK}{(1 - p^2 LC)^2} : \text{(where K is the "resistance ratio," } \frac{R}{Ro}\text{,}$$

given in "Radio Instruments and Measurements." (Wireless Press, N. Y.) These results are plotted on curve 2.

Impedance measurements were then made to determine the magnitude of the actual skin effect in the banked winding. The measurements in question were made by means of the radio frequency bridge sketched in figure 5. Although elementary precautions were taken to maintain a balance between the capacities to ground of the various corners of the bridge, it was found that shifting the apparatus changed the balance point noticeably, so that an accuracy greater than 5 per cent. is not claimed for the results.

Table I summarizes the increments in effective resistance contributed by the capacity and skin effects. The effective inductance apparently did not suffer any appreciable deviation from the theoretical values computed from the capacity effect formula along: $\frac{L}{1 - p^2 LC.}$ The inductance curve has been plotted from these calculations. The points on the curve represent the results derived from the impedance determinations.

Types of Coils: By far the most practical and convenient information available for the rapid computation of the inductance of coils of all shapes is contained in bulletin 53 of the University of Illinois by Brooks and Turner. The results obtained from these data are sufficiently accurate for engineering work.

This paper assigns to all coils three characteristic dimensions, viz.: a, the inside radius of the winding; b, the length of the winding; and c, the depth of the winding. It is shown that a given length of wire will have a maximum inductance when wound into a multilayer coil of the relative proportions, a:b:c = 1:1.2:1, approximately. Coils containing the same length of wire but of different proportions will have a lesser inductance equal to a "shape factor," Fo, times the optimum inductance. Curves for Fo in terms of the fundamental dimensions a, b, c are given in the bulletin.

If we accept these relations, we may draw certain instructive conclusions regarding the relative efficiencies of various types of coils for radio work, keeping in mind that our problem consists in designing a coil for a given inductance with the smallest possible resistance consistent with cost.

Coils employed in circuits intended to receive long wave signals, i.e., 5000 meters or more, fall into three classifications:

1. Single layer coils.
2. Multilayer coils.
3. Bank-wound coils.

As stated above, the effective resistance of a coil is an inverse measure of its efficiency. This effective resistance may be expressed as

$$R_{eff} = R + R_c + R_s$$

where R is the direct current resistance, R_c is the increment in resistance caused by the distributed capacity effect, and R_s is the increment in resistance caused by the skin effect.

The single layer coil possesses a decided advantage in that it suffers a smaller resistance increment due to capacity and skin effect. However, for a given inductance, such a coil requires a very much greater length of wire and therefore has a much greater D.C. resistance than a coil of the same inductance wound in either of the other two forms. A glance at the curves of figure 3 will show that for long wavelengths, the D.C. resistance R is decidedly the largest term in the total, $R + R_c + R_s$. For wavelengths in excess of 5000 meters, therefore, a bank-wound coil is many times more efficient than a single layer coil. Brook's shape factor data shows, in fact, that a single layer coil may have a D.C. resistance as much as ten times the D.C. resistance of a bank-wound coil of the same inductance. For long waves, some form of multilayer coil approaching the maximum inductance shape is nearly always even more efficient than a bank-wound coil. The reason is, in brief, that the increase in resistance due to the greater capacity and skin effect in the multilayer coil is more than made up for by its smaller direct current resistance, since the latter comprises the major part of the total effective resistance at these frequencies.

Of course, for short wavelength circuits the reverse is true; that is, when the frequency is high enough to cause $R_c + R_s$ to become comparable in magnitude with R, the single layer coil may be the most efficient.

A type of coil called the "honeycomb-wound" coil has recently appeared on the amateur market. It is a multilayer coil with the layers wound askew so as to enable the turns to be spaced while still retaining the desirable multilayer maximum inductance form. The spacing of the turns is no doubt quite effective in reducing the increments R_c and R_s. At the same time it is obvious that for a given inductance a greater length of wire is required due to the less compact nature of the coil, which increases R a certain amount. Whether the total R_{eff} is reduced by the scheme depends of course upon the relative magnitudes of these two opposite effects for a given frequency range.

NOTE: The resistance increase caused by dielectric loss in the insulation of the wire is entirely negligible at frequencies lower than 60 kilocycles, in comparison with the three terms just mentioned.

The term R_s can be most effectively reduced by the use of litzendraht wire in place of solid wire. At high frequencies, where R_s occupies a formidable proportion of the total, R_{eff}, litzendraht is highly desirable. For long wavelengths, however, its desirability becomes more questionable. The choice between solid and litz-conductor must be governed by the practical consideration of maintaining a balance between the increase in efficiency and the accompanying increase in cost.

For example, in the case of the load coil whose effective resistance is shown on figure 3, it would have been decidedly uneconomical to use litzendraht braid. At the minimum wavelength for which this coil was designed, 5000 meters, $R + R_c$ is 14.1 ohms and R_s is 2.1 ohms. Assuming for the moment that the use of an equivalent litz braid would have eliminated the skin effect entirely, the resulting gain in efficiency would have been about 15 per cent. at the same time, the cost of the coil would have been increased about 225 per cent. This increase in cost might possibly have been justified had the coil been intended for use in a standard measuring circuit, but never in the case of its application to a practical receiving circuit; since a 15 per cent increase in audibility can be gained far more cheaply by a few modifications in the amplifier.

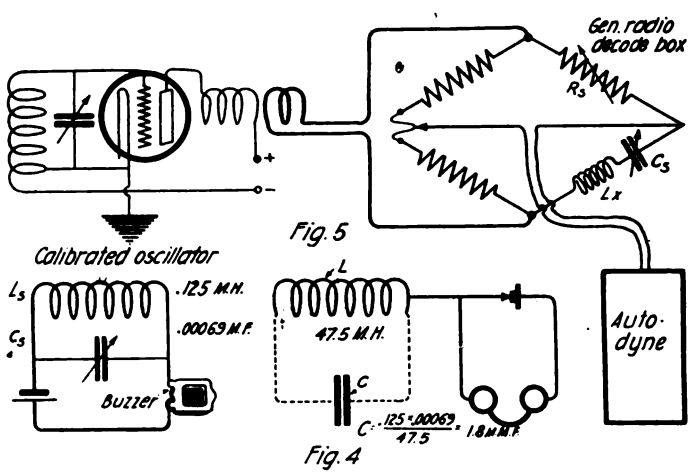


Figure 4—Simple wavemeter arrangement used in making calculations
Figure 5—Radio frequency bridge used in measuring impedance

TABLE I

Characteristics of 47.5 Milhenry Load Coil

Wave Length, Meters λ	$p.10^{-6} = \frac{600\pi}{\lambda}$	$p^2 LC$	$1-p^2LC$	KR computed on basis of isolated straight wire U. S. B. of S. Bulletin 74, table 19, p. 311, and formula 209	R_{eff} on straight wire basis $\frac{KR}{(1-p^2LC)^2}$	R_{eff} from test results	R_c increase in R_{eff} due to capacity effect $R\left[\frac{1}{(1-p^2LC)^2} = 1\right]$	R'_s increase in R_{eff} due to skin effect on straight wire basis $\frac{R(k-1)}{(1-p^2LC)^2}$	R_s Increase in R_{eff} due to skin effect—from test results—by remainder	L_{eff} computed from $\frac{L}{1p^2LC}$
300	6.28	3.37	-2.37	41.3	7.36					
500	3.77	1.215	-.215	33.9	734.					
600	3.14	.844	.156	30.42	1252.					302.5
700	2.69	.618	.382	28.36	194.4					124.9
1,000	1.884	.304	.696	24.23	50.00					68.1
2,000	.942	.0759	.9241	18.18	21.30	31.5	2.37	5.16	15.36	51.4
3,000	.628	.0337	.9663	15.97	17.10	21.3	.98	2.35	6.55	49.1
4,000	.471	.0190	.9810	15.15	15.73	18.0	.53	1.43	3.70	48.4
5,000	.377	.0122	.9878	14.60	14.95	16.2	.34	.84	2.09	48.1
10,000	.188	.0030	.9970	14.05	14.14	14.5	.08	.29	.65	47.6
15,000	.126	.0013	.9987	13.86	13.90	14.0	.04	.09	.19	47.6

A Spark Coil Panel Transmitter

By Thos. W. Benson

IN the design of spark coil panel it is not sufficient that we merely group the apparatus as conveniently as possible; an effort should be made to centralize and simplify all variable factors so as to make them easily and quickly adjustable. In spark coil design it is difficult to calculate the values of capacity and inductance required, hence we make them adjustable, actual tests determining the proper values. Furthermore, the modern spark coil set must be inductively coupled with the antenna, or trouble is sure to result from interference with other stations.

The set described here possesses several novel features, including a quenched gap as well as an easily adjustable oscillation transformer. Figure 1 illustrates a front view of the panel with the apparatus assembled. For the sake of clearness the secondary of the oscillation transformer is omitted.

The panel may be made of bakelite or fibre. Any hard wood, however, will serve if insulating washers are used in mounting the live parts.

The panel, which should measure 12" x 15", is attached by braces to a base 12" x 10".

A hole is cut in the lower left corner of such a size that the interrupter on the spark coil mounted in the rear can be adjusted. A switch occupies the lower right corner.

Above the interrupter is mounted the quenched gap. This comprises two brass rods ½" square, and 1¼" long, mounted 1½" apart. The upper rod is drilled and tapped to take an adjusting screw 1" long which serves to hold the gap elements together. The elements of the gap are made from a strip of copper 1" wide and ⅛" thick. This strip is cut up into one inch lengths and all corners neatly rounded with a fine file. The faces of the elements are polished up on fine emery or sand paper. Eight elements suffice for a one-inch coil, the exact number to be determined by test.

Separators one inch square are cut from mica .005" thick, a hole ⅝" in diameter being cut in each with sharp pointed dividers. In assembling the gap, alternate pieces of copper and mica are piled up, the edges made even by tapping on a flat surface and then clamping them between the brass posts rather tightly.

The condenser for a one inch coil can be made by placing 7 plates of tinfoil or thin copper or brass 4" x 6" between sheets of glass 6" x 8". Four of the plates have lugs brought out to a common terminal, the other three plates being brought out separately for the purpose of varying the capacity. The usual practice of coating the plates with vaseline should be followed, clamping them between two pieces of wood 6" x 8".

The condenser unit is held upright behind the panel by 4 brass clips as

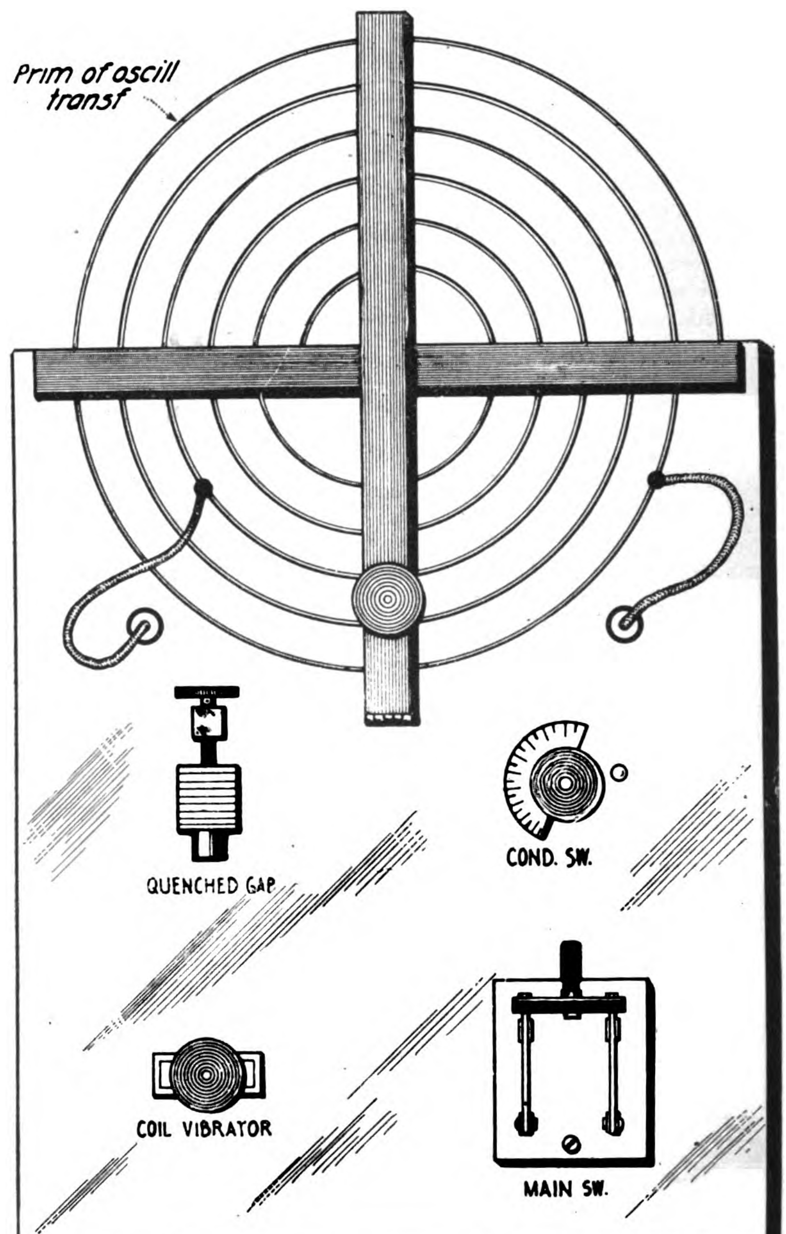


Figure 1—Front view of panel with apparatus assembled

shown in the side view, figure 2. A 3-point multiple switch on the front of the panel controls the capacity. This is made in the usual manner from a semi-circle of thin copper with a radius of 1", fitted to an insulating knob. The copper is split near the edge with a pair of snips, 3 contacts connecting to the condenser plates being mounted so that the copper contactor travels over them.

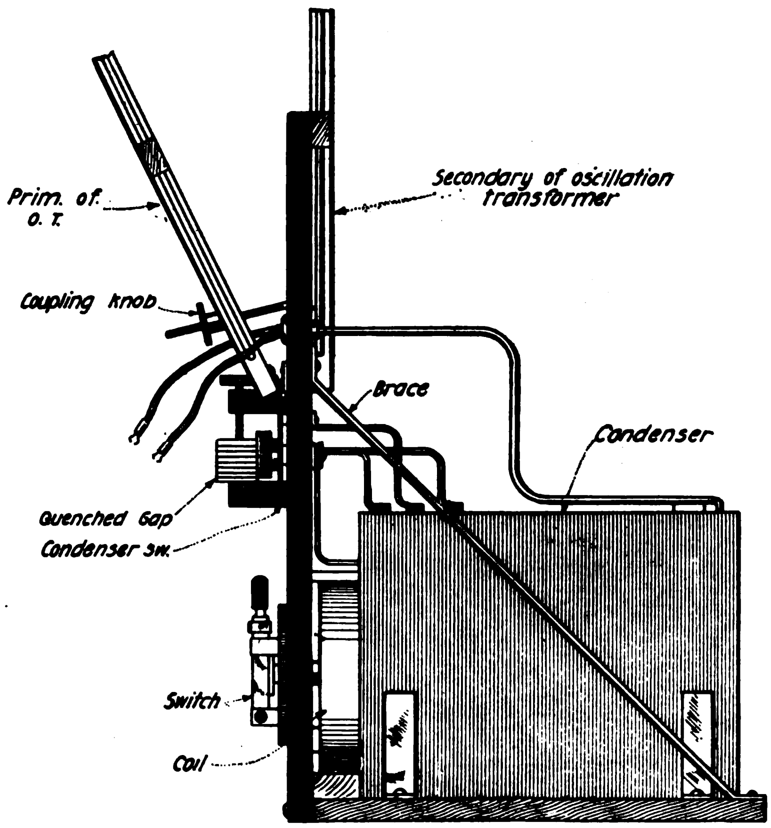


Figure 2—Side view of panel showing condenser unit, oscillation transformer and other apparatus in place

The oscillation transformer is simple in construction, the primary and secondary being identical. The cross is made from 3/8" x 3/4" strips, notched and glued together. Before assembling, holes are laid out and drilled in the arms to pass No. 10 copper wire. It is preferable to use stranded wire or difficulty will be experienced in threading the wire through the holes. If preferred, slots can be cut for the wire in place of holes, thus simplifying the assembly. The turns are 3/4" apart, starting 1½" from the center, making 5½ turns.

The secondary is mounted on the rear of the panel as shown in figure 2. The primary is mounted on the front, being pivoted at the bottom by a small brass hinge. The adjustment for coupling is obtained by means of a threaded rod shown in the side view. One end of this rod is fitted with two nuts jammed together and slipped through a slot in the panel. The primary is slotted directly opposite and the rod passing through has a knob threaded on it. The slots permit the up and down movement of the rod when the coupling is varied by turning the knob.

The flexible leads to the primary are passed through holes in the panel properly bushed to prevent leakage of the high voltage current.

The hookup presents no difficulties. Stranded wire is preferred. Binding the wire in smooth curves and keeping it away from all supports maintains the efficiency. No connections are made to the front of the set. Binding posts for the primary current should be mounted on the base at the rear. This leaves a clean panel with no wires at the front, making unnecessary the drilling of the operating table.

The wiring diagram shown in figure 3 shows the preferred method of wiring in the aerial switch. This reduces leakage across the switch, permitting the use of a smaller and more compact aerial switch. In addition, the lead can be brought directly to the secondary of the oscillation transformer, making a much neater installation.

It should not be necessary to dwell on the advantages of this set. By marking the inductances with different values of capacity the set may be tuned for three or more wave-lengths. In this connection it might be well to state that for local work it is best to cut down the wavelength to 150 meters or so. This will enable a spark set to get through when a number of sets are working around 200 meters. For maximum distance, however, the wave length should be run up to the limit, 200 meters.

Most Government stations do not tune lower than 300 meters, so even if you run over 200 and emit a sharp wave, little interference will result. By all means, keep the wave sharp. It is easily accomplished with an inductively coupled set as described. Watch your operating range increase.

For other than a one inch spark coil the size of condenser and number of gap elements will be different. For a ½" coil, use 5 plates in the condenser and about 4 elements in the gap; for a 2" coil, use 9 plates in the condenser and 12 or 14 elements in the gap. The panel described will permit of the change of power, the gap being designed to take more elements, and the condenser can be increased by adding plates. One of each pair of additional plates can be connected permanently to the condenser switch.

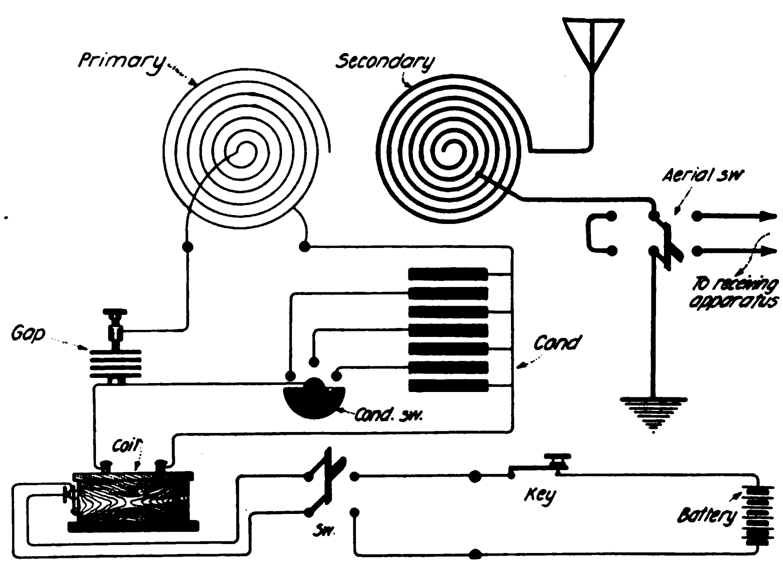


Figure 3—Wiring diagram used in the spark coil transmitter

Multi-layer Inductances for Long Wave Work

By Frank V. Bremer

FOR many obvious reasons coils of rectangular cross section are much more convenient than single layer solenoids when one wishes to effect reception at the longer wave-lengths.

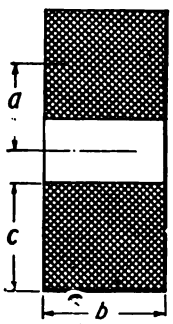


Figure 1

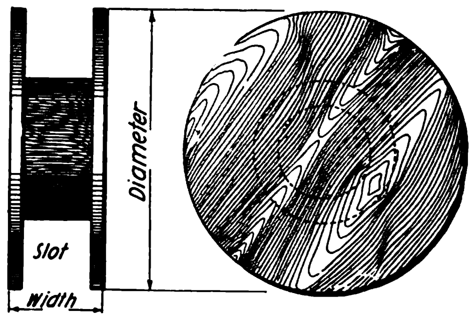


Figure 2

Figure 1—Dimensions used in the formula. Figure 2—Constructional details of block used for winding the coils

Not only are there physical advantages arising from decrease in amount of space taken up by the coil but there are no electrical disadvantages which will in any way materially affect the results to be obtained when coils of rectangular cross section are used. The usual large single layer loading inductances are very awkward to handle and there is always the disadvantage that, by reason of the comparatively low value of distributed capacity which the long solenoid has, any movement of the hand in the immediate neighborhood of the long coils changes the effective distributed capacity. As a result the wave-length of the circuit of which the coil is a part is also changed. In the case of the multi-layer coils, the distributed capacity is not only considerably higher, but the electrostatic field of the coil is so concentrated that the proximity of foreign bodies has no appreciable effect upon the wave-length of the circuit of which the coil is a part.

Although it is considered best practice to use single layer solenoids when dealing with shorter wave-lengths, it is possible to build and use multi-layer coils of rectangular cross section on the shorter wave-lengths.

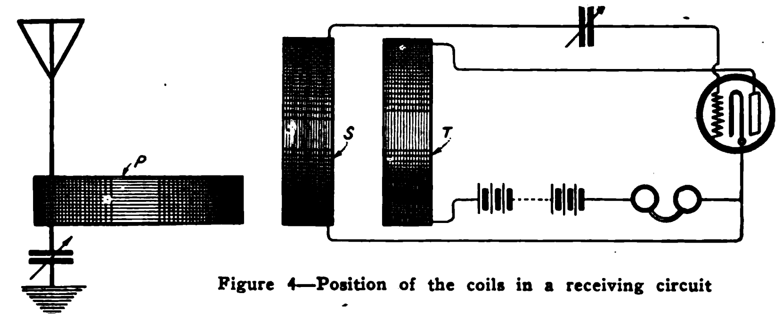


Figure 4—Position of the coils in a receiving circuit

Formulas for the calculation of multi-layer inductances of rectangular cross section are to be found in the circular of the Bureau of Standards No. 74, "Radio Instruments and Measurements." In the formula

$$L = \frac{4\pi n^2a^2}{.2317a + .4466b + .39c}$$

a very fair approximation of the inductance value of a multi-layer coil of rectangular cross section may be obtained. Here *n* equals the number of turns, *a* the mean radius, *b* the width, and *c* the radial depth in centimeters. See figure 1. For example, assume that we wish to construct a coil to work up to 10,000 meters in conjunction with a variable capacity having a maximum value of .001 microfarad. Using the formula, $\lambda = 59.6\sqrt{LC}$, we determine that approximately 28,000,000 cms. inductance will be required. Ignoring the distributed capacity and assuming that the coil is to be 6" outside diameter and 1" wide and the winding to have a radial depth of 1", we find by solving the equation for *n* that it will be necessary for us to place within this space (1" x 1") approximately 910 turns of wire. It will then be necessary, of course, to choose a size of wire such that it will be possible to place this number of turns within the space allotted, but if only a certain size of wire is available for use, a certain number of turns in a certain area may be assumed and the formula solved for *L* which being too large or too small, a new assumption is made, etc.

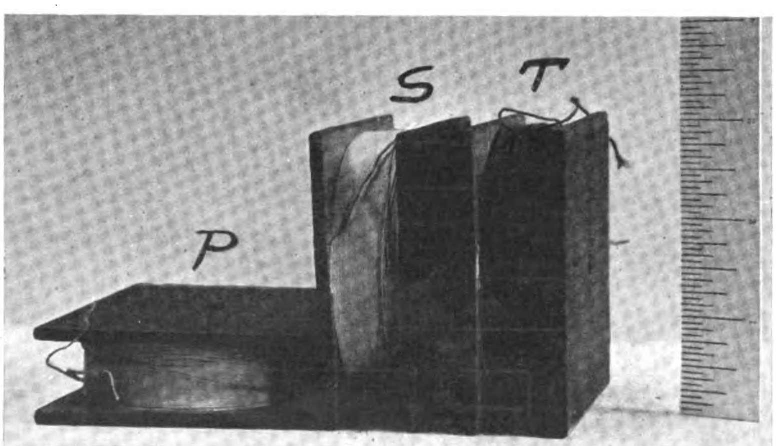


Figure 3— Rectangular cross section coils constructed by an amateur in New York

For undamped wave reception in conjunction with vacuum tube detector, three coils will be required, viz., a primary, a secondary and a tickler coil. The coils are all constructed in a similar manner, the only difference being in the dimensions, these varying with the wave-lengths. A solid block of close-grained wood, such as birch, of a size suited to the dimensions of the coils to be constructed, is selected and placed in a lathe. This block is turned round to the correct diameter and width. Without removing it from the lathe a slot of square cross section, figure 2, is turned in and the whole given a smooth finish.

A layer of bond paper, about .01", is then laid in the bottom of the slot and the winding is begun by placing a layer of wire upon the paper, being sure to have the turns all even and to fill the layer up full. Another layer of bond paper is then laid over the first layer of wire and the winding is continued, a layer of paper being placed

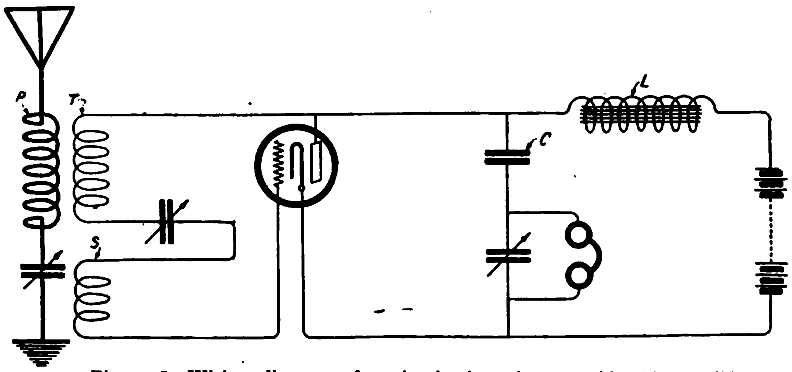


Figure 5—Wiring diagram of a circuit that gives considerable amplification

over each layer of wire, etc., until the slot is completely filled up.

For use in conjunction with the average amateur antenna it will usually be found desirable to construct two coils of the same dimensions for each range of wave-lengths chosen, one of these for use as a primary and the other for use as a secondary. The tickler coil may be made smaller and usually a value of inductance about one-third that of the secondary is sufficient. Because of its lower resistance, it is desirable to use Litzendraht, but solid wire may be used with excellent results. No taps should be taken off from any of these coils.

For those who may have difficulty in having the forms for the winding of the coils turned out a substitute may be made by obtaining two pieces of close-grained board ¼" thick and cut to the desired size. Next obtain a round piece of wood of the proper diameter, divide each piece of board so as to get the exact center, and glue a piece of round stick between the boards, but do not fasten the pieces together. The winding is done about as outlined above. Some dimensions of coils constructed in this way are given below and are shown in figure 3. All the European stations have been copied in Jersey City, using these coils in connection with an antenna 150 ft. in length and a single vacuum tube.

For wave-lengths from 2,200 to 6,000 meters the diameter of the core should be 2", width of slot ½", depth of slot ½", wound with about 300 turns of No. 10-38 Litzendraht or No. 28 single silk-covered wire.

For wave-lengths up to 15,000 meters, the diameter of the core should be 3", width of slot ¾", depth of slot ¾", wound with about 2,100 turns of No. 10-38 Litzendraht. In this and the above case, 6.5 mil paper was used between layers.

For receiving, the coils should be placed as shown in figure 4. In the event that the circuit does not oscillate, the position of the tickler coil T as related to the secondary S, should be changed and it may be that the coil should be reversed in the circuit. This same effect may be accomplished by reversing it in its plane. If everything is in proper order, a slight click will be heard when it is dropped from a plane parallel to the plane of the secondary coil to a plane at right angles to the secondary coil. Figure 5 shows another circuit which may be tried and which gives considerable amplification. Here C has a capacity of about .5 microfarad; L an iron core inductance such as the secondary of a telephone transformer. For damped wave reception the circuit shown in figure 6 is convenient.

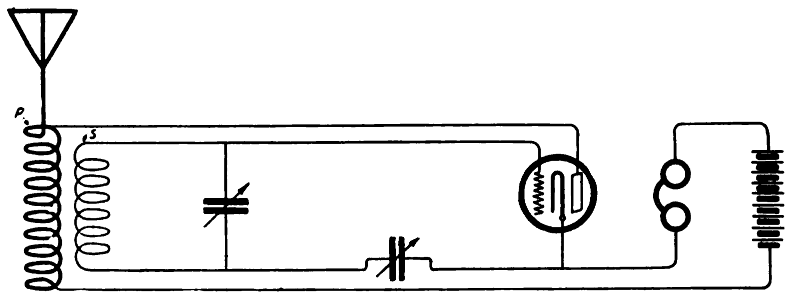


Figure 6—Diagram of a circuit suitable for damped wave reception

The coils shown in the photograph were constructed by an amateur, Emil Heydolph, of New York.

A Modern Receiving Set

By L. W. Van Slyck

HAVING designed and operated the receiving set shown in the photo, and since my results were so good in every respect, I am submitting the specifications, believing they might be of interest to readers of The Wireless Age.

The "loop" is constructed as shown in figure 2, and can be seen at the left in the photograph. The loading coil and the "X" circuit coil may be made in any required dimensions. For 2,500 meters, I find that a coil 4" in diameter and wound for a length of 10" with No. 24 wire is amply sufficient.

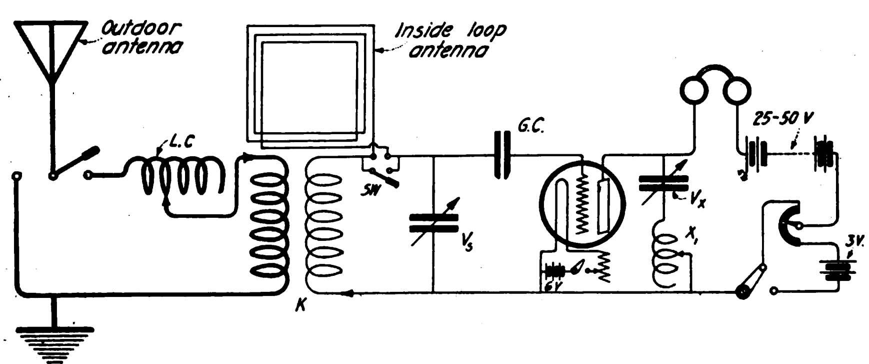
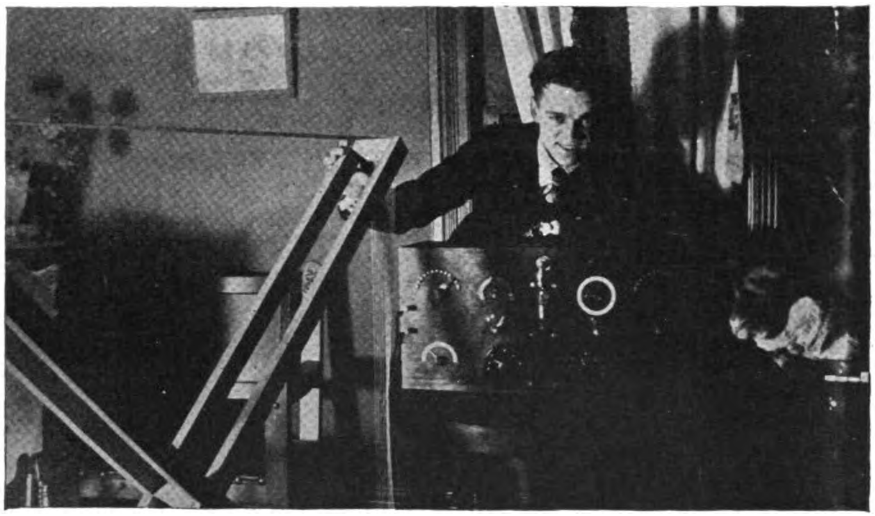


Figure 1—Wiring diagram of circuit used

The two variables, Vx and Vs are of .001 and .0005 mfd. capacity, respectively. The loading coil, LC, and the loose coupler K, may be of any design for the range of wave lengths desired. I am using a loading coil similar to the coil X, and about half as long, with a "Blitzen" receiving transformer. The rest of the outfit is, I believe, self-explanatory.

When it is desired to use the loop, open switch SW, turn the secondary



The complete receiving set using a loop antenna

of the receiving transformer to 0° coupling and disconnect the outdoor antenna (if desired). Then tune with Vs and Vx, orientating the loop until signals are a maximum.

With the set described, and using the loop, I find no trouble in copying along the coast from NAH to NAR, and NAT, and the large majority come in plenty loud enough to read.

Using the outdoor antenna with these instruments, the same stations come in about five times as loud, and, of course, many others which are in-

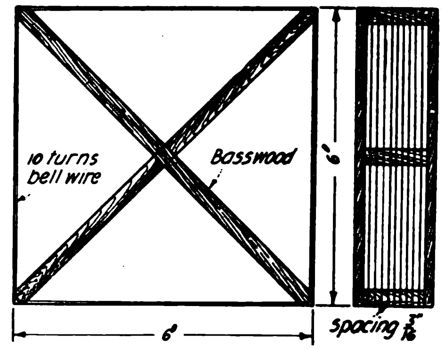


Figure 2—Dimensions and constructional details of the loop

audible with the loop. The loop in this form is not highly directive, having a maximum range of orientation for a given signal of approximately 60° without a noticeable change in signal intensity.

If it is desired that the loop be more directive, it can be wound pancake style.

An Antenna Switch

By F. McGuirk

THIS type of antenna switch is somewhat different from the usual ones in use today. It is a rotary type, as will be seen from the diagrams that accompany this article.

Details of the construction follow:

Procure a rubber or dilecto cylinder 4" long and 1½" in diameter, 6 inches of brass strip, ¼" wide and ⅛" thick, and 3 inches of brass ½" wide by ⅛" thick, and about 3 inches of phosphor bronze strip, 1¼" wide and 1/64" thick. The phosphor bronze must be thin enough to have a kink put in it. Some brass rod 5" long and ¼" thick, and two bakelite strips 4½" long each, and ½" wide and ⅛" thick will also be needed. The cabinet and knobs may be constructed to suit the builder.

First, on each end of the cylinder, draw 4 equal right angles. Cut the brass into pieces (both sizes) of 1-5/32" in length. Draw two lines and bend the brass to fit the cylinder. When fitted snugly, place each piece ¼" apart and screw it down. These are put in place between the lines. Next put the rod through the cylinder and thread the ends for bolts to prevent the cylinder from slipping. Now cut the phosphor bronze into strips ⅛" wide. In the one end cut out about ⅜" in the middle to increase the spring and hammer a kink in it similar to the kink in figure 3. Then take the bakelite strips and drill holes of a size to fit the builder's screws or bolts at ½" from either end and in the center of the strip.

The cabinet is very easy to make; the front should be put in place last. The end of the rod should set ⅛" in, as is shown in figure 1. The bakelite strips should be put in place 1⅛" from the bottom and the phosphor bronze strips stuck in and left ¾" out. When the strips are in place and wires are soldered into them the front may be put in place. The strips should be bent until they bear with force on the cylinder itself to make a still better contact on the brass. When the strips are properly in place and function O. K. then connect the wires to the binding posts on the top, labelling everything carefully. The knob may be placed on the previously threaded rod and the lettering on the front.

This makes a switch that can be shut off and on from the operator's table, and prevents the aerial from having a clear path right through the apparatus. The operation is positive and the builder could arrange a spring to make it impossible to leave the switch only half on.

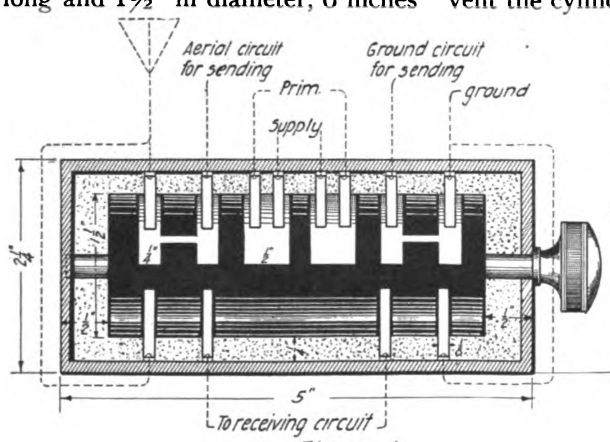


Figure 1

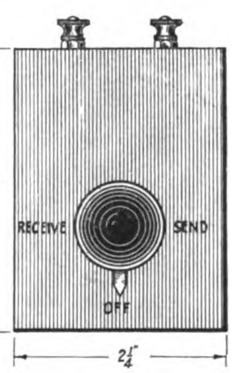


Figure 2

Constructional details and dimensions of the antenna switch

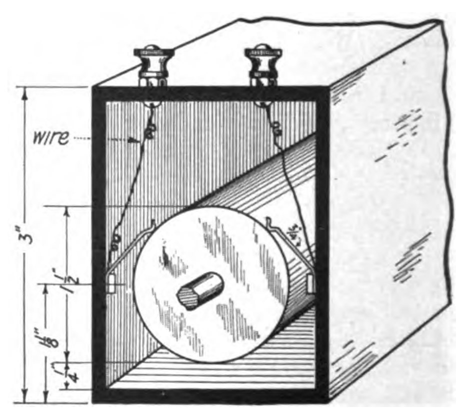


Figure 3—Cut-away view to show method of connecting

A 60-Watt Low Power Transmitter

By L. R. Felder

FIRST PRIZE, $10.00

THE set described in this paper is one which has actually been built and used by the writer and has given the most satisfactory results. Several important considerations which resulted in the choice of this set may prove interesting to the amateur.

A simple set was desired which would transmit about 25 miles, operate at maximum efficiency without making numerous adjustments, and could be built out of material which every amateur already has. A further consideration was that it should not depend for its operation on peculiar differences in the different items of the set. The set which fills these requirements best is one consisting of a battery operated induction coil, properly designed, actuating a closed circuit directly coupled to the antenna.

While vacuum tube sets are coming more and more into use, the writer did not think it desirable to use one in this case, although he has had considerable experience with tube sets. In the first place, with the tube set, the question of life is an important item. Although the tubes that most amateurs are using are of a very high standard they burn out occasionally, especially when they are used for transmitting. Furthermore, too many tubes would have to be used for the powers desired. For the above power rather high voltages would be required. This either means a high voltage D. C. generator which is quite expensive, or using rectified A. C. which involves the building of a transformer with the required smoothing out circuits, all of which means considerable expense, and requires a good deal more experimenting and fussing to get results than most amateurs imagine. Again the tube set depends to a large extent on the constancy of the different items in the set. Those who have had any experience at all with tube sets know that if for some unknown reason the capacity of the antenna has changed the least bit, the adjustments of the set will have to be changed or the set may not operate at all. In other words, the tube set is too critical for good amateur use. This statement applies to any small change that may occur in any other part of the set.

The set described has none of these defects and is very easily built and does not require a large amount of apparatus. The diagram in figure 3 shows all the apparatus needed, and what the set consists of. It consists of a specially designed induction coil the primary of which is operated by means of a key and 12-volt storage battery. The secondary is connected across two condensers in series, which with the spark gap and inductance form a closed circuit. The inductance is directly coupled to the antenna. As seen in figure 4, the assembly is very simple and the items in the set are reduced to a minimum. When assembled and placed in its case, the whole set occupies a space of about 10 x 6 x 6 inches.

The transformer which has been built for this set, is an unusually good one and is recommended to all. The details of the design and construction are given so that any one may build one without having to go through the whole process of designing it. It is intended to be used with a 12-volt storage battery. The secondary voltage necessary to jump the gap is 7,000 volts. The ratio of transformation is, therefore, 600. The primary consists of 80 turns of No. 20 D.C.C. wire wound in 1½ layer along a length of 3 inches. The primary is wound directly on the core. The core is made up of silicon steel strips No. 29 gauge; this is, 0.014 inches, 3¾ inches long. The strips are tied together by linen tape and when built up, occupy a space ½ x ½ x 3¾ inches.

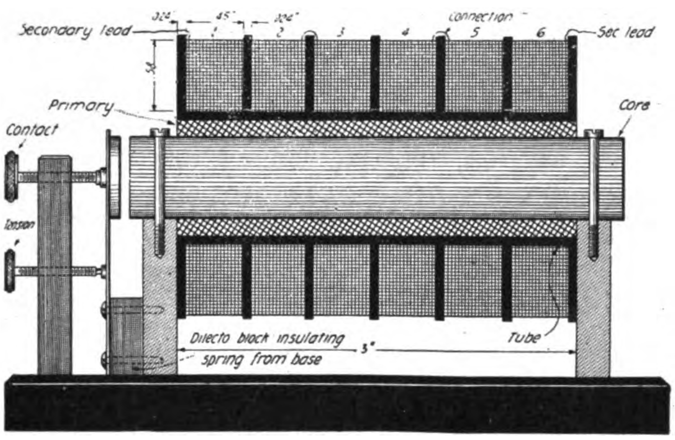


Figure 1—Assembly of the induction coil used in the 60-watt low-power transmitter

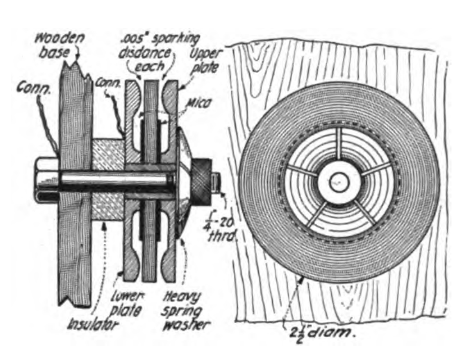


Figure 2—Detailed side and end views of the quenched spark gap

The secondary is wound on a tube ⅞ inch inside diameter and 1⅛ inches outside diameter. The tube is made of paper rolled on a mandrel of the proper size. The paper is thoroughly shellacked and allowed to dry well. The secondary is then wound on the tube. The secondary consists of 6 pies, with 8000 turns per pie, total number of turns being 48,000. The size of the wire is No. 40 enameled. Each pie is 0.45 inches long and has 130 turns per layer, with 61½ layers. The insulation between layers is paper about 0.005 inches thick and about 0.45 inches wide. The pies are insulated from each other by fish paper 0.020 inches thick, 1⅛ inches inside diameter and 1.725 inches outside diameter. In winding the pies it was found that the most convenient way of winding them without running into trouble due to high potential leads crossing low potential leads, was as follows: Wind coils, 1, 3, 5, as shown in figure 1. Then turn winding form around and wind coils 2, 4, 6, always starting at the bottom left. Then solder connection as shown so that one continuous winding is formed. The whole winding should then be covered with one wrapping of bookbinder's cloth.

The assembly of the transformer is seen in figure 1. The base is made of cast aluminum about ¼ inch thick. The spring is made of spring steel, and the armature which is riveted to the spring is made of soft iron. The contacts are silver ⅛ inch in diameter. There are two screw adjustments which are made of brass. The upper screw adjusts the spacing of the contacts and the lower adjusts the tension of the spring. As indicated in the diagram, the spring is insulated from the base by a dilecto spacer.

There are two condensers across the secondary of the induction coil. The object of the two condensers is to prevent possible breakdown and to provide ample capacity over which to distribute the potential. One condenser can of course be built to withstand the voltage generated across the secondary. Each condenser has a capacity of 0.005 mf., the total effective capacity being 0.0025 mf. The size of these condensers can be very easily figured by the usual conventional formulas and is therefore not given here. It is advised that 2 mil mica be used.

The voltage which is built up across the terminals of the condensers discharges through a quenched spark gap and inductance. The inductance used is a flat spiral made up in the usual way. There are three and one-half turns of copper strip ¼ inch wide by 1/32 inch thick. The turns are spaced ¼ inch. The adjustments are made for the proper wavelength by taking taps off the spiral, as shown in figure 3.

The spark gap (figure 2) is of the quenched gap type. There are three plates forming two gaps. The plates are made of ¼ inch brass or copper silver plated. Each of the plates has a clearance hole of ½ inch so that the ¼ inch screw running through the plates does not short-circuit any of the sections. The upper and lower plates both rest on the center plate but are insulated from each other in the center by mica 0.005 inches thick. The sparking takes place at the formed portions of the plates at the outer circumference and the sparking distance per gap is 0.005 inches. The mica insulators are 0.005 inches thick, ¼ inch inside diameter and 1½ inches outside diameter.

The set has proved very successful, is very simple to construct and operates with very little trouble. It puts about ¾ ampere in the usual amateur antenna and can be depended on to send at least 25 miles.

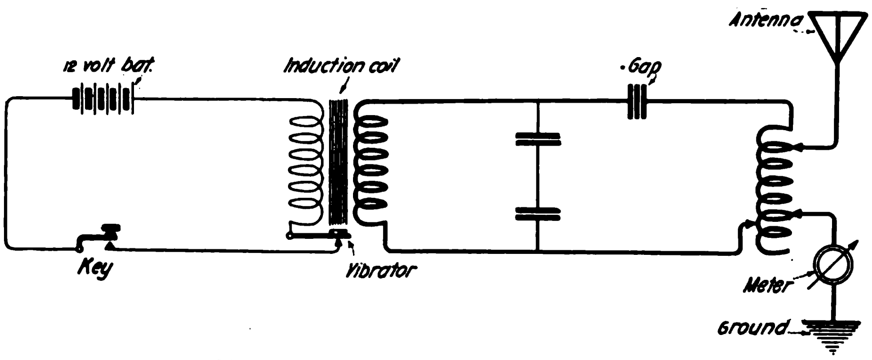


Figure 3—Diagram showing hook-up of instruments

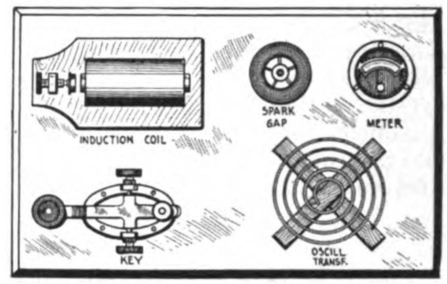


Figure 4—Panel arrangement of instruments

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

By Walter A. Remy

SECOND PRIZE, $5.00

AS operator of 2KV the writer has noticed that in the past two months QRM has again reached the same stage as it did in 1917. It is impossible to do any long distance amateur receiving or relay work until after 10 or 10:30 p. m.

This is not alone due to the spark coil—which has been blamed for interference to such an extent that it is looked upon as a thing only capable of causing QRM—but also the big transformer station. The writer, in fact, has experienced more trouble with the latter than with the spark coil. More than once two stations 5 or 6 miles apart have been heard working with ½ kw. power on each end, and in some cases even 1 kw.

The Government Station License says that only the minimum amount of power necessary to carry on communication should be used. It is the purpose of this article to describe the construction of a spark coil transmitter which serves the double purpose of reforming the spark coil and of providing a transmitter which can be used by the big stations for local work.

Let us first consider the technical aspects of a low power transmitter. There are two types, namely, the vacuum tube or continuous wave transmitter, and the spark coil set. The vacuum tube set has the advantage of having little or no decrement and therefore produces a very sharp wave, causing practically no QRM. On the other hand, the initial expense of this type of transmitter makes it prohibitive for general use, for the builder must purchase the tubes and solve the financial problem of supplying the plate voltage. There are two types of spark coil sets. The one in which a commutator interrupter is used in the primary circuit and a synchronous rotary gap in the secondary circuit is exceedingly efficient, but for economic and constructional reasons this, too, is impractical for general use. Hence, we have left the conventional type of spark coil transmitter with a vibrator and a fixed gap.

The panel type set which is described in this article has been constructed and is in daily use at the writer's station; it is quite efficient, and with 6 watts input on exactly 200 meters, signals from this station have been heard at a distance of 25 miles. Sixteen miles is the consistent working range—ample enough for local work.

The set mainly consists of a spark coil (a Ford ignition coil was used), a fixed spark gap, condenser, and pancake type helix.

The front view of the panel is shown in figure 1. This panel may be of bakelite, asbestos, or hard wood, and is 10" x 16" in width and length, respectively. A small DPST switch is used to connect the power to the set. Above this is the spark gap, and then comes the hot wire ammeter, which is of small scale, with the shunt switch to "short" it when it is not in use.

The side view (figure 2), shows the general layout of the apparatus. The spark coil is mounted on the condenser, and may be of ½" to 2" rating. It is not recommended that the spark coil be built, as it requires a considerable

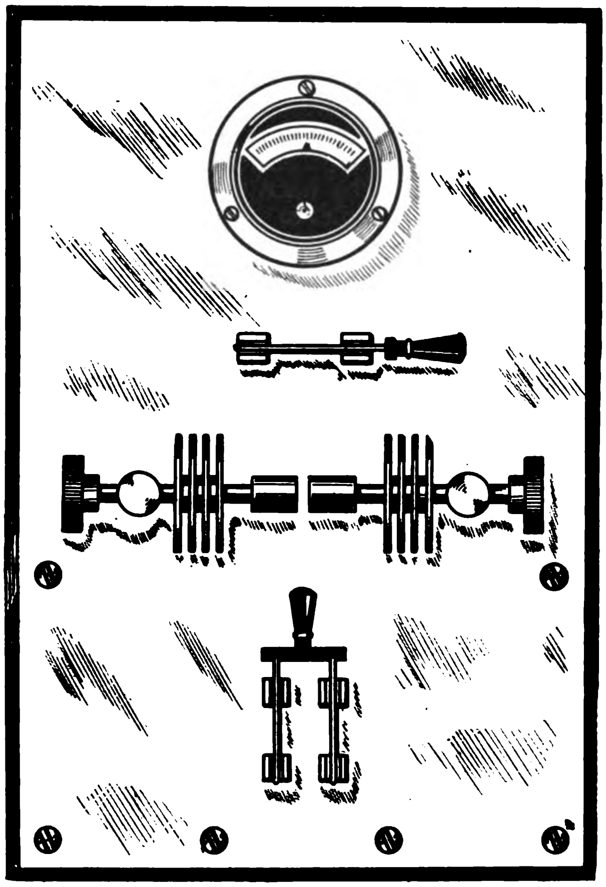


Figure 1—Front view of panel

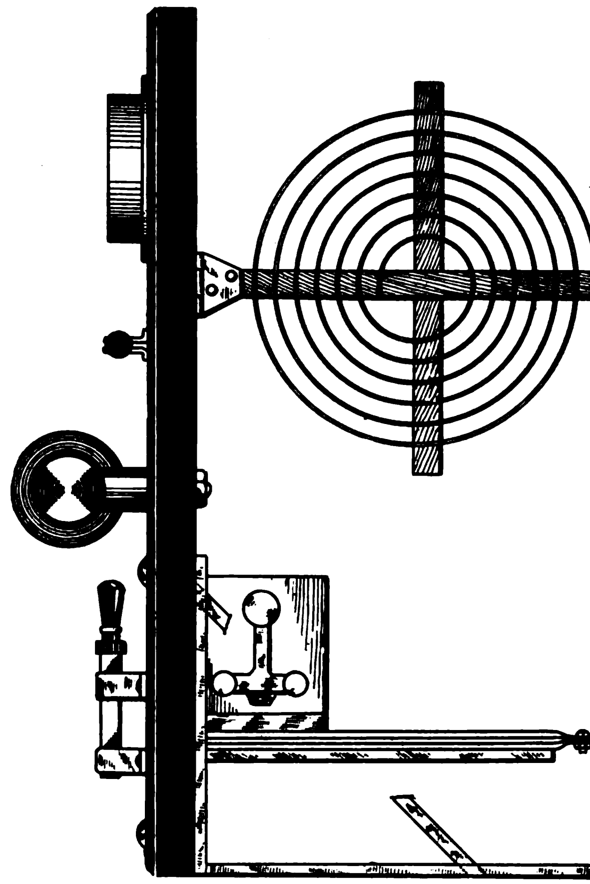


Figure 2—Side view showing layout of apparatus

amount of labor to construct one and the expense will not be much less than the manufacturers' selling price.

The spark gap may be purchased or constructed, as the builder may desire. It is mounted on the panel and should have sparking electrodes at least ⅜" or ½" in diameter, depending upon the power of the set. Four cooling fins 1½" in diameter should be provided on each electrode and should be of brass. This offers a large amount of surface which dissipates the heat and keeps the gap cool, making it more efficient.

The condenser consists of three glass plates 4" by 6", coated on either side with tin-foil 3" x 5", connected in parallel. Lugs ¾" x 1½" must be included in each tinfoil conductor. This wound on two cross-pieces 9" long by ½" square. On the supports were wound 9 turns of ½" copper ribbon spaced ⅜" apart. When making the grooves for the ribbon, remember to begin in the first notch on each arm ⅛" further from the end than the preceding arm, so as to form a perfect spiral. The first notch of the first arm is cut ¼" from the end, the first notch of the second arm ⅜" from the end, and so on. Each notch should be ⅜" deep. The helix is then mounted at right angles to the panel by an angle bracket. It will be noted that the various instruments are close together and the leads will be very short.

The conventional transmitter circuit is shown in figure 3. For greatest efficiency the leads should be of braided

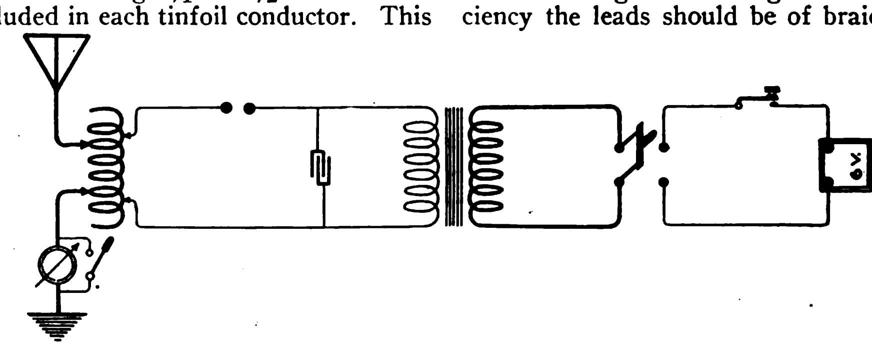


Figure 3—Diagram of the transmitter circuit

condenser is mounted on a piece of bakelite or hard wood of the same dimensions as the condenser, fastened to the panel by means of angle brackets, or it may be placed directly on the operating table. Another piece of bakelite or hard wood about the same size as the base of the spark coil is placed on top of the condenser, upon which the coil is mounted. These pieces insulate the condenser from the other parts of the transmitter.

The helix was chosen in preference to the oscillation transformer, after a little experimenting which showed that there was too much loss between the primary and secondary. The wave emitted when the oscillation transformer was used was sharper, but with the helix in use the emitted wave was sharp enough for all practical purposes, and there was a greater radiation. And again, the helix was used on most of the army's low power spark sets during the war. The helix is copper ribbon, which has a large conducting surface and is quite flexible.

In conclusion, it might be well to note several points in adjusting this transmitter. No one must expect to get the results mentioned in the first part of the article without the use of a wavemeter and, of course, the hot wire meter. As the use of the wavemeter is taken up at length in various text books nothing will be said about its use here. Another point to keep in mind is the vibrator of the spark coil. As long as the vibrator is kept bright and clean the set will have a smooth note, but the minute it is allowed to become pitted or dirty, the note will be scratchy and will lessen the efficiency of the set and also the popularity of its owner. If the builder follows the directions in this article with some amount of care, and he has a good aerial, there is no reason why the performances set forth here cannot be duplicated, as the second district is not especially noted for excellent radio conditions.

Low Power Transmitter for Local Use

By Louis S. Butler

THIRD PRIZE, $3.00

I HAVE used several types of low power transmitting sets, but the one here described has been found the most efficient. To get the proper wave length, together with good results, the aerial should be one of four wires between 40 and 50 feet long, and should be at least 40 feet high. The oscillation transformer is the well-known Murdock hinge type. Any good spark gap is sufficient. The condenser may consist of four Leyden jars, or any good glass plate condenser designed for use with spark coil sets. For power, a 1" spark coil made for radio use is sufficient. The spark coil can be run on six dry cells with very good results, but when run on a 110 v. light line, with an electrolite interrupter, the range of the set can be increased about 10 miles.

I have found this type of low power good ground, and he must have as many connections soldered as possible. The set here described when *properly tuned* is very efficient for local work, and due to its very moderate cost will be found within the reach of most every amateur. A 25 watt 110 v. lamp

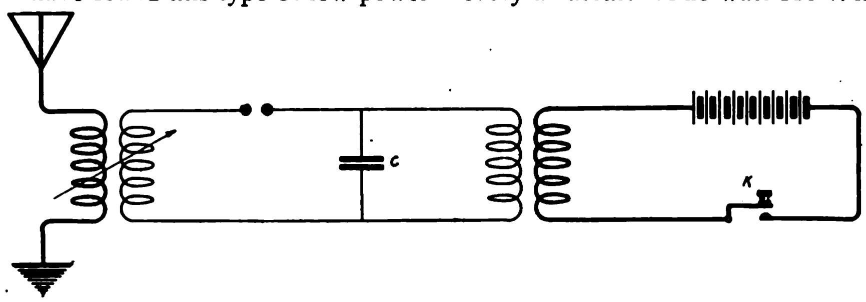


Figure 1—Diagram of circuit for the low-power transmitter

transmitter to be very efficient for sending strong and clear signals from 20 to 30 miles in the day time, the receiving station using a vacuum tube, but no amplifiers. Of course the experimenter must bear in mind that to get the very best results from his set he must have a good aerial and in series with the antenna will be found suitable for determining the antenna radiation where a hot wire ammeter is not available. The great advantage of this set is that it can be tuned sharply so as to cause small interference, which will be greatly appreciated by other operators.

A Useful Switch Arrangement

SOMETIME ago I had occasion to build a single unit receiving set, having regenerative features and one-step amplifier. The diagram shows how a single anti-capacity jack switch was used to throw in the audio-frequency amplifier.

Starting at the aerial: the primary of a loose coupler is shown, also a switch for putting the primary condenser either in series with ground lead or shunt to the primary inductance.

The secondary of the coupler has the ordinary detector hook-up when the tickler coil is short-circuited.

When the tickler coil is not shorted, you have the regenerative feed back circuit. Now, when the master jack switch (anti-capacity) is thrown to the left, you have a regular detector hook-up or a regenerative hook-up,

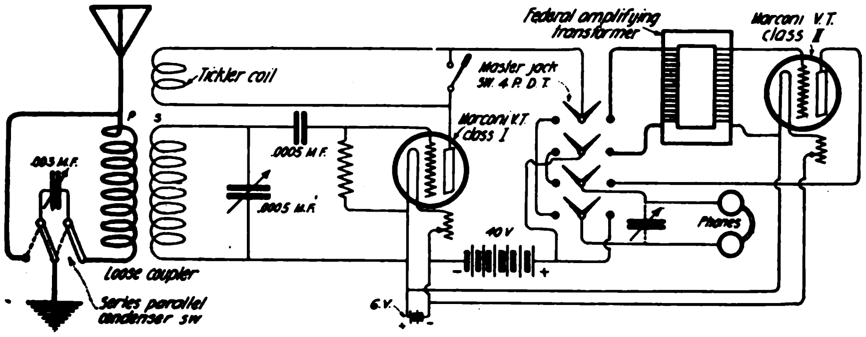


Diagram of single unit receiver having regenerative feature and single step amplifier depending upon whether the tickler is short circuited or not.

When the master jack switch is thrown to the right, the single-stage audio frequency amplifier is connected in circuit.

The advantages of a hook-up of this sort are as follows:

1. All instruments can be mounted on a single panel.
2. Detector hook-up alone can be used.
3. Regenerative hook-up alone can be used.
4. Detector and single-stage amplifier can be used.
5. Regenerative and single-stage amplifier can be used.
6. All these combinations are effected by the throwing of only two switches, namely, the master jack switch and the tickler short circuit switch.
7. Also a single "A" and "B" battery are used.

I have given no dimensions, leaving it entirely up to the amateur desiring a compact flexible receiving set.

The popular "honeycomb" coils may be used for loose coupler and tickler coil.

VINCENT H. BROWN.

A Small Portable Set

By William Holladay

SOME time ago I became interested in a very small set I saw illustrated, for which a wave-length of 4,000 meters was claimed. It was about six inches long and three or four inches high and wide, but at the beginning it was apparent that there were several inherent defects. The coupler was wound with 36 enameled wire, the high resistance of which, coupled with the well-known distributed capacity effects of enameled wire, cut the efficiency down to minimum. The coupling was fixed, and therefore would have to be designed very carefully in order to have the coupling at the proper point for the larger percentage of stations. Of course all stations which are received with very loose or very close couplings would be heard more faintly than necessary, and selectivity would be almost impossible.

The detector was placed on top of the set, where it would be exposed to dust and hard knocks, and could not, therefore, be used for portable purposes.

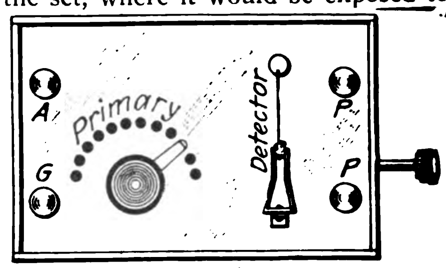


FIGURE 1
Front view of cabinet

A small set designed and constructed by the writer seemed to offer all the advantages of a portable set, with none of the disadvantages referred to above. It is an excellent thing to take along on a vacation jaunt, and may be made

mostly of materials at hand in the workshop.

The set consists of a coupler, galena detector, and fixed condenser, mounted in a cabinet 6 x $5\frac{1}{2}$ x 4. The primary tube is 3" long and 3" in diameter, wound with about 130 turns D.C.C. With silk covered wire it is possible, of course, to wind more turns, but on such a set I believe the extra cost over-

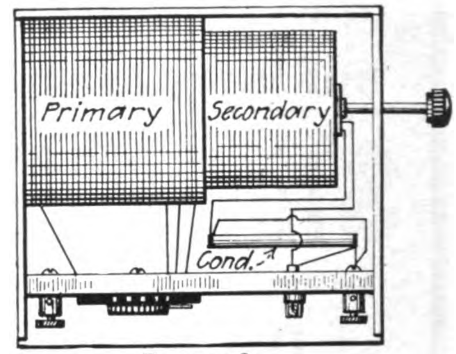


FIGURE 2

Top elevation showing arrangement of apparatus

shadows the benefits. The secondary is $2\frac{1}{2}$" long and $2\frac{1}{2}$" in diameter, wound with 110 turns 32 D.C.C. Such a secondary will respond to wavelengths up to approximately 1200 meters with a 200 meter aerial. The resistance of the wires used is only slightly greater than that of the usual sizes, and the efficiency on the short waves which it will receive is not materially lowered. The primary is tapped to a single twelve-point switch, and the secondary is tapped to a single four-point switch as per the diagram.

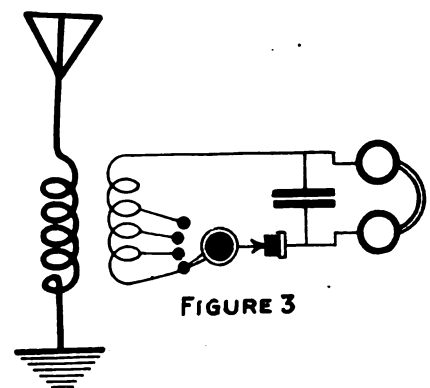


FIGURE 3

Diagram of connections used

The cabinet may be made of cigar-box wood, or if more strength is desired, of $\frac{3}{8}$" pine or hardwood. The front is hinged over the panel, which is set back about an inch for protection of the detector and primary switch, which are to the right and left respectively. Excellent switch points may be made of 6 B. & S. copper $\frac{3}{4}$" long which are driven into holes 5/32" diameter, and spaced $\frac{1}{4}$" apart. The switch arm is made 1" long so that the entire switch will occupy but little space.

The detector, placed to the right, consists simply of a phosphor bronze spring or clip to hold the crystal, and a catwhisker of 32 bare copper. Connections, soldered to the rear, are made with small stranded wire. Four Clapp-Eastham 4832 binding posts, the smallest manufactured, are provided for aerial, ground and phones. They are mounted on opposite ends of the panel.

A fixed condenser, consisting of two pieces of tinfoil 25" x 2", placed between three sheets of paraffin paper 28" x 2½", and wound on a piece of cardboard 2" x 2½" is placed immediately behind the detector, so that the leads may be short and it will not interfere with the movement of the secondary.

The diagrams show front and top elevations of the cabinet, the arrangement of instruments, and connections.

Convention in Philadelphia

AMATEURS of the Third District are invited to attend a convention and banquet to be held under the auspices of the Philadelphia Amateur Radio Association, in Philadelphia on May 8th.

This convention is intended to strengthen the bonds between the amateurs in the Eastern part of the country and give them a good time while they are meeting the men who handle the three sets. It is proposed to arrange a program for the summer and fall for all amateurs to meet the men they have talked to through the ether. There will be good talkers, plenty of good eats, smokes, music and a rip roaring good time for all who attend. Tickets are $2.00, the big show is called for 7 P.M. at 12th and Girard Avenue, Philadelphia, Saturday, May 8th. Club secretaries are invited to write how many members they will send. Address W. F. Wunder, 3220 Stillman St., Philadelphia.

Novel Type of Miniature Electrical Measuring Instruments

WITH an overall diameter of 2 9/16 inches, slightly larger than that of a gentleman's watch, and a weight of only four ounces, a novel type of miniature electrical instrument for the measurement of voltage and current is proving efficient, reliable, and profitable on small panels where economy of space, together with high accuracy and neatness of appearance is imperative. It is especially applicable to the measurement of small direct currents, such as the filament and plate currents of radio communication sets, or those in connection with farm lighting and other small charging and lighting sets, or in use with dental and electro-medical work.

Prize Contest Announcement

The subject for the new prize contest of our year-round series is:

"Operating Suggestions for the Radio Amateur."

Closing date, June 1, 1920.

Contestants are requested to submit articles at the earliest practicable date.

Prize Winning Articles Will Appear in the August Issue.

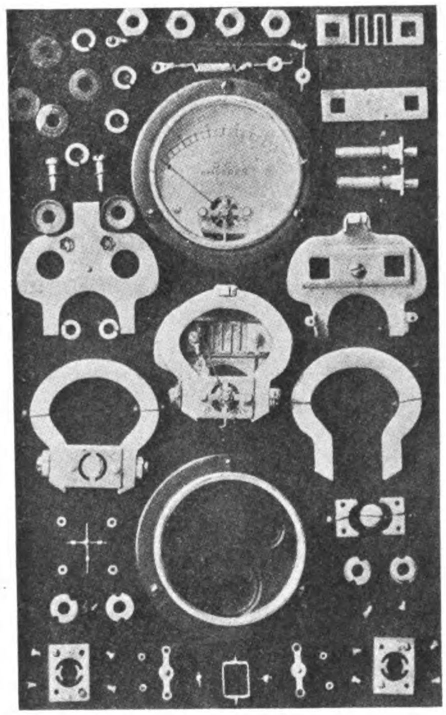
It is very obvious to those who are listening-in a great deal that a great percentage of the amateurs who operate transmitting stations either have never carefully thought about the interference problem, or have no regard whatsoever for their co-workers in the next block, the next city, or the next state. This may be particularly true of the young man who is just taking up the art, and it is with him in mind that we call for suggestions covering the use of the code, calling, handling messages, listening-in, etc., etc. There are a great many amateur operators who have this traffic business down to a fine art. This will give these men an opportunity to very materially help their co-workers and indirectly benefit themselves.

PRIZE CONTEST CONDITIONS—Manuscripts on the subject announced above are judged by the Editors of THE WIRELESS AGE from the viewpoint of the ingeniousness of the idea presented, its practicability and general utility, originality, and clearness in the description. Literary ability is not needed, but neatness in manuscript and drawing is taken into account. Finished drawings are not required, sketches will do. The contest is open to everybody. The closing date is given in the above announcement. THE WIRELESS AGE will award the following prizes: First Prize, $10.00; Second Prize, $5.00; Third Prize, $3.00, *in addition to the regular space rates paid for technical articles.*

All manuscripts should be addressed to the Contest Editor of THE WIRELESS AGE

To meet the growing demand for instruments of smaller size, together with increased sensitiveness and greater accuracy, the Westinghouse Electric & Manufacturing Company has developed this miniature type. It combines extreme delicacy of action with high sensitivity and ruggedness, and the design, construction and materials are such that the instruments are permanently accurate.

A salient feature of design wherein these instruments differ from the other makes consists in the method of supporting the cylindrical core and movable element between the pole pieces of the magnet. Instead of providing for this purpose a casting supported at the back of the instrument, independently of the magnet and pole pieces and requiring, in order to secure accuracy, a high degree of machining, the Westinghouse instruments make use of two simple, easily and inexpensively made bronze alloy punchings securely fastened to either side of the pole pieces. This makes the instrument more compact, greatly simplifies the construction, and lessens the amount of space required within the case, thereby making it practical to construct the instrument to miniature dimensions and secure at the same time accuracy, reliability and sturdiness of design.



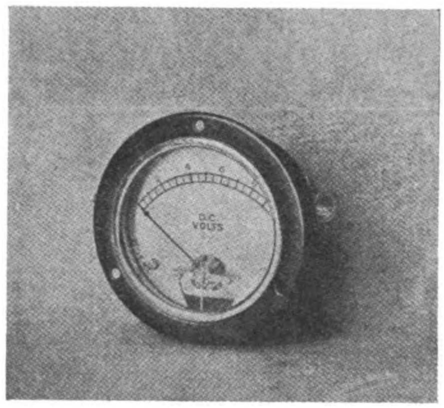
Details of the volt meter

Another departure from a method in common use with other makes consists in the insulation, by oxidation instead of by paper, of the small aluminum frame which carries the coil of the movable element. The oxide of aluminum, thus used, is highly effective as an insulator and greatly facilitates the mounting of the coil.

The fastening of the pivot support

of the movable element constitutes an additional departure from older practice. The base of the support, instead of being cemented directly to the coil, is elongated and clinched around either side of the aluminum frame of the movable coil. This gives a more accurate centering of the pivots.

By combining the milli-voltmeter with a non-inductive heater and thermo-couple, it is made suitable for the measurement of high frequency alternating currents such as are encountered in radio communication. The same instrument can also be operated on alternating current circuits of commercial frequency, provided they are not subject to overloads.



Assembled small panel d.c. volt meter

The instruments can be furnished for mounting with the face flush with the panel, or for projection. They are arranged for rear connection. The standard finish is white dial, nickel bevel ring and black marine case. Black dial instruments are furnished if desired.

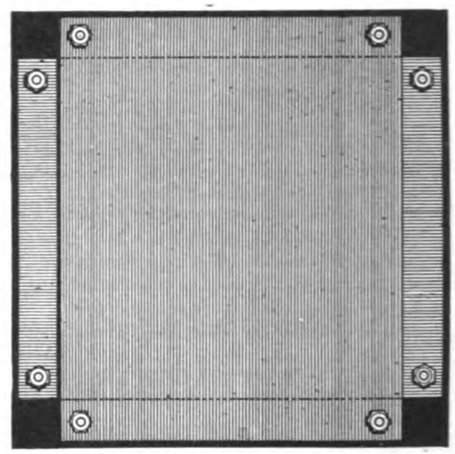
They are checked throughout their entire range for accuracy. The calibration at any point of the scale is within two per cent of full scale reading on direct current and radio frequency current of the frequencies now in use.

These instruments are the smallest of the D'Arsonval type that are being regularly manufactured.

An Oil-Dielectric Condenser

WHY is it that high-voltage condensers using oil as a dielectric have never become popular for amateur stations? Such condensers are self-restoring, even if punctured; the dielectric absorption is low, comparing favorably with compressed air and many times better than bakelite, where this loss is very troublesome and brush discharge is entirely absent. Also the construction is simple and rugged, involving only a little machine work in making the spacers. In all respects this condenser is nearly ideal. Sheet aluminum was used for the plates of the condenser which I constructed. Number 30 sheeting, which has about seven square feet to the pound, is the most satisfactory. About 3½ pounds are required. This was cut into 28 pieces 12" by 10", which are required for a capacity of .008 mfd., and a 3/16" hole was drilled in each corner. For separating alternate plates, 112 spacers are required, ⅜" long, each cut from ¼" brass tubing, with 3/16" inside diameter. The plates are mounted on supporting rods 6½" long, 3/16" in diameter, and threaded ½" on each end. Eight of these rods are required. The whole condenser was then assembled on a hardwood base 12" square, as shown in the accompanying drawing, the plates being alternated, and four 3/16" spacers being placed under the first plate.

From the foregoing it will be seen that alternate plates are spaced 3/16". The best grade transil oil on the market such as "Mineral Seal" or "Highflash," should be used for the dielectric, this grade withstanding 36,000 volts on a 1-10" gap, so that the spacing of 3/16" gives a margin of safety sufficient for all ordinary purposes. The oil should be tested by dropping some



Assembly of condenser plates and base

pieces of calcium carbide into a sample taken from the bottom of the container, and if bubbles are given off, it indicates that water is present, which *must* be removed.

This is accomplished by filtering the oil through calcium chloride several times, and then through several thicknesses of cheese cloth. The oil should then be tested again with carbide. The dielectric constant of this grade of oil is about 2.5, which compares favorably with glass and does not require an excessive area of the plates.

The entire condenser should be placed in an oil-tight container with a cover to keep out the dust. A galvanized tank into which the condenser is placed edgewise will be found very satisfactory, using a top piece of bakelite for a cover and as a terminal mounting. Such a condenser as this will repay any amateur in the satisfaction of knowing that it is both efficient and permanent, and the cost is but a fraction of some of the commercial condensers on the market.

Learn for Yourself

IT HAS often occurred to us that there are a great many amateurs who, rather than provide themselves with the means of finding out things for themselves, will either blissfully go along in ignorance without daily improvement in their knowledge of radio, or who when they desire to know something or other concerning the action of a circuit or concerning constructional details, will depend upon the knowledge of their friends or the help which the editors of the radio publications are able to give them.

Has it ever occurred to the man who experiments with radio that his first requisite should be a thorough knowledge of the textbooks on the subject? For the beginner, perhaps the best book available is Bucher's "Practical Wireless Telegraphy." For the man who is a little more advanced, serious study of Bulletin No. 74 of the Bureau of Standards, "Radio Instruments and Measurements" is recommended.

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. N. G., New Jersey:
The natural wave length of an antenna can be approximated by the use of formula for the capacity and distributed inductance of the wire. Results obtained thus are almost invariably lacking in accuracy. The fundamental should be ascertained by measurement, if at all possible, and we refer you to textbooks on the subject. A rule for the predetermination of the fundamental of an antenna within limits which compare favorably with those of any formula available, calls for the multiplication of the length of the antenna in feet by 1.52 where the antenna is the L of the type used by a great many amateurs, and by 1.6 where the antenna is a T, or fan, type. Thus your antenna, height 35 feet, length 36 feet, total length 71 feet, will have a fundamental of about 108 meters, when used as an L. As a T, whose height is 35 feet and length 18 feet, total length 53 feet, the fundamental would fall around 85 meters.

* * *

W. F., Alabama:
Any type of three-element vacuum tube may be used in a resistance coupled amplifier circuit. If you desire to use only two tubes, your over-all amplification will be greater, providing a transformer is used between the two. Resistance coupled amplifiers are used to greatest advantage where several stages are essential, due to its greater stability and freedom from self-oscillation.

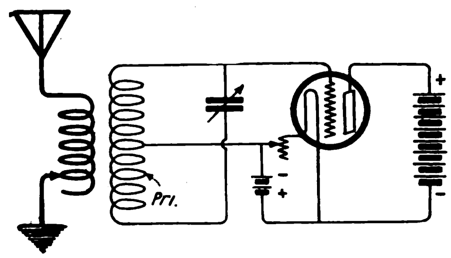
* * *

D. R., Wisconsin:
We are sorry to report that we know nothing concerning the detector you mention. The filament of a Marconi V. T. should draw between 0.7 and 0.8 of an ampere, at which current the filament is incandescent. Noises in the telephones when the tube is in operation may be occasioned by gassing of the storage cell, a faulty cell in the plate battery, a loose connection in the circuit, a loose connection in the tube itself, or may be due to the presence of gas within the tube, under which circumstances a hissing sound will be given off when either the filament is too bright or when the plate potential is a little too high.

A .001 mfd. condenser placed in shunt to the telephones will give you the same louder signals which you received from Arlington when you placed your fingers across the terminals. There is a tendency for radio frequency currents to build up in the plate circuit of the vacuum tube. The telephones will not pass them to any great extent. If a path is provided they will be repeated back into the grid circuit to a limited degree, solely by virtue of the filament circuit connections which are common to both plate and grid circuit. This results in increased amplifying action, or regeneration, on the part of the tube, and can be taken full advantage of only when the coupling between the two circuits is sufficient to start self-oscillations in the vacuum tube circuits. If you are not using a regenerative circuit by intent, you should be, and we refer you to textbooks on the subject. If you are using a regenerative circuit bear in mind that a bridging condenser for the telephones is essential for anything like proper action. If you are receiving Arlington—and it should be possible for you to do so consistently—you should also be able to receive Great Lakes. Perhaps you have not properly tuned your receiver. His wave length is 1,512 meters.

* * *

A. L. H., New Hampshire:
A hook-up suitable for the outfit described in the November, 1919, issue by Mr. Pignone is given herewith.



J. A., Porto Rico:
If you are having trouble in adjusting your detector from your test buzzer, we suggest that you try—instead of your present arrangement—the arrangement where a wire is connected to the vibrator of the buzzer, carried to one of the leads from the secondary inductance coil and wrapped around this lead 6 or 8 times, on top of the insulation.

If you are using a variable condenser on the secondary of your receiving transformer, the secondary will tune up to about 15,000 meters. The primary, taken in conjunction with your antenna alone, will only tune up to about 6,500 meters. You may increase the wave length of your primary by shunting a variable condenser across the inductance.

The fundamental wave length of your antenna is about 230 meters. The fact that you connect two receivers on the same antenna and hear signals from a certain station through both of them is not unusual. The signal in either will be greater, however, when the other is disconnected.

As far as we know, it is not the practice under any circumstances to short circuit the secondary tuning condenser. This is often done in the case of the *antenna* tuning condenser where the condenser is connected in series to the antenna, and we presume that it is to this arrangement you refer.

* * *

H. G. G., Pennsylvania:
We presume that by "collapsible aerial" you refer to the loop antennae which were used to such a great extent during the recent war for direction finder purposes and also in the trenches. If so, you will find in recent numbers of this magazine instructions and data which will enable you to construct what you wish.

Or perhaps you were referring to an antenna which is collapsible in the true sense. Such an arrangement has never been used to our knowledge for practical purposes. A two and four wire aerial fills the requirements in every way and is considerably cheaper and more nearly fool-proof. We suggest that you use the latter.

* * *

R. R. W., Pennsylvania:

Any dealer in general hardware and supplies should be able to furnish you with 1½" O. D. fibre tubing. If you are unable to make connections with anyone in your vicinity, we suggest that you write Patterson Bros., Park Row, New York City.

* * *

F. V. B., Alabama:

Any effort to control small movable objects on a table by a radio station concealed in the vicinity becomes a rather complicated matter. This can be done in a very simple manner magnetically, provided there is a movable magnet underneath the table of sufficient strength to control the small steel objects above. To do this by radio would necessitate the use of a radio controlled power unit mounted in the small object which it was desired to move, and, taken as a whole, we consider the idea impracticable.

* * *

W. D. M., Michigan:

After reading your query referring to the diagrams in "Practical Wireless Telegraphy" which you mention, we are unable to understand just what you are driving at, unless it is a combination of the circuit shown by Mr. Bremer in the May, 1919, issue, and some of the magnetically coupled regenerative circuits shown in figures 179 and 181 of "Practical Wireless Telegraphy." There would be no advantage in such an arrangement, since the accomplishments of the one are the same as the other.

* * *

A. S. B., Connecticut:

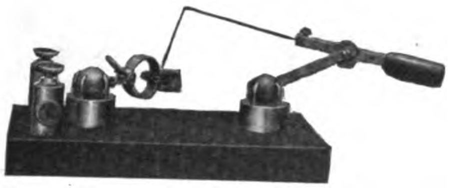
We are not aware of any "Impact System" which operates without transformers. We presume that you have in some way received the wrong impression as to the operation of an impact transmitter. For particulars as to operation of this type, we refer you to any up-to-date textbook on radio telegraphy.

* * *

R. S. T., California:

If you have followed the instructions covering the long wave receiver in the September issue of THE WIRELESS AGE, and providing all your connections are as shown in the diagram, there is no reason why you should fail to get operation. Are you certain that the positive terminal of your plate battery is connected to the plate? With reference to the latter part of the last paragraph on page 36 of this article, the author states: "Any failure of oscillations to start may be due to an incorrect value of bridging condenser, antenna coupling, tickler coupling, filament current, and plate potential, assuming, of course, that the receiver is properly wired." In addition to this, as just mentioned, it is necessary to have the positive terminal of the plate battery connected to the plate of the tube. The fact that you used No. 31 wire instead of No. 22 will not affect the operation of the outfit; only the wave length range, which will have been slightly increased.

It is impracticable to make up a set of this type for operation over shorter wave lengths, with the expectation of getting *best* results. In case you wish to do so, however, you should provide yourself with a secondary coil having about 130 turns, and wound on a form 3" in diameter, 10 turns per layer. The primary coil may be a duplicate of this, taps being taken out to accommodate the switch.



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presents six different surfaces of the Crystal to the action of the needle. without changing its position. It keeps you on the LIVE SPOT at all times and thereby gives you the loudest and clearest signals.

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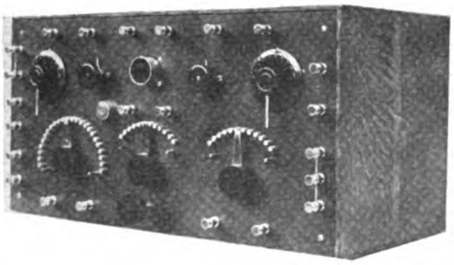

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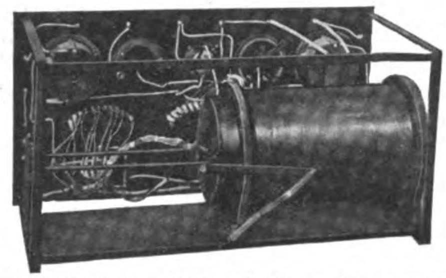
Interior view from the Rear, showing Loose Coupler, its action, and Wiring Diagram of the Vacuum Tube Circuit. Also showing how the entire Apparatus is built within the metal frame, to permit its removal from the cabinet for examination or additions.



We reproduce the set in its entirety that you may see and understand its construction, instead of enclosing it in a Cabinet and allowing you to guess. It is now used in Schools of Radio instruction where Technical and satisfactory results are necessary.

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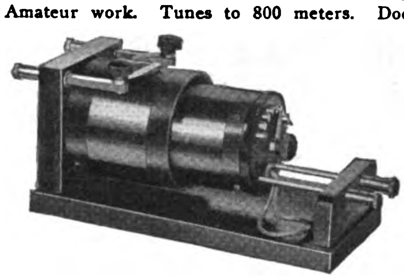

Mahogany finished woodwork. Brass metal parts. Has new slider feature. Secondary has six taps. Wound with Red Enameled Wire, or, secondary with Green Silk if so ordered. Measurements over all, length 12 inches, width 4½ inches, height 5 inches.

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L-25	170-375	$1.40	LL25	$1.40	L-300	1340-4800	$2.10	LL300	$2.66
L-35	200-515	1.45	LL35	1.45	L-400	1860-6300	2.25	LL400	3.10
L-50	240-730	1.52	LL50	1.64	L-500	2340-8500	2.40	LL500	3.35
L-75	330-1030	1.60	LL75	1.70	L-600	2940-12000	2.65	LL600	3.00
L-100	450-1460	1.70	LL100	1.76	L-750	3100-15000	2.80	LL750	3.20
L-150	660-2200	1.80	LL150	2.16	L-1000	5700-19000	3.00	LL1000	3.75
L-200	860-2850	1.90	LL200	2.28	L-1250	5900-21000	3.35	LL1250	4.16
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Cat. No. LC-101—Same as above, but mounted on oak base **12.00**
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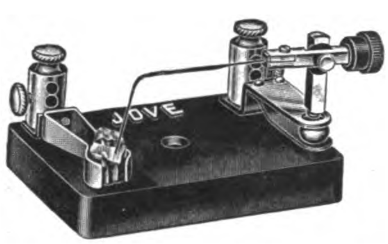

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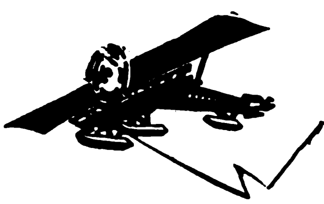

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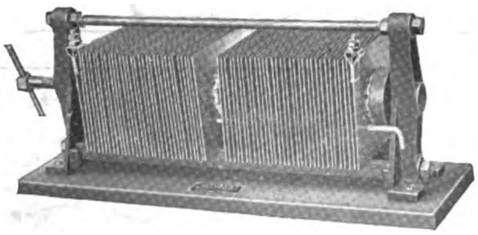
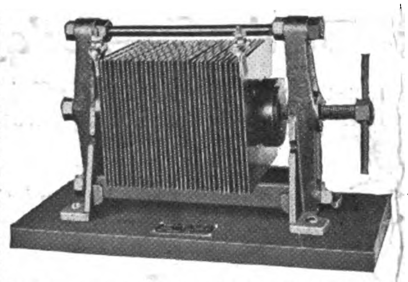


TYPE G-1—This gap is built to control the energy necessary to do real long distance work, 1,000 miles and over. It has 32 sparking chambers. Designed for use with transformers delivering 20,000 volts up. Maximum power 1,000 watts. Price, **$26.50.**



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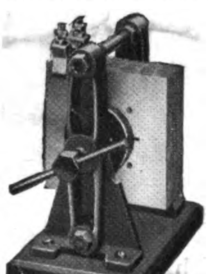

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8. It increases speed of handling traffic. No waiting for motors to come up to speed or slow down. Quick back-and-forth communication over the longest distances.
9. The Amrad Quenched is the *standardized quality* Gap. All plates in the various types are identical and interchangeable. Each gap plate is tested to meet a high standard of accuracy. The entire instrument is essentially a "commercial" product especially designed for private use.

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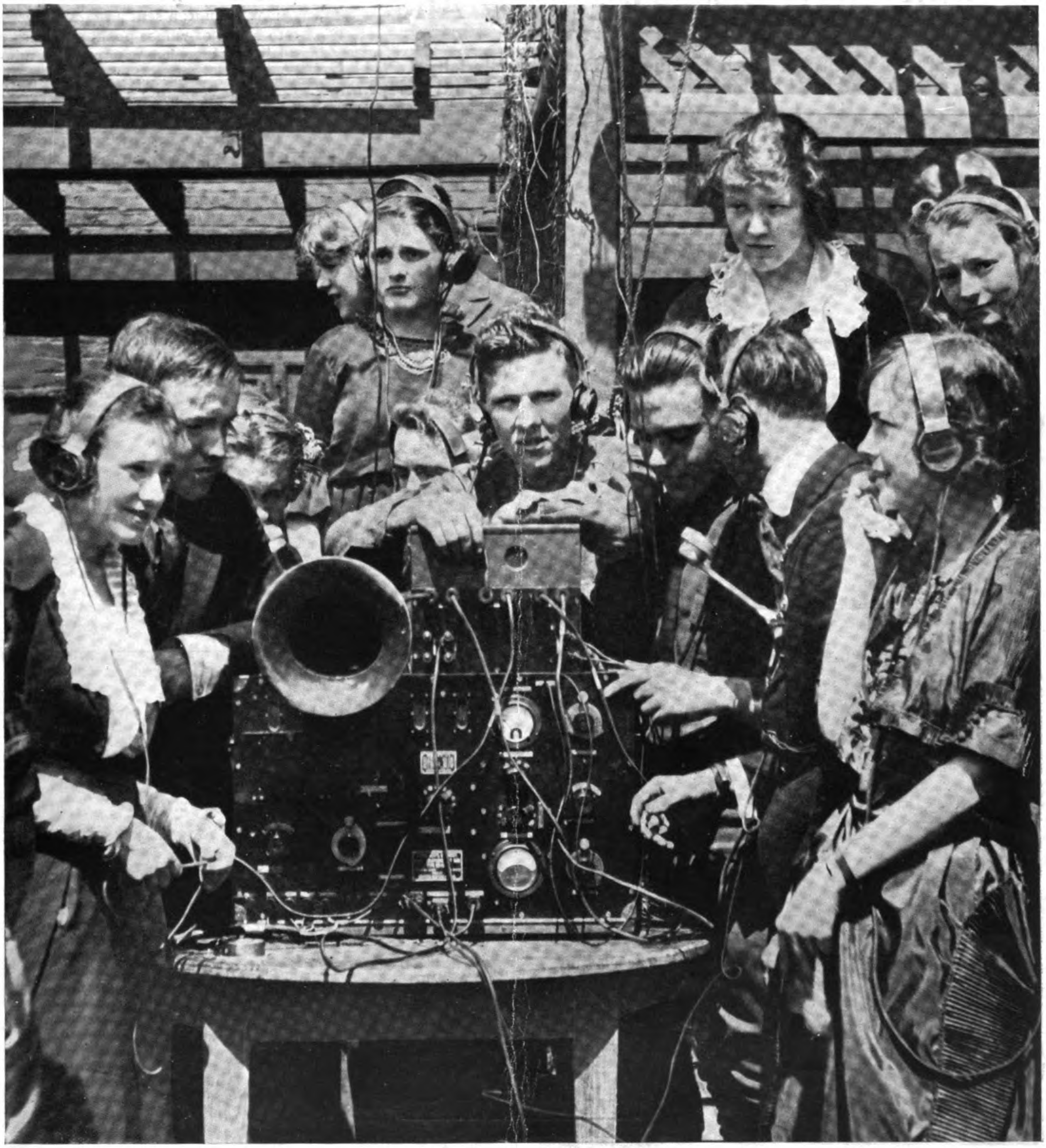
The WIRELESS AGE

Volume 7 Number 9



Members of an Atlanta Club Who Danced to Music Received by Wireless 'Phone

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And a Dozen Exclusive Features in This Issue

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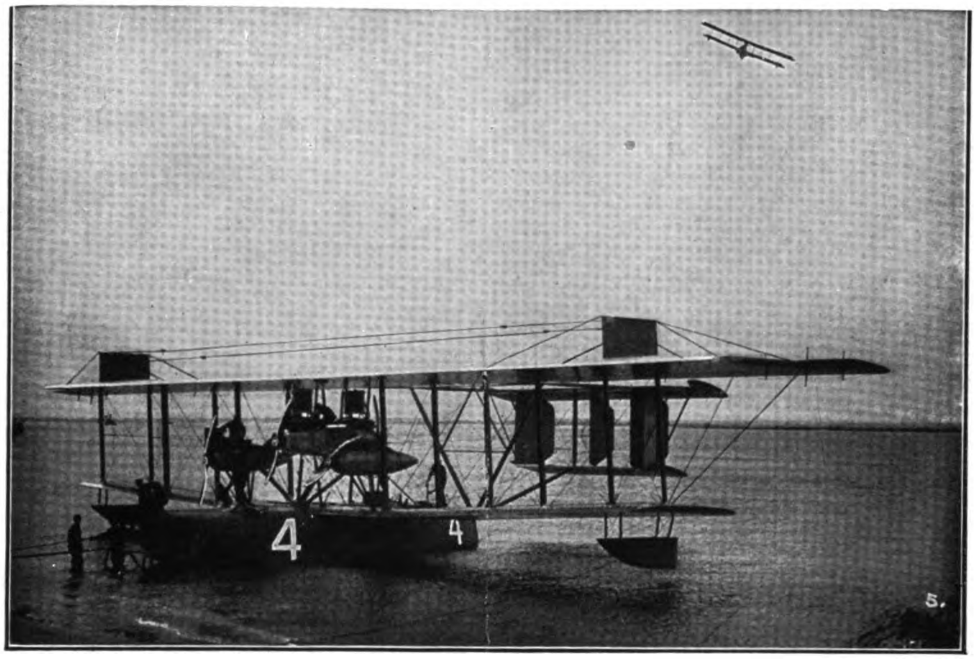
"By courier, coach and sail-boat, it took days for the news of Waterloo to reach London. During Lieut. Commander Read's flight to Halifax, Assistant Secretary Roosevelt n Washington sent a radio message to NC-4, of whose position in air he had no knowledge. In three minutes he had a reply."

Extract from New York World, June 3, 1919.



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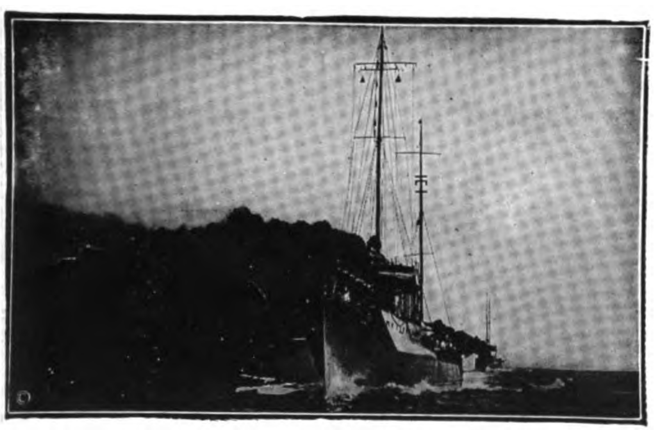
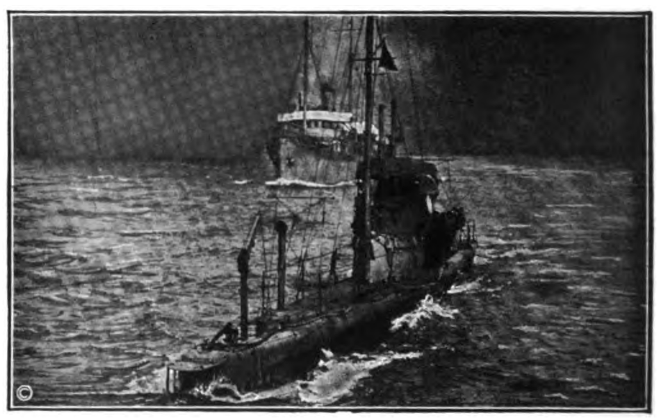


U. S. S. Cassin and U. S. S. McDougal Working Up a Smoke Screen—ELECTROSE Equipped.



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Vol. 7 Contents of The Wireless Age for June, 1920 No. 9

Edited by J. ANDREW WHITE

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Edward J. Nally, Pres. Lee Lemon, Vice-Pres. David Sarnoff, Secy. George S. De Sousa, Treas. J. D. Conmee, Business Mgr.

Owing to the fact that certain statements and expressions of opinion from correspondents and others appearing in these columns from time to time may be found to be the subject of controversy in scientific circles and in the courts, either now or in the future, and to sometimes involve questions of priority of invention and the comparative merits of apparatus employed in wireless signaling, the owners and publishers of this magazine positively and emphatically disclaim any privity or responsibility for any statements of opinion or partisan expressions if such should at any time appear herein.

Vol. 7. No. 9. JUNE, 1920

THE WIRELESS AGE

WORLD WIDE WIRELESS

Radio Corporation Holds First Meeting

IMPORTANT developments in long distance wireless communication were announced at the annual meeting of the Radio Corporation of America held in the Woolworth Building, New York, on May 4th, the first meeting to be held since the merger was effected between the General Electric Company and the Marconi Wireless Telegraph Company of America.

Edward J. Nally, in his address to the stockholders, stated in connection with the agreement with the General Electric Company: "It brings to our commercial department the co-operation of that company's world-wide organization, and, what is probably the most valuable asset of all under the agreement—exclusive control of the Alexanderson Alternator. This device bids fair to practically revolutionize the art of long distance communication by wireless. The report comes to us that the signal transmitted from our American stations equipped with the Alexanderson Alternators has attracted the attention of the wireless experts of Continental Europe. It is said they wonder what manner of device it is that sends a signal so noticeably superior to that to which they are accustomed. Already, the British Marconi Company has adopted the Alexanderson Alternator to be purchased from the Radio Corporation as its standard high frequency apparatus for communicating for distances exceeding 2,000 miles. Commissions or representatives of the Governments of Poland, Denmark, Sweden and other foreign countries, have been sent here to investigate and examine it, with a view to procuring sets for their stations. It is safe to predict that as a result of these investigations it will soon be conceded your company controls the world's foremost device for long distance wireless communication. The resultant advantages to the company, both financially and in the way of prestige, are readily apparent."

Mr. Nally also stated that "a representative of the United States Government in the person of Admiral Bullard of the U. S. Navy has been designated by the President and Secretary of the Navy to attend the meetings of our stockholders and Board of Directors, with view to a close co-operation between the Government and the company. This interest on the part of the Government and its full accord with our program has already proved helpful through gaining the assistance of the State and Navy Departments in connection with certain of our dealings in European and South American countries."

It was also announced that the Board of Directors has approved a large program of construction for the near future. It is proposed to immediately purchase a site near New York City for a group station of five units, the station when completed to be devoted to the following purposes: one unit to work with Buenos Aires, Argentina; one to work with France; one to work with Germany; one to work with Scandinavia; and one with Italy and Poland.

The following were elected to the Board of Directors: Edwin W. Rice, Jr., Albert G. Davis, Owen D. Young, Gordon Abbott, James R. Sheffield, John W. Griggs, Edward W. Harden and Edward J. Nally.

Officers were elected at the Board meeting on the following day: Owen D. Young, Chairman of the Board; Edward J. Nally, President; Charles J. Ross, Secretary; George S. DeSousa, Treasurer; Hon. John W. Griggs, General Counsel.

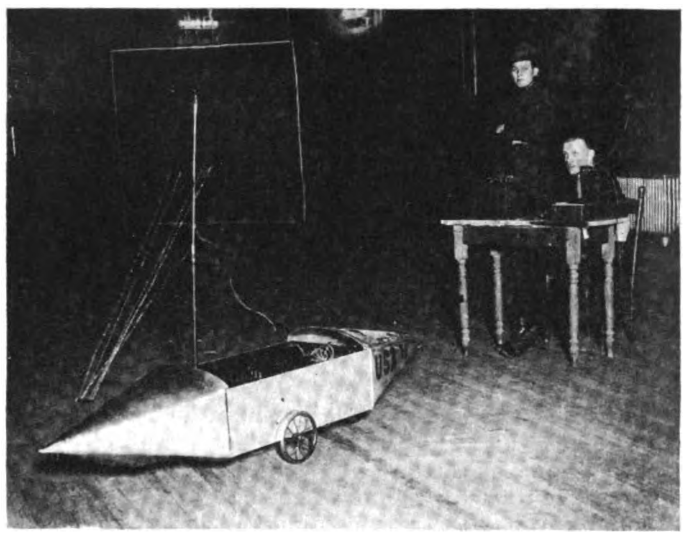


Photo Int'l

Wireless controlled torpedo demonstrated at the 12th Regiment Armory, New York

Radio Message From Amundsen Breaks 19 Months' Silence

CAPTAIN Roald Amundsen, discoverer of the South Pole, has arrived at Anadir, a trading post on the Bering Sea, in Eastern Siberia, according to a wireless message from Anadir, received at Nome, Alaska. The dispatch gave no details other than suggesting that the explorer had reached the village in a ship.

For more than nineteen months the silences of polar seas have shrouded the vessel that bore Amundsen and his shipmates in their unusual endeavor to reach the North Pole.

Wireless Service Between England and Egypt

THE British Post Office is hurrying the construction of two new high power wireless stations to supplement cable service between England and Egypt. Cable companies have also laid new lines between England and Gibraltar and between Malta and Alexandria. Another new line between Aden and Bombay is to be laid this year.

Cable congestion in the Near East, India, the Far East, South Africa and Australia was recently made the subject of inquiry by the Federation of British Industries.

Chess Played by Wireless

A GAME of chess played by wireless between Edward Lasker, of Chicago, and A. F. Whittaker, of Washington, awaits decision by J. R. Capablanca, Pan-American chess champion; as to the victor.

The moves by the Washington man were telephoned from the Capital City Chess Club to the naval operator at the Arlington wireless station. Messages were received at an amateur's station in Evanston, and relayed to the Illinois Athletic Club.

It is said the game proved to be much faster than those played by telegraph and chess play by radio may be the means of reviving the cable-matches that formerly were played between English and American teams.

Photo Int'l

Dancing to music transmitted by radiophone. Illustration shows headsets being adjusted

Radio a Practical Aid to Fishing Industry

WIRELESS communication in conjunction with the airplane has become a valuable stabilizer for the fish packing industry of Southern California, following a program of co-operation which has just been outlined with officials of the North Island aviation school by members of the state fish and game commission.

Airplanes have become "spotters" for the fishing fleets of canneries and as a result reliable information is being obtained which has tended to stabilize the industry.

The planes, flying over the sea are in constant lookout for fish schools which can be easily sighted from an airplane, says Fish and Game Commissioner M. J. Connell. By wireless information is then flashed to the headquarters of the commission in Los Angeles and this information is immediately distributed to all fish packing plants of the location of fish schools.

Radio Service Aboard Trans-Atlantic Ships

SUCH striking results have been obtained by the new long distance Marconi wireless sets on board the Cunarders Imperator, Mauretania and Carmania that a rapid extension of these instruments to other great liners may be expected. The White Star vessels Olympic, Adriatic, Baltic, Celtic, Cedric and Megantic are being similarly equipped. All these ships will now have direct intercommunication with land over a distance of 1,400 miles. Radio-telegrams intended for passengers may be handed in at any post office in England. The word "Aberdeen" must be included in the address after the name of the ship. The charge for such radio-telegrams is 10½d per word.

Marconi Welcomed in Spain

NEWS of the arrival in Spain of Guglielmo Marconi and of the enthusiastic popular reception accorded to the distinguished inventor in that country serves to draw attention to a voyage which has been pronounced comparable in a way to the venture of Columbus. The voyage of the Electra has excited great interest in scientific circles.

Marconi expects upon his voyaging, which may be extended, to make a special study of atmospheric and meteorological conditions as these may affect wireless communication and to chart his findings, it being expected that these will prove of importance in respect particularly to the problem of standardizing communication through the air in all parts of the world.

The Passing of Theodore Newton Vail

THEODORE NEWTON VAIL, chairman of the board of directors of the American Telephone & Telegraph Company, died April 15, in the Johns Hopkins Hospital, Baltimore, Md.

Mr. Vail came from Jekyl Island recently for a slight operation. He had been in a rather serious state of health. He was born in Carroll county, Ohio, July 16, 1845.

Theodore N. Vail was among the many successful Americans who got their start in life by learning telegraphy. This list of former telegraphers includes such men as Andrew Carnegie and Thomas A. Edison, and Mr. Vail, in his chosen field, was as successful as they were in theirs. So successful, in fact, that in 1907 he became the head of the largest telephone company in the world, the American Telephone and Telegraph Company.

When Alexander Graham Bell invented the telephone, Mr. Vail was just 31 years old, but he quickly saw the possibilities of conversations by wire.

His first line was from Boston to Providence, and he was ridiculed for the attempt. It was called "Vail's side show" by the scoffers, but it really was the start of one of the greatest developments in modern life. Thirty-five years later, in 1915, it was possible to talk from New York to San Francisco, and in the same year it was possible to talk by wireless telephone from Arlington, Va., to the Eiffel Tower in Paris and to Honolulu simultaneously.

It was his frequently expressed belief that the next few years would produce wireless telephone communication of practically unlimited distance and effectiveness.

Newsy's Interest in Radio Results in Robbery

THE burglar who appropriated a complete wireless receiving apparatus from a supply house in New Haven, Conn., has been captured. LeRoy B. Dortche, age 15 years, is the name the accused gave at police headquarters. He said he was a student of radio and intended setting the apparatus up in his home and "listening in" on distant radio stations of the world. He said he delivered morning papers about the city, and while out early in the morning he took advantage of the opportunity to secure the instruments, which he had yearned for ever since he became interested in radio-telegraphy.

American Freighter Mystic Rescued by Radio

RADIO advices received by the Naval Communication Service announced that the coast guard cutter Ossipee had found the disabled American freighter Mystic 400 miles east of Sandy Hook and was standing by. The Mystic sent a call for help saying that she was disabled and was out of fuel and fresh water. The disabled vessel was bound from Avonmouth for New York.

The 3,000-Mile Iowa Radio Relay Test

THE Iowa Aerial Daylight Relay test with neighboring states, covering a territory of about 500,000 square miles, was successfully carried out, according to Clifford W. Patch, district superintendent of Iowa. The message, sent around to a number of stations, was planned to discover how rapidly the various stations could receive and transmit messages. Many cities in Iowa, Illinois, Wisconsin, Minnesota and North Dakota participated in the test.

The message, which was started from Patch's station in Dubuque, read: "Progress today depends more and more upon speed and snap. Radio furnishes the speed. You furnish the snap."

The message was sent on three routes. Route number one, beginning at Dubuque and ending at Minneapolis, was the longest, and the message, starting at 8 o'clock, closed at 10 o'clock. There were twenty-six stations on this route, through which the message had to be relayed.

Radio Compass Guides Airplanes

A RADIO compass for airplanes which will enable them to locate other planes accurately regardless of weather conditions has been successfully tested by navy flyers. On a recent trip of the NC-3 from Philadelphia to Pensacola that machine and another from Anacostia, D. C., field were equipped with the new compass.

Officials at Anacostia kept in communication with the NC-3 constantly by wireless and took bearings at stated intervals on both planes by means of the compass.

The two planes were directed toward each other from the field until, when sixty-five miles apart, the compass of each came into operation, confirming their positions and establishing communication.

S O S Radio Service

DISTRESS calls from two vessels, each outbound from New York, were received by radio recently stating both ships were fast filling with water. Assistance was rushed to them.

The first S O S was received from the freighter E. A. Morse, which was steaming for Genoa. It said: "We have no steam; are filling rapidly." She was then 280 miles southeast of New York.

"We may be able to keep afloat for two or three hours," ran a later radio from the Morse. The Acushnet, a coast guard cutter, and the San Mateo, bound from Boston to the West Indies, headed for the disabled craft.

The wooden steamer William O'Brien, three days from New York bound for Rotterdam, wirelessed from a position about 500 miles east of Philadelphia:

"Hatch covers off; taking water rapidly. Please stand by."

The coast guard cutter Acushnet, which has been searching for the disabled steamer William O'Brien, reported by wireless that she found the sea covered with fuel oil and a name board of the steamer drifting about 500 miles east of New York. An empty life boat was picked up in the same locality.

It is feared the steamer went down not long after she had asked for assistance during a gale. She left New York for Rotterdam.

Radio Brings Aid to Ship off Fire Island

THE Naval Communication Service recently received a wireless announcing that the Coast Guard cutter Seminole had taken the Shipping Board freighter Ipswich in tow about eighty-five miles east of Fire Island. The message failed to disclose the nature of the freighter's trouble, but stated the craft was not in danger. The Ipswich, of 3,700 tons, was bound for New York from London.

Uncle Sam Has 135 Wireless Stations

THE government shore wireless stations number 135, of which eighty-eight are in continental United States, twenty in Alaska, nineteen in the Philippines, three in the canal zone, two in Hawaii and one each in Porto Rico, Guam and Samoa. The government ship stations total 470.

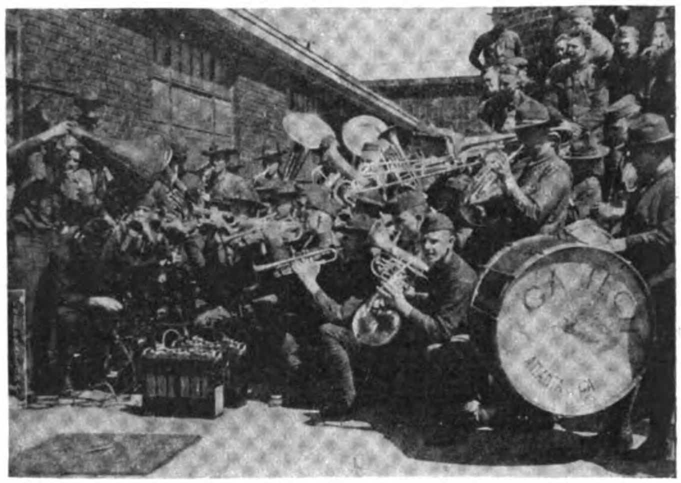


Photo Int'l.

Band rendering dance music that was transmitted by radiophone

Pacific Coast Radio Compass Stations

FOG will soon be robbed of its dangers to Pacific Coast shipping by means of radio. The opening of the naval radio compass stations on the Pacific Coast is but a few weeks off. The first will be four stations at the entrance of San Francisco Bay, at Point Montara; Bird Island, near Point Benita; Point Reyes, north of Point Reyes lighthouse, and Farallon Islands.

The method of operation is based on determining the direction of radio waves. The vessel, concealed in fog, sends out radio signals. Each of the radio stations intercept these signals, and by compass radio determines from which direction they come. Each station notifies a central station, which in turn notifies the vessel the precise direction it is from the station, and these directions charted show by intersection of the lines the vessel's precise location.

Due to shortage of enlisted personnel, the opening of all stations cannot be expected at present, but it is the intention to open at the earliest possible date one station, probably Bird Island, at the northern enrance of the Golden Gate, as soon as personnel can be trained.

Radio Realizes the Horse Marines

ENGLISH sea captains are betting on the races—by wireless. The first week of the opening of flat racing brought a number of turf transactions flashed from the high seas, passengers as well as ship masters and officers ordering their bookmakers to place bets on "live ones."

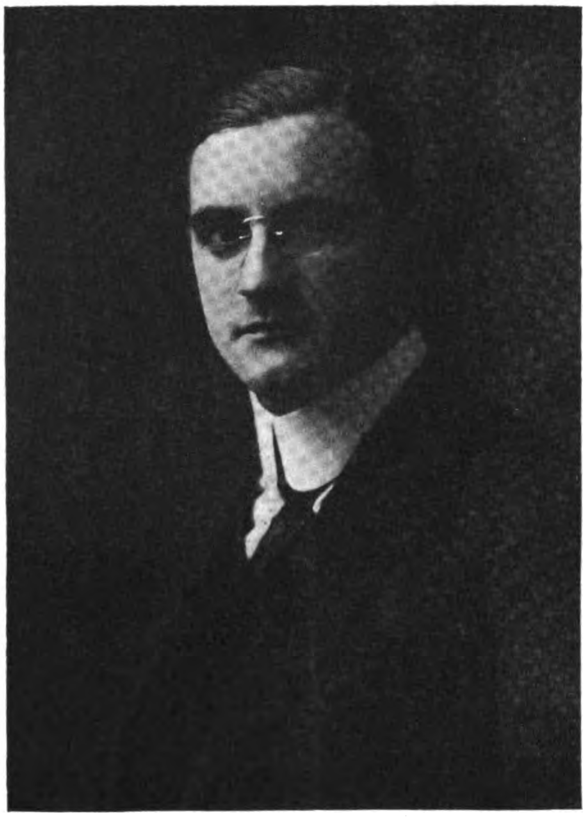
A system of flashing racing "tips" by radio is being fast developed.

Radio Telephony Across Oceans and Continents

By Dr. Alfred N. Goldsmith

Director of the Radio Laboratory, The College of the City of New York

THE recent announcement by Senatore Marconi that we may shortly expect to telephone by radio across the Atlantic and that regular service will be available, is both startling and encouraging. It is clear, for example, that in the comparatively near future the president of any large corporation will be able, from his desk in any town in the United States, to telephone to the managers of his branch offices in distant countries. In effect, London, Rome, Paris, Tokio, Cape Town and Buenos Aires will be as much within his immediate reach as his next-door neighbor.



Dr. Goldsmith, who looks forward to a not far distant date when every telephone subscriber will have direct access to the radio telephone

This revolutionary step forward in communication marks the beginning of a new era. From the days when fast runners laboriously carried messages over moderate distances to fall exhausted at the end of their trying trip, communication has never been quite capable of meeting all the demands on it. The loss of time in getting word to the other man is more of a brake on efficient business than almost any other single factor; but there has been tremendous progress made, and more is expected for the near future. Already it is possible to send radio messages from the United States to Hawaii and Japan on the one hand and to England, France, Italy and Norway on the other.

The great stations now in existence in the United States, or planned for the immediate future, will extend this range of communication until telegraph messages can be sent speedily to any corner of the world.

A very natural question which the individual user of the radio telephone of the future will desire to have answered is: "How shall I send a radiophone message to Mr. William Brown in London? Just what will I have to do to get the connection and to talk to him? How will it sound? And what will it cost?" It is fortunately possible to answer some of these questions fairly definitely today.

All that Mr. Smith will have to do in New York to talk to Mr. Brown in London, is to take his telephone receiver off the hook and ask either for "Radio Long Distance" or for the number of the special high power radio telephone transmitting station which will carry his voice across the Atlantic. As soon as he gets the long distance radio station, he will be asked by the operator to whom he wishes to speak. On giving the name and address of the desired man in London, he will be told to "Hang up the receiver, please. We will call you when your party is ready." In a few minutes his telephone bell will ring, and he will be told "Your party is ready: go ahead, please"; and he will be in touch with his correspondent in London.

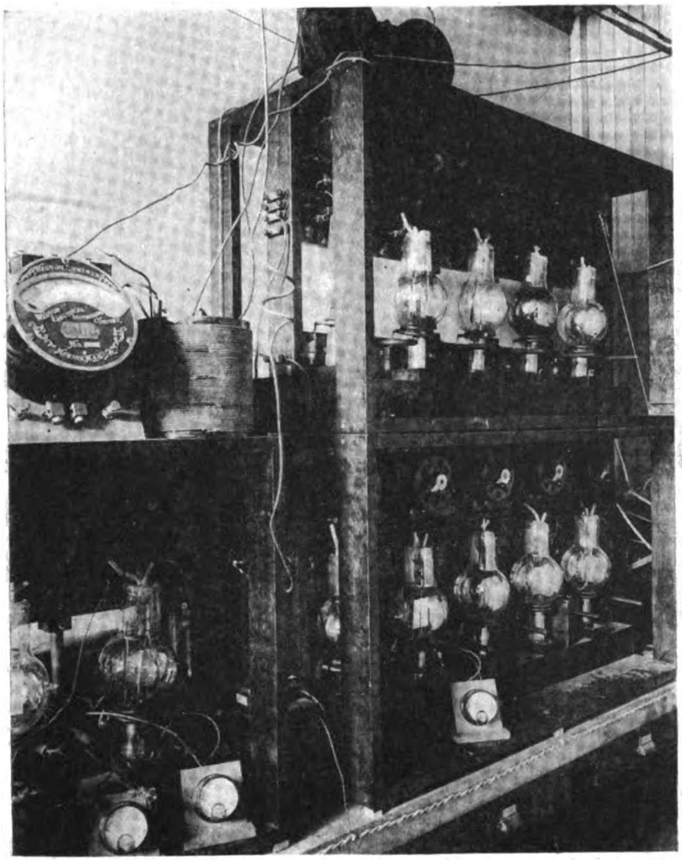
It will not be necessary for him to leave his office or his home, or wherever he happens to be, to telephone to any point that he desires. Every telephone subscriber will become automatically a subscriber to the radio telephone without further expense or trouble on his part.

As regards the connection itself, it is certain that the speech will be clear and easily understood. There may be a little difficulty about the language when a subscriber in Rio de Janeiro talks with a subscriber in Vladivostok, Russia, but this cannot be blamed on the radio telephone. We shall all have to become accomplished linguists to utilize to the full the immense possibilities of this new means of long distance communication. Or else the long deferred hope of the adoption of Esperanto, or some such universal language, will have to be realized.

As regards the cost of a radiophone message to far distant cities, this will naturally depend on a number of things which cannot be accurately measured today. Of course, the further the message must be carried by wire lines to the radiophone stations, the more expensive it will be. And the further the radiophone stations send it over ocean or continent, the higher the cost. And the time of day and speed with which the connection is demanded will probably have to be considered also. If a man is willing to telephone during the slack period late in the evening or early in the morning, he will probably get reduced rates.

In any case, it is clear that the radiophone should not be used for casual gossip between Chicago and Melbourne, Australia. On the other hand, it is likely that the rates for a three-minutes talk to London, Paris, Rome, or any other of the greater European capitals from the chief American cities, will be well within reason and entirely worth while if important matters are to be handled. During the slack hours the rates will probably be such as to permit the use of the radiophone on special family occasions, such as weddings, births and so on, even by most of us.

Of course, the chief users of the long distance radiophone will be the larger commercial interests and the banking houses. Their business is handled best at high speed, on short notice, and by competent men in effect speaking face to face. There are, however, many other uses of the radio telephone, which, while less spectacular and over shorter distances, will nevertheless be very valuable to society. Ships at sea will be in telephone



Dr. Goldsmith's radiophone set, showing the dozen vacuum tubes which were used to generate several horsepower for wireless telephony regularly conducted over a distance of 160 miles

touch with land. Any traveler who is immune from sea-sickness should have no difficulty in calling up his office from mid-ocean and making sure, by direct question and answer, that all is going well. Or he can call up the other side of the ocean, personally arrange for accommodations, and even make his business appointments and outline the matters he wishes to talk over when he arrives. If, as now seems likely, the radio telephone is used to a considerable extent on the better through-trains, the railroad trip will be much less of a loss of time than it is at present. The traveler on the future Pullman, equipped with its radio telephone set, will be in personal contact with any point in the country which he desires to reach. In fact, if a passenger on the "20th Century Limited" desires to speak by telephone direct to a passenger on the "Mauretania," in mid-ocean, or to a business associate in Madrid, it is quite within the bounds of possibility that he will be able to do so.

The man who does not want to be reached by those who want to speak to him him will not have much chance in the future. As soon as he approaches any telephone booth or enters his office or home, he is at one end of a wire, the other end of which reaches practically to any important point in the habitable globe.

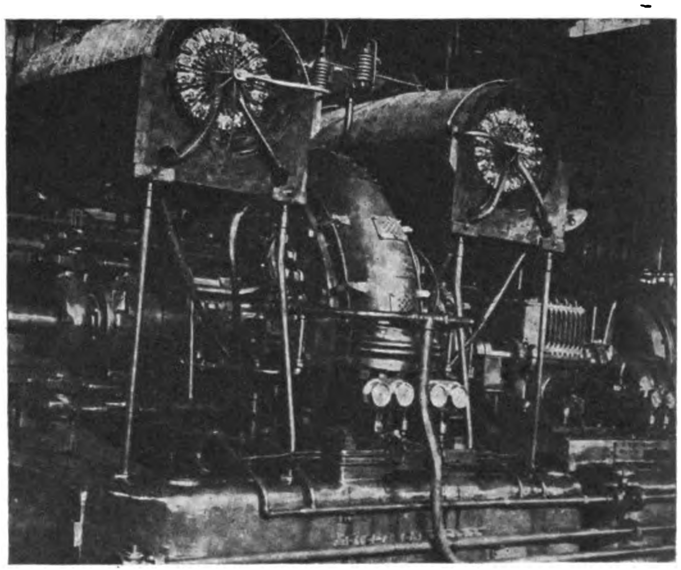
To carry out the plans mentioned, will require the erection of a number of high power radiophone stations here and abroad. These sending and receiving stations will be connected to the ordinary telephone lines of the country in which they are situated. That is all that is necessary to enable them to be fully used by the telephone subscribers of that country. Every radiophone message will go by the wire lines from the subscriber to the radiophone transmitting stations, then by radio across ocean or continent to be received at the radiophone receiving station and automatically transferred to the wire lines in the distant country leading to the called party. The reverse holds for everyhing the called party says. It will be noticed that the spoken words are automatically transferred twice, once at the radio transmitting station and once at the radio receiving station. This will be done instantaneously and accurately without human intervention, by the remarkable "amplifiers" which have recently come into extensive use. So that, long-distance telephone communication will have in it two short wire links, on each side of the ocean and a long stretch of air, which will be bridged entirely by radio.

There are two important ways of transmitting wireless telephone messages successfully; the bulb and the alternator.

The bulb method uses vacuum tubes, which look like large lamps but have remarkable possibilities in the way of producing and controlling the highly special currents required to carry a radiophone message. These bulbs are made of special glass which will not melt when subjected to a high temperature and other difficult conditions of operation. Inside the bulb, from which practically all the air must be carefully removed, are placed appropriate metal parts. One of these is the brightly glowing filament, somewhat as in an ordinary tungsten lamp. Another is a plate of some special metal, usually tungsten or nickel. A third metal part known as the grid may be placed in the tube. Or else, to accomplish similar results in a different way, a third metal part may be fastened outside the tube. These lamps, which in their way are as wonderful as the one used by Aladdin to evoke the genii, are capable of taking the faintest electric currents and "amplifying" or increasing their effect until hundreds or thousands of horse power are controlled by the voice of the speaker! These bulbs are also capable of producing currents that alternate or reverse millions of times in a second! In a smaller form, they are used for receiving the signals as well.

The original effect on which these bulbs are based was discovered by Edison, but they were first successfully applied in a basic and fundamental way to radio telegraphy by Professor Fleming, the eminent English electrical engineer. Substantial improvements have been made in these bulbs by Dr. de Forest, the American inventor, Dr. Langmuir of the Research Laboratory of the General Electric Company, and Mr. Roy A. Weagant of the Radio Corporation of America. America can well be proud of the share her scientists and engineers have played in the development of this remarkable device, the vacuum tube amplifier, oscillator and modulator.

When one of these bulbs does not supply sufficient power to telephone by radio the desired distance, a number of them may be connected up to work together successfully.



The New Brunswick high power station of the Radio Corporation of America, equipped to enable wireless to carry the spoken word over land and sea; the photo shows the giant 200-kw. high frequency alternator with dynamo at the right and the transformers on top

Nearly five years ago the writer used a radiophone set employing these bulbs as shown in the illustration. It will be seen that a dozen of these large "radio lamps" were used to generate several horsepower which was then sent out from the aerial wire system stretched over the buildings of the College of the City of New York, also shown in an accompanying illustration. This set enabled the writer to telephone by radio to Schenectady, 160 miles distant, at almost any time. This was by no means the greatest distance over which the words could be heard when conditions were favorable. In fact, words spoken at the Laboratory in New York were clearly heard in North Dakota, 1,300 miles distant, on numerous occasions! At the time this work (which was carried on in conjunction with the General Electric Company) was done, it was close to being the world's long-distance record for radio telephone communication.

Interesting work along these lines has been carried on by the United States Navy and the Western Electric Company. Not only were long distance tests carried out, but excellent radio telephone communication with airplanes and over short distances for military purposes were achieved.

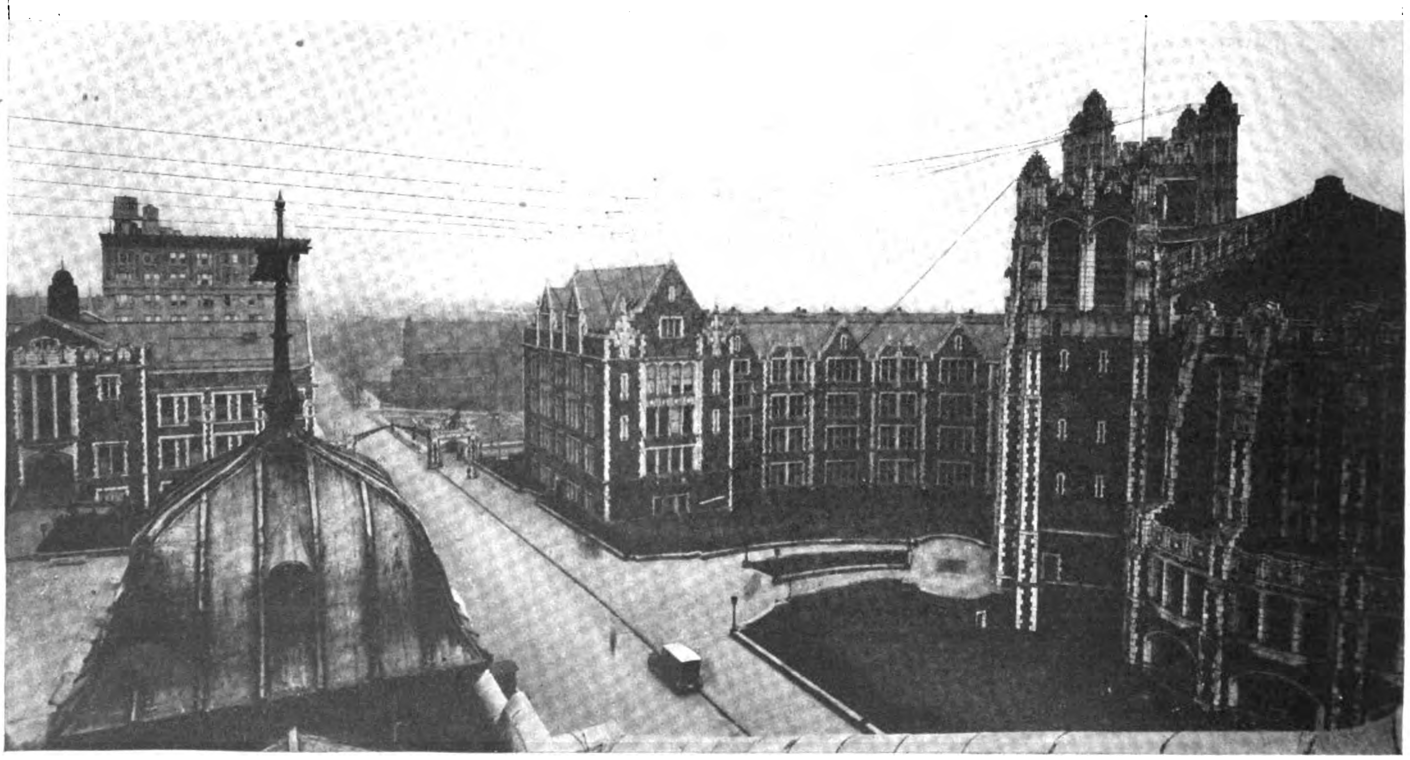
The equipment used by the English Marconi Company to telephone across the Atlantic recently was very similar in nature and operation to that used by the writer and mentioned above. It also consists of a number of appropriate bulbs, acting together, and producing the "modulated aerial current" needed for this purpose. In the writer's earlier experiments it was found possible to talk by radio telephone from points quite distant from the laboratory. For example, speaking from a residence seven miles away from the laboratory, it was possible to transfer every word spoken automatically to the radio telephone and send it out to the desired destination. This was quite along the lines mentioned above.

There is a second way of sending radio telephone messages, using an alternator. The form found most desirable in America and giving excellent results is known as the "Alexanderson Alternator" after its inventor, Mr. E. F. W. Alexanderson, Chief Engineer of the Radio Corporation of America. These machines were developed by the General Electric Company over a long period of years and are powerful and sturdy generators of the currents required to send over long distances. It is likely that the alternator will compete successfully or even supersede the bulb radio telephone transmitter when very long distances are to be covered. These machines are triumphs of careful engineering. Their rotating parts, made of the finest steel with most accurate machining, spin at an unusually high speed and require careful balancing and centering. They have proven themselves capable of handling heavy radio telegraph traffic from the United States to our Allies through the war.

When President Wilson sailed to Europe on the "George Washington," radio telephone messages from Secretary Daniels of the Navy in Washington were sent to the President all the way to France. The equipment used was the Alexanderson alternator with its bulb and magnetic amplifier controls. More recently, radio telephone messages have been repeatedly sent from the New Brunswick, N. J., station of the Radio Corporation of America, to France, using this equipment.

Efficient radio telephone service in America requires two things: mastery of the art in America, and proper working arrangements with competent foreign radio companies. Fortunately, both of these conditions have been met.

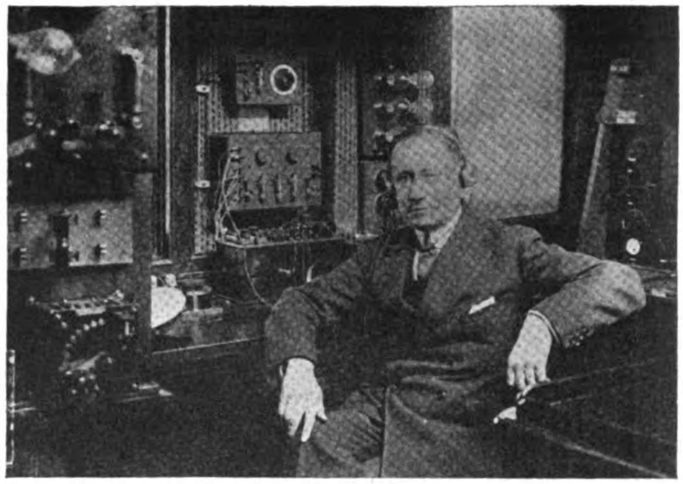
Quite recently, the General Electric Company and



The aerial wire system at the College of the City of New York, connected to the wireless 'phone apparatus installed in the building at the right; words spoken here were clearly heard in North Dakota, 1,300 miles distant, on numerous occasions

the Marconi Wireless Telegraph Company of America concluded arrangements whereby their radio interests in the future will be handled by a great all-American company, the Radio Corporation of America. Suitable working arrangements have also been made between the Radio Corporation and the English Marconi Company and its associated companies. Controlling, as it does, practically all the high power stations in the United States (with the exception of those belonging to the United States Navy), with American engineers and capital back of it, and strongly fortified by suitable arrangements with its foreign correspondents, the Radio Corporation will unquestionably maintain the present high standing of radio in the United States and insure our future prestige and standing.

One of the powerful Alexanderson alternators used for radio telephony at the New Brunswick station of the Radio Corporation is shown herewith. Controlled by the delicate voice currents, such machines as this will carry the spoken word over land and sea. The beneficial influence of this triumph of science will be felt in many different ways. The speeding up of business and production, the ready correspondence with our friends in times of emergency, the simplification of foreign affairs in diplomacy and the safety of life at sea will be but a few of the great results of radio telephony in the future. As communication advances, the world shrinks and dwellers in far distant lands become our next-door neighbors.



Marconi as he is today; this picture shows the distinguished inventor on board his yacht shortly after he announced that there will soon be regular radiophone service across the Atlantic

What the Amateur Can Learn from the Navy

By Robert J. McAusland, Jr.

MR. LAWRENCE C. F. HORLE, formerly United States Navy expert radio aide, in a talk before the Radio Club of America recently, made it clear to anyone familiar with the development of amateur receivers, that history can and did repeat itself in the case of the navy receiver design.

Although Mr. Horle's talk thoroughly covered the trend of development for the period of the last three years, we shall not attempt to explain in detail all of the designs. The problem that confronted the navy consisted of the following elements: Facing war, it became necessary to produce large numbers of receivers for use on naval boats, which would live up to the severe service required. The specifications laid down for these receivers were five in number. First, they must have a wide range of wavelengths; second, they must have a high selectivity and sensibility over the range covered; third, ease of operation must be secured, so that inexperienced operators could be used; fourth, the design must be light and compact and yet capable of giving service during heavy gunfire; and, fifth, ease and economy in manufacture were of paramount importance.

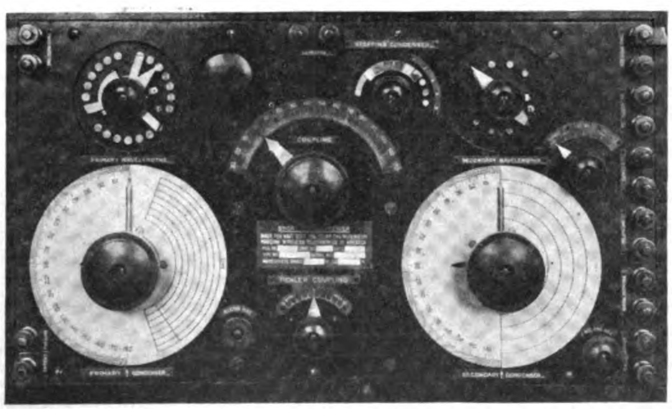


Figure 1—Front view of CM 294C receiver

The method by which the navy found solutions to these problems led to the development of apparatus of standardized design incorporating the features just outlined.

The reader may find some points of interest in the navy design and by utilizing them he may find a solution of his problems along the lines of the above mentioned five specifications. For example, many an amateur may use to advantage such standard parts as condenser plates, knobs, binding posts, etc., which he can buy cheaply in the open market, and by assembling some of his own apparatus save a few dollars.

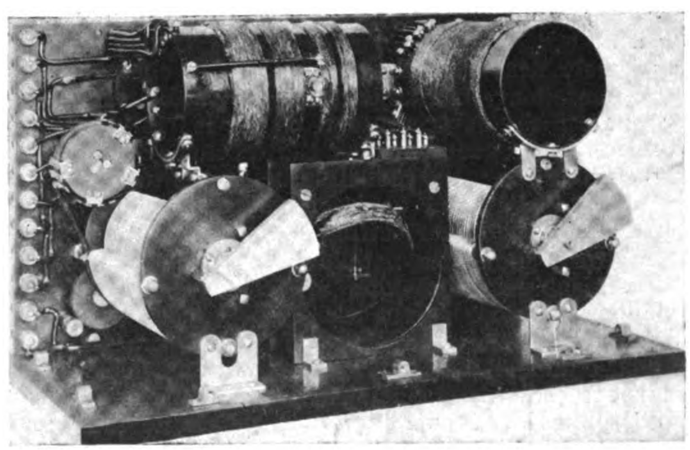


Figure 2—Rear view of receiver built by Marconi Co. for the U. S. Navy

Figures 1 and 2 show respectively the front and rear views of a CM 294C receiver, designed for the navy by the Marconi Wireless Telegraph Company, having a range of 250 to 3100 meters on an antenna of .0008 mfd. and 55 microhenries inductance—the ordinary navy antenna. In figure 3 is given the wiring diagram of the device, clearly showing each of the parts and their function in the circuit.

A study of the front view, which is practically the standard layout, will show that the parts have been very logically arranged. Primary and secondary con-

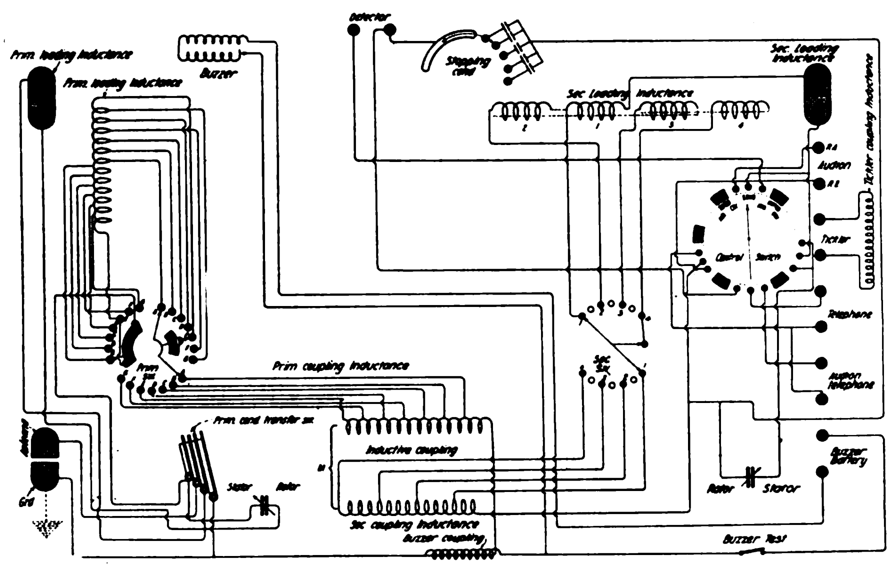


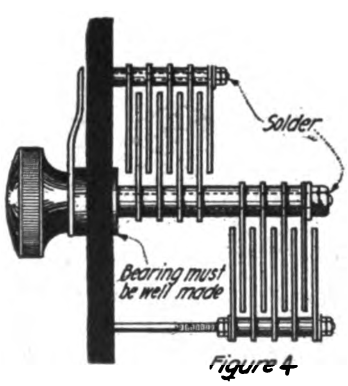
Figure 3—Wiring diagram of CM 294C receiver showing connections and function of each unit

densers are at the two sides and near the bottom, at just the right height for ease of manipulation by the operator, while the two and three point inductance switches for the secondary and primary coils are placed above their respective condensers, at a place demanded by their lesser usage. A neat feature of the design is that as the inductance switches are turned from point to point, the pointer shown above the condenser knob is automatically operated by a cam movement to the proper wavelength scale on the condenser dial. Further, these inductance switches are so arranged as to put the primary condenser either in series or in parallel with the primary loading coil as required by the setting. Coupling and tickler coupling in the center, and the other controls such as detector test, stopping condenser, etc., offer a logically useful layout and an extremely neat appearance. One more characteristic is the secondary fine adjustment device for tuning the secondary circuit accurately. This is really only a train of three gears driving the secondary condenser through an idler, the reduction being ten to one. The principal use of this device is to take care of small changes of condenser setting when tuning.

Figure 2 shows the details of the design. The fine adjustment gear and idler are clearly shown. The condenser, whose values are .0045 primary and .0032 secondary in the usual Class I design, are made of 5-inch diameter aluminum plates, 32 mils thick. The balanced plate type condenser, in which one-half the rotor plates are located on one side of the shaft and the other half on the other side, as shown in figure 4, was adopted as standard practice later. This idea by eliminating the heavy counter weight of the usual design, will reduce the cost of the amateur condenser.

Details of the inductance coils are noteworthy. The navy coils were invariably wound with Litzendraht on natural dilecto tubing 4 inches inside diameter and 4⅛ inches outside diameter, a saving in efficiency for the longer wave stations, say above 1000 meters. Below this value the litz is of little use. Primary and secondary tubes were nearly always located at right angles to prevent direct coupling from primary to secondary load. In some of the later sets it was found necessary to provide additional protection against this by placing a shielding partition between the two circuits. The secondary coil is wound in four distinct sections to cut down the distributed capacity of the coils.

There were two distinct classes of navy receivers. These were based on two different researches to obtain the best inductance resistance ratio for the coil. The first type was based on the idea that a high capacity and a small inductance would be the best. Hence all the first group of receivers had the characteristics outlined above. This assumption was found incorrect, as will be seen by a study of the decrement of a receiver circuit. It can be shown that for a given wave length, the decrement varies inversely as the cube root of the inductance. Hence the greater the inductance the less the decrement the receiver introduces. The second group of receivers were almost identical with the first group except the condensers, which were about one-quarter as large, and the inductance correspondingly larger. Coils were now made of No. 20-38 litz rather than the No. 3-16-38, which had been the previous practice. The amateur will find the former litz better than the latter. A great improvement was also made by building the detector valve directly into the receiver. When you consider that a foot of lead introduces disturbing capacities of the order of .000003 mfd, the advantage of this arrangement is clear. Careful shielding also was done. Best practice shows that complete shielding inside the receiver box with 1/16 inch soft copper, and shielding of the telephone cords with flexible copper braiding will give best results and prevent electrostatic couplings.



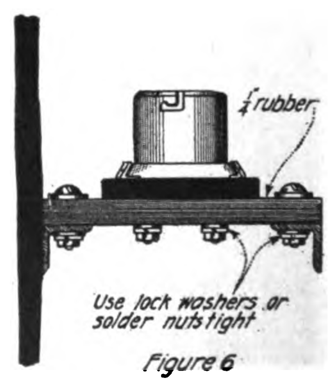


Figure 4—Balance plate type condenser
Figure 6—Shock-proof mounting for audio frequency tube

Let us now turn to the amplifiers the navy built, which in all cases were manufactured as units separate from the receiver. The type of circuit used—the ordinary transformer coupled—is shown in figure 5. At first air core transformers were used, but later, iron cored came into practice, and that is the best present day design. Two-mil carbon steel was found the best but three-mil silicon steel, which is a little less expensive, will give the amateur almost as good results for the radio frequency transformers. In the diagram shown, three radio frequency and three audio frequency amplifiers are assembled in one unit, each amplifier being shielded from the other. This makes expensive construction and should be avoided by the amateur, as the advantage over the method outlined above is very small. Another point for the amateur to remember who has a noisy and vibrating room to work in

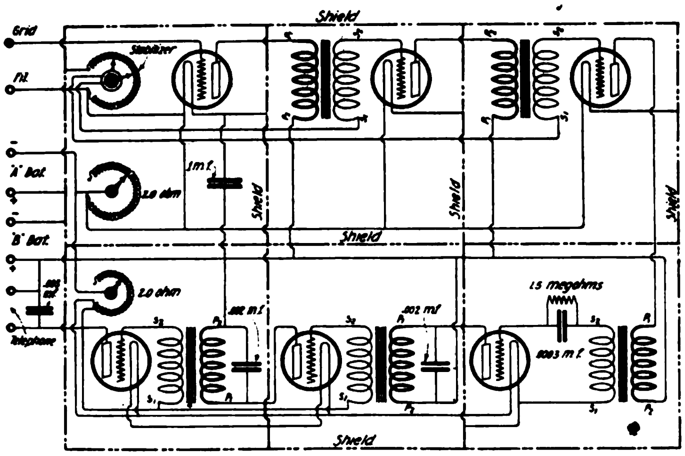


Figure 5—The ordinary transformer coupled type of circuit used

is that shockproof mountings are not needed for the radio frequency amplifier tubes. A good cheap shockproof mounting for the audio frequency tube is shown in figure 6. It consists of a sheet or several strips of rubber ¼ inch thick, mounted as shown. For a noisy place it will be found that an inductance of 100 microhenries inserted in series with the grid of the first tube will filter out extraneous noises. This was invented particularly for weeding out induction from the magneto on aeroplanes.

The navy added to the knowledge about transformers, particularly that each transformer gives best results at a given wave length. Below is a list of possible designs for you to try out. All coils are wound with No. 36 single silk enameled wire, on closed iron core transformers, sections of which are not exactly known, but which probably fill up the inside hole of the coil.

Primary or Sec.	Dimensions in inches Outside	Inside	Thick	Induc. (μhy)	Turns	Working Range (meters)	Best Point (meters)
Both	1.75	1.25	.22	19.5	800	2000-8000	5500
Both	1.75	1.25	.11	8.7	400	800-3200	1800
Both	1.05	.825	.11	.80	100	200-800	450
Prim.	1.75	1.25	.12	...	468	6000-24000	14000
Sec.	1.75	1.25	.24	...	830		
Prim.	Core	⅝" sq.	Gap .72"	...	170	300-1100	700
Sec.		.11" thick		...	190		

It is earnestly hoped that in the above outline, the reader may find sufficient information to try out some new apparatus for himself, and profit by the navy's experience.

The "Casey" Free Radio Schools

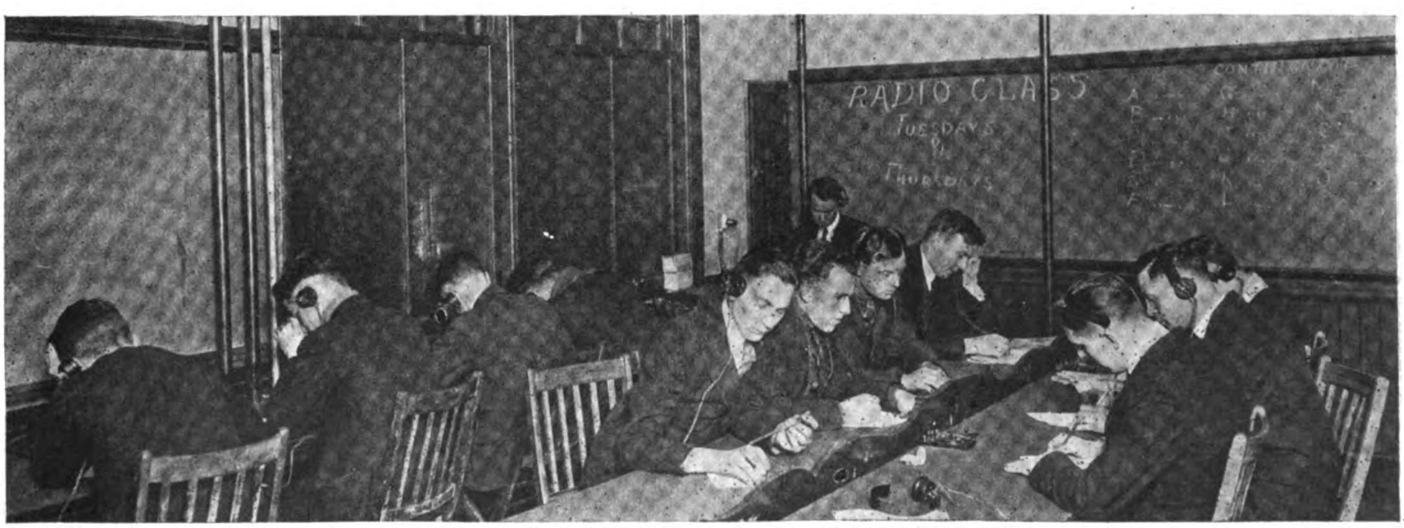
By William M. Bolger

Wanted—Any number of industrious ex-service men and women for a free scholarship in either elementary or vocational training by the Knights of Columbus. Must not object to sacrificing two hours each alternate evening; must be regular and consistent in attendance. To qualify must have served in army, navy or marine corps, army nurse service, or have an honorable discharge from War or Navy department. Apply to any Knights of Columbus council near your town or city. Courses free: wireless telegraphy, auto mechanics, acetylene welding, commercial law, English, arithmetic, stenography and typewriting, salesmanship, advertising, journalism, etc.

THE above invitation extended to former service men and women has been responded to by some 100,000 students who are now attending the chain of free evening schools under the auspices of "Casey" from the Canadian border to the cactus plains of Texas and from the bustling Atlantic seaboard across the continent to the Golden Gate and picturesque northwest. More than six and one-half millions of dollars have been laid aside to give the ex-service men and women an opportunity to make up for the time they lost in serving Uncle Sam in the World War.

The Knights have gone into the education business with a vim. William J. McGinley, the Supreme Secretary, and himself a "wireless fan," has decided to so develop this particular course that before next winter arrives the K. of C. will be able to transmit by relay wireless messages from New York to the Golden Gate, from Kansas to Texas, from Washington to Oregon and other far distant points.

The students of the San Francisco school recently sent out a message which was to be picked up along the route to New York City. Every station "listening in" reported afterwards the time and contents of the message, but on account of the low voltage they were not able to transmit any considerable distance. With the establishment of



Ex-service men attending the wireless class of the K. of C. school at Portland, Ore., one of twenty schools for free instruction of those who served with the colors several more radio schools where there is a distance of several hundred miles intervening, the K. of C. will be able to skip across the transcontinental aerial route and keep the schools testing the ability and progress of its individual student body.

J. F. Maher, radio instructor in the K. of C. school at Savannah, Ga., reports establishing direct communication with another experimental station in Washington, D. C., located at 1744 Corcoran street, and adds: "Every night we hear amateur stations as far north as Massachusetts, and west to Kansas."

The K. of C. schools will shortly be allowed, according to Mr. McGinley, to send a postal card to every amateur station whose call letter they pick up. In this way they will be able to render invaluable data to the amateurs throughout the country regarding the sending power of their apparatus.

The supplementary chain of evening schools were conceived at the Peace Convention of the K. of C. last August and within three months time had become a reality. A group of educators from various parts of the country constituted the committee which planned the nation-wide supplementary evening schools. In New York City the wireless school at 240 West 51st Street is never lacking in steady attendance. It has been in communication with the Boston school, another in Delaware, and has communicated with the steamships off Fire Island and other points adjacent to the harbor.

There are approximately twenty radio schools now located in different cities under the auspices of the Knights. An interesting sidelight on the attendance is the fact that many army nurses are taking the course. In a survey made of the radio schools it was found that they maintain a high record for attendance and that the students are deeply interested in their work which makes it less hard for the faculty.

Several of the teachers in the schools are men who formerly served with the signal corps of the Army and radio service of the Navy. In many of the schools the students spend the first hour with the wireless and second period with the class in electricity. With the resumption of the fall term of the K. of C. schools this autumn it is planned to have several more radio classes established and a complete relay service that will take in a radius of at least 2,500 miles.

A New Three - Electrode Vacuum Tube

A NOVEL type of three-electrode vacuum tube has been evolved by John Scott-Taggart. This tube differs from the usual pattern in that the grid takes the form of a metal plate close to the filament, while the anode, also in the form of a metal plate, is placed diametrically opposite and on the other side of the filament. The tube is illustrated in figure 1. The filament F is arranged vertically, the tube support being a nickel-iron spring which keeps the filament taut. The anode P is a small metal plate placed at a considerable distance from the filament. The control electrode which takes the place of a grid is in the form of a large metal plate G, situated within a few millimetres of the filament F. The curves in figure 2 were obtained with a vacuum tube which possesses the following dimensions:

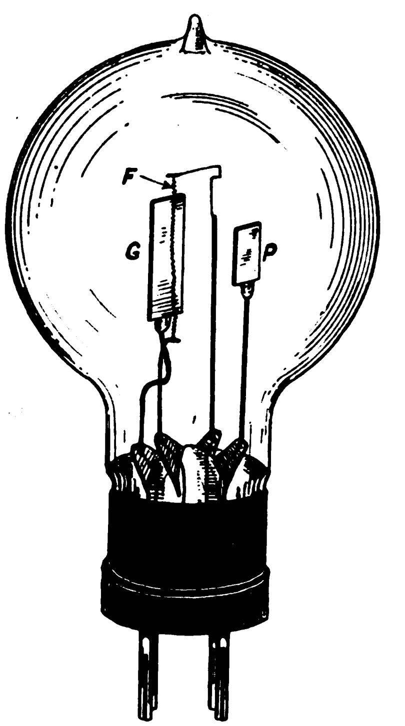


Figure 1—The new type of three-electrode tube

P plate 10 m/m x 10 m/m x 0.008" nickel sheet.
G plate 22 m/m x 10 m/m x 0.008" nickel sheet.
Filament F crimped 25 m/m x 2/3 mils tungsten wire.
Distance F to P, 9 m/m.
Distance F to G, 2 m/m.

It will be seen from the curves that varying voltages on G will cause variations in the anode current to P, causing the tube to operate in a very similar manner to an ordinary three-electrode tube with the grid placed between the filament and plate. An increase of control potential causes an increase of anode current, and vice versa. It will be seen that parts of the curves lying to the left of the ordinate through zero potential on the control electrode are very regular and similar to those obtained with an ordinary vacuum tube. When, however, the control

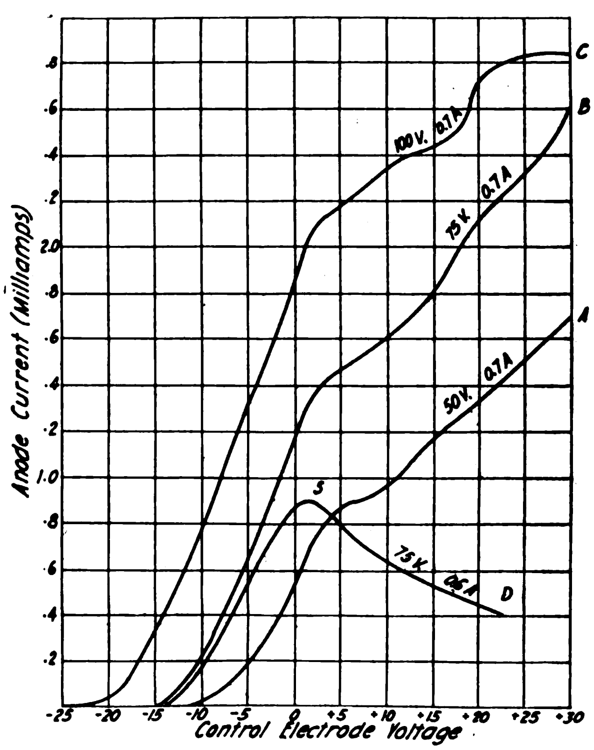


Figure 2—Graphic curves showing the operating characteristics of the tube

electrode is made positive with respect to the filament, it will be seen that the curves commence to lean over rapidly to the right. The electrode G is now drawing to itself an appreciable portion of the electrons emitted from the filament. The effect is far more marked than in the case of an ordinary vacuum tube, since the plate is a more suitable electrode for absorbing the electrons than a fine wire grid. To the right of the zero ordinate the curves become less regular when the control potentials reach higher positive values than those shown in curves A, B and C. The anode currents reach a saturation value and then begin to decrease. This effect is shown in figure 2 by the D curve, which corresponds to 75 volts on the anode and 0.6 amp. through the filament. The anode saturation current is reached at S. An increase of control potential now causes the anode current to drop, electrons which formerly went to the anode are now being drawn to the control electrode.

The same effect is obtainable with an ordinary vacuum tube, but the comparatively sharp bend at S is far more marked in the case of this special tube. This is explained by the fact that the control electrode is of such a nature as to absorb electrons very rapidly. From the curves it will be seen that the amplification obtainable is not as high as in the case of the more usual types of vacuum tubes, in which the grid is placed between the filament and anode. When tested on an actual amplifier, the results, however, are almost as good. The representative point should preferably move only along the negative portion of the curve.

The tube operates efficiently as a detector, the point S being specially suitable for strong signals, both half-oscillations producing decreases of anode current. The vacuum tube also operates excellently as an oscillator or self-heterodyne receiver with 100 volts on the anode and 6 volts across the filament.

No doubt the characteristics and general properties of the tube could be greatly improved by further research.

An Oscillating Current Generator

LEE DE FOREST has devised a high frequency generator which he claims is simple and efficient. With reference to the figures, 1 designates an evacuated vessel provided with two chambers which are united by a narrow passage 4. In these two chambers a mercury electrode or a mercury amalgam electrode is placed. A source of electromotive force, indicated at 7, supplies the current to the electrodes to heat them and causes a vapor trodes. A high resistance, 19, is also connected between the grid and the vapor arc column in the vertical passage to form a "leak" path between these electrodes, the purpose of this leak being to carry off the excess charge which may accumulate on the grid and thereby reduce the efficient operation of the oscillator.

DeForest finds that if a second oscillating circuit is established, which includes the electrode 9 and the vapor

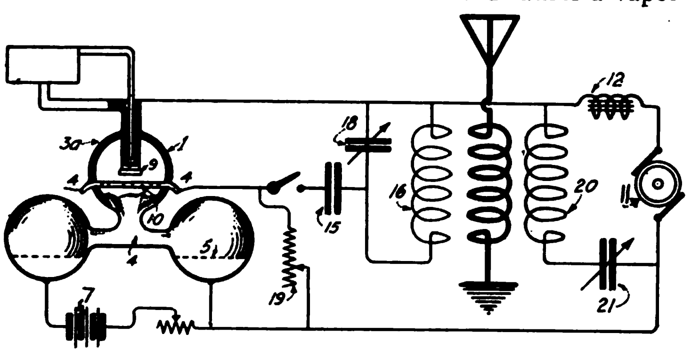
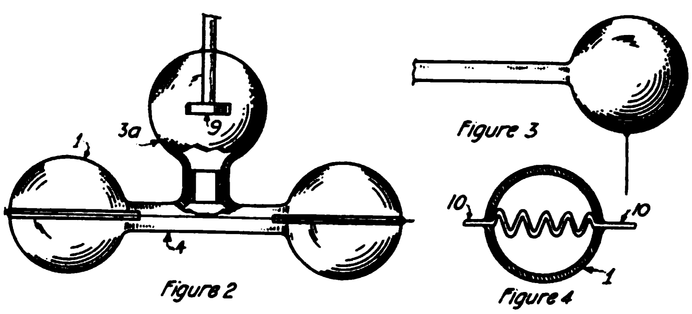


Figure 1—Circuit showing hook-up of the oscillating current generator



Figures 2, 3, 4—Details of the evacuated chambers, showing electrodes, passage for vapor arc column and hollow grid

arc column to form in passage 4. In chamber 3A, forming part of the evacuated vessel and communicating with the mercury arc passage, are located two cold electrodes, 9 and 10, arranged at different distances from the vapor arc column maintained in the vertical passage. The electrode 9 is electrically connected to one terminal of a source of emf. 11. Direct current is used for this purpose. The other terminal of this same source is connected to one of the cathode electrodes, for example, 5. The circuit connection between these two last mentioned electrodes also contains an "inertia" coil, as indicated at 12. The electrodes 9 and 10 must be kept cool. This may be accomplished in several ways. In the case of the electrode 9, a simple arrangement is shown wherein a reservoir which is provided with pipes opening upon the electrode 9 and adapted to allow a cooling medium such as air, water, etc., to circulate through it. The electrode 10 may be of any shape; in the illustration it is in the form of a bent hollow grid with extensions projecting out through the walls of the tube to allow the circulation of air or oil through it. The cooling medium may be supplied from the one reservoir, but for the sake of avoiding confusion in the drawing, this connection is not shown.

An oscillating circuit is connected to the electrodes 9 and 10, the circuit consisting of a condenser and an inductance. A switch, or make-and-break device, is also placed in series with this oscillating circuit and its electrodes.

arc in the vertical passage, and an inductance and a condenser 20 and 21, all in series with each other, the oscillations set up in the original oscillating circuit are increased in intensity provided the period of the second circuit is made equal to that of the first. It is not essential, however, to use this second circuit, but when the two circuits are employed, they should be inductively coupled as shown.

An output circuit may also be associated, either inductively or conductively, with one or both of the circuits. In the arrangement shown, the output circuit is made up of a variable inductance connected between the radiating antenna and the earth in the usual way. The natural period of this output circuit should be equal to that of the first oscillating circuit.

DeForest states that he has as yet been unable to fully and completely understand the operation involved in a generator of the type described. He has found, however, that such an arrangement does operate as a generator of high frequency oscillations suitable for radio work, and whether correct or not, explains the phenomena involved as follows:

If the generator 11 is a direct current source, a negative current is set up across the oscillator by means of the thermions passing from the hot electrode (vapor arc in passage 4) to the cold electrode 9. A negative charge impressed upon the grid will greatly reduce the electron flow from the vapor arc to the cold electrode 9, or in other words, will increase the potential drop between the cold electrode and the hot electrode. Therefore, if the electrical connection between the grid and the plate, 9, be suddenly established by closing the make-and-break switch, the positive potential of the plate and of the positive terminal of condenser 18, will be suddenly increased. Further, any positive charge on the grid will be rapidly carried away by action of the negatively charged electrons from the hot electrode attached thereto, inasmuch as the capacity of the stopping condenser, 15, is small. Thus a difference in potential is quickly established between the two terminals of the condenser. The inductance coil, 16, prevents this difference of potential across the condenser from immediately equalizing, and in consequence, an oscillatory discharge is set up through the inductance. At the end of a half period of this discharge the potential of one terminal of the condenser is therefore reduced or made negative, while that on the other side is made positive relative thereto. The reduction of the positive potential at one terminal of the condenser and on the plate causes a sudden increase of positive current from the generator, which again charges one terminal of the condenser positively and again sets up a negative current across the coil to the other terminal of the condenser and to the grid. This inrush of negative charge to the grid will again reduce the electron flow from the hot electrode to the cold electrode, that is, will still further increase the positive potential of the plate and the corresponding terminal of the condenser with respect to the other terminal of the condenser. Thus the condenser will once more begin to discharge a positive current through the coil and the entire action as above described will be repeated, growing in intensity as it proceeds, due to the magnetic inertia of the coil, up to the point where the loses in the circuits and in the oscillator itself are equal to any further increase in the energy representing the oscillation.

Improvements in Arc Generators

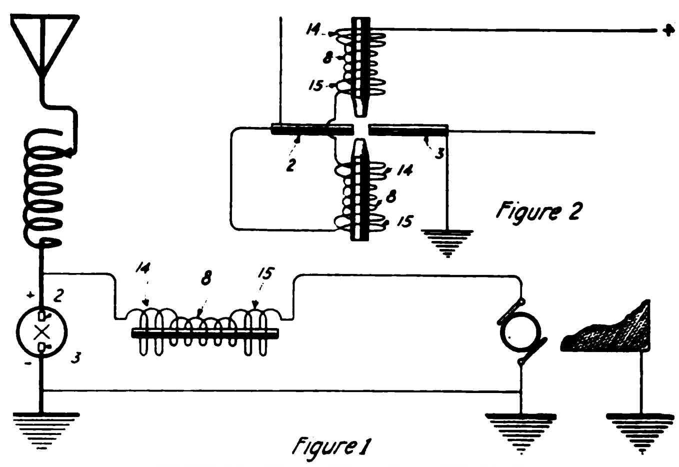
A PATENT recently issued to L. F. Fuller, covers the reduction in size, cost, and weight of an arc radio transmitter, and also provides a transmitter which has a D.C. generator which is safer to handle than the generators formerly used in arc transmitters. The Poulsen arc radio generator comprises a closed chamber containing an atmosphere of hydrogen in which are arranged electrodes between which the arc is formed. The arc gap is subject to a strong transverse magnetic field produced by field windings arranged in the D.C. circuit which supplies the arc. A choke coil is arranged in each arm of the circuit between the D.C. generator and the arc to prevent the high frequency oscillations produced by the arc from reaching the generator.

For purposes of coil insulation, it has always been considered essential to place the magnetic windings in the lead between the generator and the arc electrode, which is grounded. In this prior construction, it is inadvisable to ground the frame of the D.C. generator on account of the large inductive kick of the arc magnet winding which produces dangerous potential surges which, if the frame were grounded, would be impressed on the D.C. generator insulation, causing burn-outs. The generator frame has, therefore, always been insulated from the earth with the result that it frequently became highly charged, and therefore, a source of danger. Also, in the tropics, the material used for insulating the frame from earth, sometimes warps and shrinks, throwing the generator out of alignment with the prime mover. Fuller has found that by combining the choke and magnet coils and placing them in the lead which is connected to the antenna side of the arc and by grounding the generator side of the armature to the generator frame, that a better and cheaper construction is produced than was possible with the prior arrangement. Usually, but not necessarily, the negative lead is connected to the grounded side of the arc.

Figures 1, 2 and 3 are respectively a diagrammatic representation of Fuller's invention, a diagrammatic representation of a modified form of arc generator, and an elevation, half in section, of the combined magnetic and choke coils.

The oscillation generator of the invention comprises two electrodes, 2 and 3, between which the arc is formed, the electrode 2 being connected preferably to the positive side of the electric generation and to the antenna and the electrode 3 being connected preferably to the negative side of the generator and to the ground. The magnetizing winding, 8, is arranged in the lead between the generator and the electrode 2. This winding may be concentrated on one pole or may be placed on both poles, and when so placed, the winding may be in series as shown in figure 2, or they may be in parallel. The other lead connects the ground electrode directly with the armature of the generator and this side of the armature and the generator are grounded. Fuller has found it advantageous to combine the magnetic winding and the choke coil in one winding. That end of the combined winding which is connected to the electrode 2 is constructed so as to serve as the choke coil and since it is often impossible to determine in advance which end of the coil will be connected to the electrode on account of various features of installation, he prefers to form choke coils 14 and 15, at each end of the combined coil. The turns of the winding nearest the electrode are subject to higher duty than the inner turns of the coil and outer turns 14 and 15 are more heavily insulated than the inner turns. The end turns of both ends of the coil are covered with increased insulation for the reason stated before, but when it its definitely known which end of the coil is to be connected to the electrode, the turns on that end only, will be provided with heavier insulation.

The combined coil is built up on a spool, 16, within which the magnet pole is arranged.



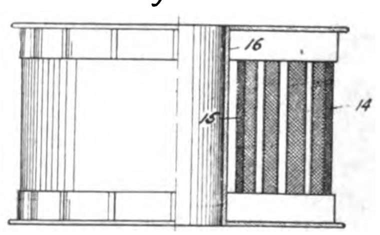


Figure 3

Figures 1, 2, 3—Wiring circuit, arc generator and the combined magnetic and choke coils respectively

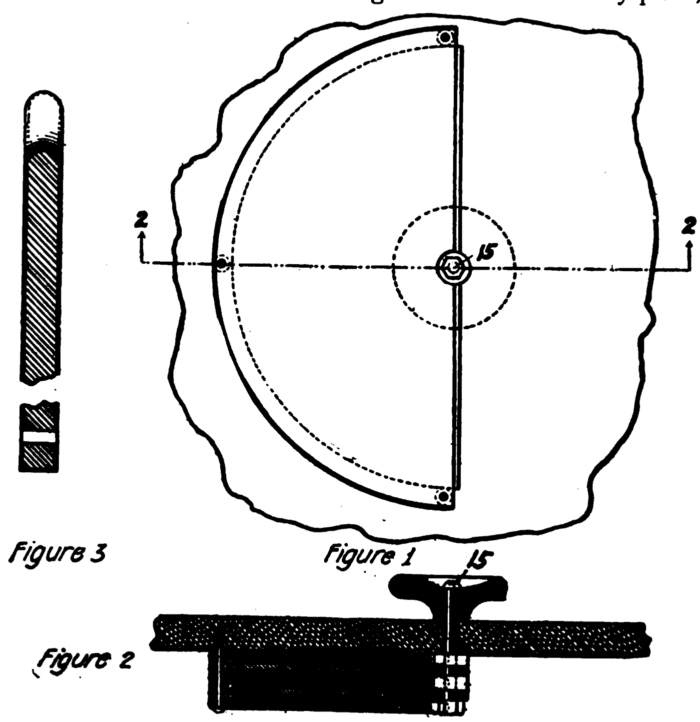
A New Variable Condenser

A NEW method of condenser construction is disclosed in a patent recently issued to Robert J. Fitzgerald. The main object of his invention is to provide more efficient and more easily applied insulation for the condenser plates and as an important feature of the invention, he coats the various conducting elements with a non-conducting film, permanently deposited thereon and enveloping the conductor. This non-conducting film or jacket is of such a character that it is not affected by the temperature, chemical or electric conditions with which the condenser is subjected. As an example of such a film, an enamel composition of such character that it may be backed onto the plates may be employed.

In the accompanying drawings, one embodiment of the invention is illustrated on a large scale so far as the thickness of certain parts is concerned, in order to facilitate illustration. Figure 1 is an inverted plan view. Figure 2 is a section of the line 2-2 of figure 1. Figure 3 is an enlarged view of one of the elements.

In the form shown, the condenser is mounted on a slab of any suitable non-conducting material. Several stationary condenser plates of semi-circular form are rigidly secured to this slab by connecting bolts or other suitable means and the plates are held in spaced relationship by spacers. The single rod 15 extends through the plates approximately at the center of the curvature and is positioned at the center of the curvature of the stationary plates, which are shown as cut away midway of the straight line, to form a recess receiving the shaft as is the usual apparatus.

By means of this invention, the use of separate insulation plates is avoided. Each plate carries its own insulation and in case of the breakage of insulation of any plate,



Figures 1, 2, 3—Details of the variable condensers

the plate may be readily removed and replaced by a new one.

Condenser Construction

IN THE construction of condensers where solid dielectric is used, intimate contact between the surfaces of the conducting plates and the insulating sheets is highly desirable. If there are spaces present between the conducting sheets and the dielectric, the capacity of the condenser is cut down owing to the larger distances between the plates and the capacity of different elements varies

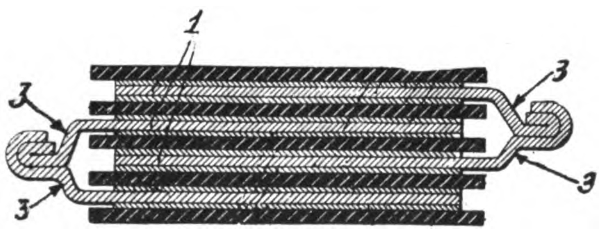


Figure 1—Assembly of the conducting and dielectric plates

because of the irregularity of such spaces. Furthermore, the dielectric medium lacks uniformity since it consists at some points solely of mica and at other points of mica and air, or impregnating compound, if the latter be employed.

In figure 1, William Dubilier shows a method whereby the inconvenience above mentioned may be avoided. Between the hard conducting plates 3, and the dielectric plates 1, are interposed conducting plates made of soft foil. The assembly is then subjected to an extremely high pressure of the order of several thousand pounds, with the result that the faces of the conducting plates and insulating sheets are intimately connected and brought into absolute union, with each other; for instance, if mica be employed as a dielectric, its hairy and minutely irregular surface will be imbedded into absolute union with the conducting plates so as to eliminate any small voids or spaces between the same; that is, the soft foil works itself into the depressions of the mica sheet at the same time maintaining perfect connection with the hard copper conducting sheet, 3.

Dubilier also shows his method of adjusting fixed condensers in order that they may have a predetermined capacity value. Figure 2 shows condenser sections set up and connected in series in order to form a condenser which will withstand high electromotive forces. Heretofore, condensers made of a large number of conducting plates and insulating sheets have been tested after being completed, and the capacity adjusted, by tearing off or adding the required number of insulating sheets and conducting plates to bring the capacity within the necessary limits. After adjusting the capacity in this way, there is a certain amount of "patch work" on each condenser, which is obviously undesirable, and it is necessary to change the terminal connections of the conducting plates in order to accommodate a greater or smaller number, as may be required. In some instances, condensers made up of several condenser sections have been employed, each of such sections consisting of a number of conducting plates and insulating sheets bound together and the terminals of the sections connected in series or in parallel to make up the complete condenser. The capacity of condensers of this latter type has been brought within desired limits by tearing off or building on the necessary number of conducting plates and insulating sheets to the last section. This practice is open to the same objections as above mentioned and also to the further disadvantage that the removal of conducting plates from the last or end section may reduce the area or effective surface of the latter to such an extent as to give a breakdown in that section. In condensers where high potentials are to be withstood, it is desirable to distribute the potential over a large number of condenser sections in order that no single section may be subjected to undue stress. Figure 2 shows a condenser of the last mentioned type in which the disadvantages heretofore encountered in making capacity adjustment are avoided. In making up a condenser of any desired capacity, several sections are built up and the individual capacity of each section is made of such value that when approximately the number of sections necessary to provide a complete condenser of approximately the desired capacity, are connected, the addition or withdrawal of a section from the complete condenser will produce a change in the capacity of the condenser less than the permissible error. In other words, when about the proper number of sections have been connected, the capacity of the complete condenser is tested and one or more sections added on or removed, as may be necessary.

Since the capacity of the sections has been so chosen that when the approximate desired capacity has been reached, the addition or removal of a section will produce a change in capacity well within the permissible variation from standard. It is also possible to bring the capacity of the condenser to a value within the prescribed limits in the above manner.

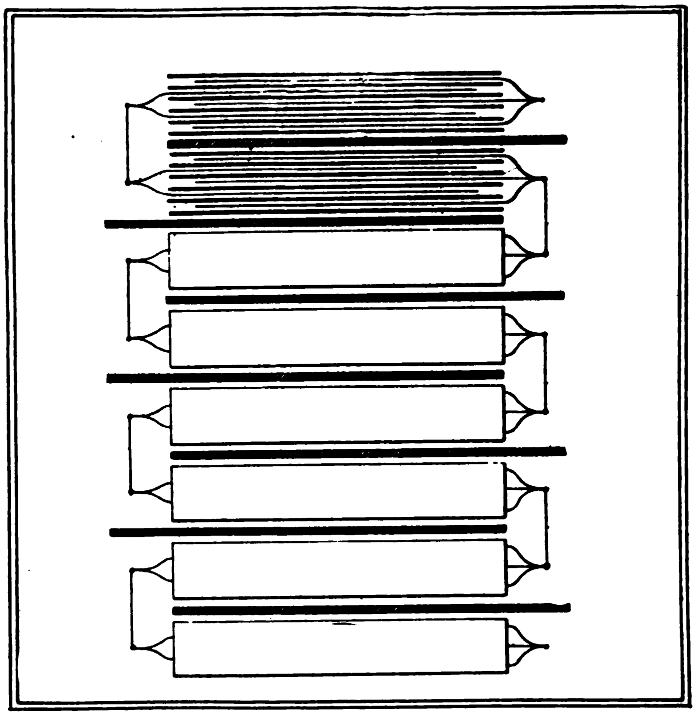


Figure 2—Condenser sections set up and connected in series

Controlling the Amplitude of Radio Frequency Continuous Oscillations

IT has been found that an electron discharge device comprising an incandescent cathode, a co-operating anode, and a discharge controlling member of the grid inclosed in an evacuated envelop may be employed for producing radio frequency oscillations. In order to secure this result a source of energy is placed in the plate circuit of the device, which includes the cathode, the anode, and an inductance, and this circuit is coupled with the grid circuit, which includes the cathode and grid, and a second inductance. If a suitable degree of coupling is provided between the two circuits enough energy is transferred from the plate circuit to the grid circuit to impress upon the grid the potential necessary to control the flow of current in the plate circuit in the desired manner. In some cases the electrostatic coupling betwen the two circuits, which is always present by reason of the capacity between the electrodes, is sufficient to bring about the desired result. In other cases this is supplemented in various ways, as, for example, by a coupling between the inductances in the two circuits, or by an additional electrostatic coupling consisting of a condenser between the grid and anode, or by a combination of the two forms of coupling. Because of the unidirectional conductivity of the electron discharge device, the current in the plate circuit will usually be pulsating in character. For practical purposes, however, it may be considered as being made up of two components, one a constant direct current, and the second an alternating current superimposed upon the direct current. In order to utilize this alternating component in a radiating system it has been customary to couple a coil in the antenna with the plate circuit inductance. It has also been customary to employ variable condensers in the plate or grid circuits, or in both circuits, for tuning the system to produce the desired frequency of oscillations. With the systems heretofore employed, in order to secure maximum efficiency of output, it has also been necessary that the antenna should be tuned to the same frequency as the system which produces the oscillations.

Dr. A. N. Goldsmith provides a system in which the entire tuning may be accomplished by varying one of the constants of the antenna, and in which the necessity of an inductive coupling between the antenna and the system producing oscillations is avoided. In accomplishing this object the grid and plate circuit inductances are included directly in the antenna, and the capacity of the antenna is made use of in place of the condensers previously employed for tuning the grid or plate circuits.

In case it is desired to utilize the radio frequency oscillations produced by the electron discharge device for the transmission of sound waves, it has been proposed to superimpose upon the grid circuit of the device a variable current produced by means of the sound waves which it is desired to transmit. With this arrangement the degree of control which can be secured is limited to some extent by the amount of energy which can be controlled by an ordinary telephone transmitter. Hence it will be apparent that if means are provided for amplifying the current variations produced by the telephone transmitter a larger degree of control may be secured. A further object of this arrangement is to provide simple and efficient means for amplifying the audio frequency current produced by the telephone transmitter. In accomplishing this an audio frequency coupling is used between the grid and plate circuits. When the telephone current is superimposed upon the grid circuit corresponding but amplified variations are produced in the current in the plate circuit. These amplified current variations are, by means of the audio frequency coupling fed back into the grid circuit, and as a result of the audio frequency potential variations upon the grid are made much greater than it is possible to secure by means of the original telephone current alone.

As indicated in the drawing, an electron discharge device is used which comprises an electron emitting cathode of filamentary form, a plate-shaped anode, and a grid interposed between the cathode and the anode, all inclosed in an evacuated envelop. The plate circuit of this device includes the cathode, anode and inductance and a direct current generator. Current for heating the cathode to cause it to omit electrons is supplied by a battery, the means for regulating the heating current which is customarily used being omitted in order to simplify the drawing. The grid circuit comprises the cathode, grid, an inductance and coils 9 and 10 of transformers adapted to the transformation of audio frequency currents, for

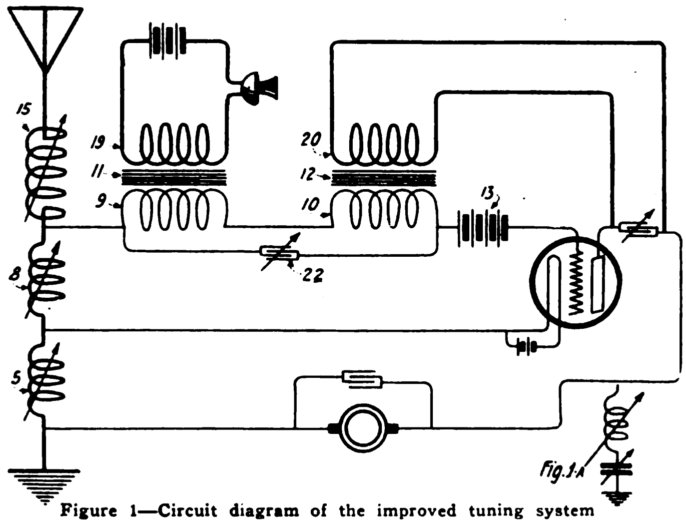


Figure 1—Circuit diagram of the improved tuning system

example, the iron core transformers 11 and 12. The antenna may be connected to the top of the inductance through a tuning coil or directly connected to the top of coil, depending upon the antenna characteristics, and the radiating system is grounded through inductances 8 and 5. With the connection thus far described the grid and plate circuits are coupled electrostatically by reason of the capacity between the electrodes and this coupling is supplemented by the capacity of the antenna which is in effect connected between the grid and anode. The relative positions of coils 5 and 8 may also be made such as to furnish any desired degree of inductive coupling between the two circuits.

It is desirable to have the effective impedance in the output circuit of an oscillation discharge device, or several such devices in parallel or series, equivalent to the net internal impedance, which is mostly resistance, of such device or devices. This requires the introduction of the antenna reactance and resistance into the oscillating circuit with a transformer ratio which is, in general different from unity so as to obtain the most efficient operation. The coil 15 provides such a means of varying the ratio of transformation whereby the antenna reactance and resistance are introduced into the oscillating circuit, and a condenser in the antenna circuit, usually in the ground lead, would provide a similar means of adjustment though in the opposite sense.

The arrangement thus described is adapted to produce radio frequency continuous oscillations, the frequency of which may be varied by varying the tuning of the system by means of the tuning coil. The tuning of the system may also be varied by varying the inductance of coil 8 or coil 5, or, if desired, a variable condenser may be connected between the bottom of coil 5 and ground as shown in figure 1A. It will also be apparent that the desired result may be obtained by varying any two or more of the above-mentioned elements. In order to control the amplitude of the oscillations thus produced in accordance with the amplitude of the current produced by sound waves, current from the telephone transmitter supplied by a local battery is caused to flow through the primary of the transformer 11. When the transmitter is acted upon by sound waves, a variable telephone current will flow through the primary of the transformer. The potential of the grid is thus caused to vary in accordance with variations in the telephone current and the amplitude of the oscillations produced in the antenna will thereby be varied in accordance with the variations in the current through the transmitter. The current in the plate circuit will vary in the same way. This current will now have in addition to the radio frequency component an audio frequency component which varies in accordance with the variations in the telephone current, and this component is caused to flow through the primary of transformer 12, and is thus superimposed upon the grid circuit causing a further increase in the amplitude of the audio frequency potential variations upon the grid, provided the coils 19, 9, 20 and 10, are connected in such a way as to give the proper polarity to secure the reinforcing action. The condenser in the plate circuit which shunts the primary 20 is given such a value that it offers a low impedance to the radio frequency component of the plate circuit by a high impedance to the audio frequency component. The condenser which shunts secondaries of transformers 11 and 12 is also given such a value that it offers a low impedance path to the radio frequency component of the current in the grid circuit. The condenser may be employed for shunting the source of current in order that the radio frequency component of current in the plate circuit will not be compelled to pass through this source.

In the arrangement shown in figure 2, a plurality of electron discharge devices connected in parallel are employed for producing oscillations, the cathodes of all of these devices being supplied with heating current by common battery. In this case the source of current instead of being connected in series in the plate circuit is connected in the parallel branch, and an inductance is employed to prevent the radio frequency component of the plate current from flowing through the source and to insure efficient production of radio frequency energy. The coil 25 acts as a maintaining inductance in that it gives rise to radio frequency potential differences at its terminals. The result is that the plate circuit voltage of the electron

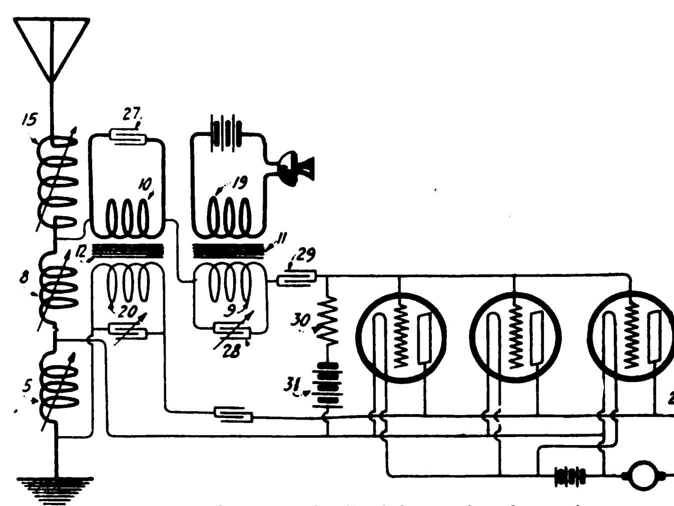


Figure 2—Modified form using three tubes

discharge device, that is, the voltage between filament and plate, is variable with a radio frequency component. Because of the phase of the grid potential control, the voltage is highest when the internal resistance in the bulb is highest between plate and filament, and the external voltage is least when the energy is absorbed per cycle in the discharge device, and increased efficiency results. The condenser in the second branch of the plate circuit serves to prevent the direct current component of the plate current from flowing through this branch. In this case separate condensers 27 and 28 are employed for shunting the coils 9 and 10 instead of the single condenser 22.

Construction of a Simple Wavemeter, Range 150-500 Meters

By A. H. Rice Jr.

THE construction of a wavemeter of efficient design is so simple and the benefits to be derived from its use so numerous, that the writer feels that the small expense involved in making one is more than justified.

There are probably two reasons why a wavemeter is not a part of every experimenter's equipment; first, the bugbear of having it calibrated; and, second, the extravagance of possessing an idle condenser. Both of these objections have here been eliminated and if directions are followed carefully, an accuracy within 5% may be obtained without calibration, which is sufficient for practical work, and the condenser, when not being used for measurements, may be placed in any part of the receiving circuit.

A wavemeter consists essentially of an inductance of known value and a variable capacity. A Murdock No. A366 condenser, having 43 plates and a maximum of .001 mfd. capacity was selected, as they have been found to be uniform in construction and are very reasonable in price. The corresponding wavelengths for the various settings of the condenser may be calibrated directly on a celluloid scale and this, in turn, may be fastened to the condenser or they may be plotted in curve form. In order to simplify construction, the latter method has been chosen, see figure 5.

The inductance may be wound on a mailing tube having an outside diameter of 5 inches and about 2 inches long, although, if there is a lathe handy a wooden ring of these dimensions will result in a much better looking coil. Nineteen turns of No. 20 SSC wire are necessary, the winding covering a space of about 3/4 inches. Small binding posts should be mounted at each end of the coil, as indicated in the diagram, to which the terminals should be carefully soldered. The tube should be dipped in shellac and dried out to prevent shrinkage, but no shellac should be placed over the winding.

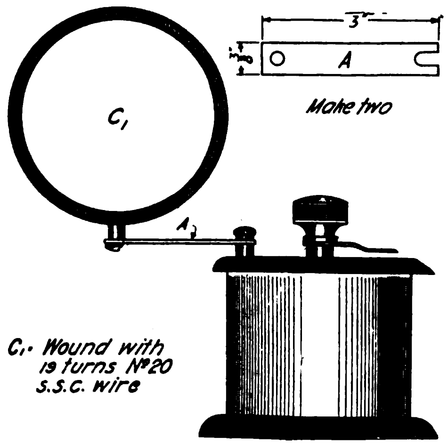
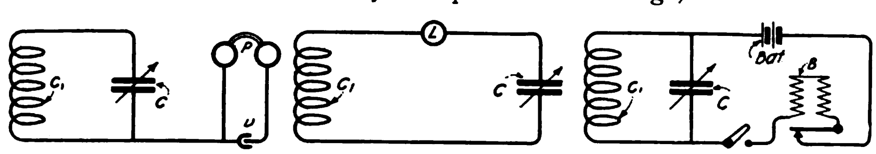


Figure 4—Showing the coil connected to condenser



C_1 - Inductance. C - Var. Cond. L - Lamp. D - Detector P - Phones B - Buzzer

Figure 1 Figure 2 Figure 3

Figures 1, 2, 3—Connections required for various measurements

In addition to the inductance and capacity, a buzzer, small flash light bulb and mineral detector are necessary; the bulb and detector are used for ascertaining the maximum efficiency of the transmitter or the wavelength of an incoming signal and the buzzer is used as a transmitter to generate oscillations of known wavelength.

In connecting up the meter, the experimenter is advised to make all connections as short and direct as possible with No. 16 bare copper wire, excepting those from the coil to the condenser, which should be made of strip brass 1/16 inch thick, see figure 4.

Figures 1, 2 and 3 show the connections required for various measurements and particular attention is called to the fact that in figure 1, the phones are not connected across the condenser, for if this were the case, their additional capacity would require a re-calibration of the meter.

No effort will be made to burden the reader with instructions on the various methods of using the wavemeter, as this has been fully covered in several complete works on the subject and in many of the current magazines.

Reference to the diagram will disclose any details which may have been omitted in this description. All of the apparatus may be mounted on a panel and placed in a cabinet for convenience if desired, but unless the reader is an expert at woodworking, he is urgently advised to turn this job over to his cabinetmaker, as careful workmanship here will make the wavemeter a "thing of beauty and a joy forever."

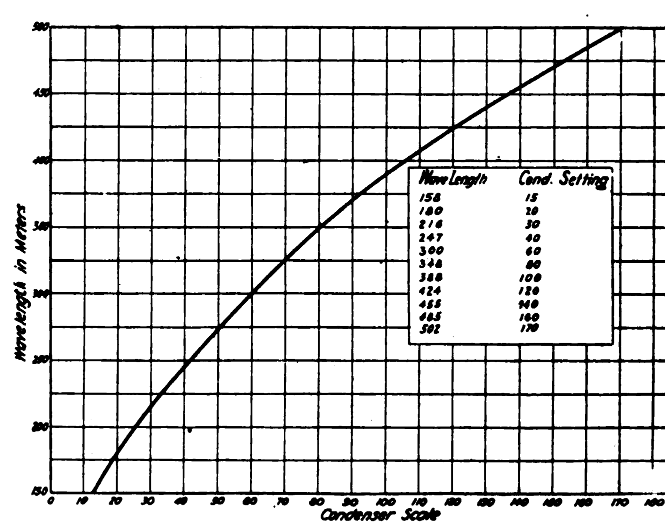


Figure 5—Graphic curve and chart showing various calibrations

Wind Your Own Honeycomb Coils

By C. J. Fitch

THERE is no doubt that honeycomb coils are the most practical inductance coils that the amateur can find. The price of a complete set of coils including the coil mounting is, however, beyond the reach of many experimenters. The obvious remedy is to wind your own honeycomb coils.

The experimenter who tries to wind these coils by hand usually fails, because each turn being wound diagonally around a cylinder is oval shaped and tends to straighten out to a circle, taking the shortest path around the cylinder. As a result the winding collapses. To prevent this, the wire must be wound on a form so shaped that each turn is already around the shortest path of the form. The form, therefore, must be spherical in shape; then each turn, no matter which direction it is wound, will not shrink to a smaller size and loosen the whole winding. This not only facilitates the winding, but makes a better coil mechanically and electrically. Mechanically, the coil is self-supporting and will stay as wound when removed from the form. If given a coat of shellac, the coil is very strong, and can be used for many purposes, as for variometers, wavemeters, etc. Electrically, the coils have a greater inductance than those wound on a cylinder with the same amount of wire.

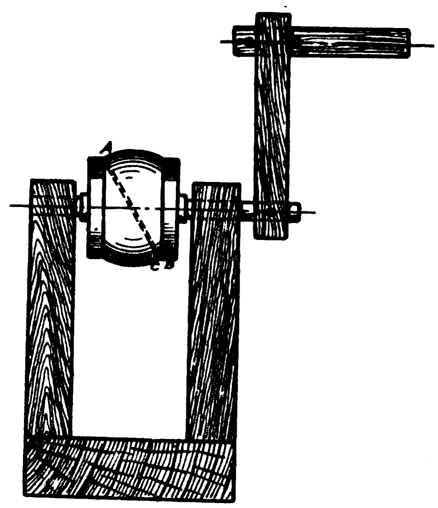


Figure 1—Machine for winding honeycomb coils

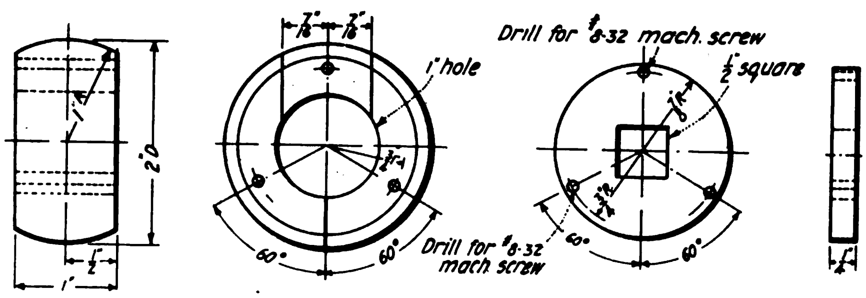


Figure 2—Constructional details of the arbor

Figure 1 shows a machine for winding honeycomb coils which anyone can build. The entire machine is made of wood.

Figure 2 shows the details of the arbor. It can be cut out of a piece of soft wood with a knife and sandpapered smooth or turned out on a lathe.

To wind a coil, first fasten the machine securely to a bench or table. Clamp the end of the wire under the end plate at A, figure 1, and wind diagonally across the arbor to B, as shown by the dotted line. From B, wind around to A, cross over the first turn at A and wind onto C. Continue in this way, spacing the turns about 1/16" apart, till the winding is complete. Then remove the coil and apply a coat of white shellac.

The writer has wound several coils in this way as easily as a single layer cylindrical coil could be wound, and they have an appearance equal to machine wound coils.

Figure 3 shows the method of mounting the coils on a panel so that they can be swung back and forth on hinges to vary the coupling. Two coils should be hinged to the panel and a third coil fastened stationary to the panel between the hinged coils. One hinged coil is the primary, the middle coil the secondary, and the third coil the tickler coil, for the regenerative circuit.

As shown on the drawing, the clips are arranged so that a coil can easily be removed, and another coil inserted in its place.

The following gives winding data for a set of coils suitable for the average amateur station:

No. of Coils	No. of Layers of Wire	Size of Wire
2	2	24
2	4	24
2	6	24
2	10	26
2	14	26
1	18	26
1	22	28
1	26	28
1	30	28

Tuning is accomplished with variometers or variable condensers. With a primary condenser of .001 mfd. and a secondary condenser of .0005 mfd., a wide range of wavelengths can be covered.

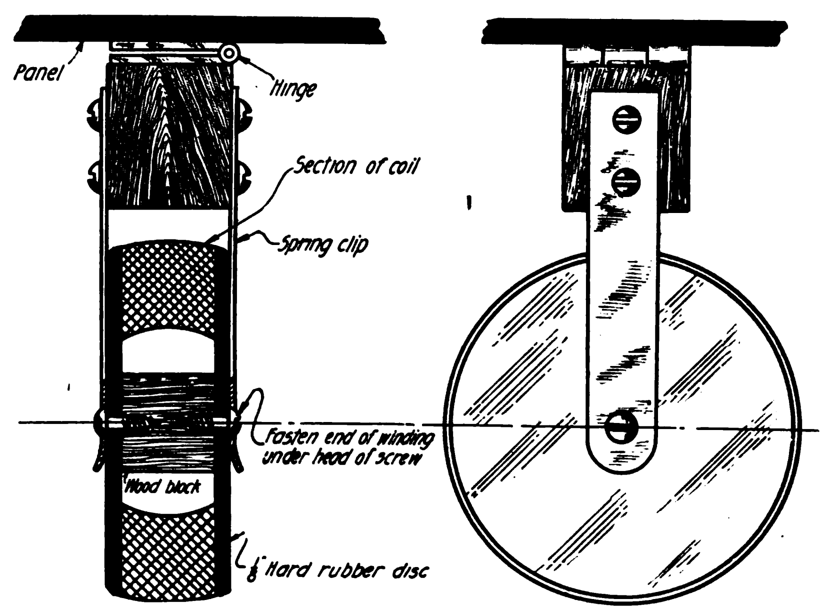


Figure 3—Method of mounting the coils

Second District Call Letters of Amateur Stations

Letters.	Power.	Name and address.
2AA	18	Vincent J. Fritch, 939 College Ave., New York City.
2AB	1000	M. W. Sterns, 129 Wadsworth Ave., New York City.
2AC	50	Chester R. Gernert, 41 Bridge St., Somerville, N. J.
2AD	45	Theo. N. Whildin, Oakdale, Long Island, N. Y.
2AE	80	Wm. H. Hoppi, 365 Quincy St., Brooklyn.
2AF	500	Benj. Berlin, 1252 Flatbush Ave., Brooklyn, N. Y.
2AG	25	Howard Terry, 25 Myrtle Ave, Keyport, N. J.
2AH	500	A. Edelman, 956 Legett Ave., New York City.
2AI	50	John G. Eber, 5505 Third Ave., Brooklyn.
2AJ	40	Edwin T. Buttner, 1376 Third Ave., New York City.
2AK	500	Carl J. Hunkins, Johnson Ave., Newark, New Jersey.
2AL	36	Walter N. Stanley, 451 Hancock St., Brooklyn.
2AM	250	Henry L. Bantelman, Jr., Tuckahoe Rd., Yonkers, N. Y.
2AN	250	Conrad J. Sedlak, 633 Main St., North Bergen, N. J.
2AO	1000	Robert J. Freeman, Aloah Rdo. Sta., Southampton, N. Y.
2AP	500	C. F. Unger, Franklin Ave., Harrison, N. Y.
2AQ	25	Harry Blutstein, 723 Stone Ave., Brooklyn.
2AR	500	G. H. Underhill, 78 S. Hamilton St., Poughkeepsie, N. Y.
2AS	220	Harvey Kennedy, 1965 Vyse Ave., New York City.
2AT	15	Herman Fischer, Jr., 146 Myrtle Ave., Irvington, N. J.
2AU	220	Chas. J. Huff, 1972 Honeywell Ave., New York City.
2AV	250	Frank S. LeRoy, 103 So. Maple Ave., Ridgewood, N. J.
2AW	14	Arthur A. Heberlein, 768 Melrose Ave., New York City.
2AX	500	Howard Blower, 664 E. 18th St., Brooklyn.
2AY	100	Burton Greenburg, 332 E. 67th St., New York City.
2AZ	500	Eugene S. Pearl, 307 Gregory Ave., Passaic, New Jersey.
2BA	550	H. M. Ash, Oakland, N. J.
2BB	990	I. R. Lounsberry, Jr., 15 Ann St., Ossining, New York.
2BC	50	Charles Mulligan, Washington Ave., Bergenfield, N. J.
2BD	24	Elmer G. Baier, 253 Ninth St., Brooklyn.
2BE	50	George S. Yerbury, 331 Lafayette Ave., Passaic, N. J.
2BF	500	B. H. Mills, U. S. Gen. Hospital No. 41, Fox Hills, S. I.
2BG	250	George F. Gaede, Pompton Rd., Paterson, N. J.
2BH	22	Henry G. Muller, 2900 Eighth Ave., New York City.
2BI	50	James Wood, 1420 Putnam Ave., Brooklyn.
2BJ	550	H. H. Dahms, 21 Manitou Ave., Poughkeepsie, N. Y.
2BK	700	Carl E. Trube, 6 Livingston Ave., Yonkers, N. Y.
2BL	25	Reed Cline, Main St., Millerton, N. Y.
2BM	770	E. Heermance, 523 State St., Hudson, New York.
2BN	800	E. G. Sisson, Jr., 57 Union St., Montclair, N. J.
2BO	500	M. A. McIntire, 1127 Ave. G, Brooklyn, N. Y.
2BP	500	John Pollock, 230 W. 99th St., New York City.
2BQ	236	Baldwin Guild, 636 Mt. Prospect Ave., Newark, N. J
2BR	75	Leroy S Callan, 1087 New York Ave., Brooklyn, N. Y.
2BS	500	Frdk. E. Garlick, 23 Occident Ave., Tompkinsville, N. Y.
2BT	12	Earl F. Adams, 1048 Julia St., Elizabeth, N. J.
2BU	50	Harold T. Sniffin, 730 E. 178th St., New York City.
2BV	12	Reginald K. Woodward, 84 Amherst St., East Orange, N. J.
2BW	500	E. T. Hynes, 2429 Valentine Ave., New York City.
2BX	18	Brownes Business College, Brooklyn, N. Y.
2BY	220	Erwin Oeller, 511 Mumford St., Schenectady, N. Y.
2BZ	250	Will T. Weatherbee, 609 W. 186th St., New York City.
2CA	50	Harry G. Lichtenstein, 1245 Madison Ave., New York City.
2CB	30	John D. Schram, 283 E. 32nd St., Brooklyn.
2CC	500	Clarence Collignon, Montvale, New Jersey.
2CD	980	Roger D. Prosser, Chestnut St., Englewood, N. J.
2CE	1000	J. W. Dain, 1100 Orchard St., Peekskill, New York.
2CF	75	Arthur E. Prince, 30 South Eldert Ave., Rockaway Beach.
2CG	550	Frederic K. Shield, Coxsackie, N. Y.
2CH	500	S. Isaacson, 900 Riverside Drive, N. Y. C.
2CI	25	Clarence H. Osborn, 97 Watkins Ave., Middletown, N. Y.
2CJ	500	Walter E. Bathgate, 102 High St., Passaic, N. J.
2CK	880	T. F. O'Brien, 19 Nassau Ave., Freeport, N. Y.
2CL	500	George L Storm, 742 Highland Ave., Newark, N. J.
2CM	220	H. Zimmerman, Jr., 2590 Third Ave., New York City.
2CN	220	Edward T. Dickey, 1649 Amsterdam Ave., New York City.
2CO	50	Peter Cooper, 512 Sewal Ave., Asbury Park, N. J.
2CP	600	Jas. P. Devine, 1068 University Ave., New York City.
2CQ	660	E. M. Washburn, 111 Miln St, Cranford, N. J.
2CR	75	Morris Lieberman, 524 Barbey St., Brooklyn.
2CS	1000	Charles M. Schaefer, 201 Park Ave., Port Richmond, N. Y
2CT	750	Matthias Thury, 878 Macy Place, New York.
2CU	24	H. B. Von Thun, 271 Decatur St., Brooklyn.
2CV	50	Herbert G. Rowley, 107 Clifton Ave., Newark, N. J.
2CW	995	F. M. Ham, 403 Prospect St., Westfield, New Jersey.
2CX	50	Ernest K. Seyd, 531 Washington Ave., Brooklyn.
2CY	50	Herbert G. Rowley, 107 Clifton Ave., Newark, N. J.
2CZ	440	Frank V. Becker, 12 Callister St., New York City.
2DA	1000	A. H. Winn, 325 Church St., Poughkeepsie, New York.
2DB	220	R. D. Zucker, 46 Clinton Place, Mt. Vernon, N. Y.
2DC	25	John Stofan, 95 Grand St, Garfield, New Jersey.
2DE	25	Arthur Mahn, 539 E. 145th St., New York City.
2DF	500	Harry G. Silversdorff, 641 Pavonia Ave., Jersey City, N. J.
2DG	108	Harry Y. Higgs, 30 Irving Place, Brooklyn, N. Y.
2DH	72	Samuel W. Knapp, 75 Cooper St., Brooklyn.
2DI	250	Ernest A. Cyriax, 219 E. 71st St., New York.
2DJ	1000	E. B. Lant, Scarsdale, N. Y.
2DK	50	Wm. R. Chinn, 25 Westchester Ave, White Plains, N. Y.
2DL	990	V. F Bangert, 34 Orchard St, Jamaica, N. Y.
2DM	880	H. C. Nightingale, 349 18th Ave., Paterson, N. J.
2DN	25	Arnold Brilhart, 10 Cornell Ave., Yonkers, N. Y.
2DO	30	Louis J. Wadsworth, 1494 Bushwick Ave., Brooklyn.
2DP	500	Charles Fucci, 606 Henderson St., Jersey City, N. J.
2DQ	12	R. W. Porter, 166 78th St., New York City.
2DR	500	T. C. Cooper, 269 Garfield Ave., Jersey City, N. J.
2DS	880	LeRoy Clark, Chestnut St., Englewood, N. J.
2DT	500	F. T. Hermann, 131 Main St., Hempstead, L. I.
2DU	100	J. E. Engstrom, 100 St. Marks Place, Brooklyn.
2DV	500	E. D. Hallett, 86 Prospect Pl., Rutherford, N. J.
2DW	18	J. J. Hallahan, 180 Market St., Perth Amboy, N. J.
2DX	100	I. R. Greves, 34 Hobart Ave., Summit, N. J.
2DY	500	A. J. Haynes, 128 W. 80th St., New York City.
2DZ	50	Daniel D. Hancock, Newman Springs Ave., Red Bank, N. J.
2EA	500	Edwin S. Crane, 47 Sinclair Ave., Flushing, N. Y.
2EB	50	Edward V. Neuser, Ridge St., Pearl River, N. Y.
2EC	24	F. C. W. Thiede, 486 Decatur St., Brooklyn.
2ED	400	Graham V. Lowe, 262 W. 77th St., New York City.
2EE	250	E. W. Maurer, 65 Osborn St., Keyport, New Jersey.
2EF	50	Theo. Hurd, 7 Tilton Ave., Red Bank, New Jersey.
2EG	1000	Egmont Arany, 62 W. 124th St., New York.
2EH	1000	E. M. Williams, 1627 Seventh Ave., Troy, New York.
2EI	500	Henry C. Quick, 471-75th St., Brooklyn.
2EJ	200	Russel Davis, 601 Page Ave., Allenhurst, N. J.
2EK	50	M. Ferris Roberts, 17 Heights Terrace, Ridgewood, N. J.
2EL	990	H. H. Carman, 217 Bedell St., Freeport, L. I., N. Y.
2EM	50	Chas. F. Jacobs, 279 Park Place, Brooklyn.
2EN	18	George B. Huss, 30 Clifton Ave., Lakewood, N. J.
2EO	50	Samuel Levelle, 255 So. Manning Blvd., Albany, N. Y.
2EP	25	Chas. P. Baulser, No. Main St., Pearl River, N. Y.
2EQ	990	J. J. Nightingale, 741 Market St., Paterson, N. J.
2ES	50	Frank M. Ende, MacFarland Ave., Arrochar Park, S. I.
2ET	500	G. B. England, 917 St. Nicholas Ave., N. Y. C.
2EU	50	Harry Davis, 520 Clinton Ave., Newark, N. J.
2EV	500	Edwin Lentz, 5 Mertz Ave., Hillside, N. J.
2EF	500	John C. H. Steinkamp, 89 Hyatt Ave., Yonkers, N. Y.
2EX	550	B. B. Jackson, 34 E. Newell Ave., Rutherford, N. J.
2EY	475	F. J. McKinney, 300 Glenwood Ave., Bloomfield, N. J.
2EZ	50	Jas McAnley, 311 W. 54th St., New York City.
2FA	24	Wm A. LeMay, 1117 Hutton St., Troy, N. Y.
2FB	24	Harold Cohn, 546 W. 146th St., N. Y.
2FC	50	Fred Clayton, 607 Emory St., Asbury Pk., N. J.
2FD	30	John DiBlaisi, 227 E. 75th St., New York City.
2FE	1000	M. G. Pawley, Blair Academy, Blairstown, N. J.
2FF	90	Harold S. Brower, 19 So. Clinton St., Poughkeepsie, N. Y.
2FG	1000	F. H. Myers, 540 Providence St., Albany, N. Y.
2FI	750	Geo. E. Cole, 36 Watsessing Ave., Bloomfield, N. J.
2FJ	50	Frdk. A. Girard, Magnolia St., Montvale, N. J.
2FK	440	Richard W. Freure, 439a McDonough St., Brooklyn, N. Y.
2FL	1000	K. R. Woodruff, 616 Clifton Ave., Clifton, N. J.
2FM	880	Francis McCartin, Jr., 524 Paige St., Schenectady, N. Y.
2FO	50	W. S. Blanchard, 401 Westervelt Ave., New Brighton, N. Y.
2FP	60	Harold Peiler, 321 E. 90th St., New York City.
2FQ	50	Joseph Pignone, 2065 Anthony Ave., New York City.
2FR	75	J. R. Richardson, 16 Culver St., Yonkers, N. Y.
2FS	500	Howard L. Stanley, Prospect St., Babylon, N. Y.
2FT	1000	Wm. E. Murray, 521 N. James St., Peekskill, N. Y.
2FU	180	Chas. I. Hertz, 510 W. 144th St., New York City.
2FW	990	C. V. Macpherson, 590 W. 172nd St., New York City.
2FX	880	Ray V. D. Gedney, Center Ave., Little Falls, N. J.
2FY	500	Dan Voepel, Jr., 1140 Clay Ave., New York City.
2FZ	500	F. Frimerman, 334 E. 100th St., New York City.
2GA	32	F. W. Miller, 4 Hicks Ave., Winfield, L. I.
2GB	50	Frank H. Giefer, Ravenhurst, West New Brighton, N. Y.
2GC	50	A. E. Sonn, 282 Parker St., Newark, N. J.
2GD	750	R. G. Kaufman, 20 Llewellyn Ave., Bloomfield, N. J.
2GE	990	George C. Otten, 58 Chichester Ave., Jamaica, N. Y.
2GF	48	J. C. Ruckelshaus, 566 Ridge St., Newark, N. J.
2GG	9	Chas. P. E. Gruetzke, Jr., 1237 Brook Ave., New York City.
2GH	500	M. Hardy, 373 W. 126th St., New York City.
2GI	50	Henry J. McCue, 76th St. and Shore Road, Brooklyn.
2GJ	440	E. G. Cronenmeyer, 1269 Theriot St., New York City.
2GM	50	W. Grumbacker, 514 W. 170th St., New York City.
2GN	50	John H. Peitler, 45 53rd St., Corona, N. Y.
2GO	50	H. G. Mulligan, 356 Madison Ave., Albany, N. Y.
2GP	50	Thos. Martin, 15 Troy Road, Menondo, N. Y.
2GQ	18	Chas. T. Manning, 81 Maple Ave., East Orange, N. J.
2GR	1000	John M. High, Jr., 254th St. and Independence Ave., N. Y.
2GS	75	Geo. D. Stewart, 90 N. Bway, Yonkers, N. Y.
2GT	600	J. V. N. Bergen, Port Jefferson, L. I.
2GU	36	N. Y. Catholic Protectory, Walker Ave., Van Nest, N. Y.
2GV	550	C. J. Ripperger, 147 Wisner Ave., Middletown, N. Y.
2GW	440	C. L. Homan, Sayville, L. I., N. Y.
2GX	500	Y. M. H. A., 92nd St. and Lexington Ave., N. Y. C.
2GY	50	Frank X. Hayes, 162 E. 82nd St., New York City.
2GZ	220	Robt. C. Barnes, 916 E. 179th St., New York City.
2HA	275	W. H. Sands, 80 Forster Ave., Mt. Vernon, N. Y.
2HB	22	H. L. Brown, 152 S. Broadway, Yonkers, N. Y.
2HC	250	Gordon Peck, 68 Woodruff Ave., Brooklyn.
2HD	12	K. C. Underwood, 54 N. 11th St., Newark, N. J.
2HE	50	Leroy Wm. Rock, 201 Beach St., Red Bank, N. J.
2HF	250	Chas. W. Coote, 725 W. 172nd St., New York City.
2HG	500	G. W. Krueger, 73 Lincoln Park, Newark, N. J.
2HH	500	P. H. Betts, 238 Valley Road, Montclair, N. J.
2HI	80	Howard I. Becker, 185 Division St., Schenectady, N. Y.
2HJ	15	H. J. Hasbrouck, Jr., 71 Elmont Ave., Port Chester, N. Y.
2HK	500	H. Geitz, 1926 Bleecker St., Ridgewood, L. I., N. Y.
2HL	25	M. Freyfus, 154 Fairmount Ave., Newark, N. J.
2HM	50	Clarence A. McKee, 821 E. 216th St., New York City.
2HN	440	Chas. H. Burch, 72 Third St., Long Island City, N. Y.
2HO	850	Wm. B. Lyons, Broad St., Bloomfield, N. J.
2HP	50	Thos. Martin, 15 Troy Road, Menondo, N. Y.
2HQ	50	Frdk. Doscher, 246 Morris Ave., Rockville Centre, N. Y.
2HS	25	Donald Van Brakle, 83 Maple Pl., Keyport, N. J.
2HT	50	Howard W. Ticknor, 316 Mt. Prospect Ave., Newark, N. J.
2HU	472	Grosvenor Hotchkiss, 146 Halsey St., Brooklyn.
2HV	50	Edw. D. Blodgett, 335 Rugby Road, Brooklyn.
2HW	16	Frank M. Hanna, 1211 Hutton St., Troy, N. Y.
2HX	100	Harry Alexander, 838 Riverside Drive, New York.
2HY	1000	Nelson M. Smith, 143 Norton Ave., Port Chester, N. Y.
2HZ	585	Arthur F. Clough, 96 Hamilton Ave., Yonkers, N. Y.
2IA	500	F. V. Bremer, 3613 Boulevard, Jersey City, N. J.
2IB	25	T. V. Geohegan, Pleasant Ave., Athenia, N. J.
2IC	990	Raymond I. Gratzner, City College of N. Y., New York.
2ID	50	Frank H. Schubert, Thatcher Ave., Harrison, N. Y.
2IE	24	H. A. Benzing, 802 E. Jersey St., Elizabeth, N. J.
2IF	500	John H. Bates, 513 Tinton Ave., New York City.
2IG	36	Wm. K. Caughey, 25 Mada Ave., W. New Brighton, N. Y.
2IH	25	Leo Samuels, 43 Treacy Ave., Newark, New Jersey.
2II	30	W. J. Howell, 135 Edgecombe Ave., New York City.
2IJ	50	Wm. Weller, 2156 Webster Ave., New York City.
2IK	550	O. L. Davis, 1337 S. Boulevard, New York City.
2IL	250	G. C. McClintock, 319 Dudley Ave., Westfield, N. J.
2IM	11	E. C. Williams, Jr., 120 Greenway North, Forest Hills, N. Y.
2IN	750	Geo. T. Droste, 203 E. 202nd St., New York City.

(To be Continued.)

A Small Radiophone Transmitter

By Clinton R. White

LITTLE has been said about radiophone transmitters in the past, yet many amateurs would have a wireless telephone transmitter were it not for the very high cost of the sets made up by dealers. This article is intended to make clear just what is necessary, and how to construct a complete short distance wireless telephone transmitter at a small cost.

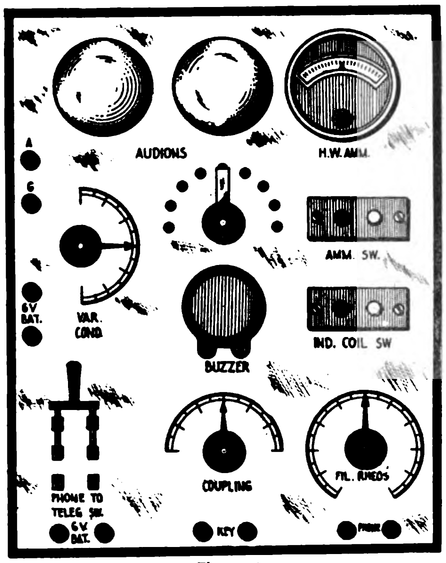


Figure 1

Figure 1—Front view of the panel showing position of instruments

First, a list of the material necessary: 2 Marconi VT transmitting tubes; 2 sockets; a hot wire ammeter (0 to 1 ampere); a telephone transmitter; a filament rheostat; a 43-plate variable condenser; a telephone induction coil; a double-pole-double-throw knife switch; 2 single-pole-single-throw switches; a wireless key; 10 binding posts (small size); a piece of good insulating material, such as bakelite, rubber, or even wood, size about 12 x 14", 3/8" thick; a fuse block with two 3-ampere fuses; a half-pound of No. 20 D.C.C. magnet wire; a bakelite or cardboard tube, 4" in diameter and 3" high, another 3" in diameter and 2" high; and a good high-pitch buzzer.

Many amateurs will have some of the listed apparatus around the work shop. The average amateur knows how to mount the various instruments on the rear of panel, as this subject has been gone over many times in previous articles in THE WIRELESS AGE. By studying the diagram, one can readily see how the instruments are placed.

The small vario-coupler can be made and mounted in the following manner:

Wind 40 turns of the magnet wire on the larger tube, taking taps off at every 10 turns. Then wind 30 turns on the small tube, taking taps off at each end and one long flexible lead from the center. Mount the large coil on the back of panel, as shown in diagram, then mount small coin as shown. After the large coil is mounted, solder leads from the large coil to ten taps.

If house current is used, it is very important that the positive side of the lighting circuit be found. This can be determined by a glass of water with a little salt in it; when the ends of the wires are dipped in the water the negative will bubble.

Additional bulbs may be connected in parallel, which will add to the output. The variable condenser serves to tune the closed circuit while the tapped large coil varies the open circuit. It will be noted that there is a switch to open the circuit of the secondary of the telephone induction coil. This is done so that the transmitter may be put in series with the ground lead for experiment leaving the closed circuit free.

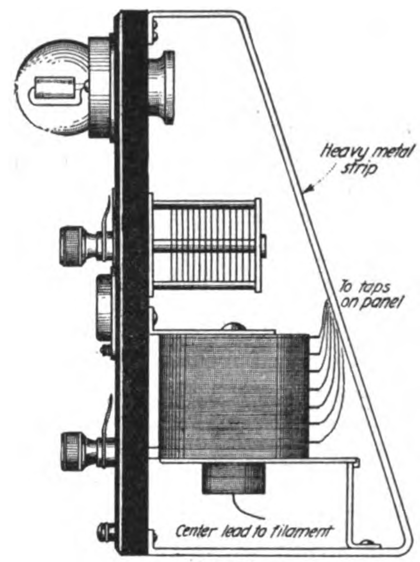


Figure 2

Figure 2—Side view of the radiophone transmitter

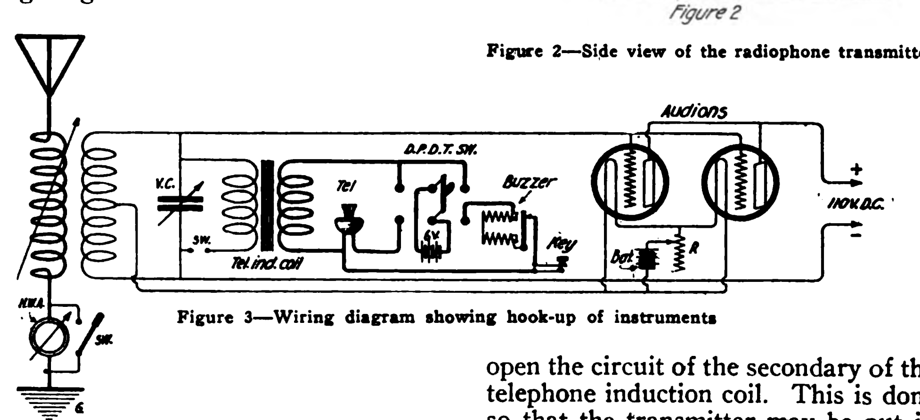


Figure 3—Wiring diagram showing hook-up of instruments

Design and Construction of a Short-Range Wavemeter

By A. Rosander

A VERY essential but seldom used piece of apparatus in amateur stations is a wavemeter. A wavemeter consists of, in essence, a calibrated receiving circuit, by means of which transmitter circuits are tuned to a desired wavelength. In an ordinary wavemeter—the one described—the inductance of the exploring coil is fixed with the variable condenser calibrated so that each degree setting will correspond to a given wavelength. The wavelengths due to these changes in capacity are usually shown by a graph curve accompanying the wavemeter. This can be explained from the fundamental fact that every circuit containing fixed inductance and capacity has a distinct wavelength at which it will oscillate more freely than all others. By varying the capacity a complete set of waves (wavelengths) can be obtained for a given fixed inductance and variable condenser.

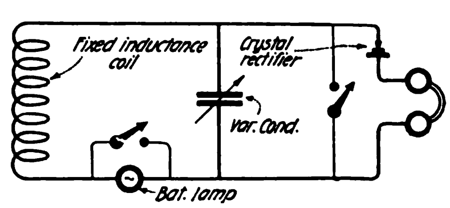


Figure 1—Circuit diagram of the short-range wavemeter

This wavemeter is inexpensive and accurate enough to comply with the law. It is similar to the low range wavemeter described on page 46 in "How to Conduct a Radio Club." It consists of the following pieces of apparatus: a fixed inductance; a variable condenser; crystal detector or lamp, or both; and an ordinary 2000-ohm head set. The inductance consists of 22 turns of No. 16 S.C.C. copper wire wound on a shellacked cardboard tube 6½ inches in diameter. This tube is mounted on standards somewhat like primaries of receiving transformers. Flexible connections, one foot long are made from each end of the coil to the variable condenser. The variable condenser is an ordinary Murdock variable condenser having a maximum capacity of .0005 mfd.

The detector and condenser are mounted on a base with room for holding the inductance coil when it is not in use. These pieces of apparatus are so fixed that they can be incorporated into the ordinary receiving set without any inconvenience, thus reducing the cost to a minimum and comprising a very compact wavemeter. In preference to using a crystal detector and phones for tuning the primary circuit, a small 2 or 4-volt battery lamp may be used, provided it has a proper short-circuiting switch.

In conjunction with this, using a current indicator such as a milli-ammeter or hot wire wattmeter, a resonant curve may be plotted from which an accurate idea of the purity and sharpness of the emitted wave may be obtained. Nothing is of more importance than knowing these two conditions. The manipulator will then know whether or not he is complying with the law, and furthermore, can quickly ascertain whether the radiated energy appears in a single sharp wave or in two or more broad waves.

With this necessary adjunct and a hot wire ammeter in every station, the efficiency of amateur stations will rise to an unprecedented height.

WAVEMETER DATA

Degrees of Condenser Scale	Corresponding Values of Wavelength
0	140
10	160
20	195
30	235
30	260
40	300
60	300
80	340
100	365
120	400
140	440
160	470
180	500

Indoor Antenna

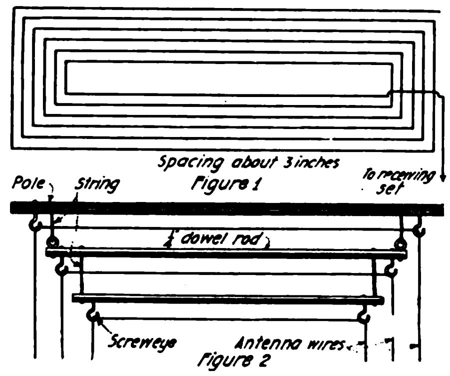
By C. Chandler Pidgeon

THE article in THE WIRELESS AGE for March, 1920, beginning near the bottom of page 40, entitled "Apartment House Antenna," attracted my attention. Since I live in an apartment house, I have had to solve the same problem, and I submit the following for your consideration.

Being desirous of operating a receiving set, and being unable to have a regular aerial, I tried several things, principally the bed springs, the gas fixtures, and a loop, such as is used in direction finders. None of these proved very satisfactory.

One evening I measured the length of the small hallway in our apartment. This I found to be nearly 30 feet. By placing bamboo poles across between the tops of door frames at opposite ends of the hall, I had a space 3 feet wide and 25 feet long for my antenna. In that space I have hung eleven turns of wire, arranged as in figure 1. I suppose any wire would do, but I happened to have No. 22 cotton covered enameled wire and used that.

With this antenna and a 200 to 3000 meter receiving set, I receive the time signals from Arlington and hear some of the radio telegraph and telephone



Figures 1, 2—Constructional details of the indoor antenna

work that is being carried on at about 200 meters in the city and surrounding neighborhoods.

My receiver is very small and quite young yet, so I don't get much in the way of results. I am using a "crystaloi" detector now and am sure the results I get are as good as can be expected. The batteries for my audion set are out of order, but when working I could hear NAA 20 feet from the phones, using a single "audiotron" bulb. As soon as I get my two-step amplifier to work and with sufficient inductances, I hope to have all of the large stations on the Eastern coast and probably some European stations.

The antenna I use is one which any apartment dweller may put up with little expense and I feel sure the results will be better than those which can be attained by the scheme given on page 40 of the March WIRELESS AGE.

Figure 2 shows a detail of the manner of supporting the wires. I have too many turns for 200 meters, but I use a series condenser and have not bothered to take down a few turns of wire.

A Two Stage Amplifier Cabinet

By Arno A. Kluge

IN THE average amateur receiving set, no provision has been made for the use of a number of vacuum tubes such as are required for multistage amplifiers, but this difficulty may be overcome by the construction of an amplifier cabinet, and the original receiving equipment thus retained intact. A two stage amplifier will be found the most suitable for all-around amateur purposes, as the investment required for tubes, coupling transformers, and batteries will often be found prohibitive in the more elaborate equipment.

In figure 1 such a cabinet is shown. It consists of an oak or mahogany box about 12 inches square and 6 inches deep, having hard rubber or bakelite panel for the front. The top of the

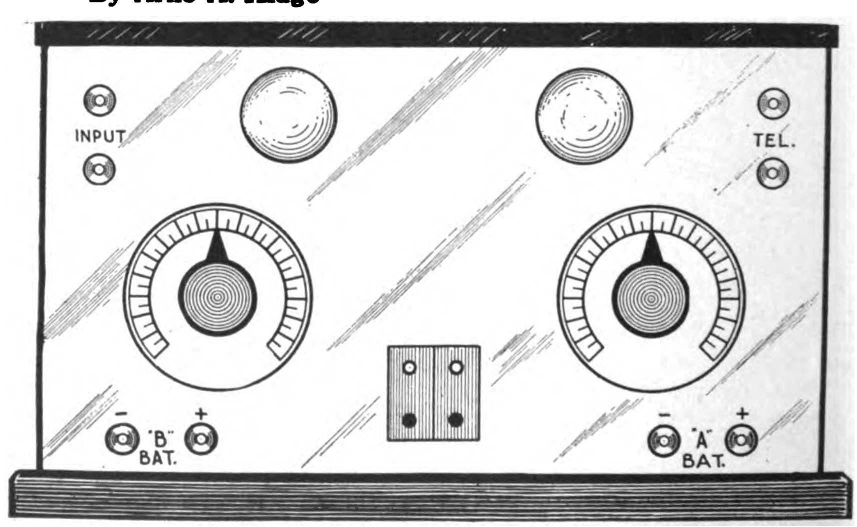


Figure 1—Front view of the amplifier cabinet

box is hinged, to give ready access to the vacuum tubes, which are mounted inside the box for greater protection. Two circular celluloid windows are provided for observance of the filaments during operation. Directly below these are two "back-mounted" rheostats for controlling filament current. In the center of the panel near the bottom are two miniature flush switches for turning the supply current on and off.

Sockets for the tubes are fastened to the back of the box inside. Their type will depend upon the style of tube used. No design is shown therefore. In case that the tubular style with wire leads is used, binding posts will of course have to be provided.

The tubes are coupled to each other and to the input circuit either by the use of impedances, as in figure 2, or by the use of coupling transformers, as in figure 3. The circuits shown are used in Signal Corps receivers, type SCR-59 and SCR-72, and require only one "A" battery and one "B" battery. Other circuits, such as that furnished with the Marconi V. T. tube, may of course be used, depending largely upon the style of tube employed.

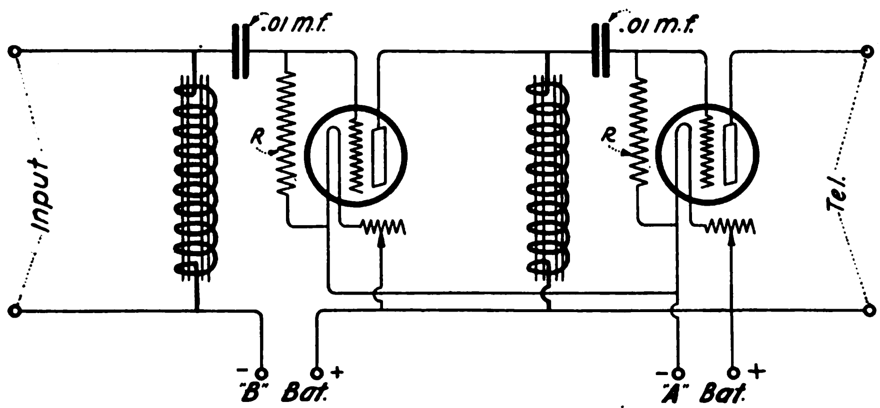


Figure 2—Circuit showing tubes coupled to each other and to the input circuit by use of impedances

Of the two circuits shown above, the one employing coupling transformers is the simplest and the best, no grid condensers or grid leak resistances being required. In figure 2, the resistances R are 2 megohms each, and give the grid a slight negative potential. The impedances consist of 25,000 turns of No. 38 enameled wire, wound on an iron core 2 inches long and ½ inch in diameter. The completed coil will be about 1 inch in diameter, and should be enclosed in a soft iron case.

For the circuit of figure 3, the coupling transformers should consist of 4,000 and 12,000 turns of No. 44 enameled wire on the primary and secondary respectively. Owing to difficulty attending the winding, these are best purchased complete.

The last mentioned is a closed core transformer. Core pieces may be cut from thin annealed iron to form an "L" 2½" high and 1½" broad, the body of the "L" being ½" wide. These are then built up after coil is wound and so placed that the coil is on one leg of a hollow rectangle formed by the "L" shaped pieces. A core of 8 inches long and ⅞ inch in diameter is used for the open core type, with 15,000 turns of No. 34 on the primary, and 25,000 turns of No. 38 on the secondary.

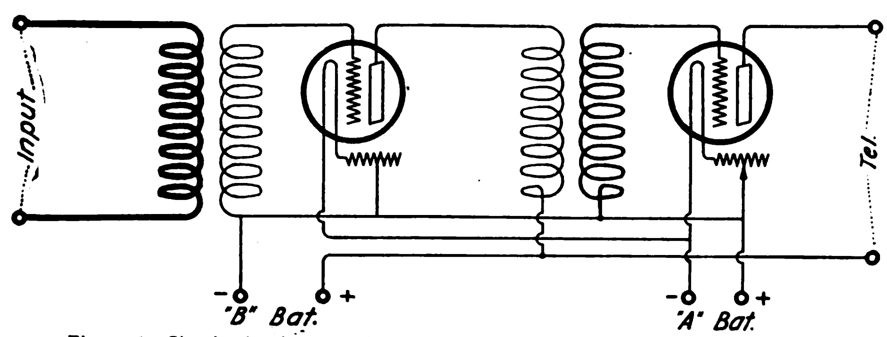


Figure 3—Circuit showing coupling secured by means of coupling transformers

These dimensions should enable the amateur to construct a suitable amplifier for any style of bulb, and such an instrument will shortly find a place in every up-to-date station.

The Design and Construction of a Simple Wavemeter—Range 150 to 300 Meters

By F. C. Brockman

First Prize—$10.00

THIS wavemeter is designed so that the average amateur with few tools can make it. Some of the construction is intended to provide substitutes for parts which require the use of machine tools in their manufacture. I have made most of the apparatus with very few exceptions without the use of machine tools. Most amateurs have a large stock of odds and ends on hand which they will want to use and for them the design is intended as a guide.

The essentials of a wavemeter are, of course, an inductance and a capacity—that is, a coil and a condenser, in series. This circuit will oscillate at a wavelength determined by the relation between the inductance and the capacity according to the expression:

$$\lambda = 1884\sqrt{LC} \qquad (1)$$

where L is the inductance in microhenries and C the capacity in microfarads. The condenser selected for this instrument is made by the General Radio Company. By ordering their No. 124C, the condenser, handle, and scale can be obtained without the case, cover, or binding posts. The plates are made of hard aluminum and are rugged enough to withstand ordinary usage without bending. The ten rotary plates are cut away to give approximately geometric variation of capacity, allowing closer adjustment at the lower end of the scale. The support of the condenser itself is a ribbed aluminum casting to which is riveted a dilecto disc riveted in turn to an accurately machined brass bearing about 1 inch long. The shaft is accurately machined with a flange which locates the plates and acts as a thrust bearing. The contact for the rotary plates is made through a bronze spring washer. The brass scale rotates opposite a line indicator so that readings are always made at the same point. A knob is used for ordinary adjustments while an extension handle is very useful for fine adjustments. The minimum capacity is about 0.00002 mfd., the maximum is 0.00065 mfd. Curve

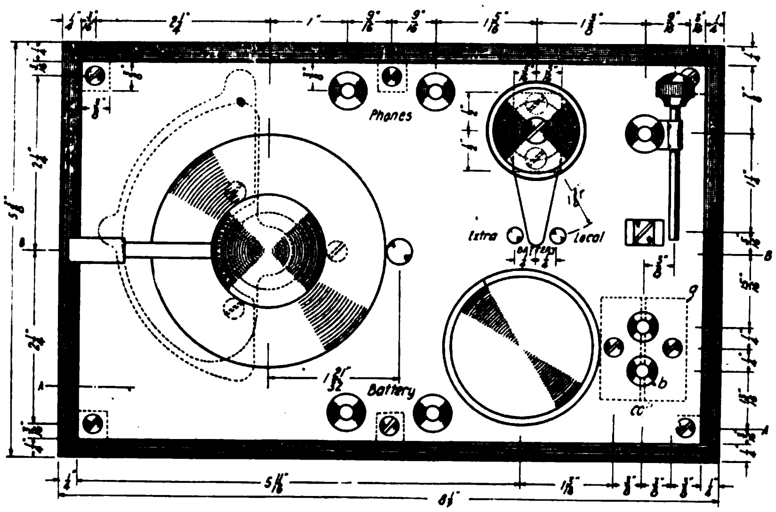


Figure 1—Top view of the wavemeter itself with constructional details

A, figure 11, is the calibration curve of the condenser used.

Figure 1 is a top view of the wavemeter itself. Figure 2 is a side view in sections. Figure 3 is an inside view of the cover. Sufficient dimensions are given for construction. The corners of the box and cover are lock-jointed and finished afterwards. This joint makes a strong box of neat appearance. The cover and bottom are glued and nailed or screwed on after the sides and ends have been glued together. Mahogany of the softer grades is easy to work and can be given a neat wax finish. A small suitcase handle can be fastened to the cover, or a strip of leather can be secured to it as desired.

The panel is preferably of 3/16 inch XX black dilecto, although hard rubber may be used. The dilecto can be given a neat grained finish by rubbing lengthwise with a piece of emery cloth fastened to a block of wood until all the high spots are taken off and the surface presents a uniform appearance. The panel is fastened to six supports by number 6-32 round head screws. The supports may be 3/8 inch square brass drilled as shown in the section at A, figure 2, or they may be of wood, glued in the corners of the box. In this case wood screws are used for securing the panel.

Mount the condenser as shown dotted in figure 1. The condenser is held on by three No. 6-32 flat head screws. The dial and knob are held to the shaft by a set screw under the end of the extension handle.

No drilling dimensions are given for the buzzer because they are easily determined from the base of the buzzer to be used. It may be either a "Century" high frequency buzzer, made by the Century Telephone Construction Company, or a Mesco No. 55 radio buzzer, advertised in various issues of this magazine.

The plug receptacle is made of two 3/8 inch brass bushings B, figures 1 and 5, forced into a dilecto block shown at A, figures 1 and 5, and pinned. It is best to make the block first, secure it to the front of the panel at the proper place and use it as a templet for drilling the panel holes. Be sure to drill carefully so that the dilecto will not splinter as the drill breaks through. Instead of dilecto, hard rubber or hard wood may be used, but in the latter case, it is held to the panel by No. 6 wood screws. The block serves as a reinforcement for the thin panel and makes a sturdy

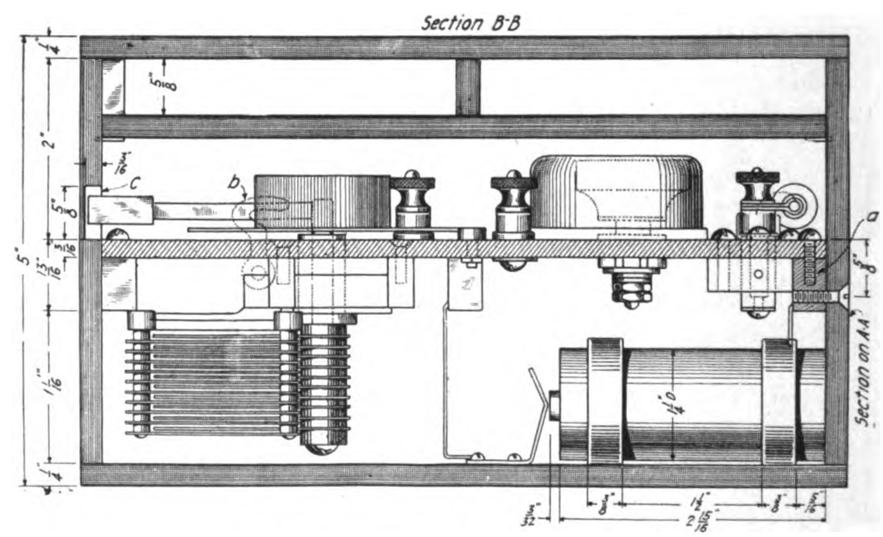


Figure 2—Side view in sections

receptacle. The bushings are shown at B, figures 1 and 5, and are long enough to project 1/16 inch above the panel. If it is found inconvenient to use screws for securing the wiring to them, drill the 3/16 inch holes through and cut slots across the ends or drill holes just large enough to hold the wire used.

The battery switch is shown in section in figure 4. The blade is made from phosphor bronze or coe bronze 1/32 inch thick, although spring brass may be used. The width of the blade, as well as the length of the shaft (a No. 10-32 screw) depends on the style of knob used. The blade is held to the knob by a nut and washer. The bushing is a 3/8 inch diameter brass rod with a 3/16 inch hole through the center. The switch is secured to the panel in the same way in which the plug receptacle is secured, using the same precautions in drilling and allowing the bushing to project 1/16 inch. Connection is made to it by soldering a flexible lead to the nuts on the end of the shaft, or by soldering the wire into a hole in the side of the bushing. The switch points are made of 3/16 inch brass rod forced into the panel. The lower end of each has a saw slot into which the connections are to be soldered.

The detector is of the "cat-whisker" type and is shown in figure 1 and 2 with details in figures 6 and 7. Figure 7 shows the crystal clip which is made of 1/32 inch phosphor or coe bronze held to the panel by an 8-32 round head screw. Figure 6 shows the arm holder made of the same material. The arm itself is 1 7/8 inch long by 1/8 inch diameter, threaded 6-32 on one end and fitted with a wire cat-whisker on the other. It is clamped in the holder by tightening the nut on the binding post. The knob may be of any convenient shape, a simple one being like that on the condenser arm.

Two pairs of binding posts are provided, one for the phones, the other for an external battery.

Figure 2 shows a battery mounted in clips in the bottom of the box. The battery shown is an Eveready as made for the U. S. Signal Corps. However, any small flashlight battery is suitable and for that reason the dimensions of the clips are not given. A convenient way for wiring it is to solder leads to the proper clips and to two of the panel supports, if they are of metal. Connection is taken from them by leaf copper held between the panel and the supports and clamped by the panel screws.

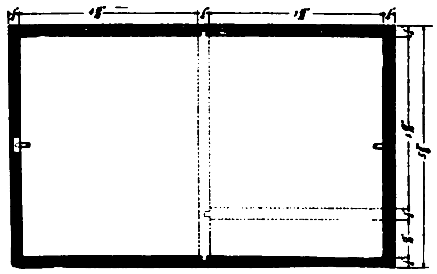


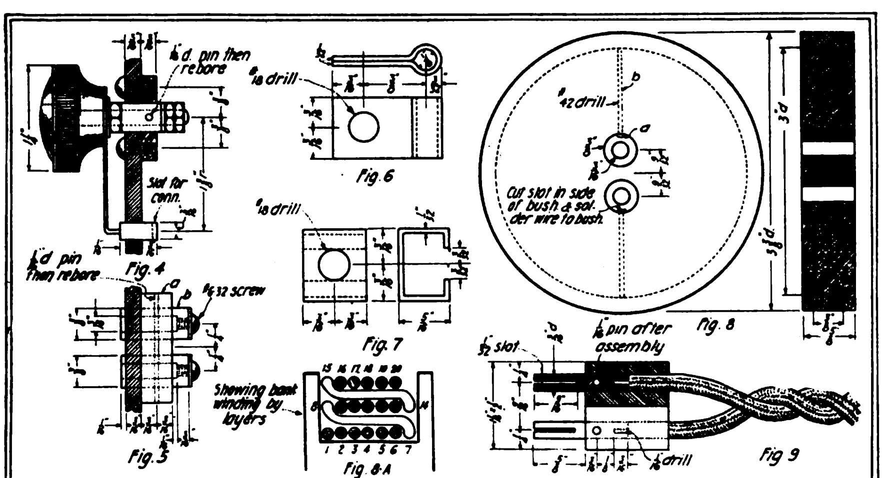
Figure 3—Inside view of cover with constructional details

Figures 2 and 3 show the inside of the cover. It provides a place for the coil, the cord, and crystals. There is no place for telephones, as they are generally in the receiving circuit and never packed away. If desired, the internal battery may be eliminated and a compartment with a door in the end of the box made for the phones. The calibration curve may be pasted to either side of the lid inside the cover. The cover is held to the box by four hooks shown dotted at B, in figure 2. The slot in the edge of the cover shown at C, figure 2, and A, figure 3, fits over the condenser handle and keeps it from swinging when carrying the meter.

The inductance used is shown in figure 8. The spool used by the writer was turned from 5/8 inch XX black dilecto sheet. The amateur who has no lathe may make his spool of the 1/8 inch mahogany used in cigar boxes. To do this, but three discs 3 inches in diameter and two discs 3 3/8 inches in diameter are needed. Glue them all together to form a spool with a hub 3/8 inch long by 3 inches in diameter as in figure 8. Clamp while gluing and when dry reinforce with three 1/4 inch wood dowels forced and glued in. Finish neatly when dry and apply two coats of Ajax or Sterling varnish. These are the best to use. Shellac may be used if the others cannot be obtained, but the spool must be thoroughly dried before and after applying it. Drill two 3/8 inch holes for the brass bushings, which also serve as coil terminals. The bushings are made of 3/8 inch brass rod and have a saw slot on one side as at A, figure 8. Tin the slots before assembling the bushings so that a good electrical connection can be made.

For the coil, wind 20½ turns of No. 20 DCC copper wire, banked by layers (figure 8a). Push the ends through the lead holes, B, and let about 3/8 inch project into the 3/8 inch holes. Tin the ends of the wires. Force the brass bushings into the holes in the spool, being careful to get them tight and see that the coil ends fall in the slots. Apply heat to the bushings, also a little solder to secure a good connection. Treat the winding with varnish and cover with book binder's cloth to give a neat appearance.

The plug connection is shown in figure 9. The block is preferably made of hard rubber as dilecto or wood splits if the plugs fit very tight. However, with reasonable care, dilecto may be used and makes a better finish. In order to secure good alignment it is best to use the receptacle in the panel on a templet for one and that in the coil as a templet for the other when drilling the 3/16 inch holes through the blocks. The plugs are of 3/16 inch brass rod—though coe bronze has more spring—worked down with emery cloth till they fit the receptacle bushings snugly without forcing. Then slot one end of each and drill a small hole about 3/16 inch deep in the other end.



Figures 4, 5, 6, 7, 8, 8A, 9—Details giving constructional dimensions

For the cord use 20 inch of No. 16 or 18 twisted lamp cord with extra heavy insulation. This is not for protection against high voltage, but for obtaining greater spacing of the wires and hence lower capacity in the cord itself. A better way is to take two individual wires and make a flat cable by sewing them with their centers 9/16 inch apart to a flat strip of leather or heavy canvas doubled around them. The capacity of this length

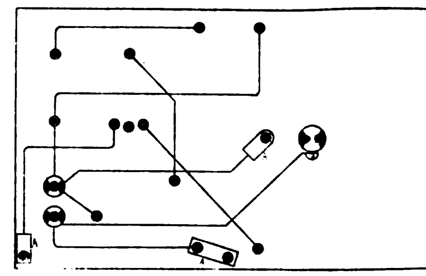


Figure 10—Wiring diagram under the panel

of lamp cord having thin insulation, is about 0.000039 mfd., which is the capacity of the condenser at about 16.8 divisions. A high capacity cord will raise the minimum wavelength considerably more than the maximum, thus reducing the ratio of maximum to minimum, or the range of the instrument.

Thread the wires through the holes in the blocks and solder the ends into the holes in the plugs. Draw the wires back through the blocks and force the plugs in after them. Drill two small holes and pin the plugs as indicated in the figure.

Figure 10 shows the wiring under the panel. It should be made with No. 16 bare solid wire, though other

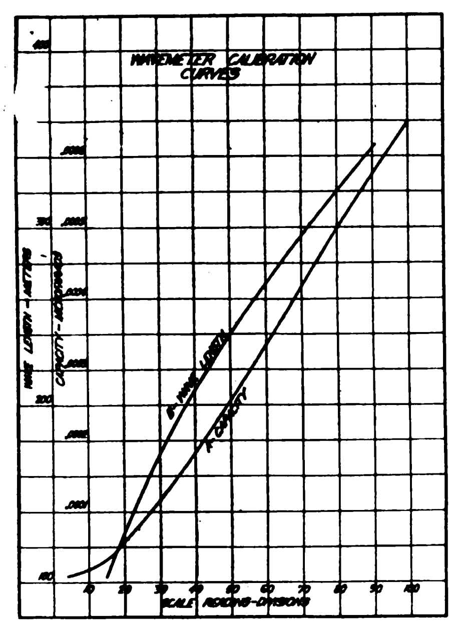


Figure 11—Graphs showing the capacity and wavelength calibration of the meter

sizes not smaller than No. 20 will do. Where wires cross, bend the outer one to clear that next to the panel to prevent short circuits. All joints should be securely soldered. Connection is made to the condenser stationary plates as well as to the panel supports carrying the internal battery connections by strips of leaf copper as shown in figure 10.

Figure 11 shows the capacity and wavelength calibration of the meter, and table I gives the values for replotting them if desired.

The instrument can be used as a receiver for measuring the wavelength of a transmitter, or as a transmitter for measuring the wavelength of a receiver or other circuit. Coupling it in the antenna circuit of a receiver, tuning in a signal on the receiver, and then tuning the wavemeter till the signal in the receiver phones is a minimum will give the wavelength of the received signal. Another method is to tune in a signal and then operate the wavemeter as a transmitter in proximity to the receiver secondary circuit and tuning it till the two are in resonance. The wavemeter then shows the wavelength of the received signal. Coupling between the two must be fairly loose so that coupling waves are not generated, as these waves are of different frequencies from the desired wave.

The wavemeter may also be used to measure inductance or capacity, when one or the other is known, by the use of formula (1).

TABLE I

Condenser Divisions	Wavelength	Capacity
10	...	.000018
15	102	.000033
20	126	.000055
30	171	.000116
40	207	.000183
50	239	.000257
60	268	.000335
70	296	.000417
80	321	.000498
90	344	.000576
100	...	.000650

Simple Wavemeter

By O. E. Cote

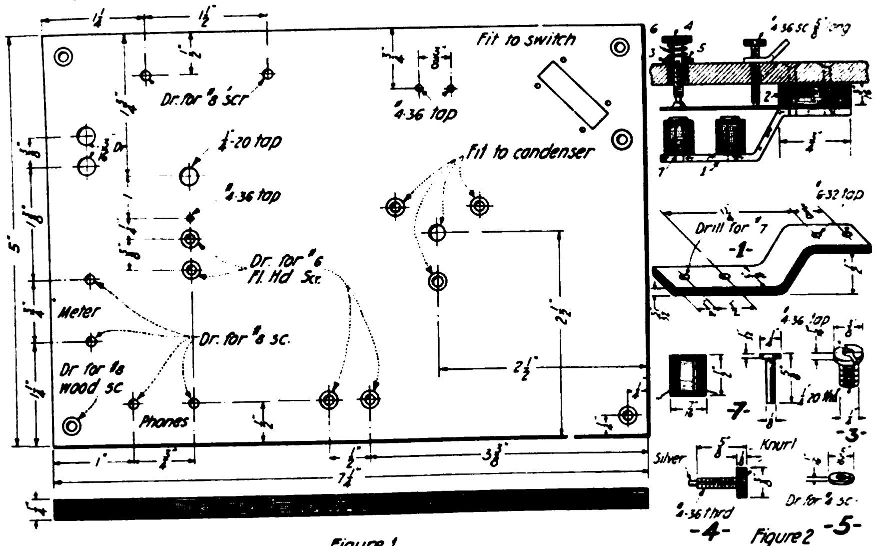
Second Prize—$5.00

HEREWITH are the drawings and photos of a simple wavemeter. This meter, while being simple, is at the same time very rugged and of reliable construction throughout. Complete drawings will be omitted, as the average experimenter can suit himself as to the design of the containing case as well as detector and buzzer switch. Figure 1 shows the general layout of the panel, which is made of bakelite and finished in the usual way.

Figure 2 shows the construction of the buzzer and although many amateurs will undoubtedly use other types of ready-made buzzer, this construction will be of some help to many.

Part No. 1 is the yoke and is made of soft iron. Part No. 2 can be either brass or fibre, as this only serves the purpose of holding the yoke away from the panel. Part 3 is a brass bushing and holds the adjusting screw 4, which is also made of brass. Part 5 is a small brass washer which fits under spring 6. This spring is for the purpose of keeping a tension on the adjusting screw. 7 are the magnet cores, which are made of soft iron. After the magnet coils are assembled on these cores, the latter are driven lightly into part 1.

The magnets each contain about 420 turns of No. 32 enameled wire. I have used a piece of silicon steel about .01 inch thick for the vibrator and it gives very good results.



Figures 1, 2—General layout of the panel and construction of the buzzer

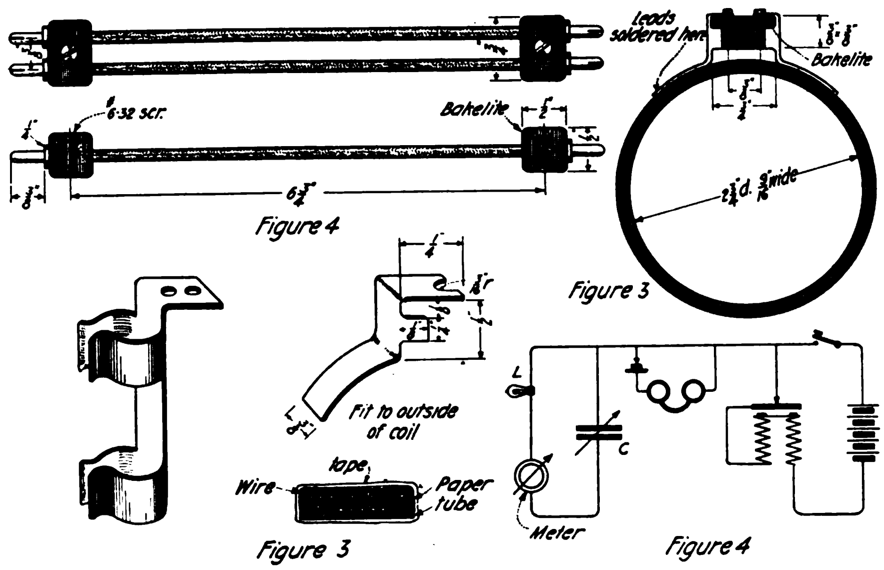
Figure 3 shows the holder for the battery. No dimensions are given, as the maker can use his own judgment, but it will be found that a flashlight battery (round) will do very nicely.

The coils and clips are shown in figure 3. The holders are of brass with a piece of bakelite in between, which holds the small bushing into which the connecting plug fits. The coils are made in the following manner.

Coil No. 1, which is the small one, contains 20 turns of 48/38 double silk covered litzendraht.

A tube is made by wrapping around an arbor 2¾ inch diameter about 5 or 6 wraps of brown wrapping paper having glue on one side in order to hold the tube together after it is removed from arbor. This tube is 9/16 inch wide, and takes just ten turns of wire for one layer. Two layers are put on and leads soldered to brass pieces as shown in sketch figure 3. Several thicknesses of paper or varnished linen must be put between these holders and winding for insulation. After this, the coil is taped with ordinary cotton tape 3/8 in. or 1/2 inch wide. The taping is carried over the ends of the holders which fasten to the cord. The bakelite end pieces are split and by bringing them together with the flat head screws they hold the brass plugs securely in place.

The condenser used is the General Radio type 182C. This condenser is



Figures 3, 4—Coils, clips, connectors and hook-up

coil. The outside of the coil is then shellacked. The second or large coil is made in the same manner and contains 70 turns. One thickness of ordinary manila paper is put between each layer of wire to cut down distributed very rugged and is ideal for this type of instrument. A chart is also enclosed giving the wavelengths and if the amateur would prefer, he can make it direct reading by fastening a piece of white paper on the dial and

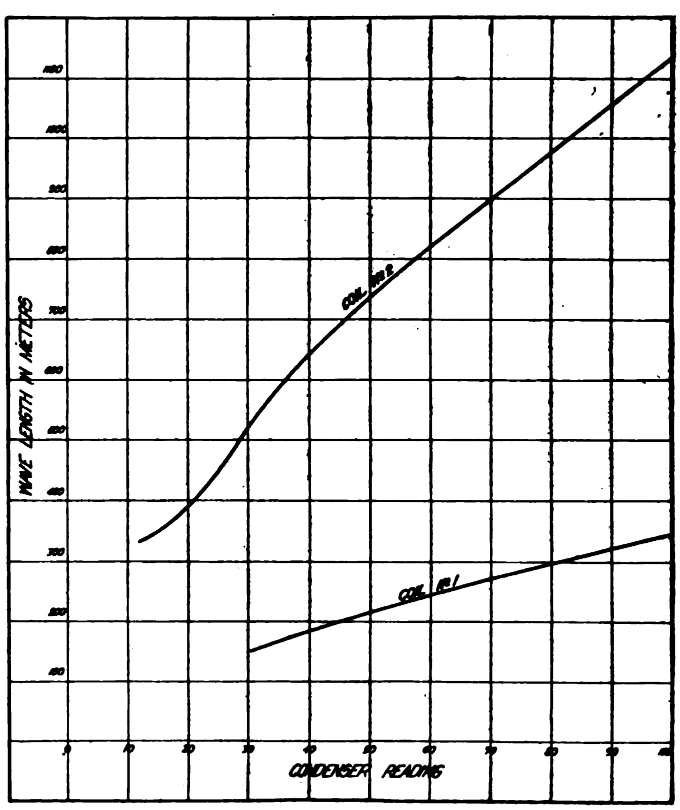
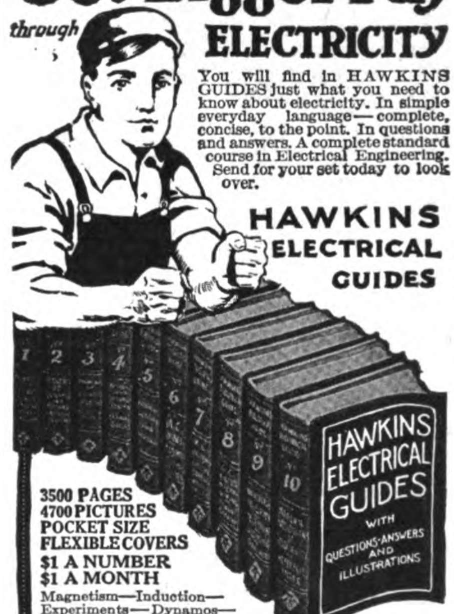


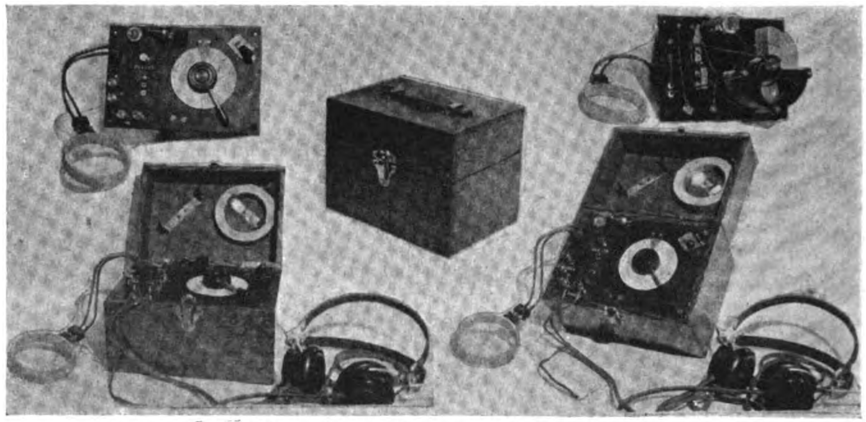
Figure 5—Graphic chart showing calibration of meter

capacity. The inside diameter of the big coil is 2 1/4 inches.

Figure 4 shows the connectors. The wires are rubber covered silk lamp marking down the wavelength direct. I would advise the maker to calibrate his meter from some other standard, as it will be found that the condenser



values vary slightly and it is also very hard to duplicate a set of coils unless they are all made at one time. Two binding posts are brought out and marked "meter" so as to be able to connect a milliammeter for quantitative measurements. These binding posts are short circuited when no meter is used in order to complete the circuit through the coil.



Photos giving various views of the meter

A Wavemeter for $3.50

The Design and Construction of a Simple Wavemeter

By E. S. Herrick

Third Prize—$3.00

THE wavemeter described in this article was built to fill a long felt want. It not only has proven itself satisfactory in every way in my own station, but it has been used by several friends in the vicinity, who do not possess such an instrument.

The meter was personally calibrated to a U. S. standard wavemeter at a Government radio laboratory. The condenser was also calibrated to a standard condenser. Both curves are given (figure 1), and with these, one may determine the inductance of most any circuit from the formula $\lambda = 1884\sqrt{LC}$.

It is, of course, known that another condenser may not have exactly the same capacity as the one here described, neither may two inductances built to measure, have identical values in microhenries. However, the curves and values of this instrument and another built as near as possible to these specifications, will not differ to such a degree as to make an appreciable difference.

My own little meter has paid for itself many times over. It has been put to many uses, such as tuning the transmitter, calibrating my receivers, measuring inductances, and last, but not least, it has been used as a secondary of a loose coupler. It makes an excellent secondary receiving circuit and if slid along the table, to and from a primary coil, any degree of coupling may be obtained.

The condenser used is a Murdock 17-plate variable air condenser. This makes a light, durable, little unit and costs but two or three dollars. The inductance is wound on a tube, figure 2, 2½ inches outside diameter and 1 inch in width. Two holes are drilled in the tube ⅛ inch from the edge and

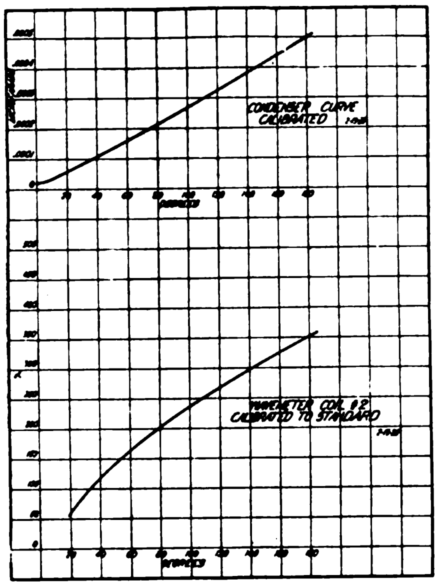


Figure 1—Graphs showing calibration of meter

exactly on the diameter line of the tube. These holes should be made to take a 4-32 machine screw. The winding space is ½ inch and should be wound with rubber tape or some adhesive substance in order that the windings will not slip. The coil is wound with No. 20 B&S DCC wire. There are 33 turns banked 3 layers. This bank winding may be found described in a copy of THE WIRELESS AGE. Figure 4 shows the relative position of the turns on the coil. A hole is drilled at each end of the winding to pass the ends of the coil through the tube. The wire is then soldered to the brass bolts which hold the coil to the condenser leads.

The leads, figure 3, are made from 1/32 inch brass strip, ½ inch wide and 2½ inches long. One end is rounded, and drilled, for clearance of the 4/32

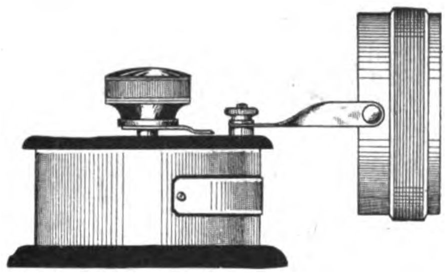
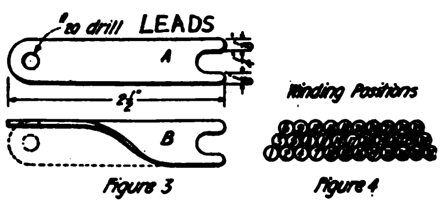


Figure 2—The inductance connected to condenser



Figures 3, 4—Constructional details of leads and method of winding the coil

machine screws in the coil. The other end is slotted so that it may be easily removed from the condenser binding posts. After the leads are drilled and shaped they should be put into a vise and with a pair of pliers twisted 90 degrees, as shown in the drawing. Two leads are needed and each should be twisted in the opposite direction.

Figure 5 gives several different hook-ups for connecting the detector and phones to the wavemeter. The wattmeter or other sensitive thermometer is not used when the phones and detector are in circuit. Neither are the phones and detector in circuit when the wattmeter is used. The table of audibilities, together with the several hook-ups, as given in the Bureau of Standards Circular No. 74, is are made as short as possible, no appreciable difference in wavelength indicated, will result.

When using the wavemeter as a driver, for calibrating received signals, the circuit shown in B, figure 5, should be used. Care must be exercised, however, that the coils of the buzzer are not connected in the wavemeter circuit. This would throw the calibration of the meter to the winds.

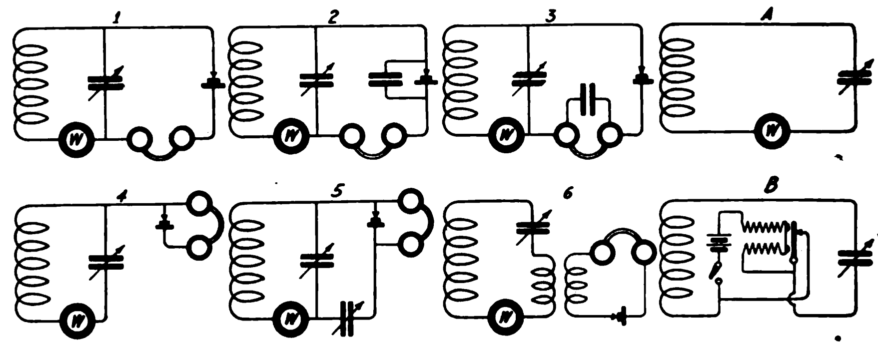


Figure 5—Several hook-ups for connecting the detector and phones to the wavemeter

worthy of a place in any amateur's book of hook-ups.

If the experimenter owns a current squared meter or thermo-galvanometer, much finer and more accurate adjustments of the transmitter may be made. It is true that an instrument of this type is easy to read and obviates listening for the maximum note in the telephone receiver. If the lengths of leads to and from the meter The contacts must make and break the circuit only, using the spark discharge across the contact points, to start the oscillations in the circuit. Larger coils have been made for this wavemeter, by the author, and if the reader desires data on coils of longer wavelengths, a letter will bring it.

The writer has had considerable experience in the use of wavemeters, but has failed to find one as good as this one.

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Due to unavoidable delays, the catalog of the National Radio Supply Co., Washington, D. C., will not be ready for distribution May 1, as promised. We will endeavor to get the catalog out as soon after May 1 as we possibly can.

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

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Headquarters, 64 Broad Street, New York

A Sectional Receiving Set

By L. B. Salt

EVERY one realizes now that the logical receiving set to have is one to which additional units can be added at any time, as well as one that can be readily disconnected and reconnected within a short time, thus making it possible to keep up with the newest connections and the "last word" in the radio art.

The unit set, such as the DeForest, has the advantage of permitting operation with a few units which can be added to at any time. I believe, however, that the sectional set has all the good features of the above and a few more, such as being able to use a condenser or other instrument separately. It keeps each instrument free from dust. It is not necessary to cut out a new board each time a unit is added, and when the entire set is assembled, it looks more like a panel set, as the small panels fit very well if the edges are true.

The best size to make the small panels is 5 inches square. The boxes

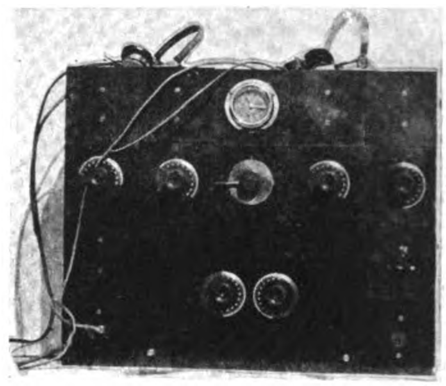


Figure 1—Complete Set

Top row (left to right)—Grid leaks with condensers. Fixed condensers. Clock. Small coil. Grid leaks without condensers.
Second row—Five variable condensers. Two .005. Two .008. One .00175.
On left of tuning coils—22.5-45 volt batteries. Two jacks for phones.
On right of tuning coils—Rheostat. Vacuum tube.

Prize Contest Announcement

The subject for the new prize contest of our year-round series is:

"The Construction of a Portable Antenna Suitable for Use in Vacation Days"

Closing date, July 1, 1920.

Contestants are requested to submit articles at the earliest practicable date.

Prize Winning Articles Will Appear in the September Issue.

Wireless is not wholly an indoor sport; those who have tried out portable sets know a lot of interesting things that develop in sending and receiving in the open. Hiking, canoe trips and camping are not complete these days unless a radio outfit is taken along. Here's a chance for the fellows who have worked out something special to tip their fellow amateurs off on how to make the "only" portable aerial.

PRIZE CONTEST CONDITIONS—Manuscripts on the subject announced above are judged by the Editors of The Wireless Age from the viewpoint of the ingeniousness of the idea presented, its practicability and general utility, originality, and clearness in the description. Literary ability is not needed, but neatness in manuscript and drawing is taken into account. Finished drawings are not required, sketches will do. The contest is open to everybody. The closing date is given in the above announcement. The Wireless Age will award the following prizes: First Prize, $10.00; Second Prize, $5.00; Third Prize, $3.00, *in addition to the regular space rates paid for technical articles.*

All manuscripts should be addressed to the Contest Editor of The Wireless Age

are made of ¼ inch wood, which leaves only four and a half inches for the instrument. The cabinet for the coils can be made any size desired provided it is a multiple of five, otherwise the small sections will not fit around it. In this set, the coil cabinet was made 10 x 15 inches in order to take the largest size honeycomb coil. The gear wheels have a ratio of one to four, as the ratio of the gears on the DeForest coil holder is two to one. Thus, when the knob is turned through a half circle, the small bevel gear makes two complete revolutions and the coil swings through ninety de-

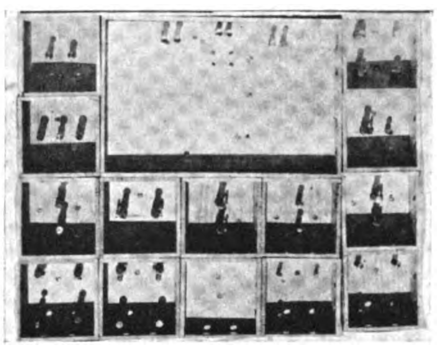


Figure 2—Rear view of the sections

grees. These gears are made by the Boston Gear Works at Quincy, Mass., and are their number G-486, costing about $1.50 per pair. The boxes were bought from a pattern maker, but could easily be made at home if one has the tools, in which case all the side pieces should be held together and the holes drilled all at one time, before the boxes are assembled. Aluminum was used to hold the panels to the piece of wood to which the binding posts are fastened, but any other metal could be used. When the set was first designed, four strips of aluminum were to be used, one on the top, one on the bottom, and one on each side, but by using 1/8 inch hard alumi-

Figure 4—Two of the condensers

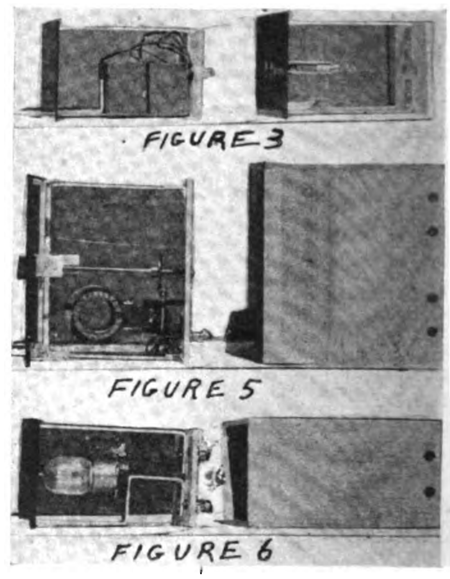


Figure 3—Batteries and phone jacks
Figure 5—Construction of tuning cabinet
Figure 6—Vacuum tube mounting

num only two strips were necessary. They were made to fit the box tightly, so that it would not be necessary to put screws or nails into the board on which the binding posts were mounted, in order to hold the instrument in the box. By using large knobs the screws holding the strips and instruments were covered up, making a very neat looking set. By setting the binding posts in an inch or so and having the holes in the sides of the boxes, it is possible to push the set up flush with the wall and have all the wiring concealed, or one condenser may be placed on end on the table and the wires brought through the holes. The boxes in this set were made 9 inches deep, but they should have been made 10 inches, as it is necessary to have 8 inches between the panel and binding post board if the set is to accommodate the largest size DeForest coil. However, if the coils are mounted on the outside or any other tuning arrangement is used, the boxes need not be as deep. The accompanying pictures show better than words or diagrams how the set looks.

In order to make the set most complete, all the diagrams in the various radio magazines for the last two or three years were cut out and pasted on pages of a loose leaf book, and indexed according to Crystal Receivers; V. T. Receivers; One, Two and Three Step Amplifiers; Misc. Connections; etc. By using a loose leaf book, new diagrams can be added as they appear in the latest magazines. By so doing, a hundred or more different connections can be collected in a very short time, thus giving the amateur an unlimited field for experimental work.

A Low Power Set

By JOS. PIGNONE

FOR local use, there are two sets which may be used. One is the telephone and the other the spark coil set. Each of these have their respective merits and demerits. For speed and

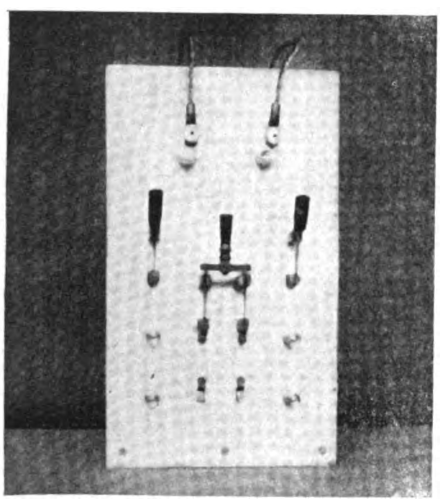


Figure 1—Front view of panel

accuracy of transmission, the wireless telephone excels. However, for original outlay and succeeding cost of upkeep, the wireless telephone equipment is out of reach of many. In addition, the operation of the telephone may also be too intricate for some amateurs. The spark coil set may seem to be a thing of the past to advanced amateurs. This is not so. If the spark coil set is properly designed, it will often do the work of a 1/4 kw. set.

In this case, for compactness and efficiency, the panel type was selected. The result is that the leads from the condenser are shortened considerably. The lead from the condenser to the gap is 2 inches and from the gap to the transformer 4 inches. Also the lead from the condenser to the transformer is 6 inches.

The make of the apparatus used will be mentioned to facilitate the procuring of them. The spark coil employed in this set is a "Ford" ignition coil. Amateurs in and about New York have been getting very satisfactory

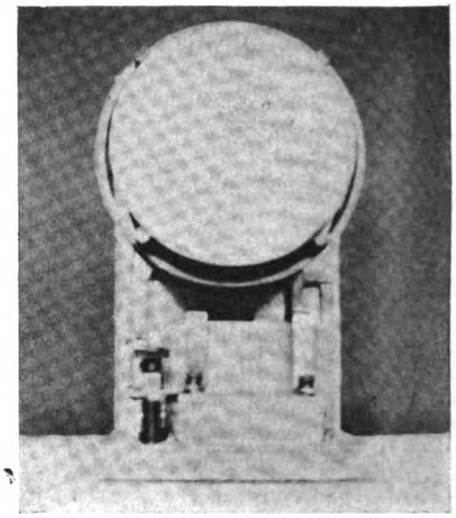


Figure 2—Rear view

results with these coils. They give a fat spark, and a pleasing note if properly adjusted. The condenser used is a small "Dubilier" .004 mfd mica. This was chosen because of its compactness. However, a small oil condenser slightly larger can be constructed to replace this. The spark gap can easily be made. It may be of any design, but the one shown, with ¾ inch electrodes

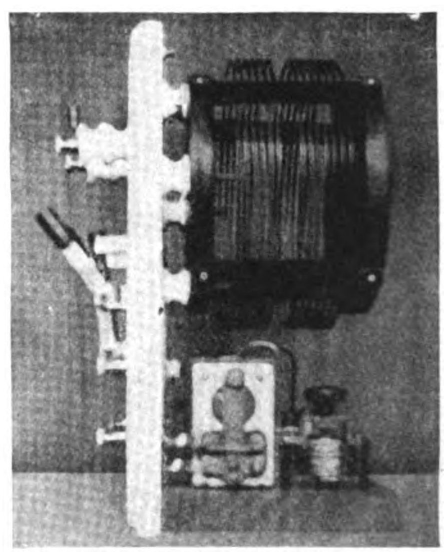


Figure 3—Side view

works best with this coil. Lastly, the transformer — having an oscillation transformer with variable coupling would be of no advantage, as the energy involved is so small. A pancake or a cylindrical coil may be used, and in the set illustrated the cylindrical type was selected only because the bakelite strips for such a coil were handy. This unit is 7 inches in diameter wound with edgewise strip. Eight turns comprise the primary and the same number the secondary. The turns are spaced 1/8 inch apart. The primary and secondary are spaced 1/2 inch apart.

The panel is 7 x 12 inches and the base attached to it is 7 x 6 inches. On the face of the panel are mounted the proper control switches. The double-pole switch is for the power supply, which is 6 volts; the single-pole switch on the left is to short the key and the one on the right is to short the vibrator. The reason for having the single-pole switch is that the builder might wish to experiment with synchronous interrupters. Also, for tests, the set might be used continuously. The aerial and ground leads are brought to the front of the panel.

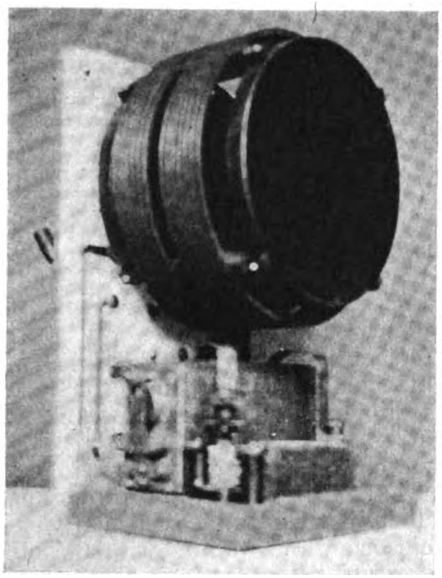


Figure 4—View of the oscillation transformer

It is useless to state the transmitting radius of such an equipment, as local conditions vary too greatly. However, with the author's set, 25 miles have been accomplished.

Correction March "Age"

In the diagram printed on page 37 of the March issue, a grid condenser should have been shown between the crystal detector connection and the grid.

Winner of Wireless Contest

James Collins, of Cleveland, was awarded the special prize—a $150 wireless receiving outfit—in the wireless contest conducted by The Press, in co-operation with associated newspapers throughout the country.

Collins was awarded the prize for his essay on "The Wireless Amateur." He is 18 years of age and is about to enter college.

Backing Up Geagan

P. F. GEAGAN'S article in the April issue on "Getting Results" was sure interesting; it has undoubtedly been read and digested by everybody, regardless of whatever else they may have passed up.

While it might seem to a casual peruser that Mr. Geagan is inclined to wax sarcastic at times, none can deny that the things he brings to our attention are appropos, and if put into practice, will, without doubt, result in a vast increase in efficiency and in the satisfaction we obtain from listening to what the "Wild Waves" are saying (a la ACE).

My first wireless set, constructed back in the medieval times when the art was new, consisted of a coherer, with its attendant bell and tapper; a dishpan, hung out of the window for an antenna; and three dry cells, salvaged from a neighbor's auto for a source of power for the de-coherer. The station which I had hopes of hearing was New York, about 150 miles away, and when after an hour nothing came in, in spite of all possible adjustments, I decided that they were not sending. Possibly they weren't. I don't know.

Of course, I now have a really excellent audion panel, with which I can get un-damped "stuff" without either heating the tube with a match or using three or four 3-foot tubes of No. 36. But in spite of the things I can get on it, there is lacking the thrill that I experienced while waiting with the old coherer for the message that never came. Familiarity breeds contempt, we are told, and nowhere does it apply more than in the wireless game. My best regards to Geagan for a long life, and may his bump of humor never grow less.

Whoever wrote "Clean English in Wireless," too, should know that the large majority of bugs are with him, and will back him up in anything he tries to do to eliminate the objectionable conversations to which we have most of us listened at times.

Good luck an' everything.

B. R. WEDEMANN.

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.

J. F. T., Kingsbridge, N. Y. C.:

In order to get the 25-mile radius with the radiophone outfit which you mention, it would be necessary for you to use a 400-volt generator. A 60-volt B battery would probably reduce your radius to something like 3 or 4 miles.

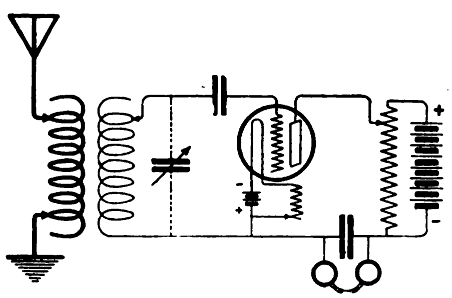
H. K., N. Y. C.:
In reply to your query requesting information which will enable you to construct a radiophone having a radius of 4 miles using 75 volts in the plate, we refer you to a recent article published in this magazine covering the construction of a 25-mile radiophone set.
With the hook-up which you show, you should be able to cover this distance providing everything is working properly. You do not show in your hook-up any meters for determining the radiation which you are getting. Using a rectified 350 volts, the distance which your outfit will cover should be in the neighborhood of 15 to 20 miles. In order for you to know what results you are getting, however, you should provide yourself with a radiation meter having a maximum range of about one ampere.

* * *

A. W. S., Billings, Mont.:
The Adams Morgan Co. is located at Montclair, N. J.
It will be impossible to tell you what size to make the primary loading inductance for your receiving transformer, unless we know what wavelength you wish to load up to, as well as the size of your receiving transformer. Neither can we advise you as to the construction of a tickler coil without some information as to the wavelength range of your receiving transformer, as well as the size and form of the secondary coil.

* * *

G. W. H., Chicago, Ill.:
We print herewith a diagram showing a hook-up for your loose coupler and auxiliary apparatus.



M. J. S., N. Y. C.
You should be able to obtain a copy of The Phillips Code through J. H. Bunnell & Co., New York City, or through the Telegraph Age. It will cost you about $1.50.

* * *

H. F. K.:
Figure 1 of the article by C. R. Leutz, which was printed in the April number, should be corrected so that the left hand filament connection of tube No. 1 and the right hand filament connection of tube No. 4 come to the negative terminal of B-1.

* * *

C. R., Valdosta, Ga.:
We are unable to tell you where it will be possible for you to obtain a ½-kw. open core Marconi transformer. We suggest that you advertise in some of the radio magazines. It may be that some amateur now has one which he would be willing to dispose of.
The efficiency of Leyden jars as condensers is usually somewhat greater than the efficiency of a plate glass condenser, due to the fact that a better grade of glass is used in the Leyden jar.
We regret that we are unable to advise you as to the power input of the new station at Savannah, Ga.
We have insufficient data at hand at the present time to enable you to construct a magnetic detector.

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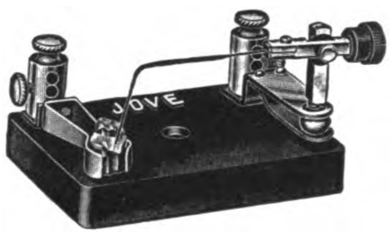

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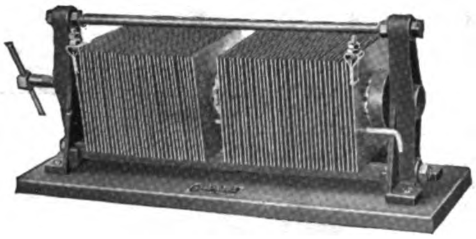

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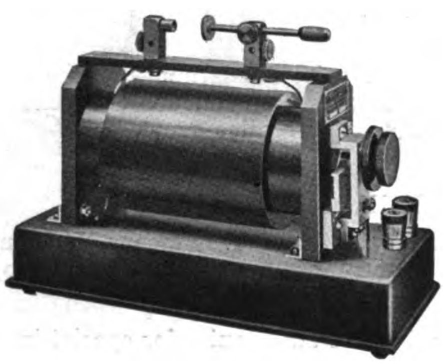

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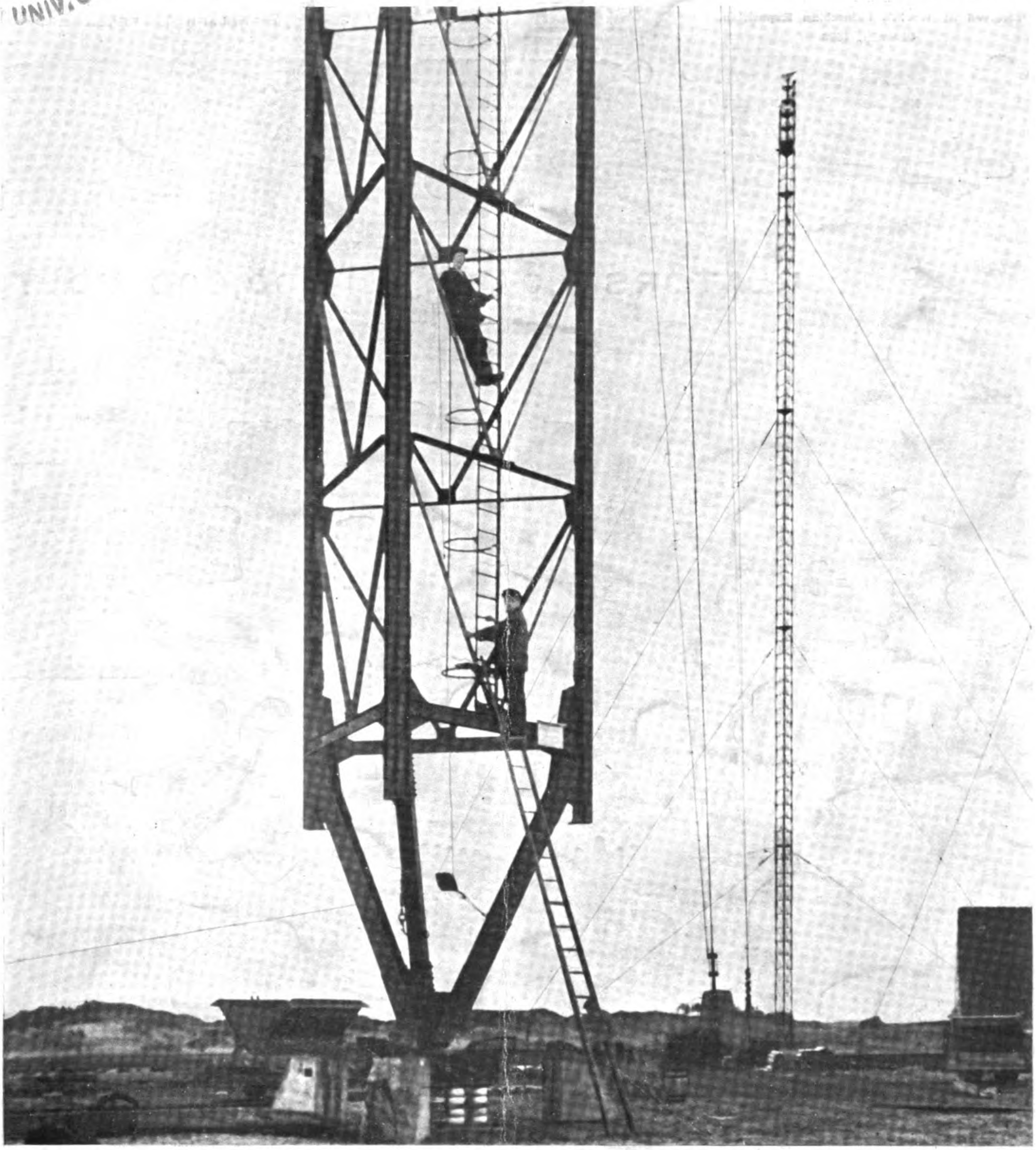

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Vol. 7 Contents of The Wireless Age for July, 1920 No. 10

Edited by J. ANDREW WHITE

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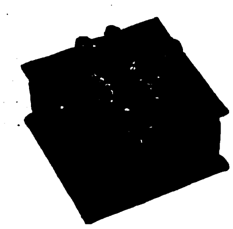

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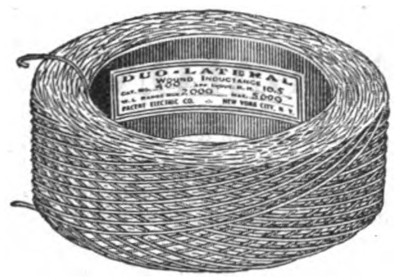

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200	1000 to 2500	2.50	2.30	1.50
250	1200 to 3500	4.2	4.	1.60
300	1500 to 4500	6.25	6.1	1.80
400	2000 to 5000	10.62	10.2	2.00
500	3000 to 6000	17.6	17.3	2.20
600	4000 to 10000	25.0	22.0	2.50
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You have our most courteous invitation to spend a few moments in our spacious show rooms and look over our complete stock. We will gladly show you any instrument or part you may desire to examine. It will be a revelation to you, besides it is part of our service.

OUR WORD OF HONOR TO YOU IS OUR GUARANTEE. LET US PROVE IT.

Write Dept. E5 for literature and price lists.

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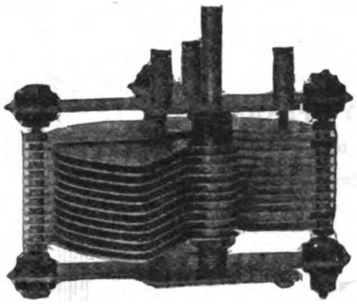


The New
Arco Variable Condenser

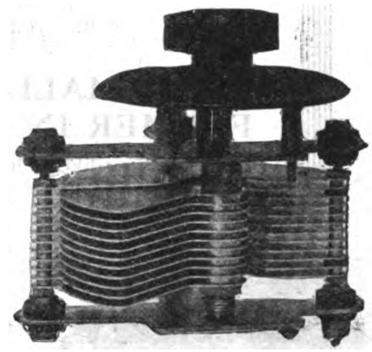
We offer Radio Men something out of the ordinary in variable condensers. This new model is a step ahead of its rivals in that the plates are made of aluminum and heavier than those found in the average condensers. The rotary plates are rounded at one end, not the usual semi-circular type, thus affording a straight line capacity, which is a very valuable feature in Wave Meter work. The zero capacity in an instrument of this type is considerably lower than that of usual condensers. Shaft on which rotary plates are mounted is carefully machined from tool steel. Instrument can be quickly mounted in case or behind panel.

Made in two capacities, furnished unmounted only, with or without dial of fine black moulded composition and bakelite knob.

Backed up by Radisco guaranteed quality of workmanship and low price.

Capacity	Unmounted	With Dial and Knob
.0005 mf.	$5.00	$6.00
.001 mf.	6.25	7.25

Shipping weight 2 pounds.



Prices quoted do not include carrying charges to Pacific Coast or duty paid for Canadian use.

RADISCO AGENTS carry only apparatus of proven merit. Look for the Radisco trade mark on all parts you buy and be sure of getting efficient apparatus.

Below are listed a few of the reliable firms who carry the RADISCO COILS, Better "B" Batteries and are our Agents for all other standard apparatus of merit.

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ALBANY, N. Y.
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ATLANTIC CITY, N. J.
Independent Radio Supply Co.
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BALTIMORE, MD.
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614 No. Calvert St.

BEINVILLE, QUEBEC, CAN.
Canadian Radio Mfg. Co.

BOSTON, MASS.
Atlantic Radio Co.,
88 Broad Street

BROOKLYN, N. Y.
Kelly & Phillips Electric Co.,
312 Flatbush Ave.

BRONX, NEW YORK
Amateur Wireless Equipment Co.,
1390 Prospect Ave.

CHICAGO, ILL.
Chicago Radio Laboratories,
1316 Carmen Ave.

EUREKA, PEORIA, ILLINOIS
Klaus Radio Co.

KANSAS CITY, MO.
McCreary Radio Supply,
4th & Delaware Sts.

LOS ANGELES, CALIF.
The Wireless Shop,
511 W. Washington St.

MONTREAL, CAN.
J. B. Miller,
1600 Hutchinson St.

McKEESPORT, PA.
K. & L. Electric Co.,
427 Olive Street.

NEW ORLEANS, LA.
L. A. Rose,
121 Camp Street

NEWARK, N. J.
A. H. Corwin & Co.,
4 West Park Street.

NEWCASTLE, PA.
Pennsylvania Wireless Mfg. Co.,
507 Florence Ave. "8HA"

PHILADELPHIA, PA.
Philadelphia School of Wireless Telegraphy,
Broad and Cherry Streets.

PROVIDENCE, R. I.
Rhode Island Elec. Equip. Co.,
45 Washington Street.

PITTSBURG, PA.
Radio Electric Co.,
3807 5th Ave.

SEATTLE, WASH.
Northwest Radio Service Co.,
1801 Sixth Ave.

SCRANTON, PA.
Shotton Radio Mfg. Co.,
P. O. Box 3
Branch 8 Kingsbury St.,
Jamestown, N. Y.

SPRINGFIELD, MASS.
Electric Service Co.,
585 Armory Street.

TORONTO, ONT., CAN.
The Vimy Supply Co.,
585 College Street.

WASHINGTON, D. C.
National Radio Supply Co.,
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If none of the above agencies are in your vicinity, communicate with

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WICONY APPARATUS is designed by super-engineers. It received the Government's highest classification.

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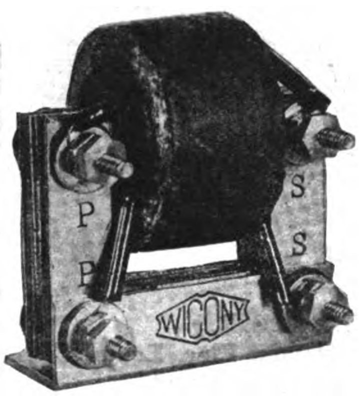
YOUR HOLIDAYS

Are you going to spend your holidays improving your Radio station, or will you *lose* that opportunity.

You can do more for your station during your holidays than during all the evenings you have worked in the past months—and it will be *genuine recreation*—you will finish your vacation with a feeling of "*something accomplished*."

THE SMALLEST TRANSFORMER IN THE WORLD

How would you like to have "The smallest transformer in the world" if you were convinced that it was also the most efficient?



AUDIO FREQUENCY AMPLIFIER TRANSFORMER; Type WI-110C.
Dimensions 2½"x2"x1½".
Shipping weight 10 oz.
Price $7.00. Code "Wictra."

After all, there is no need for a bulky affair in handling audio-frequency currents, if the design is correct. This transformer was designed especially for the operating characteristics of the Moorehead-Marconi-de Forest audion tubes. It has a closed core of the best grade laminated iron, with the primary and secondary windings of several thousand turns of extremely fine enameled wire. The design is such that the distributed capacity and current losses are extremely low.

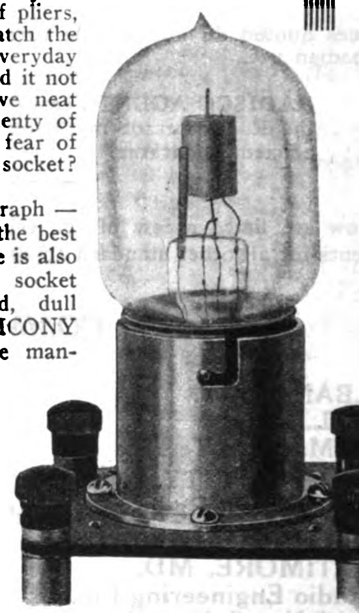
Order now if you want immediate shipment.

DO YOU USE AUDIONS?

Suppose you wanted to change the leads to your audion socket base—must you rustle 'round for a screw driver, or pair of pliers, mar the screws, or scratch the bakelite base with an everyday slip of the tool? Would it not be much better to have neat bindings posts, with plenty of room to work without fear of shorting thru the metal socket?

Look at the photograph—those terminals are of the best Bakelite type. The base is also of bakelite, while the socket is of finely machined, dull aluminum, another WICONY innovation. Notice the manner of support;—those legs are drilled and tapped and nickeled—heavily nickeled—thus giving you an ideal method of fastening to your panel or table.

We have bases with one, two, or three sockets especially mounted for interior of audion cabinets. They are most reasonable in price.



AUDION TUBE SOCKET. Type WI-111 A.
Dimensions 2¾"x2¾"x2" height.
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Price $1.90. Code "Wicbas."

WE ARE AT YOUR SERVICE

Whether you want an audion bulb or a complete audion cabinet—a coil, or a complete receiver, write us your needs. State specifically what you are interested in and we shall give you every possible item of information and assistance. Drop us a line now.

WICONY BULLETINS, handsomely illustrated and instructive, describing audion amplifiers, audion control boxes, batteries and complete receiving and transmitting sets or accessories, are yours for ten cents. (We charge this small fee to insure that they go to serious, reliable experimenters).
Write for yours today.

Dealers—It will pay you to write us NOW.

WIRELESS IMPROVEMENT COMPANY

INCORPORATED

Radio Engineers, Manufacturers and Distributors

47A West Street New York, N. Y.

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. 7)

WORLD WIDE WIRELESS

Thousand-Word-a-Minute World-Wide Radio Station

THE world's biggest wireless plant, to be built at Rocky Point, L. I., by the Radio Corporation of America, will handle 500 words in and 500 words out a minute, simultaneously, the land wire relay of seventy miles from Rocky Point to the company's office in Broad Street, New York City, being controlled mechanically, the human element entering into the process only at the point of actual transmission.

Mr. Edward J. Nally, President of the Radio Corporation, announces that the company plans a $10,000,000 plant on a 6,000-acre tract about seven miles from Port Jefferson.

"We are going to erect," he said, "five units, with another one to be held in reserve for use in the emergency of severe storm or other trouble. Each of the units will have a minimum capacity of sending 100 words a minute and of receiving the same number. This is, of course, the minimum capacity. We are hopeful, however, of doing better than this when the plant is fully geared up.

"To get an idea of the projected plant you might fancy it laid out as a wheel. The big power house represents the hub, while the spokes or wings, twelve in all, radiate out in all directions from the power house. Each wing will have six antennae strung to 400-foot steel towers.

"It is our plan to transfer the wireless signals directly from the wireless apparatus to land wires and send them right along into New York City, to headquarters, without calling manual labor into the process at any time. We are going to have a radio receiving station about seven miles from the transmitting station, and we plan to operate both simultaneously.

"It is the design to control relays entirely from our city office. All of the operating work will be done there, although the machinery of transmission will be, of course, out at Rocky Point.

"Each of the five units of the plant will serve a separate field. One will be in touch continuously with South America, another will talk to Germany, a third will serve France, another goes to Italy and the fifth will serve Poland."

The third transoceanic wireless circuit, linking America with the rest of the world, has been opened by the Radio Corporation. Opened principally for commercial messages, the new wireless route connects this country with the Scandinavian countries—Norway, Sweden, Denmark and Finland. The American stations, at Marion and Chatham, Mass., with their complementary stations at Stavanger and Naerobe, Norway, are of the duplex type, sending and receiving simultaneously at high speed.

It was announced that the rates for the new service, from New York City to any point in the countries named, would be, per word, Norway, 24 cents; Sweden, 26 cents; Denmark, 28 cents, and Finland, 29 cents. It was stated that these rates were from 30 to 50 per cent. lower than existing cable tolls. The other commercial circuits in operation by the Radio Corporation are from San Francisco to Japan, via Hawaii, and from New York to Great Britain.

London Daily Mail Has Radiophone News Service

WIRELESS telephone receiving set has been installed in Northcliffe's Daily Mail. The paper hopes to have its American news dictated by 'phone from New York in the very near future.

Keystone

Danish wireless commission to U. S. Left to right—Capt. H. Faber, Prof. P. C. Pederson, Commander H. J. Schledermann, Hon. T. F. Krarup and W. G. Thomson

Marconi Has 500-Mile 3 K. W. Radiophone

WIRELESS telephone communication over a distance of 500 miles, with apparatus of a strength of only three kilowatts, has been achieved by William Marconi, the Italian inventor. This was announced upon his return to Rome from a cruise in the Atlantic and Mediterranean on board the yacht Electra.

Albany Firm to Use Radiophone

THE Esco Electrical Company, of Albany, N. Y., has erected a powerful wireless telephone set in its Broadway store. It will use the radiophone method of communication with its agents in New York and other places as soon as the operation of the instruments is perfected to a point where such points can be reached. Carl Hoffman, employed by the company, is conducting tests in an effort to increase the working distances of the instruments. Already he has established communication with wireless operators at Troy and Schenectady. The firm especially wishes to be able to talk with New York.

Marconi Explains Radio to Spanish Workers

SENATOR GUGLIELMO MARCONI, who is known for his amiable qualities almost as much as for his great invention, has just given another proof of his urbanity. Despatches from Seville, Spain, where he stopped with his yacht Electra, state that a large party of laborers approached the yacht and requested permission to see the wireless apparatus on board. In the absence of the owner the officer in charge refused to grant the permission.

Just as the men were leaving Marconi returned to the vessel and, having been informed of their desire, he invited them aboard and personally explained to them in all its details the working of the wireless apparatus.

Keystone
Dr. Frederick Millener (standing), scientist of Omaha, trying to catch Mars wireless signals by means of special apparatus

Radiophone Talk Recorded on Phonograph

EXPERIMENTS which have been carried out in London have resulted in the making of a talking machine record on wax of a voice transmitted by wireless telephone forty miles away.

While the voice was speaking at Chelmsford, in the County of Essex, where there is a high-power instrument capable of transmitting the voice many hundreds of miles, the equipment at the receiving plant in the Strand, London, was attached to a recorder, which engraved the messages in soft wax in the same way as an ordinary talking machine disk is manufactured.

The record when produced was perfectly audible.

Commercial Application of Radiophone

THE Public Service Company of northern Illinois is installing wireless telephones at its Blue Island and Joliet stations, the intervening distance as the crow flies being only about 25 miles. The two stations tie-in together and also are interconnected with the Fisk and Quarry Street stations of the Commonwealth Edison Company in Chicago. The wireless system will have a radial power of about 100 miles, and will be used primarily during such times as the metallic telephone lines are out of service, due to weather or high-voltage system trouble.

Radio Service Between Germany and Spain

PRESS dispatches may be sent between Germany and Spain by wireless, according to an announcement made lately. Most German correspondents, however, have left Spain and consequently the service will be used principally for German propaganda, it is asserted.

Danes Seek Direct Wireless Connection With U. S.

THREE officials of the Danish Government arrived lately to confer with Washington officials regarding the establishment of a direct wireless communication between the United States and Denmark, to facilitate commercial communication between the two countries. A great trans-Atlantic wireless station has been established in Denmark of sufficient range to transmit messages direct across the Atlantic.

When this channel of communication is firmly established, commercial messages will no longer be routed via Great Britain.

Commercial Company to Use Private Radiophone

THE new Winchester stores in the New England States may be connected by wireless and all their business so transacted. Officials have consulted W. J. Butterworth of Boston, assistant federal radio inspector for New England, in regard to the proposed enterprise.

The Winchester company is considering the use of the wireless stations largely on account of the delays caused by wire troubles. This situation was particularly noticeable during the last winter. Often in very severe weather, when the telegraph and telephone lines are out of commission, the weather conditions are especially favorable for wireless. Moreover, the increasing improvement of the radiophone has added greatly to the possibilities of wireless, and radio communication would also be advantageous in that messages are simultaneously heard in all directions and hence at one time the headquarters of a company could transmit orders and information to all branch offices within a radius of one hundred miles.

Whole World to Get Wireless Time Signals

WIRELESS telegraphy may yet prove to be the means of preventing many railway and sea catastrophes. To this end in fact an International Time Bureau is being formed in Brussels, which intends to develop methods of transmitting throughout the world the time signals of the greatest precision.

The bureau is in charge of M. Bigourdin, member of the French Academy of Sciences, who for many years has been attached to the Paris Observatory. Discussing the aims of this new organization M. Bigourdin has called attention to the fact that all through the war the Eiffel Tower sent daily signals that were picked up in the most remote quarters of the globe.

"It is most essential that navigators know at every instant the precise time," says M. Bigourdin. "Extensive experiments have been carried out in the last year and we have reason to believe that the efforts will lead to unexpected discoveries concerning the variations in actual longitude similar to those known to exist with respect to latitude. With precise knowledge of the time, the sun's location and the consequent geographical position ships will more easily avoid dangerous areas."

M. Bigourdin is confident that many sea accidents have been due to the impossibility of ships picking up accurate time signals. He points out also the necessity for the most reliable records for despatching trains in all countries. Further experiments will be conducted with intermittent Hertian waves approximately 2,600 metres long to replace those of shorter length now used.

M. Bigourdin, whose investigations are receiving support in all allied countries, hopes to create a system whereby the expenses will be distributed among all nations, for it is obvious that once the signals begin to work there is nothing to prevent any mariner from taking advantage of an organization in which French scientists are taking an important part in putting into operation.

Transpacific Steamship Lines Plan Radio Charts

STEAMSHIP lines operating in the transpacific trade are planning to take advantage of the chain of powerful wireless stations, which extend along the Alaskan Coast from Juneau to Dutch Harbor and to St. Paul Island, making possible permanent wireless communication with the Orient from Seattle and other North Pacific ports.

The importance of taking advantage of these radio stations in communicating with ships at sea and in transmitting messages from Seattle to China and Japan, has been emphasized by the serious delay to cable messages, now ranging from 150 to 160 hours.

Representatives of the Nippon Yusen Kaisha are preparing maps for use aboard the vessels of the N. Y. K. transpacific fleet and in the company's offices both in the Orient and America, showing the position of the stations and the possibility of constant communication with a vessel of the fleet from the time she sails from Seattle until she berths in Yokohama. This is made possible by the radio stations in Juneau, Sitka, Cordova, Kodiak, Dutch Harbor and on St. Paul Island.

The most powerful of the stations is the one in Cordova, which has a radius of 2,000 miles in the daytime and 4,000 miles at night. The distances the other stations can work follow: St. Paul station, 1,000 miles in daytime and 2,500 miles at night; Dutch Harbor, 300 miles in daytime and 600 miles at night; Kodiak, on Kodiak Island, 1,000 miles in daytime and 2,000 miles at night; Sitka, 1,000 miles in daytime and 2,500 miles at night; Juneau, 500 miles in daytime and 1,000 miles at night.

With the present wireless arrangements of the transpacific steamship lines, the first communication with a ship at sea bound from the Orient for this coast is had when the vessel arrives within 1,000 miles of Victoria, B. C.

Radio Masts Snapped Passing Under Brooklyn Bridge

THE radio masts of the U. S. collier Nereus were snapped off as the ship passed under the middle span of the Brooklyn Bridge on her way to the navy yard recently. The fragments of the masts fell to the deck of the ship, where they narrowly missed hitting some of the crew.

The Nereus arrived from France with the bodies of sailors and marines who had died overseas.

Jap Navy to Use Wireless 'Phone

THE Japanese Navy will no longer depend on radio telegraphy for communication as a result of the perfection of the wireless telephone, which hereafter will take the place of all other forms of signaling.

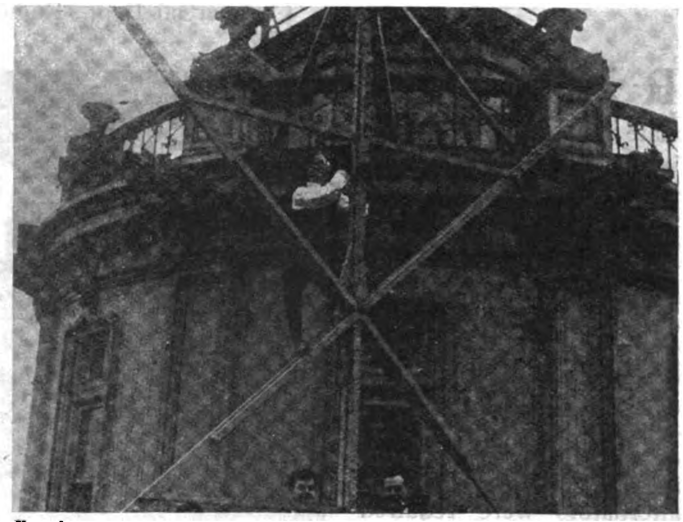
An official of the Ministry of the Navy said that the new wireless telephone apparatus had been installed on the vessels of a unit of the First Squadron and was being installed on the rest of the Japanese war ships.

Radio Rates to Japan Reduced

TO offset the rising price of necessities, comes the announcement that the high cost of sending wireless messages from Seattle to points in Japan has dropped. The rate now from San Francisco to Tokio is 72 cents a word instead of 80 cents. W. F. McAuliffe, local manager of the Radio Corporation of America, gave this information and declared that within a short time messages destined for the Orient from Seattle will be accepted by messenger boys in the same manner as ordinary telegrams are delivered.

Many will give three rousing cheers, it is said, when they learn that a night letter to the Emperor of Japan, say of fifty words, instead of costing $40 as formerly, will now cost but $36.

The cut in the rate of wirelessing Japan, says Mr. McAuliffe, is made possible by the opening of a new 400-kilowatt station at Haro-no-machi, in the vicinity of Sendai, on the Northern Japanese mainland. This station, with high frequency alternator type equipment, will work directly with the Pacific Coast stations of the Radio Corporation.



Keystone
Erecting the receiving loop on the N. Y. Times Bldg., with which it was hoped to receive radiophone messages from warships entering the harbor

"Traffic schedules are being worked out so that Seattle firms will shortly be able to file their business locally, the same as any other ordinary telegraph message," said Mr. McAuliffe. "For the immediate present, however, messages are accepted only in San Francisco, Seattle messages to Japan going through San Francisco by the wiring of messages from Seattle to San Francisco."

U. S. Radio Examinations

THE United States Civil Service Commission announces open competitive examinations for radio engineer (aeronautics), $3,600 to $5,000 a year; assistant radio engineer (aeronautics), $2,500 to $3,600 a year, on July 6, 1920. Vacancies in the Air Service at Large at the salaries indicated, and in positions requiring similar qualifications, at these or higher or lower salaries, will be filled from these examinations, unless it is found in the interest of the service to fill any vacancy by reinstatement, transfer, or promotion.

Competitors will not be required to report for examination at any place, but will be rated on the following subjects, which will have the relative weights indicated:

Subjects—Physical ability, 10 weights; education, experience, and fitness, 90 weights. Total, 100 weights.

Competitors will be rated upon the sworn statements in their applications and upon corroborative evidence. For the position of radio engineer, applicants must have graduated with a B. S. degree, with major courses in physics or electrical engineering, from a college or university of recognized standing; and, in addition, have had at least three year's experience in the design, manufacture, or installation of radio apparatus for the Government or for a contractor who has supplied satisfactory apparatus of this class to the Government.

For the position of assistant radio engineer, applicants must have had the education and one year of the experience prescribed for radio engineer.

"WII"—New Brunswick

The Alexanderson Continuous Wave System—Description of the High Power Radio Apparatus for Radio-Telegraph and Radio-Telephone Transmission

By Elmer E. Bucher

Commercial Dept., Radio Corporation of America

RADIO engineers early foresaw that the ultimate generator of oscillations for radio-telegraphy and telephony would be one of a type providing more efficient and reliable operation than the systems utilizing the "arc" and "spark." In fact the literature of the past makes frequent references to the desirability of an oscillation generator constructed along the lines of an ordinary power-house alternator; but because such alternators were required to provide frequencies a thousand times or more in excess of those used in power engineering, new problems of design were encountered which were declared by many to be well-nigh insurmountable.

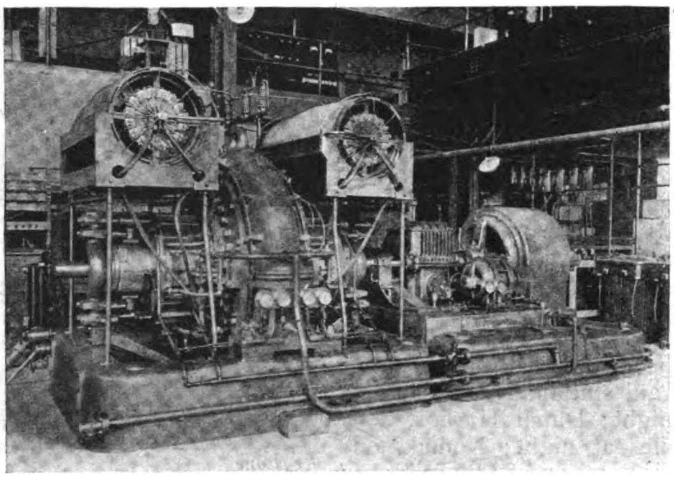


Figure 1-2—200 kw. Alexanderson radio frequency alternator installed in the New Brunswick transoceanic station

For a time the development of the art seemed to follow the line of least resistance, and it resulted in the evolution of several systems utilizing the "arc," the "spark gap," and the type of radio frequency alternator which generates at a comparatively low frequency, the necessary increase of frequency being obtained either by groups of mono-inductive transformers external to the alternator, or by tuned "reflector" circuits associated with the alternator. None of these systems, however, can be said to have satisfied fully the exacting requirements of commercial operation.

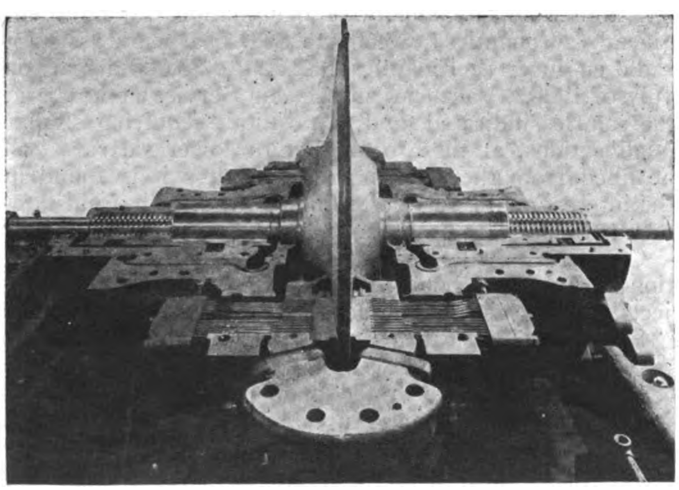


Figure 3—Alexanderson alternator with top half removed

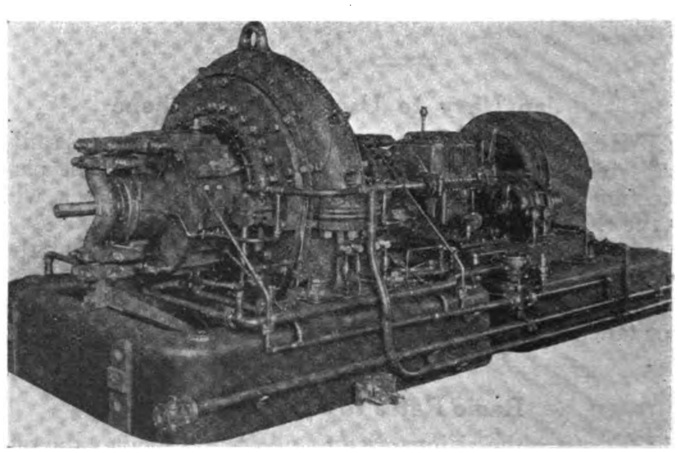


Figure 4—Alexanderson alternator with high frequency transformer removed

An oscillation generator suitable for commercial radio service over great distances, should possess the following qualifications:

1. It should generate a steady stream of oscillations of constant amplitude.
2. It should generate a so-called "pure" wave; that is, a fundamental wave in which the radiation incurred by super-imposed harmonics is negligible.
3. It should provide a performance as reliable as the ordinary power dynamo.
4. It should operate economically and efficiently.
5. It should permit manufacture of units in any desired power.
6. The design of the whole system should be such as to permit telegraphic signaling at very high speeds.

These specifications are met fully and fairly in the Alexanderson system.

As is well known, the design of radio frequency alternators has occupied the attention of Ernst F. W. Alexanderson of the General Electric Company and his staff for a number of years, and the pioneer work of these men in that branch of radio research is now a matter of common knowledge. Starting with the development of several experimental types of alternators, they have steadily progressed toward the designs of more powerful machines which are now available for commercial use. Standardized alternator sets for transmission at wave lengths between 6,000 and 10,000 meters and between 10,500 and 25,000 meters, are now in production. This description is devoted principally to the discussion of a 200-kilowatt set, although sets of other powers are now under construction.

The typical Alexanderson high-power station may be said to represent a radical departure from current ideas regarding radio design. In fact, at first glance, it seems to possess little in common with the apparatus of other systems. These features will presently be described in greater detail.

The Radio Corporation, after an extensive test of the Alexanderson system at its high power station at New Brunswick, N. J., has acquired the rights to the Alexanderson system, and it will be employed at all its stations devoted to long-distance signaling. A 200-kilowatt alternator set was installed at New Brunswick in September, 1918, and from that time it has provided continuous and most satisfactory service in continent-to-continent communication. Normal transmission is at present conducted at the wave length of 13,600 meters, with antenna current of 400 amperes corresponding to an alternator output of approximately 80 kilowatts. With this fractional value of the available output of the al-

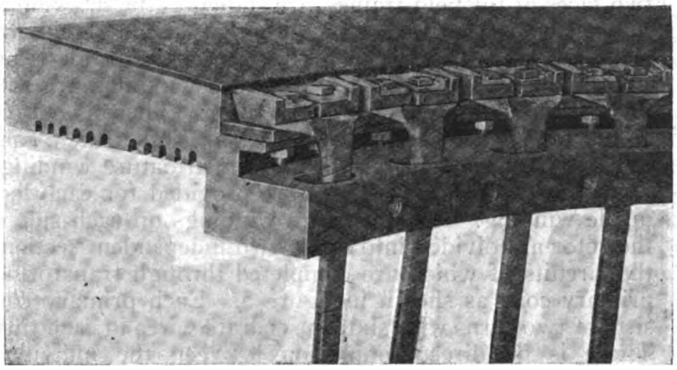


Figure 6—Detailed view of section of armature

ternator, trans-oceanic communication has been maintained with European stations throughout the twenty-four hours of the day. The alternator is capable of supplying 600 amperes to the New Brunswick antenna, but its full output of 200 kilowatts is not at present utilized, due to the lack of adequate power supply at that point. The alternator, as installed at the New Brunswick station, is shown in figure 1-2.

The following explanation of the basic principles of the Alexanderson System and the fundamental circuits of a typical station may be accepted as indicative of a standard 200-kilowatt installation, although largely based upon the apparatus at the New Brunswick station.

A high power radio station of the Alexanderson type contains three important developments:

(1) An alternator—which generates currents directly at the frequencies which are required for the radio circuits with which it is associated. The frequency of these currents is solely dependent upon the number of field poles on the machine, and upon the speed at which the rotating member is driven. This is in distinct contrast to certain other systems in which the radio frequency currents are obtained indirectly by means of "reflector circuits" or frequency raising transformers electrically associated with the alternator.

(2) A magnetic amplifier—which provides a non-arcing control of the alternator output for radio telegraphy, and is equally applicable to radio telephony.

(3) A multiple tuned antenna—a development which has markedly reduced the wasteful resistance of the flat-top antenna, and has therefore increased the transmitter overall efficiency many fold.

To date the development in radio alternators has included the following types:

2-kw., 100,000 cycle; 50-kw., 50,000 cycles; 200-kw., 25,000 cycle.

The characteristics of several alternators of other power outputs have been investigated from time to time. A standard 25-k.w. and a 5-k.w. alternator are now under construction and will be shortly put into commercial production.

With the object of providing a distinct range of frequencies, both the 25-k.w. and the 200-k.w. alternators are manufactured with armatures and rotors with different numbers of poles; also with gears of different ratio for different driving motor speeds. Thus the 25-k.w. machine can be assembled for any wave length from 6,000 to 10,000 meters, and the 200-k.w. machine for any wave length from 10,500 to 25,000 meters. Frequencies lower than these for which the machine has been assembled can be obtained by running the alternator at a reduced speed.

The standard drive for the 200-kw. Alexanderson alternator is two-phase, 60-cycles, 2,300-volt alternating current. By the use of suitable transformers, the voltage of the power supply can readily be transformed to the value for which the motor was designed. Special driving motors and control equipment can be supplied for frequencies other than 60/50 cycles.

The Alexanderson alternator is an inductor type of generator with a solid steel rotor having several hundred slots milled radially on each side of the rim. The slots are filled in with non-magnetic material, with the object of reducing wind friction to a minimum. The fillers are brazed into the disc in order that they may withstand the centrifugal strain of rotation. The rotor is designed for maximum mechanical strength by providing it with a thin rim and a much thicker hub. With this construction the strain on the material due to centrifugal force is the same from the shaft to the outer rim.

The rotor of the 200-k.w. alternator—with half of the field frame removed—is shown in figure 3. This also shows the collars of the thrust bearings and a partial sectional view of the main bearing housings.

An assembled 200-k.w. alternator with its driving moto is shown in figure 4. The alternator is driven by a 600

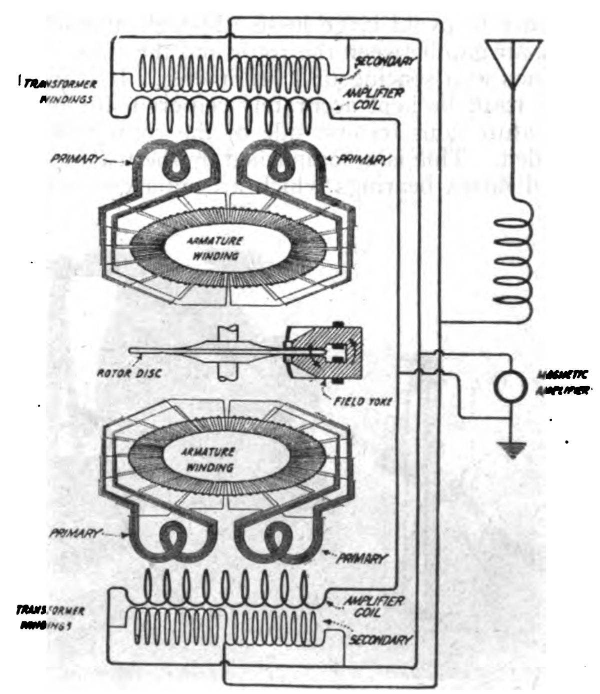


Figure 5—Schematic diagram of Alexanderson alternator circuits

h.p. induction motor of the wound-rotor type, which is operated from a 60-cycle, 2,300 volt, quarter-phase source of supply. The motor is connected to the alternator through a double helical gear—with a speed step-up ratio of 1 : 2.97—which operates in a container partially filled with oil.

The main bearings and the thrust bearings of the alternator are oil-lubricated by force feed at pressures varying from 5 to 15 pounds according to the demand on the bearing. During the periods of stopping and starting, and in possible emergencies, oil is supplied by a special motor-driven pump mounted on the alternator base. When the alternator is working under normal operating conditions, a separate pump geared to the main driving shaft feeds the bearings, and the motor-driven pump is automaticaly cut out of service. The oil-supply tank is located in the base of the alternator, to which the oil returns after being pumped through the bearings. The oil gauge on the main feed pipe is fitted with a signaling

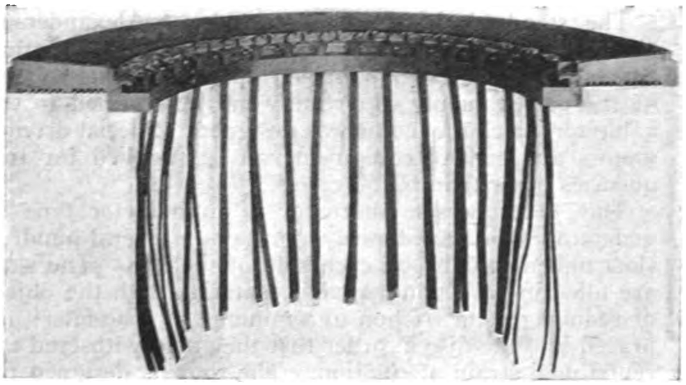


Figure 7—A section of the armature

circuit to call the attention of the operator in case the oil supply fails. The main bearings of the alternator, which are self-aligning, are also water-cooled by a series of copper pipes which run through the bearings near to the friction surface. The armatures of the alternator are also water-cooled from the same pumping source by a series of parallel copper tubes cemented in the frame alongside the laminations.

In order to avoid large losses through magnetic leakage, the air gap between the rotor and the stator frame is maintained at a spacing of 1 millimeter. It is important that the rotor be kept accurately centered, for otherwise the armature coils on one side of the rotor will become overloaded. This is accomplished by the use of specially designed thrust bearings which are inter-connected by a

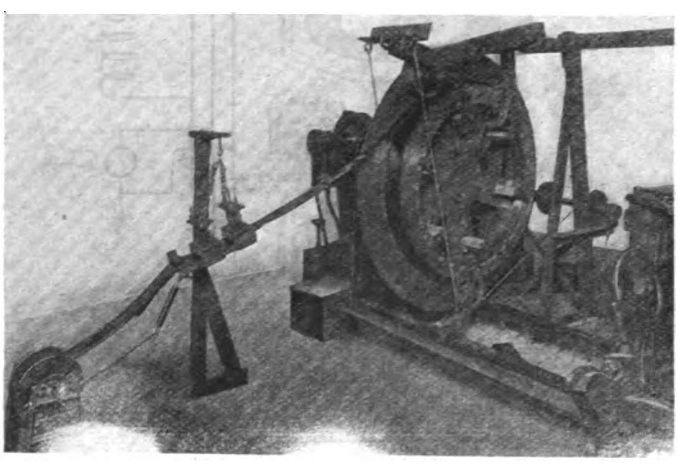


Figure 8—Method of assembling the armature

set of equalizing levers with an adjustable controlling leaf between them. These prevent the possibility of binding between the thrusts, due to expansion of the shaft from heating, and they also take up automatically all slack in the bearings as they become worn. Any tendency towards a change in the air gap is thus counteracted by the action of the levers. The equalizers are in part, the heavy vertical column shown at the end of the alternator in figure 4. Should the air gap on either side tend to get smaller, the pull of the field on that side would cause an excessive strain on the thrust at the end and cause heating. This, however, is prevented by the leverage system, which automatically corrects this and holds the rotor in a central position at all times.

In regard to some of the electrical features of the alternator, it will be noted from figure 5 that the armature and field coils are stationary, the requisite flux variations for the generation of radio frequency currents being obtained from the slots cut in the rotor. The diagram points out the fundamental construction of the alternator and the general mode of winding the armature. The rotor disc revolves between the two faces of the field yokes. The direct current supplied to the field coils produces a magnetic field flux which passes between the field yoke faces and through the rotor as shown by the arrows.

The armature coils, which are placed in slots cut in the two faces of the field frames, are shown in the drawing as tipped away from the rotor, although in the actual machine the spacing between the rotor and the frame is but 1 millimeter. Two distinct armature windings are thus provided, one on each side of the rotor. There is but one conductor in each slot and two of these slots make a complete loop, and comprise a pole in the armature windings. One slot in the rotor is therefore provided for each loop in the winding. The armature windings on each side of the rotor are divided into thirty-two independent sections, the circuits of which are completed through transformer primary coils as shown in figure 5. Each primary consists of two turns with sixteen separate wires in each turn. There is no direct connection between the individual

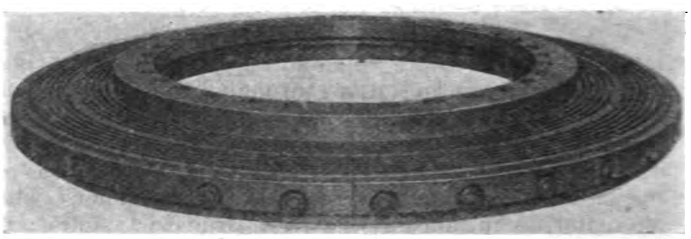


Figure 9—Completed armature ready for sawing into two sections

armature sections, but, through the two-turn primaries, they combine to act upon the secondary coils of the transformers. It is obvious that with this division of armature circuits the potential on any armature coil—or on the corresponding transformer primary—is very low, and as such, it permits a grounded or open-circuit armature coil to be cut out of the circuit and the operation of the alternator to be continued with but a slight decrease in its output—an obvious advantage.

A detailed view of a portion of the alternator armature windings is given in figure 6, and of the preliminary stages of assembly in figure 7.

Figure 8 shows the laminated armature under assembly, which is wound with 0.037 millimeter steel ribbon and afterward machined into the shape of figure 9.

The completed rotor and its shaft appears in figure 10, while figure 11 is an end view of the alternator with the equalizing column removed. Figure 12 shows the alternator during one stage of the assembly—the driving motor, the alternator transformer and the thrust-bearing equalizing system not having been placed in position.

It is to be noted that a transformer is provided for the armature coils on either side of the rotor. There are therefore two transformers, and they each contain the three coils P_1, S_5, S_1 and P_2, S_5, S_2, shown in the fundamental station diagram figure 19. The primary of each transformer contains two turns of sixteen wires each, as mentioned above. The intermediate coils S_5 have twelve turns on each transformer. The two intermediate coils are connected in parallel, and are shunted by the magnetic amplifier. The coils S_5 are also connected in series with the secondary proper, and the antenna system.

The secondary coils, which consist of seventy-four turns on each transformer, are wound so that their high potential ends are at the center, in order to provide a uniform potential gradient. The two secondaries are connected in parallel and their final terminals are in series with the antenna circuit. More in detail, the low potential terminals of the intermediate coils are connected to the ground, the other terminals of the intermediate coils are connected to the low potential terminals of the secondary coils, and the high potential terminals of the secondary coils to the antenna loading coil. The intermediate coils S_8 are placed between the primary and secondary of each transformer in order to obtain a close coupling with the alternator. One unit of the high frequency transformer is shown in figure 13.

The voltage at the terminals of the secondary winding of the transformer when the alternator is operated at normal speed is about 2,000. The normal output current is 100 amperes. It is thus seen that the alternator is designed for a load resistance of 20 ohms.

Since the antenna circuit is directly associated with the alternator circuit, any change in the rotative speed of this machine would throw the alternator circuit out of resonance with the antenna circuit; consequently it is easily seen that the speed variation of a radio frequency alternator for substantially constant output must be held within very close limits. The variable load imposed by telegraphic signaling has a tendency to cause a variation of speed that must be compensated for by some device which operates more critically than any of the mechanical and electrical methods of speed control devised for ordinary power use. The characteristics of any satisfactory governor must be such that a small variation of speed will effect a maximum change in power input to the device under control. To accomplish this, some mechanism must come into such a critical state at the speed to be maintained, that a low percentage of change in speed causes a high percentage of change in itself.

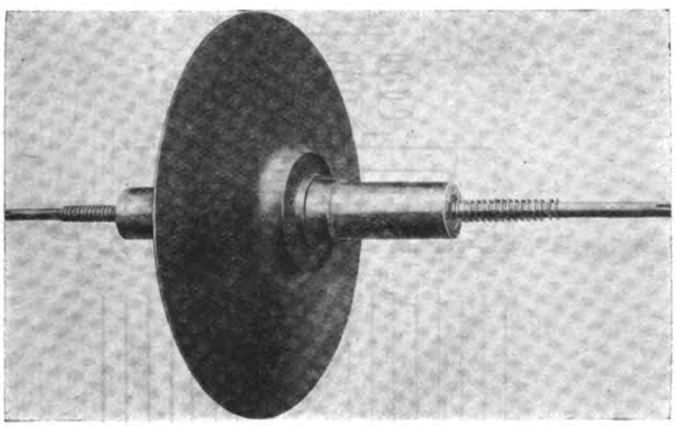


Figure 10—Typical rotor construction of the Alexanderson alternator

It can be shown that a change in speed of one-quarter of one per cent. from that necessary to maintain resonance will reduce the antenna current in a station utilizing the wave length of New Brunswick—13,600 meters—to one-half its full value. This clearly infers that the speed variation must be much less than one-fourth of one per cent. to maintain a constant output at the alternator. As a matter of fact, a regulation within one-tenth of one per cent. is obtained by the Alexanderson speed regulator.

The necessity for close speed regulation becomes equally important when considered from the standpoint of the receiving station. With a modern receiving apparatus of low decrement, a very slight change in the wave length of the incoming signal will materially decrease the received current. A change of wave length or frequency is likewise detrimental when reception is obtained by the heterodyne or beat principle, for should the speed of the alternator vary markedly while signaling, the beat note may vary to the degree that will render it objectionable for ear reception. A variation, for instance, of 50 cycles in the alternator will cause the beat note at the receiver to vary by 50 cycles, which is the equivalent of a speed variation of 0.23 per cent. at the wave length of 13,600 meters.

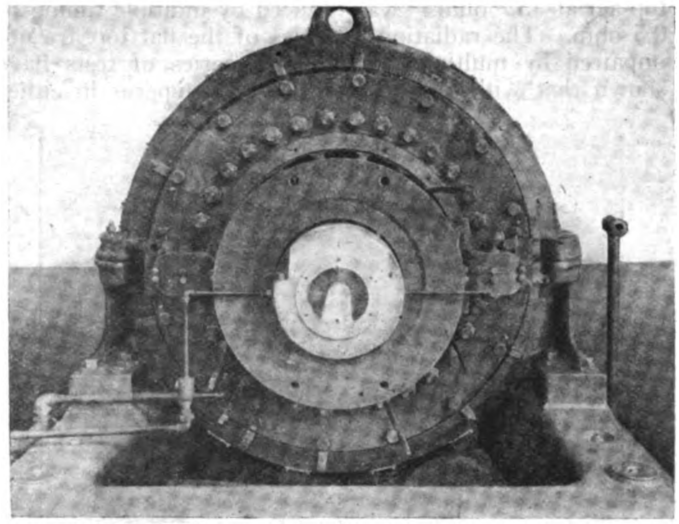


Figure 11—End view with air-gap equalizing mechanism removed

A solution of the problem of speed regulation with alternating current motor drive was found by Mr. Alexanderson in the use of a resonance circuit, which is tuned to a frequency slightly above the frequency to be maintained at the alternator. This circuit is supplied with current from one of the armature coils on the alternator. The current in this circuit increases with alternator speed and, through the agency of a rectifier, a direct current component operates on a voltage regulator connected in the circuit of the dynamo which supplies the saturation current for a set of variable impedances in the two phases of the motor supply circuit. The function of the regulator is to prevent, within established limits, either an increase or decrease of alternator speed. Additional compensation for the load imposed when signaling is provided by a relay which also operates through the direct current control circuits to vary the line impedances.

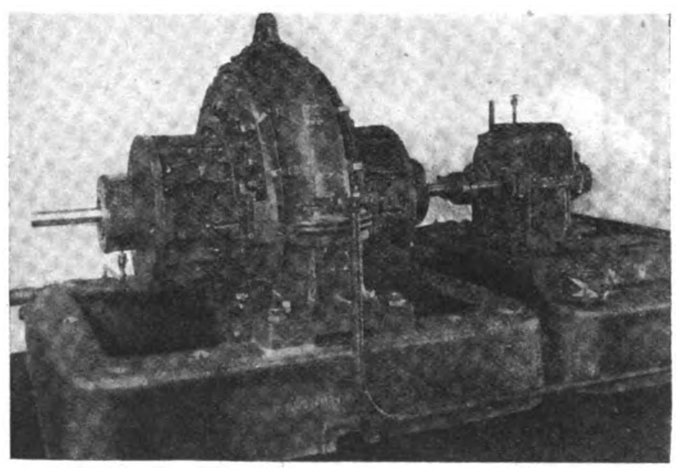


Figure 12—Alternator partially assembled

The panel board of the voltage regulator system is shown in figure 14.

The multiple tuned antenna may be said to establish a radical departure from the types of antennae formerly used for high-power radio transmission. The immediate object of the multiple antenna is to reduce the wasteful resistance of the long, low, flat-top aerials formerly used and to permit the length of such aerials to be increased indefinitely for the use of greater powers. In the case of the New Brunswick antenna, its resistance as a flat-top aerial—3.7 ohms—was reduced by multiple tuning to 0.5 ohm. The radiation qualities of the flat top are not impaired by multiple tuning, as a series of tests have shown that with an equal number of amperes in either

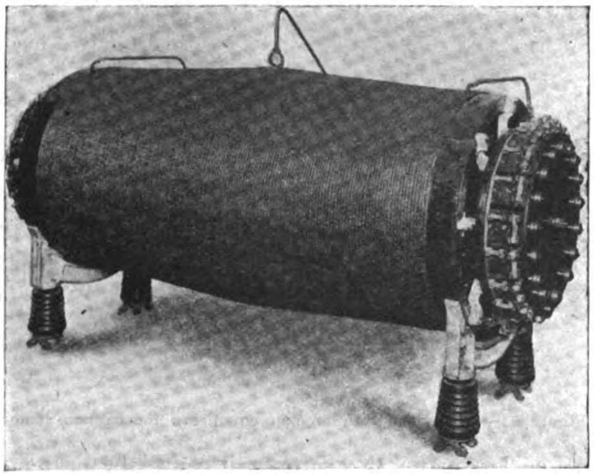


Figure 13—High frequency transformer

types, the same signal audibility is obtained at a receiving station, but there is an enormous saving of power in the case of the multiple antenna, as will be presently pointed out.

As shown in the station diagram, figure 19, the multiple antenna has, instead of the single ground wire usually employed, a number of ground leads which are brought

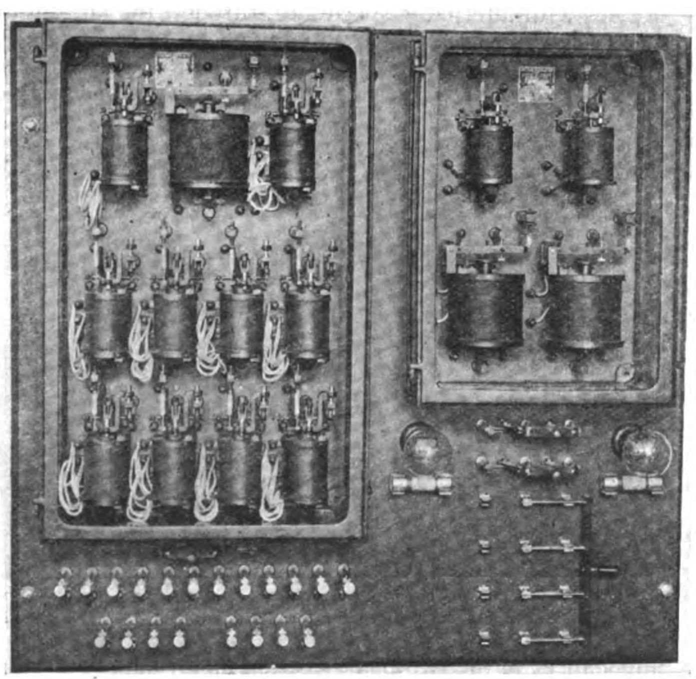


Figure 14—Control panel of current and voltage regulator

down from the flat top at equally spaced intervals, and connected to earth through appropriate tuning coils.

The capacitive reactance of the flat top is thus neutralized by inductive reactance at six points to earth, instead of but one point as in the ordinary system. The inductive reactance in each down lead is therefore made six times the capacitive reactance at a given frequency. The multiple antenna is thus the equivalent of six independent radiators, all in parallel and resonant to the same wave length. Their joint wasteful resistance obviously is much less than that of an antenna with a single ground, and herein lies the saving of power which the Alexanderson antenna brings about.

The relative power inputs required by both types of antennae for the same value of antenna current will be seen from the following illustration: To maintain 600 amperes in the multiple-tuned antenna at New Brunswick, at a resistance of ½ ohm, the power required is $600^2 \times 0.5$, or 180-k.w. To maintain the same antenna current in a flat-top antenna with resistance of 3.7 ohms requires $600^2 \times 3.7$, or 1330-k.w. The economy of power secured in the case of the multiple-tuned antenna is an important consideration from the standpoint of the cost of daily operation.

Prior to the advent of the Alexanderson antenna, theory and practice pointed to the desirability of a very high antenna structure for long distance communication at high powers, but as is well known, the cost of erecting an antenna increases very rapidly with the effective height. The multiple-tuned antenna, however, permits the use of a less expensive antenna structure, and gives

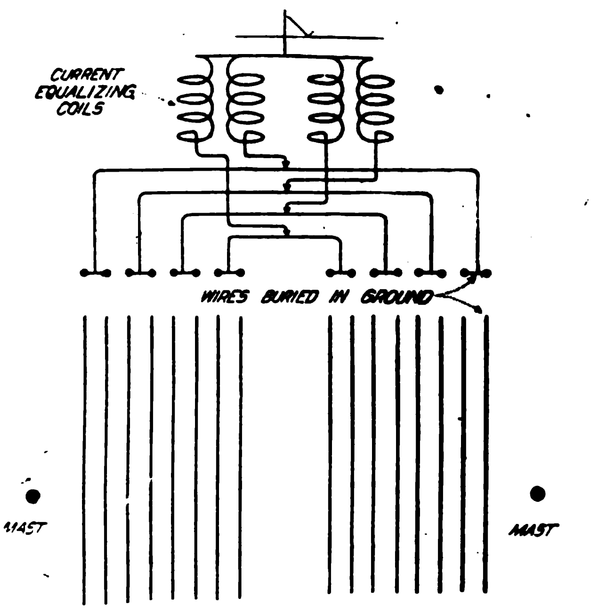


Figure 15—Schematic diagram of earth-wire system at the New Brunswick station

the same signal audibility at a given receiving station as a high antenna of the old type with less power. The example given demonstrates quite conclusively that the multiple antenna will provide the same antenna current as the flat-top type antenna, but with only one-seventh of the power. The multiple-tuned antenna will be treated more comprehensively in a later article.

The earth-wire system at the New Brunswick station is a combination of a buried metallic and a capacitive ground. Sixteen parallel copper conductors are laid underneath the antenna and buried one foot in the ground. They extend the entire length of the antenna and are spaced between towers somewhat as shown in figure 15. A network of wires and zinc plates are also buried in the ground around the station. At each of the five tuning points outside the station, connection is made from the antenna flat top to the sixteen underground wires.

In order to secure equal distribution of current through the buried ground conductors, equalizing coils are inserted between the tap on the down lead coil and the earth wires at each of the five tuning points outside the station, as shown in detail, figure 15. The function of the equalizing coils is to increase the impedance of the wires near the center and hence force current in the outside wires. Since the coils are wound in opposite directions they add no appreciable inductive reactance to the tuning circuits. In one instance, the use of these coils reduced the multiple resistance of the antenna system from 0.9 to 0.7 ohm.

A still better distribution of the earth currents at New Brunswick was obtained by using a capacitive ground commonly known as a counterpoise, which is erected underneath the antenna and a few feet above the earth. A plan view of the counterpoise is shown in figure 16.

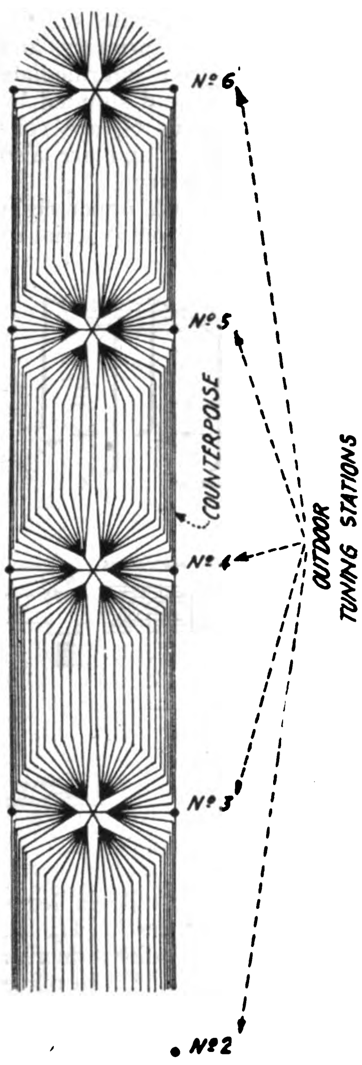


Figure 16—Plan view of counterpoise at New Brunswick Station

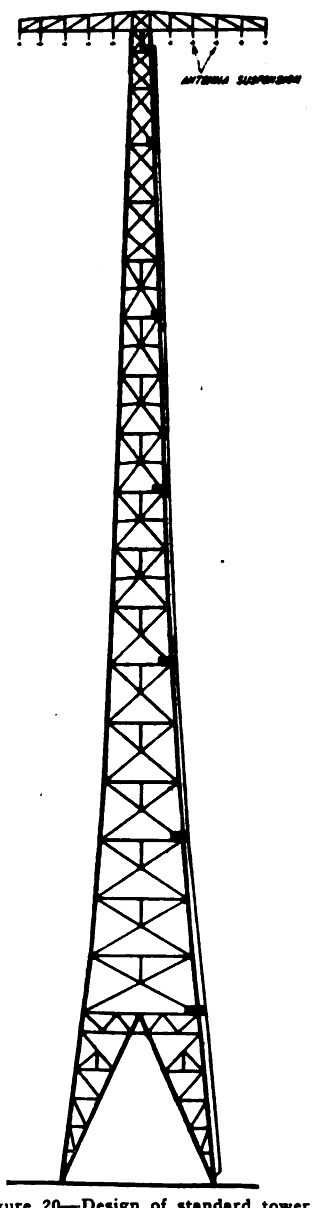


Figure 20—Design of standard tower used

The capacitive ground may be considered as a combination of a tuned and a forced oscillation circuit, and it has the effect of drawing the current from the ground circuit more uniformly than with wires lying on the ground or buried beneath the surface. In practice the total current in the down lead may be distributed betwen the capacitive ground and the wire ground in any desired ratio. The effect of adding this unit to the system at New Brunswick was to decrease the multiple antenna resistance from 0.7 to 0.5 ohm. The capacitive ground may be divided into separate units for each tuning down lead or the units may be connected together as shown. A schematic diagram of the connections between the flat top and the capacitive and earth-wire grounds is shown in figure 16a. The equivalent circuit is given at the right of the drawing. The construction of the outdoor inductances for multiple tuning is shown in figure 17.

Telegraphic control of the large antenna currents involved in high-power radio transmitters has ever presented a difficult problem. Particularly has this been

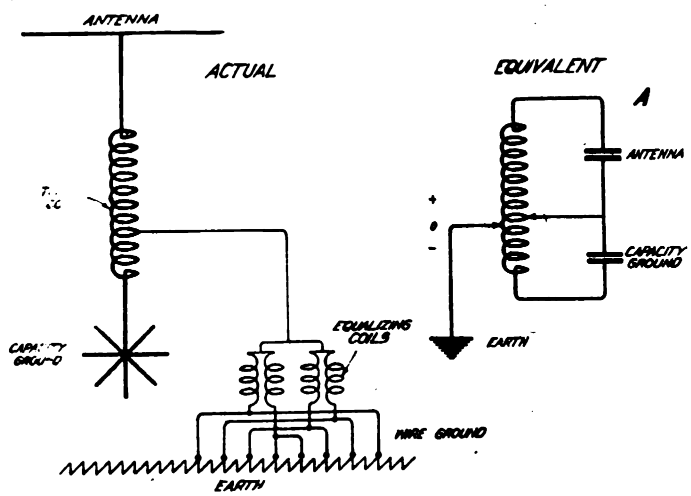


Figure 16A—Schematic diagram of antenna to earth connections of the multiple tuned antenna

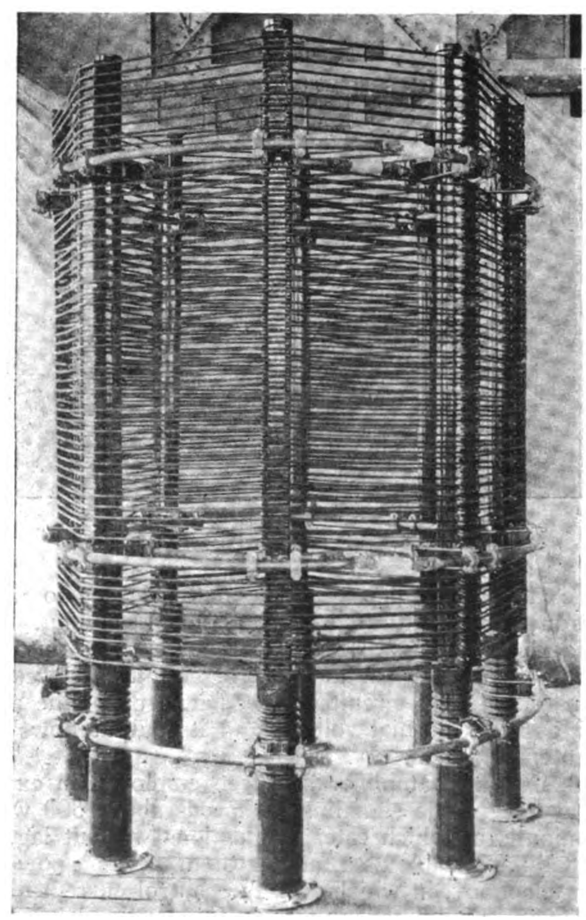


Figure 17—Tuning inductance for multiple tuned antenna

true when signaling at high speeds. Rapid signaling obviously requires some device that will not cause destructive arcs and will provide the desired modulation of antenna power without taking upon itself the burden of carrying the full power of the system, during the intervals between signaling.

The magnetic amplifier is a device which meets these exacting requirements, for it provides a non-arcing control with a minimum current in the key circuit, and it takes within itself only a small proportion of the total alternator output. A photograph of the amplifier, removed from its container, is shown in figure 18.

The magnetic amplifier in general may be described as a variable impedance which is connected in shunt with the external circuit of the radio frequency alternator. Its function is to reduce the voltage of the alternator and to detune the antenna system when the sending key proper is open, and to perform the opposite functions when it is closed. Thus when the sending key is open the amplifier short-circuits the alternator and detunes the antenna system, thereby reducing the antenna current to a negligible figure. When it is closed the output of the alternator is fed to the antenna system.

A general idea of the operation of the amplifier can be obtained from the fundamental circuit, figure 19, where it will be noted that the radio frequency coils A and a control coil B are mounted on a common iron structure, and are so disposed that the effect of the control coil upon the radio frequency coils is obtained solely through the agency of flux variations within the core. The impedance

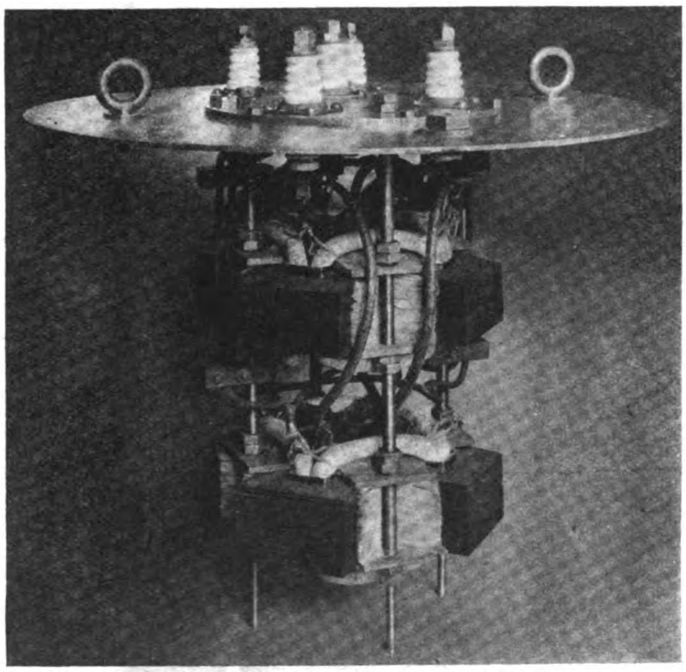


Figure 18—Magnetic amplifier removed from case

of the amplifier is dependent upon the degree to which the iron core is saturated by the control winding. The saturation in turn varies as the current fed into the control circuit. When the control circuit is closed the alternator is short circuited; when it is open, the alternator assumes normal voltage and its output flows into the antenna system.

The magnetic amplifier has been employed in experimental telegraphic signaling at speeds above 500 words per minute, at which rates it functions without lag. It is equally applicable as a modulator of antenna power in radio telephony, in which case the control current of the amplifier is modulated at speech frequencies by a bank of Pliotron (vacuum tube) amplifiers, which in turn are controlled by an ordinary speech microphone.

The characteristics of the amplifier will be treated in greater detail in a later article.

The fundamental circuits of a typical Alexanderson alternator station are shown in figure 19. Beginning at the left of the drawing, it is to be noted that a source of two-phase, 60-cycle alternating current drives an induction motor M, having a wound rotor, the circuits of which include a liquid rheostat R_3. The motor is connected to the radio frequency alternator through a helical step-up gear.

The alternator armature coils are indicated at A_3, A_4, the field coils at F_1, and the rotor at A_2. There are two sets of armature coils one on each side of the rotor, which as already mentioned, are divided into 32 sections on each side. The windings on each side connect to the primaries of two transformers shown at P_1, P_2. The primary of each transformer (see figure 5) contains two complete turns of 16 wires in each turn, which carry the current developed in the 32 sections of the armature coils on each side of the rotor. As can be seen from the diagram, there is no direct electrical connection between the armature circuits leading to the transformer primary, but the individual primary circuits are disposed so that their magnetic fields at any instant are in the same direction; that is, their fields combine to operate on the secondaries S_1, S_2. In addition to the primary and secondary coils, the two transformers have intermediate coils S_5 which are connected in parallel and shunted by the magnetic amplifier coils A. The coils S_5 are connected in series with the antenna system, and are also closely coupled to the primary and secondary.

The multiple tuned antenna, shown in the upper right hand part of figure 19, is a long, low, horizontal aerial of

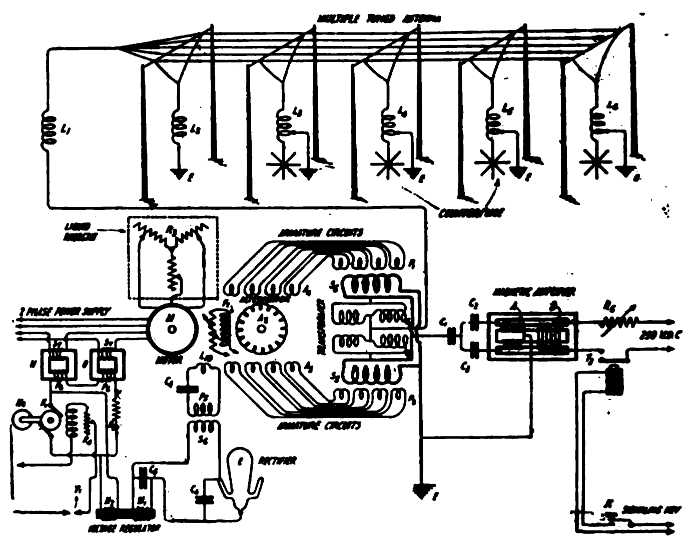


Figure 19—Fundamental station diagram

the Marconi type, from which are brought down leads to earth, which include the tuning inductances L_1, L_2, L_3, L_4, L_5, L_6. For any given wave length the joint inductive reactance of the down lead circuits $L_1 \ldots L_6$ is made equal to the capacitive reactance of the entire flat top at the operating frequency or wave length. The multiple antenna is therefore the equivalent of six independent radiating systems resonant to the same wave length, and for all practical purposes, the oscillating currents in them flow in phase.

The magnetic amplifier, shown to the right of the diagram, comprises the parallel-connected impedance coils A, which are connected in series with the condenser C_1 and the transformer amplifier coils S_5. B is the control coil, wound to include both branches of the windings A, which is fed with direct current, regulated by the rheostat R_6. When the control circuit is closed the impedance of the amplifier coils A become a minimum; when it is open the impedance is a maximum. In the former case the alternator is placed on short circuit and the antenna is detuned; in the latter case the alternator assumes normal voltage and its output flows into the antenna system. In practice the capacity of C_1 is selected to neutralize the inductance of windings A for some value of current in the control coil.

The circuits of the speed regulator appear in the lower left hand part of the drawing. Note is to be made first of the variable impedances N and O in the motor supply line with their direct current control coils P_6 and the variable impedance coils S_7.

The extremely close speed regulation essential to alternator operation is obtained from the resonance circuit L_{10}, C_4, P_5, the coil L_{10} being one of the alternator armature coils. This circuit is made resonant to a frequency slightly above the normal frequency at which the alternator is to be operated and the current developed therein acts inductively on the circuit S_6, E, M_1—E being a rectifier. The latter rectifies the radio frequency current and sends a D. C. component through M_1, which acts with an increase of speed to decrease the voltage held by the voltage regulator M_2 T_1 on the generator K_1. This increases the impedance of the coils S_7 and therefore in M_1. This keeps the speed variation within exceedingly close limits.

The trend of future development is of interest. In event that a larger output than that provided by a single alternator, of 200-k.w. is desired, parallel operation is contemplated. Such operation is entirely practicable and will be employed in the Radio Corporation's high-power stations, when great distances are to be covered.

A standard tower for high-power stations is shown in figure 20. This is of the self-supporting type erected on a suitable concrete base. The antenna wires are suspended from the steel cross arm at the top. This method of antenna suspension lends itself admirably to the long narrow antenna which has been found most suitable for the Alexanderson system.

The antenna layout for a two-alternator unit high-power station using these towers is shown in figure 21,

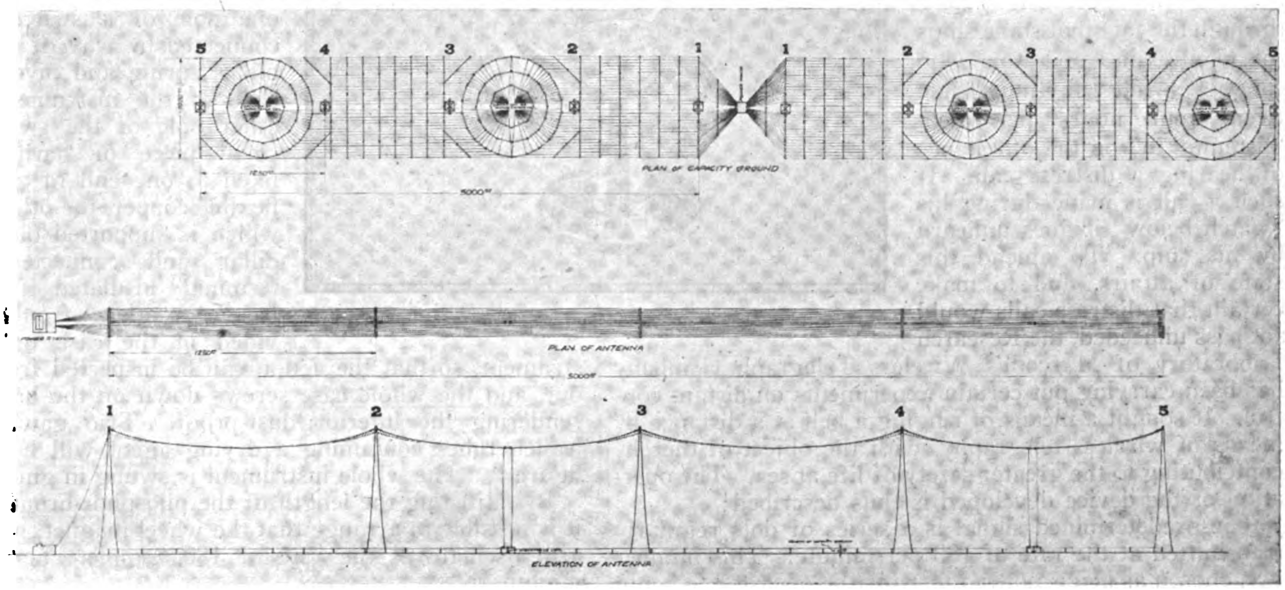


Figure 21—Typical antenna and counterpoise construction

tends to reduce the speed of the driving motor. As the speed now falls the current in the resonant circuit falls off and likewise that in the coil M_1. This permits the voltage held by the voltage regulator to increase, and therefore acts to reduce the motor supply line impedance and thus increase the speed. A given mean voltage is thus maintained in the control circuit by generator K_1, which depends upon the magnitude of the control current where two antenna wings of any desired length extend in opposite directions from the station house which is located at the center. With this construction the wings may be tuned to different wave lengths and each energized by a single alternator, thus permiting simultaneous transmission at two different wave lengths; or the two alternators may be joined in parallel to energize both wings at some selected wave length.

Performance and Operation
of the
New Brunswick Station

and the Alexanderson System will be described in detail in the August issue.

The New Marconi Distress Calling Device

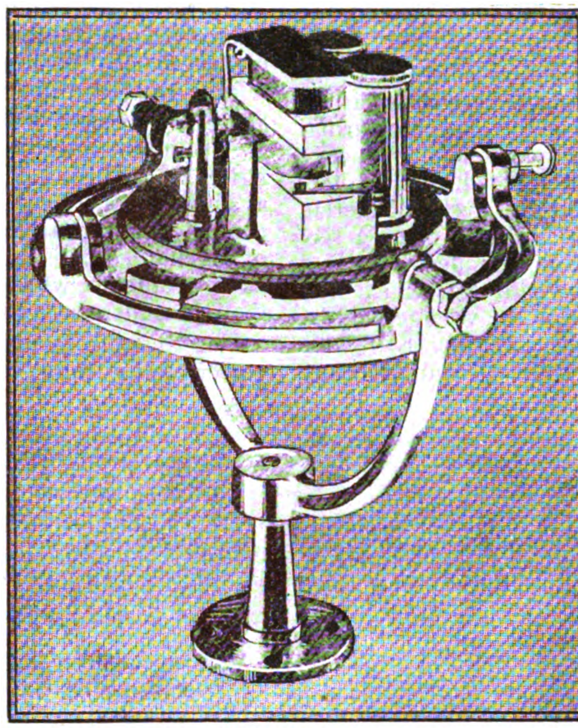


Figure 1—Final design of the Marconi distress calling device

IN THE February issue announcement was made of a demonstration conducted in England between Chelmsford and Shelford (Cambridge), in which the station at Shelford rang an ordinary electric bell ahd exploded small mines at Chelmsford, by means of special wireless signals. The purpose of the tests and a description of the apparatus are now available.

A recent article in "The Wireless World" directs attention to the problem arising through the fact that some ships carry only one operator, who cannot spend anything like twenty-four hours per diem "listening in" on the off-chance of hearing a distress call. If such a call is made during his "watch below" it goes unheard by his ship. To amend this state of affairs, and to make certain that distress calls would not pass unheeded, the Research Laboratory of Marconi's Wireless Telegraph Company has been carrying out certain experiments on distant control. It sought a means of ringing a bell at a distance by means of wireless telegraphy, with the object of thereby contributing to the greater safety of life at sea. The operation of the device developed is thus described:

The predetermined signal is a series of dots regularly transmitted at the rate of 180 per minute. This number was chosen as being not too fast for the operator to count and time, and too slow to be interfered with by ordinary transmissions.

The first thing was to make a relay which would respond only to the predetermined signal, and which could be operated by the change in current produced by the reception of such a signal. The change in current with the vacuum tubes in use in the receiver was never more than half a milliampere.

Many relays were made, and tried out, and for various reasons were rejected. The final design is shown in figure 1, and in construction is not unlike the ordinary moving needle galvanometer. In brief the description is as follows: Two rectangular hollow forms each wound with many hundreds of turns of very fine wire are placed one above the other on a brass base, the windings being connected in series, and the free ends being taken to two insulated terminals in the base. In the rectangular orifice of the coils swings a small ring magnet, pivoted at its centre and supported in jewelled bearings which are carried by two vertical brass pillars screwed to the base. The pivot also carries a small circular phosphor-bronze spring, one end of which is attached to a brass collet on the pivot, the other end being soldered to a tongued brass washer clamped to one of the brass pillars. This tongued washer serves the same purpose as the zero adjustment on an indicating instrument. By twisting it about its center the position of the magnet can be altered and the best working position obtained. Besides these two details the pivot has fixed at right angles to itself a fine platinum-tipped steel arm. This arm is one pole of a switch and is connected by way of the brass pillar, spring and pivot, to the base of the instrument. The other pole of the switch is a small piece of hard carbon, fixed to one end of a strip of flexible copper, the other end of which is supported on a small pillar and connected to a terminal insulated from the base. A glass front is provided in the case of the instrument, so that the action can be inspected from without, and the whole case screws down on the brass base, rendering the interior dust-proof. Two gauze-capped leaden tubes containing a drying agent will be seen in figure 1. The whole instrument is swung in gimbals.

By adjusting the length of the phosphor-bronze spring it is possible to arrange that the wheel magnet, pivot, and arm oscillate at the rate of 180 complete periods per minute.

The resistance of the coils and the current available are sufficient to prevent a single dash, or series of mixed dots and dashes, such as are received in an ordinary telegraphic communication from swinging the moving system far enough to cause the two contacts of the tiny switch to touch. It is only by the regularly delivered impulses arriving at the right moment that the swing can be built up from zero to full, and contact established.

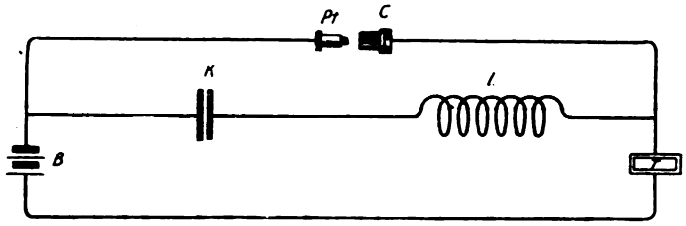


Figure 2—Circuit showing the modified connections

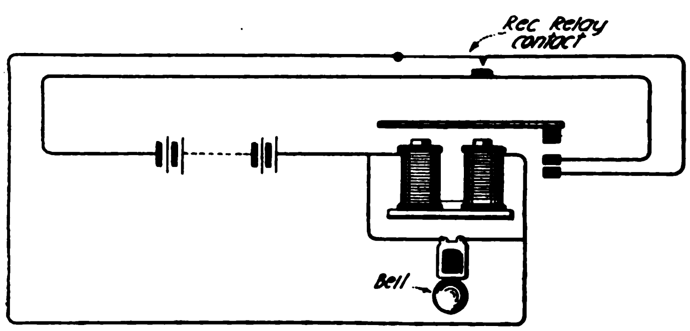


Figure 4—Circuit of instrument that operates alarm circuit

Some trouble was experienced with this tiny switch. In the original model both contacts were made of platinum and sometimes they did not strike with sufficient force to make good contact at the first time. To overcome this fault Dr. Fleming's Patent No. 112544 of 1918 was employed. The modified connections of this patent are as shown in figure 2. In figure 2, Pt is a contact of platinum or other noble metal, C is a hard carbon contact, K a condenser, L an inductance, T an instrument which it is desired to operate by the battery B on closing the switch Pt C. The battery charges the condenser, and when the switch closes the condenser discharges through the inductance and oscillations pass across the points Pt C and improves the contact at those points.

The point next to be considered was an arrangement for permanently closing the alarm circuit once the contact had been struck, and the instrument shown in figure 3 was designed.

This instrument consists of two coils with soft iron cores mounted on a soft iron plate, forming an electromagnet. Above these coils is placed a soft iron armature connected with a flat steel spring at one end to a brass standard, the other end being free. At the free end is carried a small insulator, which, when the electromagnet is energized, will depress a short platinum-tipped steel spring on to a similar one; also at a little distance from the free end is fixed a manipulating key contact which can strike a similar one situated immediately beneath it.

The action is as follows: The platinum-carbon switch of the receiving relay is connected in series with a 24-volt battery and the coils of this electromagnet; the two platinum-tipped steel springs are connected in parallel with the platinum-carbon switch. When this switch makes contact the electromagnet is energized and the armature is drawn down and closes the switch formed by

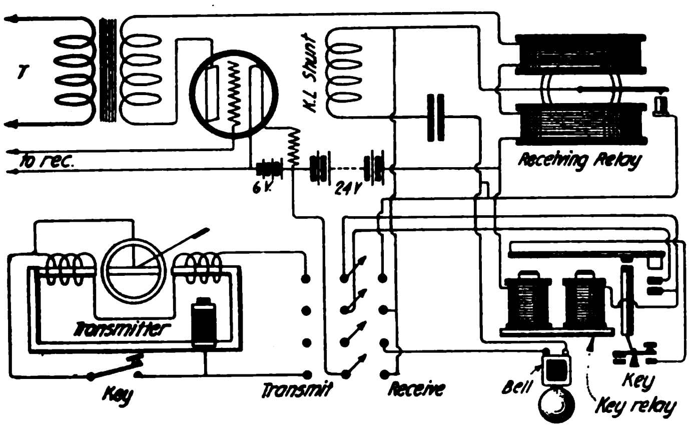


Figure 6—Complete diagram of connections from the receiver to manipulating key

the two steel springs. This switch being closed and in parallel with the first switch the magnet will remain energized, and the armature depressed, until the battery is switched off. Figure 4 shows these connections. Neglecting the resistance of the connections, it will be seen that as long as the electromagnet is energized there will be a P.D. of about 24 volts at its terminals. The alarm bell, which is an ordinary high-power bell working off 24 volts is connected in parallel with the electromagnet, and so long as the latter is energized the bell will ring.

The adopted automatic transmitter is as shown in figure 5. The instrument consists of two iron-cored coils mounted on a yoke, the whole forming an electromagnet. Between the poles of this magnet swings a heavy brass ring with a soft iron diametric bar. To the shaft carrying the ring are attached a spiral steel spring, like a clock spring, and a light flexible steel arm tipped with platinum. Below this arm is a small platinum contact, supported by a helical spring contained in a tube. The free end of the clock spring is clamped to a projection on the wheel of a worm gear, and a handle is provided on the screw of this gear, so that the distance of travel between the moving contact on the shaft, and the spring-supported contact, can be varied. The variation of this travel controls the period of the transmitter, and it is found that the shorter the travel the shorter the period. Three terminals are brought through the base and the whole instrument is mounted in gimbals.

For transmission, a series circuit is made comprising a 24-volt battery, the coils and contacts of the transmitter, and the coils of the instrument shown in figure 3; a small tapping key is connected in parallel with the transmitter contacts. To start the instrument this key is pressed and immediately released. By thus closing the circuit the electromagnets of both instruments are energized and

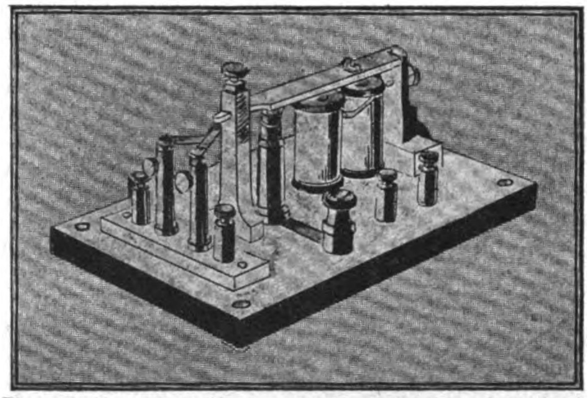


Figure 3—Instrument for permanently closing the alarm circuit

the iron bar of the wheel swings towards the magnet. The circuit being broken and the magnet demagnetised the wheel is urged by the clock spring past its position of rest, and on until the contacts of the transmitter touch; attraction starts again and the circuit is again broken, and so the cycle of events is repeated as long as the battery is switched on. Each time the wheel transmitter is energized the electromagnet shown in figure 3 is energized, the armature is drawn down, and the heavy key contacts meet. These contacts are in parallel with those of the manipulating key of the ship set, so provided that the generator is running, sparking occurs at every striking of the contacts. By means of a watch and the worm gear previously referred to, the operator can adjust the fre-

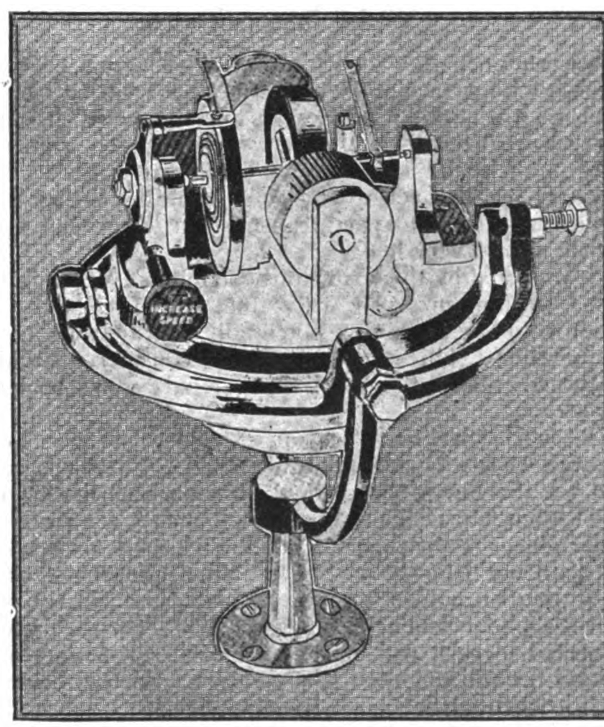


Figure 5—The automatic transmitter

quency of his signal to a nicety, and when once this is adjusted it is unlikely to vary.

Figure 6 shows the complete diagram of connections from the last vacuum tube of the receiver to the contacts of the manipulating key.

Transmission of High Frequency Waves Over Bare Wires in Water

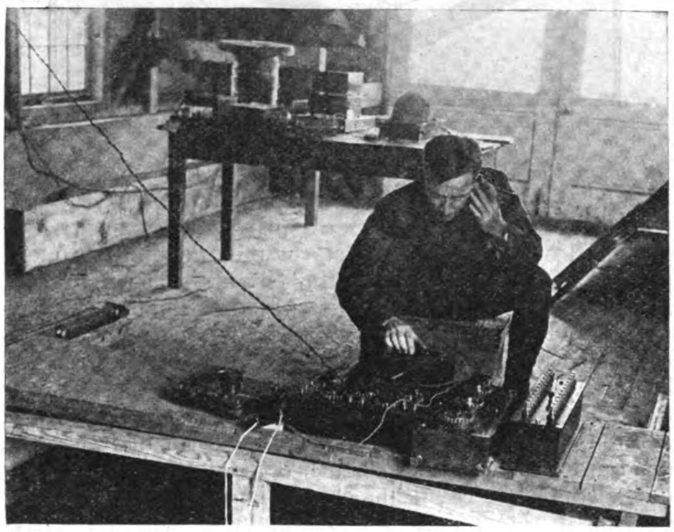
By Major General George O. Squier
Chief Signal Officer, United States Army

(Abstract of a paper presented to the National Academy of Sciences)

THE following reasoning led to the carrying out of the experiments to be described:

Since we can already communicate by radio means between one submarine and another submarine, both completely submerged, it was considered that connecting two such stations by a submerged copper wire could have no other effect than to facilitate the propagation of the electric waves between the stations.

It was considered possible that the behavior of earth or water under the action of high frequency currents might exhibit greatly different properties from those with which we are familiar at direct or low frequency currents.



Receiving apparatus used in telephoning and telegraphing by means of bare wire laid in water

It was realized that whatever high frequency energy losses might occur in the case of bare wires laid in earth or water, yet the over-all efficiency would be higher than in the case of radio space transmission where the plant efficiency is so very low.

It was noted by the writer in September, 1910, and discussed by him in April, 1912, that the three electrode audion could be used as a potentially operated device on open circuits. This arrangement was considered suitable for the reception of the signals over bare wires in earth or water.

The first experiement was an extremely simple one as follows: A bare No. 18 phosphor bronze wire, such as is used for the Signal Corps field antenna, was laid across the Washington Channel of the Potomac River from the War College to the opposite shore in Potomac Park. It was paid out from a small boat with sufficient slack to lay on the bottom of the river. A standard Signal Corps radio telephone and telegraph set, SCR 76, was directly connected to each end of the wire, one set serving as a transmitter and the other as a receiver. At the receiving end of the line the bare wire was directly connected to the grid of the receiving set and the usual ground connection left open. A frequency of about 600,000 cycles a second was used and the line tuned at each end by the usual methods. Excellent telegraphy and telephony were obtained. Care was taken to make this preliminary experiment as simple and basic as possible and precaution taken to insure that the wire itself should be bright and clean and entirely free from any grease or other insulating material.

The success of this simple experiment immediately led to more thorough consideration of the entire subject.

One of the questions to be investigated was the general efficiency of the electron tube when used as a potentially operated instrument. The following experiment was made:

A strip of wire netting was buried in the snow outside the office of the Chief Signal Officer in Washington and a wire attached thereto leading to the second story of the building. The upper end of this wire was connected directly to the grid of an electron tube. The reason for connecting the grid to the upper end of the antenna is of course obvious if we are to use the tube as a potentially operated device. It was necessary for maximum sensitiveness to connect it to the point of maximum potential of the antenna which in the case of a linear oscillator occurs at the open end. By this arrangement, messages were readily received from distant points in the United States.

These two simple experiments demonstrated the possibility of transmitting electromagnetic waves along bare wires submerged in water and the use of an electron tube as a potentially operated device for the reception of signals.

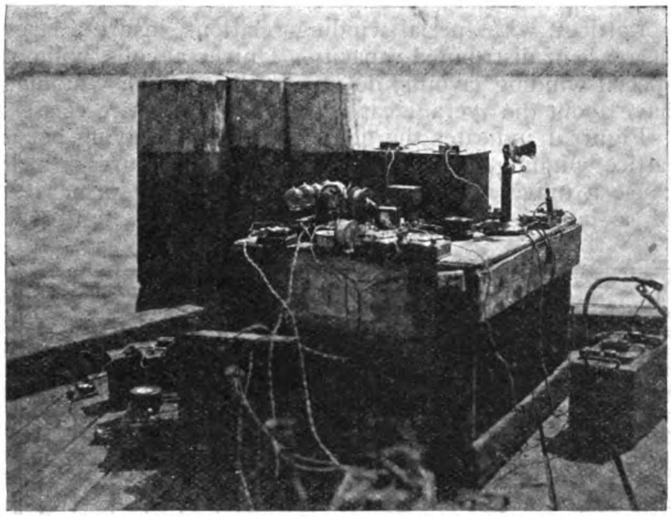
Exterior view of the U. S. Gov. research laboratory where experiments were carried out

For military reasons, if for no other, the Signal Corps has recently undertaken certain investigations in the phenomena connected with the transmission of high frequency electromagnetic waves over bare wires in earth and in water.

In carrying out these investigations and in attacking the problems from various angles, the research staff of the Signal Corps laboratory at Camp Alfred Vail, Little Silver, New Jersey, was directed to carry out experiments on bare wires laid on the surface of moist ground and also buried in earth. The staff at the Signal Corps research laboratory at the Bureau of Standards was directed to investigate fundamentally the transmission of electromagnetic waves over bare wires in fresh water. In addition to this, the engineering staff of the Office of the Chief

Signal Officer has carried out from time to time certain experiments of a more or less crucial character which have come up for solution in the prosecution of this work at the other laboratories.

Telephone and telegraph communication has been established between Fort Washington, Maryland, and Fort Hunt, Virginia, across the Potomac River, below the City

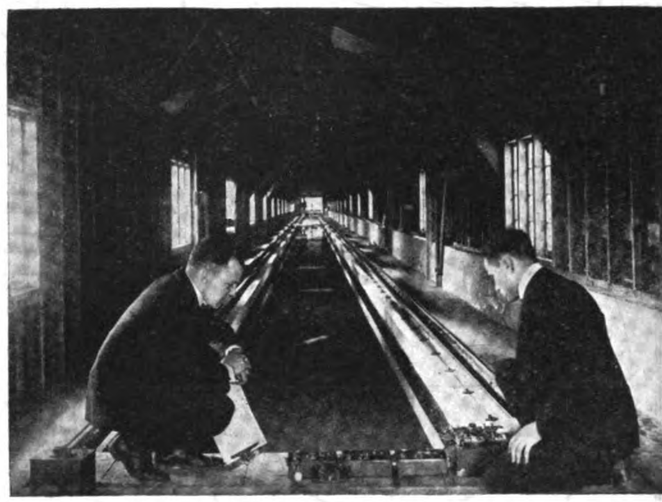


The transmitting apparatus containing an electron tube oscillator

of Washington, over a distance of about three-quarters of a mile, by the use of a bare No. 12 phosphor bronze wire laid in the water to connect the stations. The transmitter consisted of an electron tube oscillator which delivered a current of about 270 milliamperes to the line at a frequency of about 600,000 cycles a second. At the receiving end of the line an electron tube and a 6-stage amplifier were used without any ground connection. With this arrangement good tuning was obtaied at both ends of the line, and telegraphic and telephonic transmission secured over the bare wires immersed in fresh water.

A resonance wave coil has been developed. The coil is in the form of a long helix wound with a large number of turns on which stationary waves are produced by the incoming radio signals. An electron tube is used as the detector, the grid being connected to the point of maximum potential on the coil. The wave coil may be used either as a part of the usual antenna system or a part of a line wire, or it may act itself as the antenna for picking up the energy of the signals. In the latter case the coil may be either free at both ends or grounded at one end. Good results have been obtained in either case. It has been also found that the open coil has directional properties and can be used as a goniometer not only for horizontal measurements but for vertical measurements as well. This form of radio goniometer has the great advantage that it permits not only of determining the plane where the signals are strongest but also the direction from which such signals proceed.

Telegraph and telephone communication has been also established between two stations at the Signal Corps Research Laboratories at Camp Alfred Vail, Little Silver, New Jersey, using a bare No. 16 copper wire buried in the earth to a depth of about eight inches to connect the stations. The distance between the two stations was three-quarters of a mile. Frequencies as high as one million cycles a second were used. Similar communication has been carried on over a bare wire one and three-quarter miles long laid on the surface of moist earth. The current at the transmitting station in these installations was about 100 milliamperes. It has been shown that a bare wire buried in moist earth with the distant end open can



Members of the engineering staff at the research laboratory observing the effects of the transmission of electro-magnetic waves over bare wires laid in fresh water

be tuned both at the transmitting end and at the receiving end.

The development of types of resonance wave coils, both open at one end and at both ends, for general radio work offers an interesting field for investigation. This involves the study of the electron tube as a potentially operated device. The application of such coils properly designed for specific purposes may lead to the practical solution of a number of radio problems such as directional effects, and wave coils antennae of very small dimensions.

Universal, Honeycomb and Lattice Coils In General

By Oscar C. Roos
Fellow I. R. E.

THE sudden wide adoption of the universal winding by radio engineers as standard for inductances, has produced conflict and confusion in the names used in the trade to designate various makes. Technical facts have been ignored in the emphasis laid on "selling points."

There are the following names in use to denote varieties of universally wound coils—"Honeycomb," "unilateral," "duo-lateral," "uni-lattice," "mono-lattice," "bi-lattice," and "multi-lattice." Why all these "names?" Are they necessary? Cannot engineers adopt a "non-partisan" classification of the universally wound coils which are really different in winding layout and electrical properties?

This paper is an attempt to "clear the air." It touches the subject quite fully on the winding and general properties of universal coils. It adopts the terms, "uni-lattice" for "honeycomb" coil, and "bi-lattice" for "duo-lateral" coil. They are both different from "multi-lattice" coils.

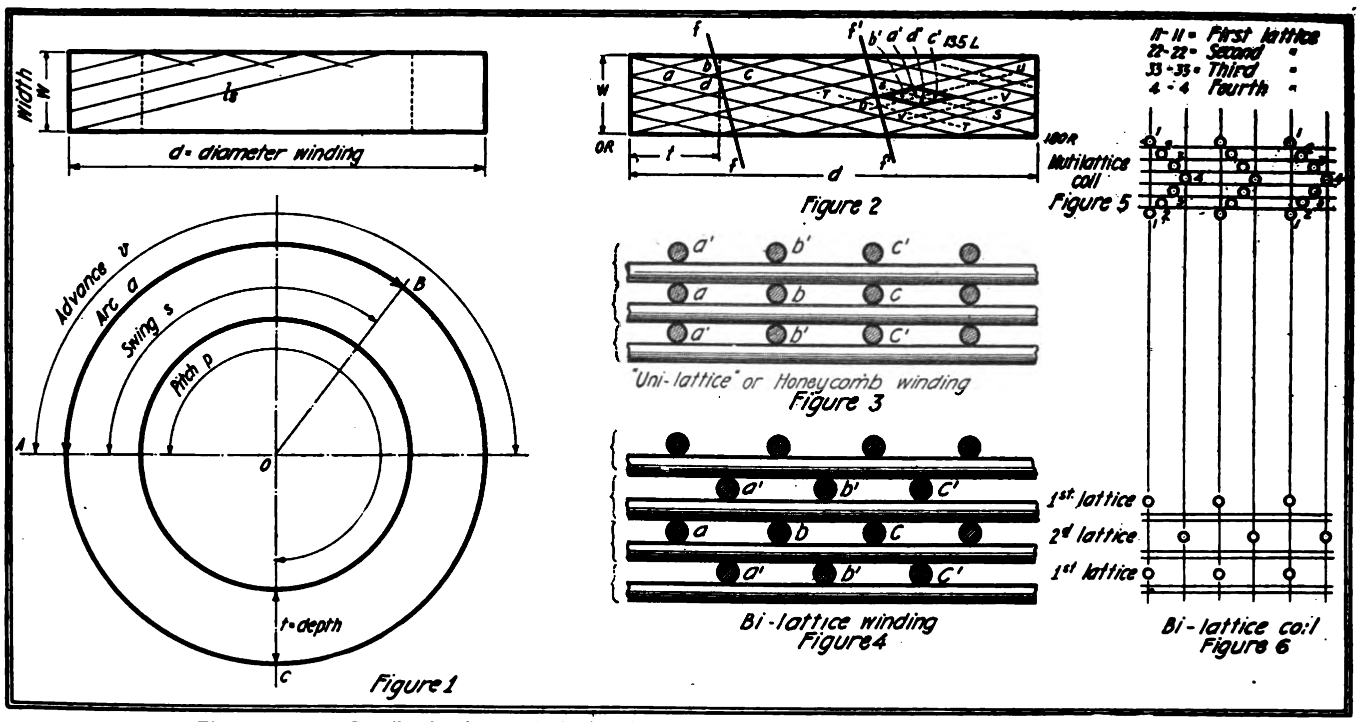
These technical names have an advantage over trade names in that they prevent the physical properties of the different forms from being confused. This has prevented, in several investigations, a great deal of misunderstanding, regarding the differences in their winding schemes.

The following definitions have been tried out by several engineers and have run the gauntlet of general discussion.

All coils wound after the methods used in the machines of the Coto Coil Co. are "universal wound." The average experimenter will not produce a real "honey comb" coil, and still less, a "bi-lattice" coil (these are defined below) by just sticking on a coil frame and winding it up "bobbin-fashion," the way our mothers used to do their sewing machine bobbins. The very thing the experimenter wants—low capacity—will not be obtained to any extent, even at the cost of the extra wire which is needed in all universal windings to obtain a given inductance.

Lattices, with special winding relations, insure a large decrease of distributed capacity. Universal coils, without special winding layouts, do not do this. Bank windings have about the average capacity of the above two classes.

Figure 1 indicates the general method of laying out a lattice winding, and shows the special features which cause a universal coil to have the additional properties of a lattice coil. The general features in figure 1,



Figures 1 to 6—Details showing method of laying out winding and views at various stages of the winding

peculiar to a merely universally wound coil are—first, the "angular swing, S," or simply the "swing" of the wire. This is the angle AOB between the elements of the cylinder, between which the "swing" takes place. Second—the length of the swing or the "linear swing, ls" is the actual length of wire in the swing. Third, the "swing arc" or the "arc," which is the length of the arc denoted by the letter "a." Fourth—the "angular pitch" or the "pitch" which is always twice the swing, e.g. the swing in figure 1 is 135 degrees, and the pitch is therefore 270 degrees. Fifth—the "advance, v," which is the angular distance which some multiple of the pitch first reaches, beyond 360 degrees. The advance in figure 1 is 180 degrees, or the difference between twice 270 degrees and 360 degrees. Sixth—a sparation of wire of h inches. Now the lattice has two additional features, an advance which is an exact submultiple of the pitch and 360 degrees also and a width such that, if m is the above submultiple, the width of the coil w, is $\frac{hm}{2}$ if m is even and $\frac{h(m+1)}{2}$ if m is odd. Hence figure 1 does not represent a lattice coil, strictly speaking.

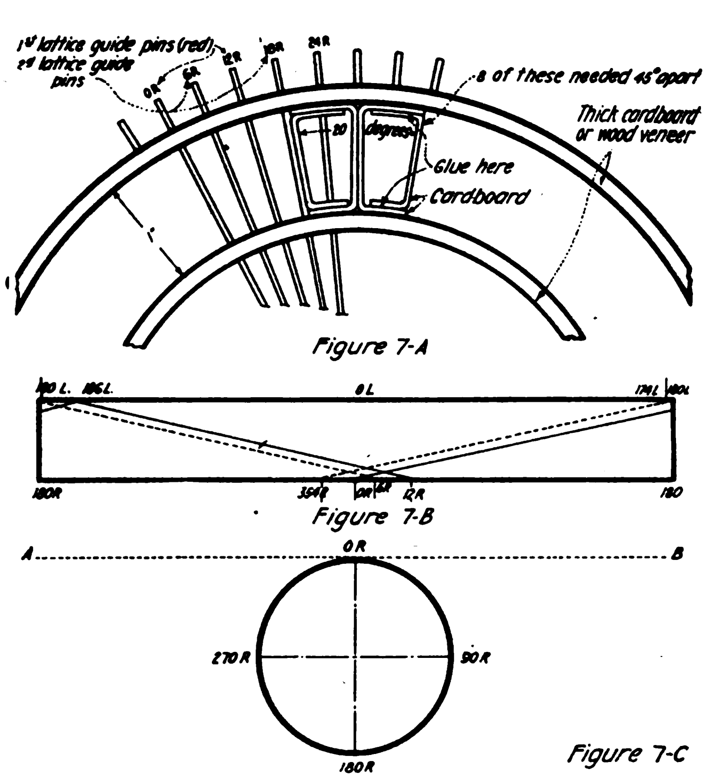
A swing of 82 2/7 degrees, or other odd fraction of a degree is the kind of swing necessary to get a true lattice, in actual computations. A good short rule is this. The advance must divide 360, and the pitch also. If we adopt 1.5 degrees as the advance v = 1.5, we can get along with a pitch of 183 degrees, 186 degrees, etc., since 1.5 goes into 183 degrees, 186 degrees, etc., and 360 degrees exactly.

We now define lattice coils as those universal coils in which the advance is a submultiple of the circumference and the swing. This is limited only by the condition that the advance must be less than one-half the pitch.

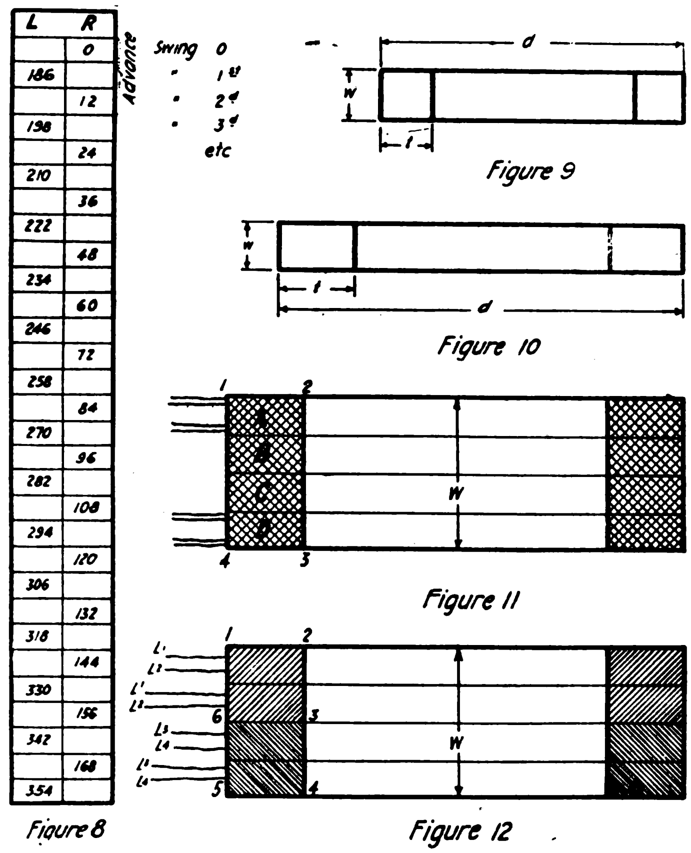
The result of this definition is that all lattice coils end at the same angular point on the circumference at which they start. There is no "creeping" forward of the turns, "stopping up" the radial view through the cells and increasing coil capacity. When the lattice winding has come back to the starting point just once, we have one "layer." This gives us the pattern of a rhombus, or lozenge, which as in the honeycomb coil. Their average self capacity is smaller. In both forms, in fact in all lattice coils, the cells get "flatter" as the coil gets larger, as will be shown later.

Figure 3 shows the cross-section of three wires and three layers of the "uni-lattice" winding taken at f f and figure 4 shows a cross section of three wires and three layers of the "bi-lattice" winding taken at f'f'. The latter is easily seen to possess less distributed capacity than the former—about 15 per cent. less on the average.

It is understood that the second lattice when finished, constitutes a complete separate system of honeycomb cells, whose walls are "staggered" half-way between the cell walls of the first lattice. Since a honeycomb coil is a "uni-lattice" or "mono-lattice" coil, the name "bi-lattice"



Figures 7A, B, C—Constructional details and method of winding bi-lattice coils



Figures 8 to 12—Chart and method of winding multi-lattice coils

resembles a honeycomb cell and suggested the trade name used by many.

All honeycomb coils are lattice coils, but all lattice coils are not honeycomb coils. The bi-lattice coil described below is not a honeycomb coil, but a uni-lattice coil is.

Figure 2 is a lattice coil of external diameter a, and width w. It shows the honeycomb structure at the left and illustrates the "bi-lattice" differences in structure at the right. If we had repeated the first single "layer" of the lattice winding above specified, until a depth t, was reached, we could look down into the four "cells," a, b, c, and d in figure 2, without finding anything to obstruct the vision. The wires forming the walls of the cells are arranged substantially one over the other. They spread slightly as they recede radially from the axis of the coil.

The bi-lattice coil is so wound that every cell of the original four, a, b, c and d, is broken up into four smaller cells a', b', c' and d' by the new wires of the second lattice. These are shown in dotted lines of which four are lettered SS, TT, UU, VV. It is true that we have smaller cells here—honeycomb cells, if you insist—as far as the mere question of looking down through the coil is concerned, but the successive cell wires are not "over" each other, has been given to this other form of winding. Only the alternate layers are started at the same circumferential point.

It was suggested in 1918 to engineers investigating the possibilities of further reducing the self capacity of the honeycomb coil, that by gradually shifting the starting point of the layers forward and then backward, as in figure 5, this self capacity would be reduced. This might be called a "quadri-lattice" coil or "multi-lattice" coil, as the series of lattices is repeated regularly.

However, it is not as good a reducer of capacity for given inductance as the bi-lattice winding, drawn to same scale in figure 6. This has a better selectivity at a given wave length.

Study of Coil Lattices

There are two distinct but related problems to be considered in making a lattice coil:

First, how shall we make the winding repeat every "layer" regularly? The solution of all electrical requirements is based on this purely arithmetical problem, in addition to determining the size and kind of wire and the diameter and width of winding.

Second, what is the best angular pitch to use in a coil of given lattice separation? This is determined by the number of turns and the coil width.

There is no exact analytical or even experimental engineering formula, it may be said, for the inductance of lattice coils. It is safe to recommend Professor Hazeltine's practical coil formula, presented at a meeting of the R. C. A. It is as follows:

This formula, based on Stephan's formula, is accurate to about 3 per cent.

$$L = \frac{.0008\, a^2 N^2}{6a + 9t + 10w} \text{ in milhenries.}$$

where a = mean radius of winding in inches
t = depth of winding in inches
w = width of winding in inches
N = total number of turns

In winding bi-lattice coils, it is not necessary to finish the first layer on one lattice, before starting the first layer of the other. This is especially evident in winding lattice coils by hand.

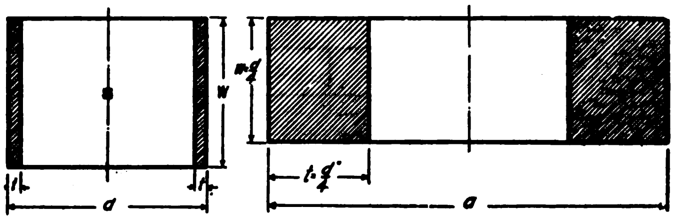


Figure 13 *Figure 14*

Figures 13, 14—Extreme and best ratios

To illustrate, place a double set of, say, red metal pins, No. 50 drill and about 2 inches long—equal in length to twice the coil winding depth—every 12 degrees around the circumference of a cylindrical coil frame, of say, 4 inches diameter and 3½ inches width. Place the holes within ⅛ inch of the faces of the frame. Then arrange another identical set of pins of different surface appearance 6 degrees away circumferentially from the first. Here we have the elements of a bi-lattice coil. We start one coil at OR on red pins only with 186 degrees swing, and another at 6 R, with the other pins only, with 186 degrees swing. Neither of these lattices will conflict, if wound by hand.

The finished coil is a bi-lattice coupler, and in large sizes cannot be surpassed for radio frequency work when used with proper "iron-dust-dielectric" in the lattices of the transformer. Transformers on this principle were tested as early as 1906. Figure 7a gives a sketch of the method. A wooden disk ¼ the width of the coil is used to support the inner cylinder of the winding frame.

In figures 7b and 7c we have a single lattice. In figure 7b it is shown in the form of a single layer, rolled out on the transparent imaginary surface A-OR-B, after being "cut" at 180 in figure 7c. The best way to gain an insight into the law giving the layout of the winding is to examine an actual winding chart to see whether it is practical or not.

Assume a "swing" of 186 degrees; make the "pitch"—which is 372 degrees—always twice the "swing." It happens that this first "pitch" is greater than 360 degrees, and the excess, which is called the "advance" is 12 degrees. The chart shows two things immediately.

First—There is room on this coil for a complete second lattice of the same description starting from the left at OL instead of the right at OR. This can be "hooked up" in series with the previous winding if a coupler is not desired, then we have a regular bi-lattice coil.

Second—The dotted lines in figure 7b are impossible under the above scheme, as winding swings. They cannot be covered by the chart-layout.

The winding chart shown in figure 8 indicates that several separate uni-lattice windings may be wound without in the least interfering with one another. The smaller the wire, the wider the coil and the smaller the "spacing" as shown in figure 4, the greater the number of separate "lattices" which can be wound. It is readily seen how windings started on 2R, 4R, 6R, 8R and 10R will give separate lattices. Thus by using six different double sets of colored pins as winding supports along the "right" and "left" faces of the coil frame, the experimenter may wind a sextuple lattice coil, by winding each lattice only on its own colored pins. The possibilities of various spacings and other winding factors will be treated in the next section.

COIL DIMENSIONS AND WINDING FACTORS

We need to establish general limits within which lattice coil dimensions may be considered to conform to practical experience from mechanical considerations. If a coil form is satisfactory from the above standpoint, it may be left unsupported; as it should be mechanically rigid.

It may keep this rigidity through a large variety of windings, of very different electrical efficiencies, without appreciable mechanical change. In figure 9 we have sketched the kind of coil shown in figure 2 without indicating the lattices formed by the windings. This form gives a ratio

$\frac{d}{w} = 6$ and $\frac{t}{w} = 1$, changing the ratio $\frac{t}{w}$ to 2 and $\frac{d}{w}$ to 10 we obtain figure 10.

Four of these coils, placed close together, coaxially, have a very good time constant if connected in series. We may put this in other words by saying that in this case $\frac{d}{w} = 5$, $\frac{t}{w} = \frac{1}{2}$. Such an equivalent coil is shown in figure 11.

In the light of the "multi-lattice" windings indicated by figure 8, it is interesting to consider the four coils A, B, C and D as wound in a single coil "quadri-lattice" coupler. Every lattice has its pair of separate terminals. By various combinations a range of inductance of 1 to about 36 may be obtained.

A smaller range is obtained by winding the four "coils" of figure 11 as two "bi-lattice" couplers, as shown in figure 12. Each "coupler" with the same area of winding cross-section, 1, 2, 3, 6 or 6, 3, 4, 5 has two sets of terminals, and starts with a lower inductance than figure 11. The first lattice terminals are indicated by L_1L_1, the second lattice by L_2L_2 etc. These changes are really of no effect in determining a change of "swing," "pitch," or "advance," when changing the coil of figure 10 into the multi-lattice coupler coil of figure 11 or the two "bi-lattice" couplers of figure 12. The chart in figure 8 would do for any of them, as the "swing" is independent of the width, within wide limits.

The extreme case is shown in figure 13, where $\frac{d}{w} = 1$.

This is about the limit of $\frac{d}{w}$. The depth of winding is that due to two "layers," and figure 13 could only by courtesy be called a lattice coil.

The best ratios to secure a high time constant are about $\frac{d}{w} = 4$, $\frac{t}{w} = 1$ shown in figure 14.

(To be continued)

EXPERIMENTERS' WORLD

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

A Loop Transmitter for Local Work

By Albert F. Murray

THE amateur of to-day is familiar with the characteristics of loop antennae, and is perhaps using or has used, some form of loop for receiving. Very few have tried transmitting on loops and up to the present, little has been written about this subject in radio journals. The reason for this, undoubtedly, is the shortened range of transmission when using a loop, although it will prove of great value to the amateur for short-distance or local work. The advantages, construction and operation of such a set follow.

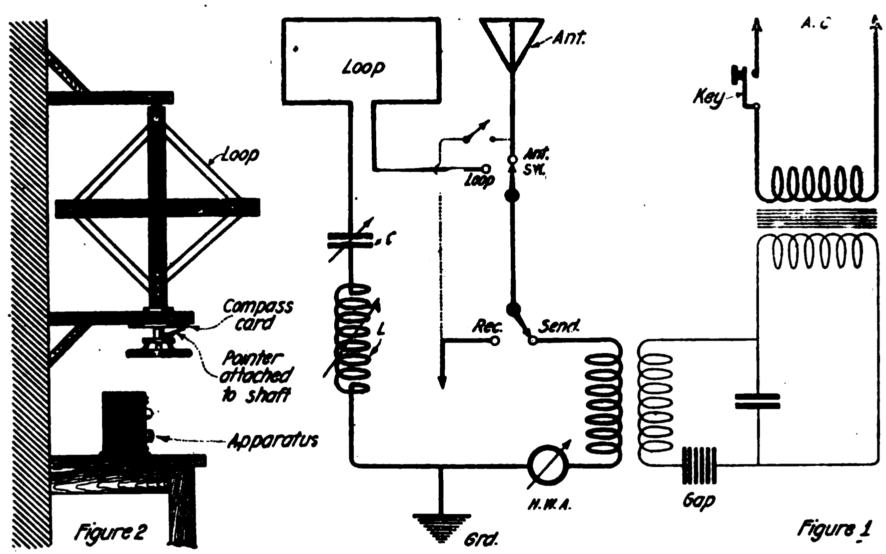
A station desiring a short-range set would be of the more advanced type, possessing a non-synchronous spark transmitter of from ¼ to 1 kw. The short range work would be among amateurs using vacuum tube detectors, located in the same city or within 15 to 25 miles. The features desired are: sharp tuning, reduction of interference to or from other stations; a good spark note; a fool-proof break-in system with no contacts or moving parts; freedom from complication or duplication of parts. The necessity of two keys, two antenna switches, two sources of power, etc., is naturally to be avoided. All of these advantages are obtained by use of the loop for transmission and at the expense of one item, that is, low radiation efficiency. The power input is large compared to the distance covered. From the amateur viewpoint this is not a great disadvantage.

The wiring diagram of the station is shown in figure 1. To change from "long distance" to "local," throw switch SW from "antenna" to "loop." The additional apparatus required is the loop (described later); a high voltage condenser C, of any type whose capacity is approximately equal to that of your antenna, say .0003 mfd. or larger (it should be roughly adjustable in steps); and the inductance L, which is provided for fine tuning. If you do not mind moving the clip on the secondary of your oscillation transformer when changing from loop to antenna, you can tune in that way and omit inductance L, which is a helix of 4 turns, 12 inches in diameter.

In tuning proceed as follows:

With the transmitter in adjustment for maximum radiation on antenna, switch to loop and vary C until the H.W. ammeter reads highest. Shunt H.W. ammeter with a loop of copper wire, unless it will stand four times the ordinary current. Now vary L until a maximum antenna current is obtained. The settings for radiation on the antenna have not been disturbed and either aerial or loop can be used by throwing one switch. However, if maximum range on loop is desired by the experimenter, C should be increased, the secondary inductance of the oscillation transformer decreased, then retune and vary coupling for greatest current in loop. The tuning of the loop is much sharper than that of any antenna circuit because of the low resistance of the former. The coupling should be such that a wavemeter coupled to the loop should show but one "hump."

To operate swing loop so that the coil points in the direction of the station you wish to work. Receive on antenna and leave receiving set connected while sending. It is assumed that an audion is used as detector. Unless the loop and antenna lead are within a few feet of each other, it will be possible to wear the phones while transmitting and be able to hear other stations in the pauses between words. Not only can another station "break in" but you can hear when some loud interfering station starts up and send only during the times when he is not working, thus saving much time in repeating parts of messages lost due to QRM. Unless one has used such a system it is difficult to appreciate the advantages of being able to listen and talk at practically the same time. The grounding of one side of the loop decreases its directive properties somewhat, but experiments show that when the loop is pointing as much as 10 degrees away from a nearby station your signals at that station are inaudible. Of course, many factors, such as sensitiveness of receiver, etc., enter into the directional properties of the loop which, however, were found to be fairly pronounced and yet not too sharp. By using a receiving loop in a horizontal position it is said to be a "pick-up" loop receiving from all directions. Whether this is true of a transmitting loop and whether the range is decreased when in this position has not yet been experimentally determined.



Figures 1 and 2—Circuit and construction of the loop transmitter

It was found that work could be carried on through considerable interference when using the loop for reception. Low power amateur stations 10 miles away could be heard on a single tube, but a one step amplifier is necessary for satisfactory local work.

The loop used by the writer is 5 feet square, this being the largest size that could be handled easily in the operating room. It is mounted above

(*Continued on page* 41)

A Sensitive Portable Receptor

By Francis R. Pray

FIRST PRIZE, $10.00

IN the past, amateurs generally depended on a crystal rectifier for the operation of their portable receiver due to the instability of the early types of gas filled audion tubes. Although they saved in space and weight, the results obtained with the crystal equipped set were not encouraging.

Now that a rugged vacuum tube has been developed for amateur use which can be used with comparatively small plate potentials and low filament current consumption, the practicability of including an audion detector in the portable outfit is an accepted fact, and with it goes the following advantages:

(1) Maximum efficiency at the detector.

(2) Elimination of the buzzer test and battery.

(3) Constancy of operation.

(4) By employing the oscillating characteristics of the tube, regeneration or amplification is obtained on spark signals and continuous wave signals may be received.

The one primary obstacle in the use of a VT, is the "A" and "B" battery problem. Most portable sets are taken to destinations which make impossible the use of a storage battery and even if charging facilities are at hand, storage batteries are a bad proposition for field use, as any Signal Corps man will affirm.

Really the only solution possible is the use of ordinary No. 6 dry cells. It would be impracticable to carry along more than a single series—3, to give 4½ volts—as six, in series multiple, although having longer life, would add too much weight to the outfit. As a Marconi-Moorhead VT requires about .65 amps. to light the filament to full brilliancy, it can be estimated that the battery will last about twenty operating hours before becoming useless. The inherent recuperative powers of the No. 6 cell may extend this time limit, depending on how the battery is treated.

Many VT's will operate with the 22-volt potential derived from a Signal Corps size "en bloc" B battery but it would be advisable to include a couple of small flashlight batteries with Fahnestock clips for terminals, as many tubes require increased plate potential with continued use.

Fahnestock terminals are ideal for binding posts on portable outfits as the wires cannot jar loose, connections are easily made, and there are no thumbscrews to lose.

The next most important consideration is the selection of the circuit. It is at once apparent that an inductively coupled circuit is not required, as a broadly tuned circuit allows the reception of "everything in the air." More and more radio men are conceding that the single coil circuit is the most efficient for all-around reception, except perhaps in 200-meter reception and in long wave continuous wave reception.

In the circuit shown herewith, all that is necessary is one coil in the tuning circuit, which need not be variable if interchangeable coils such as the De Forest plug inductances are used. All the tuning variation is done with the .001 mfd. condenser and the circuit can be made to oscillate at any point on the condenser scale by variation of the grid condenser. This makes a fairly good regenerative circuit, also, when the condenser values are set at a point just previous to that where oscillations begin.

The most practical form of inductance to use is unquestionably the universal wound coil, which is sold with a plug mounting by the De Forest establishment. Of course the amateur may buy the Radisco coils at a slight saving and equip them with a self-constructed plug with a little ingenuity. The separate brass plugs and sockets used on these plugs can now be obtained separately from the Somerville Radio Laboratory, enabling the radio constructor to devise all sorts of original honeycomb coil mountings at a very low comparative cost.

Reference to the drawings will show the best form of arranging the apparatus. These are drawn to scale, to conform with the dimensions of standard apparatus, but exact dimensions are not given as the constructor can use material already on hand, in many cases, thereby making necessary the enlarging of the cabinet. Roughly speaking, the entire outfit may be placed in a cabinet of half inch oak, 8 x 8 x 8 inches.

The front can be a sheet of 3/16 inch Bakelite or Micarta held in by brass angle strips. The sheet when removed, makes an excellent writing surface for copying messages, and also cuts down weight. The use of Bakelite as constructional material in the instrument compartment also cuts down weight, and makes the mount-

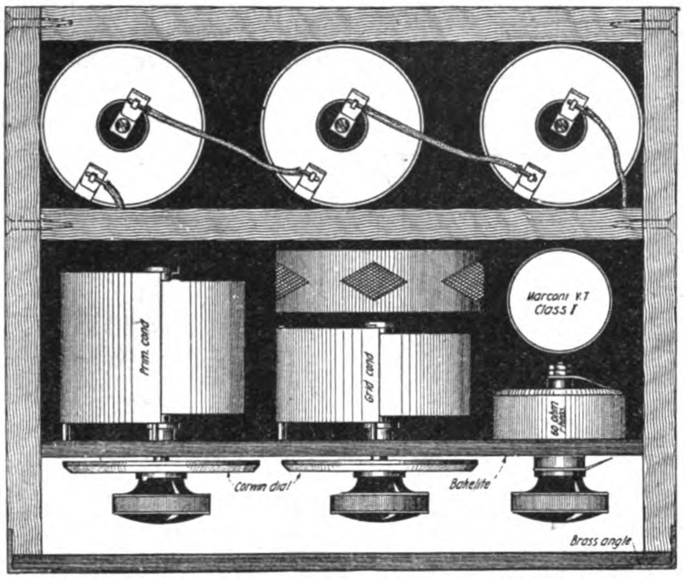


Figure 1—Top view of panel showing arrangement of instruments

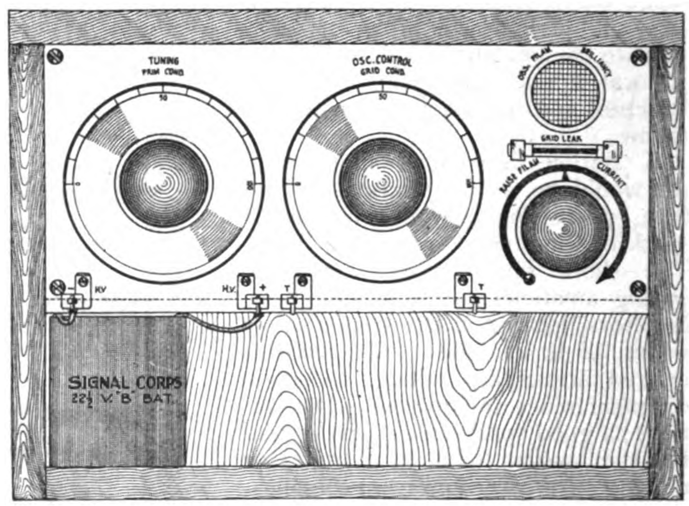


Figure 2—Front view showing controls and lower compartment for storing extra coils, phones, etc.

ing of same much easier. The material may be drilled and tapped and held together with machine screws. 4-36 thread screws are the proper size to use on 3/16 inch stock.

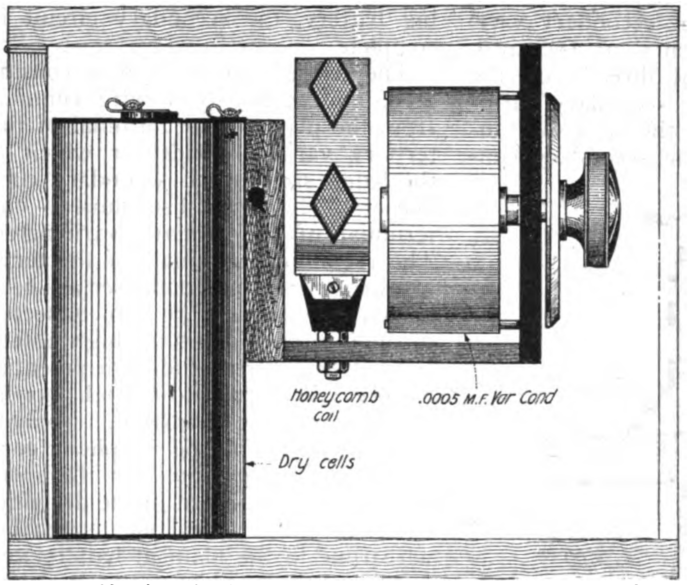


Figure 3—Side view showing mounting of coil direct to bakelite housing

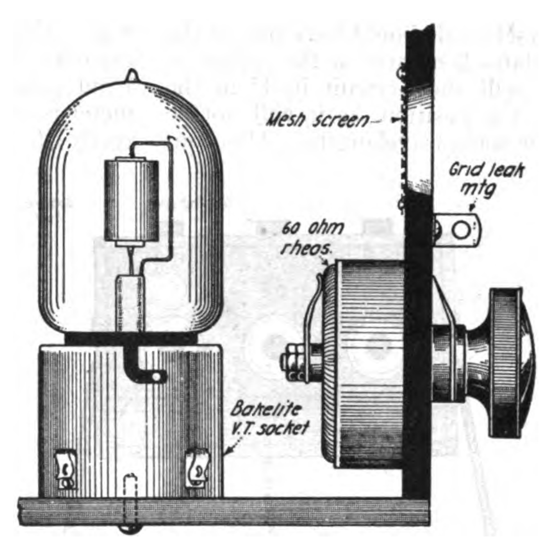


Figure 4—View of "VT" mounting, rheostat and grid leak

The neatest and most compact condenser arrangement is the Radio Equipment condenser equipped with a Radisco dial. The most compact VT socket is one made of Bakelite by a Massachusetts radio company, advertising in WIRELESS AGE. It is equipped with Fahnestock terminals and contacts of phosphor bronze.

The most desirable rheostat for the VT filament regulation is unquestionably the Paragon as it is only 2⅛ inches in diameter and very easily and neatly back-mounted. Its "off" position obviates the need of the usual "on-off" filament circuit switch. A number of fine holes may be symmetrically bored to observe filament brilliancy or a large 1-inch hole may be cut and covered with a metal gauze screen. The 2-megohm Marconi grid leak may be purchased without the base, and held on the panel by two spring metal clips. Fahnestock binding posts should be used and the No. 6 dry cells should also be purchased equipped with them. Although Murdock No. 55 phones are

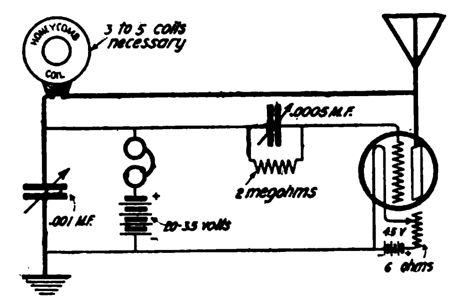


Figure 5—Single coil arc, regular spark circuit used

not necessarily the best, they can be packed very compactly, are light in weight, and their small cost discounts worry, if the set is dropped in the lake or lost in a forest fire, etc. Signal Corps P-11 phones are very good for field use, but don't take anything to camp which you prize highly.

When going into unknown territory, the best antenna proposition is a couple of 100-200 feet coils of common annunciator wire, one for the antenna and the other for the counterpoise, to serve in lieu of a ground. Don't forget to include plenty of pencils and writing paper, which may be wrapped in oiled paper and stowed away between the dry cells.

While there are many other practical suggestions which might be made, in closing, let me suggest that you commission some obliging friend or radio company to send by parcel post to the nearest mail destination another set of dry cells, and perhaps a fresh B battery, after a few weeks, as they may come in mighty handy if something should go wrong with the first set.

Portable Receiver

By Norman A. Nyquist

SECOND PRIZE, $5.00

DURING the summer, most amateurs leave their stations to go on vacations or to other towns to work for the season and consequently have no apparatus to experiment with, as the transportation and erection of their existing equipment would be difficult. In these warm months, the ideal receiver would be one that could be set up in the open and used to receive wave-lengths from 150 to 3000 meters and which could also be installed indoors as well, in a few moments.

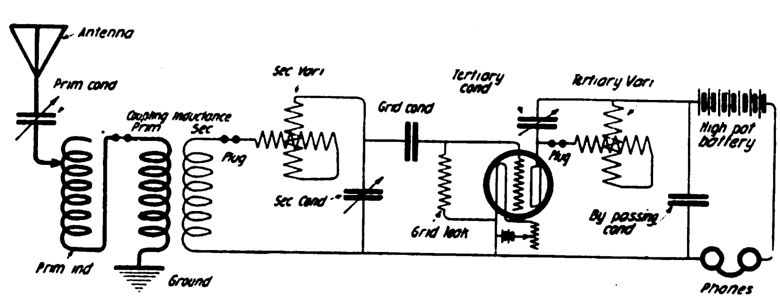


Figure 4—Schematic wiring diagram of the portable receiver

The following described receiver was designed for portable work, and by removing the cover, a perfectly satisfactory instrument for permanent station work is available. The design of an efficient receiver to cover a wide range of wavelengths is very difficult unless sufficient space and complicated mechanical movements are permitted; that is, if it is to be automatically operated. It is believed that manual operation to secure changes to the upper range of wavelengths will be satisfactory for amateur purposes.

Referring to figure 4, a schematic wiring diagram of the proposed receiver is shown. Starting at the antenna, we come to the primary variable condenser. This condenser is mounted by itself and should have one of the rotor plates bent over at the corner so that it will short-circuit itself in the 180 degree position, as it will not be used for some wavelengths. This con-

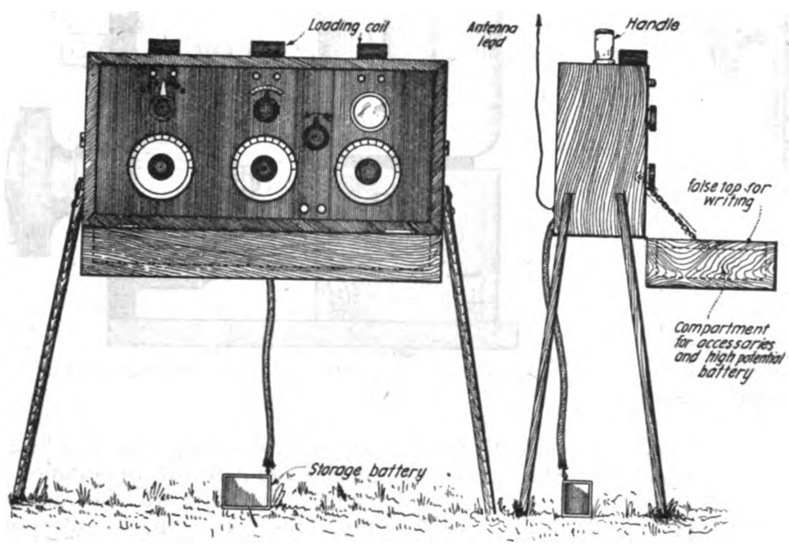


Figure 1—Front and side view of assembly

denser should have a capacity of about .0008 mfd. and work through a 180-degree scale. It is preferable to buy a standard condenser and arrange for mounting it on the front panel.

Next we come to the primary loading inductance. This is a small cardboard or dilecto tube two inches in diameter and three inches long, wound with 120 turns of 27-38 Litzendraht or No. 22 d.c.c. copper wire, bank wound, two layers. Taps should be taken every twelve turns and brought out to a 10-point switch on the front panel. When finished, the winding should be baked dry and given two coats of a good insulating varnish.

Following the primary loading inductance, is the primary coupling inductance, which is a fixed winding with no taps. A small tube three inches in diameter and two inches long, is wound with 20 turns of the same size wire, single layer, which will leave sufficient room at the other end of the tube, for fastening a bracket to mount the tube to the panel. One end of the primary coupling inductance runs to the ground and completes the primary tuning circuit.

The secondary circuit is now to be considered. The secondary coupling inductance consists of ten turns of the same wire wound on a small disc 5/8 inch wide and 2¼ inches in diameter. It should be baked and varnished. This is the movable coil shown in the sketches and swings through 90 degrees and is controlled by the handle with pointer shown in figure 2, marked coupling.

From the coupling inductance we come to the secondary variometer, which construction will be described in detail later on. The secondary variable condenser which is of .005 mfd. capacity is mounted directly on the front panel and the secondary variometer is mounted on the same shaft directly in back. The secondary con-

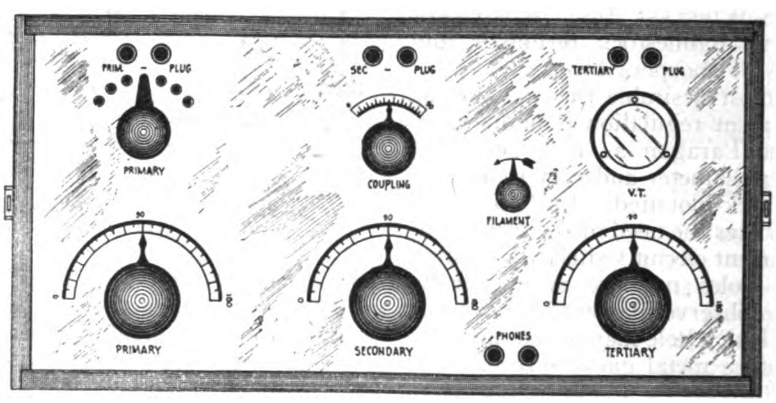


Figure 2—Front view showing location of instrument controls

denser is in shunt to the secondary coupling and variometer inductance, which are in series.

One lead of the variometer runs to the grid condenser. This condenser consists of four copper discs one inch in diameter, two connected to one side and two to the other, insulated from each other by 1½-inch discs of mica .005 inch thick. This condenser should be dipped in a good insulating varnish and dried. A small bolt insulated from the plates can be passed through the center and fastened to a bracket for mounting to the front panel from the rear. The other lead of the grid condenser runs to the grid of the VT audion and also the one terminal of the grid lead, which should be 2 megohms for ordinary VT tubes. As shown, the other lead of the grid leak runs to the positive side of the filament lighting battery.

After another wire is run from the other terminal of the coupling inductance to the other terminal of the secondary condenser to the filament lighting battery, the secondary circuit is complete.

The tertiary circuit is now considered, and starts by a wire running from the plate to one terminal of the tertiary variable condenser which is the same size as the secondary condenser. This wire also runs to one terminal of the tertiary variometer. The remaining terminals of the tertiary variometer and condenser are connected together and are also connected to the positive side of the high potential battery. From the high potential battery a wire runs to the telephones. In this case the telephone terminals are two jacks for the telephone cord plugs and are mounted on the front of the panel as shown in the drawing. From the other telephone terminal a wire runs to the filament battery and completes the tertiary circuit, with the exceptions of the by-passing condenser for battery. This is a small condenser to allow the high frequency oscillations to pass around the high resistance offered by the telephones and high potential battery and is exactly the same as the grid condenser except that there are four discs of copper on each side, eight in all.

On the filament lighting circuit a variable resistance is in circuit, to properly adjust the filament to the proper temperature for best operation and long life. The Adams-Morgan Co., Montclair, N. J., is putting out an excellent rheostat suitable for this purpose and comes ready to mount on the panel, from either the front or rear. The resistance is suitable for VT tubes on operation from 4 to 6-volt batteries.

The most difficult part of the receiver to build will be the variometer, and well spent skill on this portion of the construction will be repaid in results. Referring to figure 5, it will be noted that the variometer is extended directly on the secondary and tertiary variable condensers, and that there is no variometer on the primary condenser (figure 3).

Either a new extended shaft will have to be put through the rotor plates of the variable condensers, or the end of the shaft can be tapped and an extension threaded in and sweated with solder which will be satisfactory. A frame of dilecto is then made to hold the stator windings. This is simply two pieces spaced with brass rods and fastened to the rear end dilecto piece of the condenser. The windings are held in place by small aluminum brackets that are screwed to the dilecto frame pieces. The windings are then tied in place with strong linen thread and waxed. The rotor windings are held in a similar manner. The shaft runs through a dilecto rectangular block and is split in the middle and then the shaft continues through the other half of the dilecto block out the rear end. This shaft is split so that each of the two rotor winding ends can be brought out through one half of the shaft. The middle two connections of the rotor winding are connected together so that the winding is in a continuous direction.

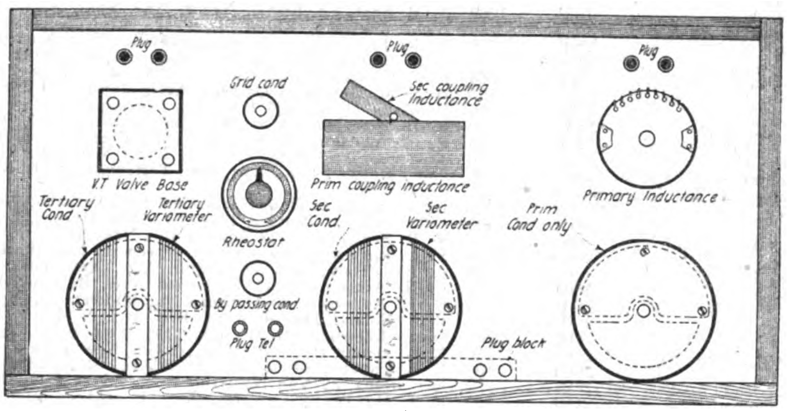


Figure 3.—Diagram of panel arrangement

Variometer winding is shown in the small sketch in figure 5. Preferably wooden forms are turned in a lathe the exact groove being cut as per sketch. The form should be made in such a manner that it can be taken apart to remove the winding. Before the windings are removed, the wires are firmly waxed together with a medium hard wax. It will be found that the windings will keep their form and a very substantial variometer can be constructed.

Now as to the assembly. A possible arrangement is shown in the assembly drawings. The front panel is dilecto which is the best material for this purpose and well worth the money it costs. Looking from the rear the tertiary condenser and variometer are at the extreme lower left end, and the secondary condenser and variometer at the lower center. True, there is some permanent coupling between these circuits, but it will not be detrimental to their operation. The primary condenser is at the extreme lower right. The primary inductance is at the upper right end of the receiver and is perpendicular to the panel. The primary coupling inductance is at right angles to the primary load and has no coupling to it. The secondary coupling inductance has no permanent coupling to the primary load in any position.

The VT tube, rheostat and fixed condensers may be mounted as shown or in any position convenient to the individual requirements. It will be noted that the telephone plugs in from a jack on the front of the panel. The antenna, ground, high potential battery and storage battery are connected to the receiver through a small terminal block on the rear of the receiver which is not covered when the case is on. The case may be of oak.

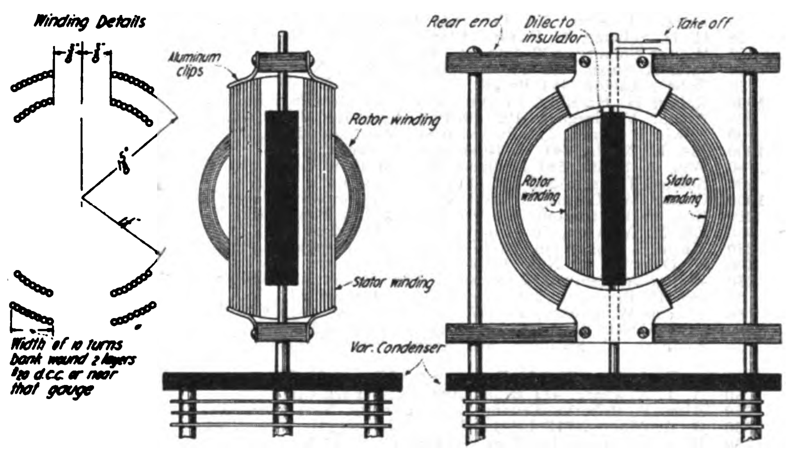


Figure 5.—Variometer and winding details and secondary and tertiary condensers

Three leg fastenings are to be made of sheet metal and fastened on the case to hold the legs. The legs should be of oak, about eighteen inches long. It is figured that the legs will hold the receiver sufficiently above the ground to allow an operator to sit at the receiver with his legs straight out under the receiver, while sitting on the ground.

As designed the receiver will cover a range of 175 meters to 875 meters which is best for experimental purposes. However, as shown in the schematic wiring diagram, plugs are provided to insert loading inductances in the primary, secondary and tertiary circuit and the receiver may be loaded up to 2500 meters, and used for both damped and undamped reception.

In regard to its operation: Assuming that we did not know the wavelength that was to be received, first, we would tighten the coupling by setting the dial at 75 degrees on the scale, then short circuit the primary condenser by moving it into the 180 degree position. Of course, telephones are now plugged into the jack. Loading coils are short circuited, valve lit and the high potential battery connected and filament adjusted to normal temperature. The tertiary circuit control is set at 0 degrees on the scale. By simultaneously moving the primary inductance switch and secondary circuit control we will cover the range of 175 and 875 meters. It is best to hover around 600 meters as most stations work on that wavelength. When signals are heard, first adjust the primary inductance to the exact point; if this cannot be done directly with the inductance, increase the inductance and throw the primary condenser in series and tune with that. The secondary circuit and coupling should then be adjusted, the coupling being reduced to a point where signals are the best and still readable, and still further if interference is prevailing. Now by moving the tertiary circuit control slowly toward the 180 degree position, we start to tune the plate circuit and the valve regenerates and the signal strength is increased. This increase will continue until the valve starts to oscillate. Of course, then the spark resembles a hiss.

If we are to tune to undamped stations, the valve must be oscillating all the time, and tuning done by the heterodyne method. Indications of oscillations are noted in many ways, but a sure indication is a dull thud as the tertiary is moved from the 0 position to the 180-degree position. After the thud, the static has a different tone.

(*Continued on page 41*)

Second District Call Letters of Amateur Stations

(Continued from June WIRELESS AGE)

Letters.	Power.	Name and address.
2IO	50	Raymond B. Cunningham, 60 Park Pl., So. Orange, N. J.
2IP	440	Wm. E. Ashmall, Jr., 11 Pavonia Ave., Arlington, N. J.
2IQ	60	F. A. Gritzner, care J. W. Hatch, 430 W. 122nd St., N. Y. C.
2IR	1000	J. W. Hubbard, 327 King St., Port Chester, New York.
2IS	500	Harold T. Daily, 25 Lydecker St., Nyack, N. Y.
2IT	1000	Norman C. Cowper, 454 Merrick Road, Lynbrook, N. Y.
2IU	500	N. Leo, 35 Pt. Washington Ave., New York City.
2IV	50	Walter J. Lans, 17 Grant Ave., Lynbrook, N. Y.
2IW	600	Jno. B. Worth, Cresskill, N. J.
2IX	550	S. W. James, 37 43rd St., Irvington, N. J.
2IY	500	Alex Dougan, 26 Spencer Ave., Lynbrook, N. Y.
2IZ	50	Melville G. Kilborn, 349 Valley Road, West Orange, N. J.
2JA	275	David Carruthers, 135 Waverly Place, New York City.
2JB	50	Wm. J. Miller, 126 Orient Ave., Jersey City, N. J.
2JC	100	Joseph Chambers, 142 W. 126th St., New York City.
2JD	275	John H. Janco, 121 Park St., Schenectady, N. Y.
2JE	1000	J. L. Eddy, Jr., 23 Washington Ave., New Rochelle, N. Y.
2JF	25	Anton C. Frey, 208 Freeman Ave., Jersey City, N. J.
2JG	750	J. E. Judson, 89 Third St., Keyport, N. J.
2JH	25	Wm. B. Fricke, 156 N. Arlington Ave., East Orange, N. J.
2JI	500	Robt. P. Norris, 906 St. Marks Ave., Brooklyn.
2JJ	25	J. Kulik, Rot Seminary, Tenafly, N. J.
2JK	150	A. H. Bardewyck, 30 Bay 31st St., Brooklyn, N. Y.
2JL	500	Jos. Roemisch, 841 Lexington Ave., New York City.
2JM	200	Louis Tepel, Jr., 176 East 109th St., New York City.
2JN	250	C. K. Atwater, 40 Oakwood Ave., Upper Montclair, N. J.
2JP	12	H. M. Bruden, 141 North 17th St., East Orange, N. J.
2JQ	300	G. F. Abderholden, 659 Henry St., W. Hoboken, N. J.
2JR	50	Leon Terwilleger, Clermont, N. Y.
2JS	25	Thos. J. Smith, 624 Summerfield Ave., Asbury Park, N. J.
2JT	500	F. F. Dennis, Main St., Fair Haven, N. J.
2JU	1000	C. J. Goette, 1624 Hamilton Ave., Woodhaven, L. I.
2JV	50	Eric Hilmer Berg, Main St., Pearl River, N. Y.
2JW	25	G. W. Stewart, 171 Kearny Ave., Perth Amboy, N. J.
2JX	50	Julius Cohen, 545 W. 158th St., New York City.
2JY	30	O. J. Goohs, 298 Palmetto St., Brooklyn, N. Y.
2JZ	1000	C. F. Mueller, Jr., 440 Monroe Ave., Elizabeth, N. J.
2KA	50	G. A. Webster, Sterling Ave. & West St., Harrison, N. Y.
2KB	1000	E. A. Schabbehar, 412 Village Ave., Rockville Centre, N. Y.
2KC	50	Robert W. Scofield, 267 Halsey St., Brooklyn, New York.
2KD	500	W. S. Browne, 1565 E. 12th St., Brooklyn.
2KE	50	Donald Lefever, 305 Fird St., Ogdensburg, New York.
2KF	25	H. D. Selvage, 45 Durand Place, Irvington, New Jersey.
2KH	55	Walter Solberg, 620 46th St., Brooklyn.
2KI	1000	Jack Hoffman, 462 Ft. Washington Ave., New York City.
2KJ	50	Robert Taylor, 464 Pacific St., Brooklyn, N. Y.
2KK	1000	Robert H. Horning, 34 Westfield Ave., Roselle Park, N. J.
2KL	220	Arthur V. Gregory, 105 Hudson Ave., Red Bank, N. J.
2KM	100	Edwin F. Jones, 311 Prospect St., Westfield, N. J.
2KN	1000	Jas. K. Noble, 441 N. Broadway, Yonkers, N. Y.
2KO	500	Wm. A. Smith, 561 Midland Ave., Midland Beach, N. Y.
2KP	500	Samuel Jackson, 345 W. 88th St., New York City.
2KQ	1000	Osmun W. Lorini, 96 Highland Ave., Yonkers, New York.
2KR	250	Geo. F. Harrington, 436 Ford Hall, New Brunswick, N. J.
2KS	530	Ed. M. Mowton, 70 Hillcrest Ave., Yonkers, N. Y.
2KT	250	Merle E. Robertson, 98 Piermont Ave., Nyack, N. Y.
2KU	500	O. Oehman, 29 New Jersey Ave., Brooklyn, New York.
2KV	50	Walter A. Remy, 356 Desmund Ave., Bronxville, New York.
2KW	50	Jas. R. Plummer, 340 Orient Way, Rutherford, N. J.
2KX	50	Theron W. Kilmer, 165 W. 85th St., New York City.
2KY	500	Wm. V. M. Spader, 103 1st Ave., Highland Park, N. J.
2KZ	30	Kenneth W. Spalding, 501 Argyle Road, Brooklyn, N. Y.
2LA	50	A. R. de Rouville, 21 Barrow St., Albany, N. Y.
2LB	50	A. T. Newborg, 421 Brook Ave., New York City.
2LC	550	Alex. P. Roberts, Tenafly Road, Tenafly, New York.
2LD	550	O. A. Morris, 817 Lenox Road, Schenectady, New York.
2LE	250	R. S. Egolf, 45 Pearl St., Oceanside, New York.
2LF	25	Wm. W. Earnest, 161 6th Ave., W. Roselle, N. J.
2LG	50	C. B. Adams, 179 Hudson Ave., Red Bank, New Jersey.
2LI	165	F. C. Meacham, 30 Linden Ave., Brooklyn, N. Y.
2LJ	500	Henry A. Weber, 227 Oak St., Weehawken, New Jersey.
2LK	25	Wm. L. Wheeler, Jr., 348 W. 22nd St., New York City.
2LL	48	A. R. Benedict, Newburgh, R. D. 1., Newburgh, N. Y.
2LM	500	A. Davidson, 347 W. 122nd St., New York City.
2LN	660	C. P. Morrison, 2513 Catalpa Ave., Glendale, New York.
2LO	500	N. Dunham, 103 S. 1st Ave., Highland Pk., New Jersey.
2LP	500	Cecil J. Reed, 26 College Pl., Newark, New Jersey.
2LQ	500	E. K. Cohan, 601 W. 156th St., New York City.
2LR	1000	E. T. Erickson, Marion Ave., Harrison, New York.
2LS	50	Everett Decker, 2100 Richmond Ter., Port Richmond, N. Y.
2LT	550	Norman C. Hall, 157 Roseville Ave., Newark, New Jersey.
2LU	500	George Beluze, 308 Angeleque St., West Hoboken, N. J.
2LV	500	H. M. Bargebuhr, 719 W. 180th St., New York City.
2LW	50	Everett N. Sider, 55 Ward Place, South Orange, N. J.
2LX	50	B. A. Hampe, 1228 Putnam Ave., Brooklyn, N. Y.
2LY	50	Chas. A. Wood, 353 Heberton Ave., Port Richmond, N. Y.
2LZ	500	Robert Schultz, 2261 Chatterton Ave., New York City.
2MA	1000	Earl Hasbrouck, Wallkill, New York.
2MB	50	Morris Press, 839 Thrall Ave., Woodhaven, Long Island.
2MC	50	Benville H. McMann, 380 Riverside Drive, New York City.
2MD	16	Manney F. Dinovo, 2305 13th St., Troy, New York.
2MG	500	H. E. H. Knight, 251 Fenimore St., Brooklyn.
2MH	50	Howard E. Anderson, 23 Liberty St., Ridgewood, N. J.
2MI	500	Earle S. Morris, 1192 Dean St., Brooklyn, N. Y.
2MJ	50	Gerard Ferre, 390 Oakland Ave., West Brighton, N. Y.
2MK	15	H. C. Midgley, 59 Brewster St., Stapleton, New York.
2ML	125	Albert M. Luxtig, 444 15th St., Brooklyn, N. Y.
2MM	50	Frank M. Soden, 1282 Hancock St., Brooklyn, N. Y.
2MN	500	Philander H. Betts, 238 Valley Road, Montclair, N. J.
2MO	48	S. Tannenbaum, 155 Seigel St., Brooklyn, N. Y.
2MP	24	R. Wolf, Jr., 431 Van Dyke Ave., Haledon, New Jersey.
2MQ	250	T. B. Comstock, 195 Fernwood Av., Up. Montclair, N. J.
2MS	50	Jos. B. Hunter, 910 Kilsyth Rd., Elizabeth, N. J.
2MT	1000	Abram W. Moses, 270 E. 161st St., New York City.
2MU	220	W. O. Schmidt, 2076 Daly Ave., New York City.
2MV	500	John J. Dane, 92 Third St., Keyport, New Jersey.
2MW	25	H. B. Wattson, 251 Union Ave., Rutherford, New Jersey.
2MX	575	C. B. LeGallez, Slingerlands, New York.
2MY	500	Edwin K. Cohan, 601 W. 156th St., New York City.

Letters.	Power.	Name and address.
2MZ	50	T. J. Mulvaney, 1911 White Plains Ave., Van Nest, N. Y.
2NA	100	Nelson Aseltine, 209 Edgewood Ave., Westfield, N. J.
2NB	18	Chas. C. Cahn, 182 Pulaski St., Brooklyn.
2NC	25	Russell N. Chappell, 338 Stanley Ave., Tompkinsville, N. Y.
2ND	50	Howard R. Hill, 15 Albion Place, Port Richmond, N. Y.
2NE	12	A. H. Saxton, 211 Claremont Ave., Jersey City, N. J.
2NF	990	Wm. G. Mayer, N. Bath & Wilson Ave., L. Branch, N. J.
2NG	25	H. Opperman, 42 Grand Ave., Baldwin, Long Island.
2NH	750	H. E. Ballentine, 51 Ann St., Pt. Richmond, New York.
2NI	50	D. Truex Buck, 116 W. Main St., Freehold, New Jersey.
2NJ	24	James E. Rossner, 5 Ditson Pl., Albany, N. Y.
2NK	500	Wm. K. Johnson, 501 Jersey Ave., Spring Lake, N. J.
2NL	500	John R. Bucknam, 4 Hemlock Place, New Rochelle, N. Y.
2NM	25	C. M. Bleiley, 43 Hamilton St., E. Orange, New Jersey.
2NO	500	Frank P. Merritt, 28 Spring St., Red Bank, N. J.
2NP	1000	N. B. Foot, So. Bway., Nyack, New York.
2NQ	50	Algot Eiserman, Ridge St., Pearl River, New York.
2NR	500	L. R. Flynn, Lincoln Ave., Sayville, New York.
2NS	30	C. R. Doty, 928 Orchard St., Peekskill, New York.
2NT	500	E. F. Glavin, 64 Scarsdale Ave., Yonkers, New York.
2NU	500	Hugh M. Henry, 21 Oakview Ave., Maplewood, New Jersey.
2NV	600	Frank S. Miller, 153 Fifth St., Weehawken, New Jersey.
2NW	770	R. B. Austrian, 49 St. Nicholas Terrace, N. Y. C.
2NX	250	R. G. Johnston, 21 So. Main St., Freeport, N. Y.
2NY	50	Nomer Gray, 301 St. Nicholas Ave., New York City.
2NZ	500	Elmer Raguse, 450 Elliott Ave., Tottenville, S. I., New York.
2OA	1000	Lester P. Hammond, Tarrytown Rd., Valhalla, New York.
2OB	500	J. T. Harahan, Beach & 133rd St., Belle Harbor, L. I., N. Y.
2OD	220	R. R. Schleckser, 118 Fabyan Pl., Newark, New Jersey.
2OE	1000	S. L. Raynor, Cottage Court, Freeport, New York.
2OG	200	A. B. O'Hara, 941 Washington Ave., New York City.
2OH	27	L. H. Armbruster, 11 Rockwood Ave., Baldwin, L. I.
2OI	50	H. E. Anderson, 60 Hanford St., Middletown, N. Y.
2OJ	500	Benj. Solarz, 1540 48th St, Brooklyn, N. Y.
2OK	200	Oscar Johnson, 501 W. 134th St., New York City.
2OL	250	R. L. Dougherty, 539 W. 155th St., New York City.
2OM	100	F. B. Ostman, 89 So. Van Dien Ave., Ridgewood, N. J.
2ON	72	E F. Bona, 82 Van Nostrand Ave., Jersey City, N. J.
2OO	200	R. T. Hawkey, 29 Virginia Ave., Poughkeepsie, N. Y.
2OT	200	W. C. Boerner, 34 Britton Ave., Elmhurst, Long Island.
2OU	550	T. J. Berger, 2626 Bway., New York City.
2OV	21	Y. A. Golobe, 1248 St. Johns Pl., Brooklyn, N. Y.
2OW	500	W. H. Tirrell, 20 Rutland Rd., Brooklyn.
2OY	16	J. Schanz, 230 E. 18th St., New York City.
2OZ	16	C. H. Hild, 165 Luquer St., Brooklyn.
2PA	660	J. H. Boolley, 1743 Montgomery Ave., New York City.
2PB	246	B. Tyler, 79 Winthrop St., Brooklyn.
2PD	160	Wm. A. Ward, 917 Gates Ave., Brooklyn.
2PE	275	H. Ronclere, Hotel Ronclere, Ridgewood, New Jersey.
2PF	500	D. Talianoff, 817 E. 16th St., Brooklyn.
2PG	50	Peter Jasko, Freehold, New Jersey.
2PI	550	J. W. Schmidt, 502 W. 143rd St., New York City.
2PJ	500	Alonzo E. Thomas, Jr., 147 Lincoln St., Jersey City, N. J.
2PK	500	H. Reifel, 489 Columbus Ave., New York City.
2PL	462	G. K. Thompson, 139 Maplewood Ave., Maplewood, N. J.
2PM	650	Adolph J. Faraon, 808 West End Ave., New York City.
2PN	50	Henry C. Berger, 33 Pennington Ave., Passaic, N. J.
2PO	945	W. T. Feeney, 819 McLean Ave., Yonkers, N. Y.
2PP	8	W. F. Scott, 207 N. 11th St., New Jersey.
2PT	50	Clifford H. Hammill, 208 Locust Ave., Port Chester, N. Y.
2PU	990	Jos. I. Lally, 117 27th St., Guttenberg, New Jersey.
2PV	21	H. H. Ammenheuser, 314 1st St., Albany, New York.
2PW	500	Wm. Hellman, 753 Jefferson Ave., Brooklyn, N. Y.
2PY	250	Carl J. Hunkins, 26 Washington Place, Glen Ridge, N. J.
2PZ	12	Harry Sadenwater, 1333 Lexington Ave., New York City.
2QA	500	W. S. Benson, 4 Fuller Pl., Brooklyn.
2QB	500	H. W. Blackford, 220 Park Ave., Plainfield, N. J
2QC	500	E. C. Hubert, 517 Summit Ave., Westfield, N. J.
2QE	60	S. L. Herdin, 21 Prescott Ave., Clifton, N. J.
2QF	300	Bowden Washington, Brower Ave., Woodmere, N. Y.
2QH	50	Abraham Hess, 431 Sackman St., Brooklyn, N. Y.
2QI	10	Alfred C. Oechler, 82 Smith St., Irvington, N. J.
2QK	616	A. K. Ransom, 701 W. 179th St., New York City.
2QL	500	J. Hornung, 203 E. 64th St., New York City.
2QM	36	Wm. S. Willis, 347 W. 14th St., New York City.
2QN	12	H. L. Estberg, 682 Bergen St., Brooklyn.
2QO	500	M. H. Leitch, 32 South Park Drive, West Orange, N. J.
2QP	24	John R. Ward, 160 Garfield Place, Brooklyn.
2QR	1000	Harold H. Robinson, 13 Walnut St., Keyport, N. J.
2QS	30	John Miller, 33 Windsor Pl., Brooklyn.
2QT	50	J. S. Dufford, 615 So. 20th St., Newark, N. J.
2QU	500	J. S. Osborne, 164 Union Ave., Belleville, N. J.
2QV	1000	Harold A. DePalma, 461 Edgecombe Rd., New York City.
2QW	54	A. D'Amico, 521 Grand St., New York City.
2QX	160	Wm. E. Gerhart, 354 Fulton St., Elizabeth, N. J.
2QY	36	V. Tassi, 3091 Webster Ave., New York.
2QZ	36	J. H. Zimmer, 81 Carman Ave., Lynbrook, N. Y.
2RA	100	R. Anders, 387 Railroad Ave., Brooklyn.
2RB	500	Wm. H. Reuman, 480 Ninth Ave., New York City.
2RC	500	C. Young, 68 Linden St., Schenectady, N. Y.
2RE	440	H. Fass, 34 Grove St., Plainfield, N. J.
2RF	40	Chas. M. Springer, 59 Gerry Ave., Elmhurst, N. Y.
2RG	550	D. S. Lockwood, 64 Elizabeth St., Keyport, N. J.
2RH	500	Lester Reiss, 580 W. 161st St., New York City.
2RK	450	John K. Hewitt, 708 Ocean Ave., Brooklyn, N. Y.
2RL	660	Victor F. Camp, Plymouth Ave., Brightwaters, N. Y.
2RM	500	F. A. Maher, 828 55th St., Brooklyn.
2RN	25	H. C. Grant, Jr., 470 West 159th St., New York City.
2RO	1000	Henry Roehrich, 2 Belmont Ave., Garfield, N. J.
2RR	100	Charles A. Kaufman, 777 14th Ave., Paterson, N. J.
2RS	1000	M. J. Schaefer, 604 West 135th St., New York City.
2RT	40	L. O. Cross, 184 Linden Ave., Middletown, N. Y.
2RU	168	G. E. Huffman, 55 Church St., Montclair, N. J.
2RW	250	H. W. Baily, Summer St., Harrison, N. Y.
2RX	500	Joseph Jacobs, 65 West 127th St., New York City.
2RY	50	R. L. Glover, 8772 113th St., Richmond Hill, New York.
2RZ	50	H. McEntee, 16 Hanks Ave., Ridgewood, N. J.

(To be continued)

A Universal Range Portable Receiver

By Chas. T. Jacobs

THIRD PRIZE, $3.00

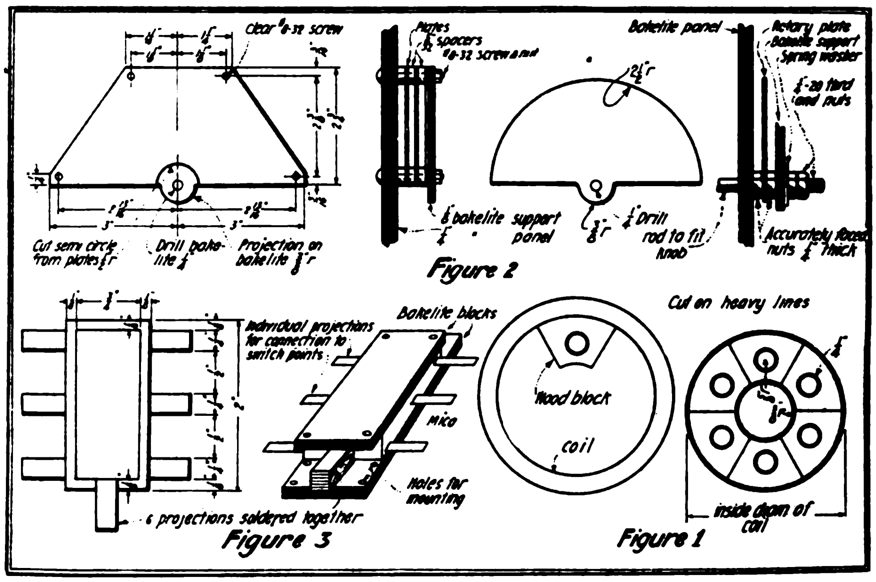
WITH the coming of the various multilayer coils into general use, the problem of the construction of a portable receiver to cover the complete range of wavelengths has been greatly simplified. Believing that there is now no obstacle to the construction of a truly universal receiver that would be truly portable, the writer has designed and is now constructing for his own use the receiver described.

The receiver is completely enclosed in a covered cabinet or case 6 x 12 x 13¾ inches, with bakelite panel for controls. It is designed primarily for use with the vacuum valve, either regenerative or simple rectifying action being obtainable at will. Binding posts are provided, however, for a crystal detector, which may be used when desired. The receiver accommodates multilayer coils of present-day design. These are to be obtained or made unmounted and a small block of wood, with a hole therein, glued firmly to the inside of each coil, as shown in figure 1. These blocks are made of wood about the same thickness as the coil, and are laid out, drilled and cut on the heavy lines, making six blocks at once.

A rod onto which the coils needed for a certain range of wavelength are slipped, is then set in notches provided for it. Flexible leads from the coils are then connected to the proper binding posts. Coupling is varied by sliding the coils along the rod, there being no tendency for the coils to revolve on the rod, as the hole in the block is above the centre of the coil. The coils are still essentially air-core coils—a great advantage over solid cores. The advantages and ease of operation of this mounting will be readily appreciated.

The secondary circuit is tuned on a novel principle which the writer picked as being most satisfactory in every way. Bearing in mind that the vacuum valve requires a low maximum secondary capacity—an almost zero minimum—and a fine adjustment of capacity for best results, and that the portable set requires a small weight and bulk, the reader will realize the tremendous advantages of this method. A home-made variable condenser having one rotary and two stationary plates, and a six-step adjustable fixed condenser are used, connected in parallel. The variable is calculated to have a maximum capacity of approximately .000065 mfd., and each step of the fixed condenser about .00005 mfd., so that the variable laps well over on each step. The step condenser is controlled by an ordinary seven point instrument switch, one of which is left unconnected. By joint use of this switch and the handle of the variable, a continuous range—very finely adjustable—from almost absolute zero to approximately .000365 mfd. is obtained, which is ample for valve use.

Details for the construction of the variable condenser are given in figure 2. The stationary plates are made from 1/32 inch aluminum as shown, a small semi-circle being cut out of the lower edge. The same layout suffices for the rear support of the shaft—a piece of ⅛ inch bakelite—except that instead of a cut in the bottom, a projection is left there, and the center of it drilled ¼ inch, as shown. The stationary plates and bakelite support are mounted directly on the back of the main panel of the set. The spacers shown are ⅜ inch in diameter, and exactly 5/32 inch thick. They are drilled in the center to pass an 8-32 machine screw. They had best be made by a machinist, together with two ¼-20 nuts accurately faced to an exact ¼ inch thickness, and a 2½ inch length of ¼ inch brass rod, turned down for ed rod up to it, and clamped firmly in place with the second accurate nut. The turned down end of the rod is now placed in its hole in the panel. Now slip the bakelite support over the threaded rod and connecting screws, and place nuts on the latter. The distance from the panel to the bakelite is now 17/32 inches, and since the thickness of the two nuts and rotary plate is the same, these should just fit between the panel and bakelite block. A spring washer is now placed behind the block, and an ordinary ¼-20 nut screwed against it till a slight tension is obtained. This nut is tightened gradually till the rotary plate will stay in any position in which it may be



Figures 1, 2, 3.—Constructional details of the portable receiver

a distance of one inch to fit the knob to be used on the condenser and threaded for the remainder of its length with an accurate ¼-20 thread. Figure 2 shows the rotary plate of 1/32 inch aluminum, drilled to fit over the threaded rod, and also a vertical cross section of the shaft and rotary plate as mounted between the panel and the rear bakelite support, all but a small portion of the latter, together with the stationary plates, spacers and screws, being removed for the sake of clarity.

In addition to making the parts, it will be necessary to drill the main panel of the set to pass the turned down end of the rod, and also for the 8-32 screws which support the stationary plates. These screws are slipped into place, and a spacer placed over each. Then one of the stationary plates is slipped on, next another set of spacers, then the second plate, and again a third set of spacers. Now take one of the accurately faced nuts and screw it onto the threaded rod so that it just overlaps the turned down portion by a tiny fraction of an inch. The rotary plate is slipped over the thread- placed, and then a second nut is screwed on behind the first to lock it. The entire assembly as seen from the top is shown in figure 2. The 1/16 inch separation of rotary and stationary plates assures great ruggedness even under hard usage such as a portable set might undergo.

The six-step condenser for the secondary is constructed of mica dielectric, a micrometer being necessary to measure the various thicknesses required. Mica 1 x 2 inches is used, together with a dozen very thin copper plates ¾ x 1¾ inches with projections for connection to switch points, etc. Alternate plates are connected together by soldering the projections, and form one terminal of the condenser, while the intermediate sheets are connected to individual switch points for variation of capacity. It should be understood that only one plate is connected at any one time, it being unnecessary to connect in parrallel.

This admits of an ordinary instrument switch being used instead of a fan switch. To this end the copper plates are spaced as shown, the numbers between them indicating the thickness of the mica in thousandths of an inch, and the numbers at the switch points, the capacity available in microfarads:

10	
10	.0003
12	
12	.00025
15	
15	.0002
20	
20	.00015
30	.0001
30	
30	.00005

Two views of the condenser are shown in figure 3. One is a top view of the mica and copper sheets, showing dimensions, and the other is a perspective view showing the assembly placed between two 1/8 inch bakelite blocks 1 inch wide which are to be clamped together by screws and nuts through the holes shown. The bottom block should be made longer than the top, and extra holes drilled therein for screwing to the bottom of the cabinet. The entire unit had best be baked at about 250 degrees F. for several hours to dispel all moisture, and immediately impregnated with insulating compound, which may afterwards be scraped off where connections are necessary.

The primary is tuned by a purchased balanced-type condenser, capacity .0006 mfd., shunted by a two-step condenser having capacities of .0005 and .001 mfd. This is controlled by an anti-capacity, single-pole, double-throw switch, having a neutral position. The capacity obtainable is therefore continuously variable from the minimum value of the variable condenser to .0016 mfd. The two-step condenser is made of the same size mica and copper and is mounted in the same way as the six-step for the secondary, but only four copper plates are needed spaced as follows:

3	
3	.001
3	.0005

A third condenser of this type is required to shunt the head telephones. This is a six-step condenser made of mica plates 1½ x 2 inches and twelve copper plates 1¼ x 1¾ inches with projections for connections, spaced as follows:

1⅔	
1⅔	.003
3	
3	.0018
5	.001
5	
9	.0006
9	
15	.00035
15	
12½	.0002

While it may be difficult to measure accurately 1 2/3 thousandths of an inch, extreme accuracy is not required in this condenser, owing to its use. The assembly is mounted as before. An eight-point switch is used here, one of the extra points being unconnected, and the other connected so as to short-circuit the "tickler" coil as explained below. The mica for these three condensers should be purchased in sheets 2 x 3 inches, from 1½ to 3½ thousandths of an inch thick, an eighth of a pound of which will be more than sufficient. For the primary and secondary step condensers the mica sheets may be cut in thirds along the three-inch dimension, and for the phone condenser it may be cut in half.

Having described the separate parts which have to be made, attention to the assembly of the instruments is now in order. Figure 4 is a sketch of the front of the receiver, cover removed, and three coils in position. The ¼ inch bakelite panel, 5½ x 13 inches, is mounted flush in the cabinet. The sliding top, 4 x 13 inches, is made to slide in grooves, so that it may be removed for access to the bulb, etc. Dimensions are not given here, but the various parts are marked. The binding posts on the outside of the set will probably be noticed. While they do not appear so well here, this arrangement conserves panel space and permits closing of the cabinet without disconnecting aerial, ground, battery and phone connections. These posts are mounted on

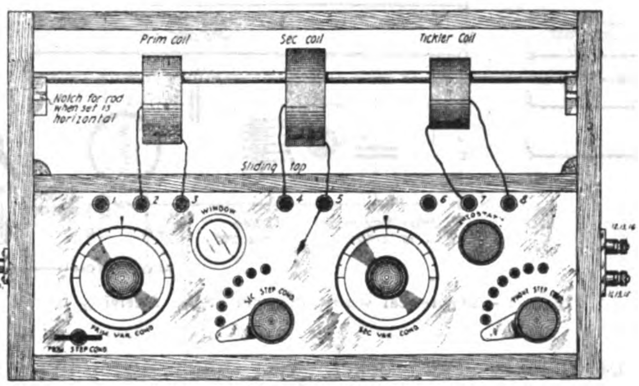
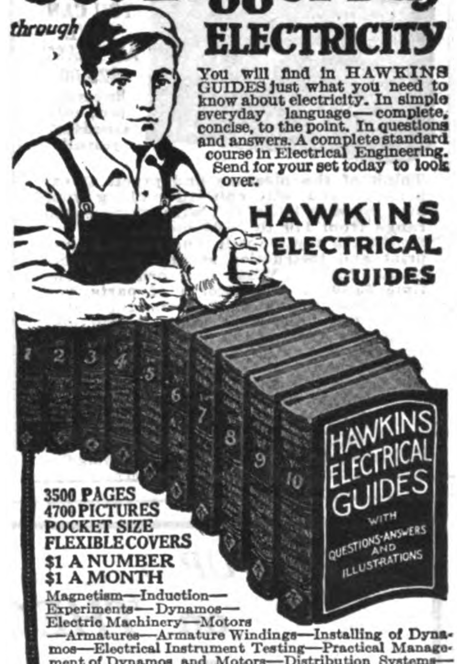


Figure 4.—Front view of receiver with cover removed and three coils in position



1/8 inch bakelite, which is screwed over the cut-outs in the side of the cabinet. On the left there are three posts mounted on bakelite 1 1/4 x 3 1/4 inch for connection to aerial and ground. On the right are six binding posts mounted on bakelite 2 1/4 x 3 1/4 inches, for connection, to "A" and "B" batteries and telephones.

The hole marked "window" is an aperture of 1 1/4 inch diameter in the panel, through which the vacuum tube is observed. The tube is mounted vertically in a socket which may have to be raised by a block or two of wood, so as to bring the filament opposite the window in the panel. The socket should be mounted as far back as possible so as to leave room for the secondary step condenser in front of it. This condenser, as well as the other two of similar construction, should be screwed to the bottom of the panel through the holes provided. The rheostat, the handle of which is shown on the panel, is a six-ohm instrument of small diameter, and is front mounted on a wooden upright in the back of the cabinet. An extension shaft enables it to be controlled from the front of the panel.

It is here appropriate to mention that since binding posts No. 5 and No. 6 are both to be connected to the stationary plates of the secondary variable, and since they can be placed in just the position of the upper two screws supporting the stationary and bakelite block, the shanks of the binding posts can themselves be used as the supporting screws, saving extra screws and wiring. The writer places the center of his variable 2 9/16 inches above the bottom of the panel, and since the holes in the plates are 2 5/8 inches above the center of the variable, the center of the binding posts is brought 5/16 inch from the top of the panel, which is sufficient.

The wiring of the set will be found very simple, owing to the logical placement of the apparatus. Bare copper wire, over which varnished cambric tubing has been slipped, is best for wiring, although a flexible lead will be required to the shaft of the home-made variable. All connections should be soldered.

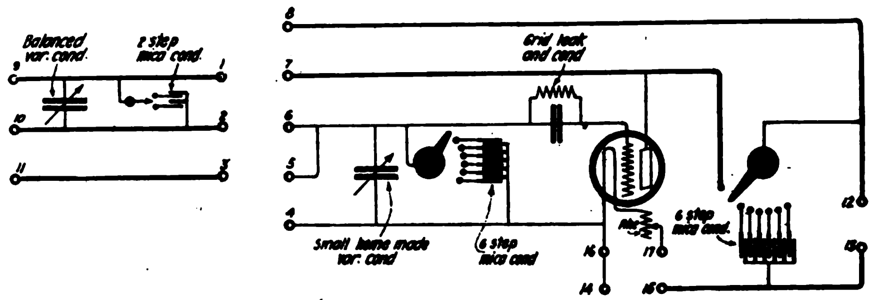


Figure 5.—Theoretical wiring diagram of the receiving set

The theoretical circuit is shown in figure 5. The aerial is connected to binding post No. 9, and the ground to No. 11. The primary coil is connected between No. 2 and No. 3. The primary condenser is now in series with the coil. A shunt connection may be obtained by connecting No. 10 to the ground without disconnecting No. 11.

The secondary coil is connected between No. 4 and No. 5, the "tickler" between No. 7 and No. 8, the telephones to the front two posts on the right—No. 12 and No. 13, the "B" battery to the middle two—No. 14 and 15, and the "A" battery to the back two—No. 16 and 17. To secure regenerative action in the valve, keep the phone condenser switch on any of the first seven points. To secure simple rectification, place the switch on the eighth point, which not only removes capacity from in shunt to the phones, but also short-circuits the "tickler" coil. To use a crystal detector, remove the "tickler" coil, set the detector on the sliding top above the posts No. 6 and No. 8, to which it should be connected, and short circuit posts No. 14 and No. 15. The remarkable flexibility of the set can be appreciated from the foregoing.

Figure 6 shows details of the cabinet, panel and instruments removed. This can be made of any wood desired, preferably ⅜ inch. For this reason only the important dimensions are given, and these are inside measurements. The cabinet may be joined in any way desired, but the back must be screwed on only, so as to be readily removable for better access to the interior than can be obtained through the sliding top. The cover is fastened to the cabinet with separable hinges so that it may be removed by opening and sliding to one side. A lock should be fastened on the side of the cabinet near the bottom. A handle should be fastened to the top of the cabinet. The cabinet may be used in the upright or in a horizontal position, two sets of notches being provided for the coil rod as shown. A front view with cover removed, a side view with cover in place, and a top view with cover separate is shown.

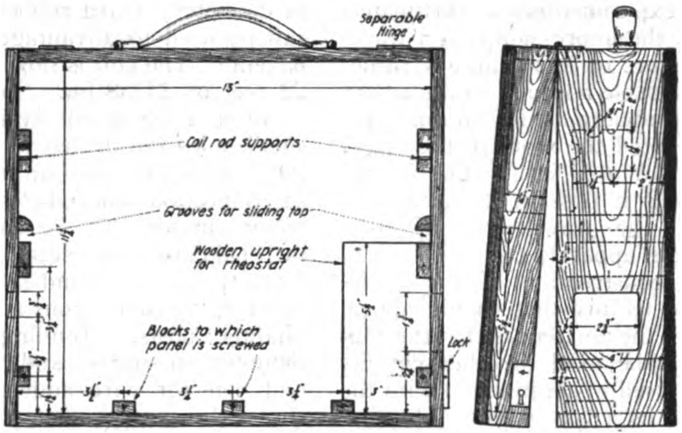


Figure 6.—Details of the cabinet with panel and instruments removed

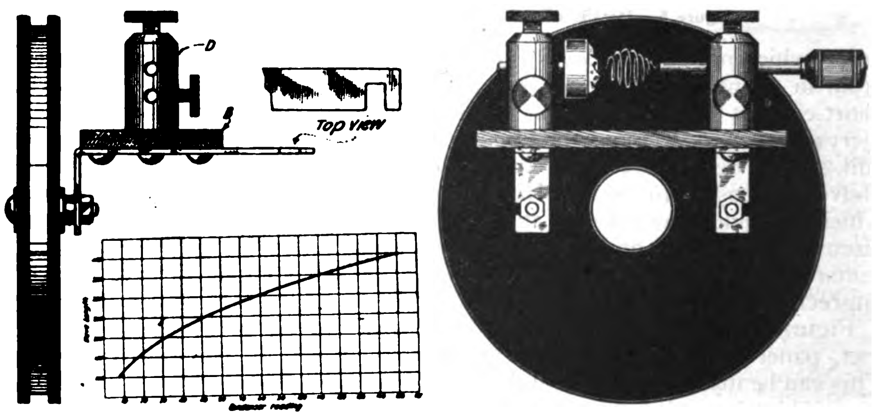
When completed this receiver will be found extremely compact. The space in which the coils slide when the receiver is in use forms an excellent storage place for all needed coils, phones, rod, small batteries, etc., when the instrument is being carried, crumpled newspaper being stuffed around the articles to prevent them from being shaken around. Thus no space is wasted. In conclusion, the writer would unhesitatingly say that, were he planning a set for stationary use only, it would not differ in any essential particular from this portable one—which shows that he believes the efficiency of the set to be as great as it is possible to attain.

A Simple Wavemeter

By E. P. Hurley

THE majority of radio amateurs and experimenters unfortunately are under the impression that a wavemeter is more or less a luxury rather than a desirable addition to the equipment of a modern radio station. This idea is refuted the moment they have installed and used it, for this instrument makes it possible to accurately determine the wavelength of their transmitting apparatus.

In the construction of the wavemeter, the feature that should appeal strongly to the amateur is that the condenser can be used in other circuits when not used in conjunction with the inductance as a wavemeter. The first two 1/8 inch discs with a center 1 inch in diameter. Hard rubber or formica can be used to advantage, instead of bakelite. The coil is now wound with 22 feet of 23/38 litz. Solid wire can be used if litz is not available. Two small holes are drilled in the coil and the ends of the wire brought through to connection marked "B." The detector support "C" is made from 1/8 inch bakelite. Two supports are made from spring brass and slotted at each end for coil connections and condenser binding posts. Binding posts are mounted on support and cup with rod and detector wire added. Figure 1 shows the arrangement as used by the



Figures 1, 2.—Construction and graph showing calibration of wavemeter

requisite is a variable condenser which should be of standard type, having a capacity of approximately .001 mfd. The mounting with the inductance is the only part of the instrument that requires specific description from the builder's standpoint. It is made as shown in figure 1.

The coil is made from a solid piece of 1/4 inch bakelite and slotted to the depth of one-half inch to receive the wire. If the amateur does not have the facilities for making a coil of this type, one can easily be made by using

author. Phone connections are made at "D."

The wavemeter is now ready for calibration. This can easily be done by comparison with a known wavemeter or for precision work the amateur can send the inductance and condenser, prepaid, to the Bureau of Standards, Washington, D. C., accompanied by a written request for the test, enumerating the articles and advising definitely of the test desired. Fees must accompany all

THE WIRELESS AGE

io Operating as a Caree

Marconi on the Future of Wireless

GUGLIELMO MARCONI, in a signed article in the Nuvo Giornale of Florence on the predicted revolution in wireless communication, says:

"Eventually science will find a way of directing electrical energy without wires in an absolutely straight line. The result will be less expenditure of energy for short distances and hence less expense for messages. Once directive control has been established we shall undoubtedly be able by means of powerful machines to girdle the whole world with waves of electric energy without wires."

Marconi describes a radio telegraphic receiver no bigger than a gramophone by means of which, without any other communication with the atmosphere, he receives all day in his study every scrap of wireless news sent to the European press. He says that very soon with an instrument of this kind "bankers, politicians and business men in general will be able from minute to minute to keep themselves in contact with both hemispheres." He continues:

"Very soon, too, that miserable ticking machine on which all newspaper offices depend will yield place to this mighty invention, which is suitable for news sending, news receiving and simultaneous communication with any number of receiving stations.

"With that installment of radio telegraphic receivers throughout the civilized globe in every public school, university and library, the prevailing languid interest of the public in international happenings will be immensely stimulated."

Prize Contest Announcement

The subject for the new prize contest of our year-round series is:

"SOME POINTERS ON RECONSTRUCTION"

Closing date, August 1, 1920.

Contestants are requested to submit articles at the earliest practicable date.

Prize Winning Articles Will Appear in the October Issue.

No one would care to venture that American amateurs are not observing. Each one of us, during the radio year just gone by, has learned many new applications of this wonderful art which has enabled us to increase the efficiency and the range of our installations. What are these things we have learned and how have they enabled us to increase our range and why? Each of us would like to hear of the other fellow's troubles and how he remedied them. It is in this way that amateur stations as a class will increase in efficiency, and we should all welcome this opportunity to do our bit toward forwarding our mutual interest.

PRIZE CONTEST CONDITIONS—Manuscripts on the subject announced above are judged by the Editors of THE WIRELESS AGE from the viewpoint of the ingeniousness of the idea presented, its practicability and general utility, originality, and clearness in the description. Literary ability is not needed, but neatness in manuscript and drawing is taken into account. Finished drawings are not required, sketches will do. The contest is open to everybody. The closing date is given in the above announcement. THE WIRELESS AGE will award the following prizes: First Prize, $10.00; Second Prize, $5.00; Third Prize, $3.00, *in addition to the regular space rates paid for technical articles.*

All manuscripts should be addressed to the Contest Editor of THE WIRELESS AGE

apparatus and remittances made by money order drawn to the order of the Bureau of Standards. The authority for a specially reduced fee for amateurs is set forth under paragraph No. 7, testing schedule No. 90, and reference should be made to this paragraph when forwarding the wavemeter. The fee is 50 cents per point.

With the condenser used as described above, figure 2 shows the curve for inductance. After the wavemeter has been properly calibrated it can be used for calibration of a receiving circuit by connecting a buzzer battery and switch in series to "D." By coupling the wavemeter coil to the coil to be calibrated, a current will be set up at the point of resonance which can be heard in the telephone of the receiving circuit. By referring to the curve the wavelength can be easily ascertained.

For the calibration of the transmitting circuit, the wavemeter is placed near the transmitter and the condenser handle rotated until the signals are the loudest at which point the condenser reading should be taken and reference made to the curve for wavelength.

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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Club to Time Races

THE Radio Club of Burlington (Iowa), organized three months ago, announces that on July 2nd, 3rd, 4th and 5th there is to be a Regatta held at Burlington under the auspices of the Mississippi Valley Power Boat Association. The Radio Club of Burlington has been given the task of timing the races which are to be held on a one mile course between two bridges. The fact that some of the fastest racing boats in the world, such as the Miss Detroit III and others capable of making a speed of almost seventy miles an hour, and because the officials know the speed and accuracy of Radio, the club has been given this important task.

The following is the secretary's brief description of the method which will be employed in timing the races: "We are to have two ½ kw. transmitting stations, together with receiving sets, one at the starting and one at the finishing points of the one-mile course. In order to avoid a possible mistake and to insure accuracy there will be three official timers and two operators at each station, the operators being members of the club. When the fast boats near the starting line a dash will be transmitted from the station located at this line. The ending of this dash will be a signal that the boats have crossed the starting line, and exactly at the ending of this dash the three official timers at both stations will set their stop watches. When the boats cross the finishing line the order of things will just be reversed."

Secretary H. H. Waugh says: "We realize that our task is to be a tedious and painstaking one but nevertheless we intend to put it across in the right manner and we believe that we have the honor of being the first club to try a stunt of this kind. We will also relay friendly messages, announce the winners of the various races, send re-

(*Continued on page 42*)

Fifty members of the Irvington Radio Club, Newark, N. J., met at Achtel-Stetter's for the first annual dinner of the organization. The club is nine years old and is said to be the pioneer among societies of its kind.

The speakers were L. M. Clement, of the Western Electric Company, and R. F. Gowan. Both praised the club for its interest in wireless telephony and telegraphy and explained intricate points in apparatus mechanism. Albert Mills, president of the club, was toastmaster. De Witt Paxton entertained with recitations. The club meets regularly Thursday nights at 55 Union avenue, Irvington.

The New Jersey Radio Club was formed at a meeting held in the New Jersey School of Radio-Telegraphy, Elizabeth. There were present about thirty wireless students, from this section of the State, who attend the evening class at the Radio School. It is expected that about ten students of the day class will also join the club. A. V. Hill, of Elizabeth, was elected president, and C. J. Frank, also of Elizabeth, secretary and treasurer.

Meetings will be held every Thursday evening at the school, 218 Broad street, Elizabeth, which is the club's headquarters. A large 1/8 KW Marconi transmitting set with a radius of 350 miles; also a receiving set with a radius 3,000 miles has just been installed in the school.

In the near future a trip to the Fleet Supply Base and Bush Terminal, Brooklyn, will be made under the supervision of Lieut. H. Armerding, U. S. N. R. F., who is the principal at the Radio School. Other trips of this sort are in prospect for the members of the club.

The Camden, N. J., Radio Club was organized about a month ago to assist the amateur in the fascinating study of wireless. It has been decided to erect an antenna on the roof of the Y. M. C. A., and install a set for the members' use. The technical committee has been elected to help any amateur who has difficulty with his set. There is to be a wavemeter for the use of the members, which all amateurs will appreciate. There is to be in connection with the club an apparatus exchange where members may buy or sell any wireless apparatus.

The club has for its president and guide Mr. Knierman, who is at the head of the League Island Radio Testing Laboratory. He is qualified and willing to help the members, so the best thing an amateur can do is to get his friend and go to the Y. M. C. A., room F.

A Loop Transmitter for Local Work

(*Continued from page* 25)

the instrument table as shown in figure 2. The loop should be either of solenoidal or pancake form, the latter being easier to build. It is wound with two turns, spaced 2 inches apart with a conductor whose cross-section is approximately equal to that of the closed circuit conductor. This can be of litzendraht, of lamp cord in parallel, a cable of magnet wire, or of copper strip. Flexible leads connect the loop to the apparatus.

Those interested in the experimental side of loop antennae for transmission should read Scientific Paper No. 354, Bureau of Standards, by J. H. Dellinger, where there is given valuable formulae for calculating distance, received current, etc., using coil antennae. The writer, when working a ½ kw., 500-cycle transmitter of a well-known make, put 8 amps. into the loop described above, when using a .0007 mfd. condenser and optimum coupling. The wavelength was 300 meters. Using a crystal detector, signals were loud at 10 miles. Amateurs within a radius of 15 miles have been worked. The maximum range has not, as yet, been determined.

It is suggested that experimenters should try the loop in a horizontal plane, try to make it uni-directional by combining it with a straight antenna, try enlarging the inductance of the closed circuit, into a loop; in fact, there is no end of experiments one can try when your entire antenna is just above the operating table!

Portable Receiver

(*Continued from page 29*)

Now after the summer season, if the amateur wishes to use this receiver in his home station, the leg fastenings, front cover and handle can be removed and it is ready for station use. The front cover was designed to hold a portable single wire antenna, telephones, high potential battery and tools.

(*Continued from page 39*)

ports and conduct amateur transmission and reception in general with a powerful 1 kw. transmitting station (Call 9 ACZ) together with a short wave regenerating receiver, long wave set, and a couple steps of amplification."

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.

J. F. T., Kingsbridge, N. Y. C.:

In order to get the 25-mile radius with the radiophone outfit which you mention, it would be necessary for you to use a 400-volt generator. A 60-volt B battery would probably reduce your radius to something like 3 or 4 miles.

* * *

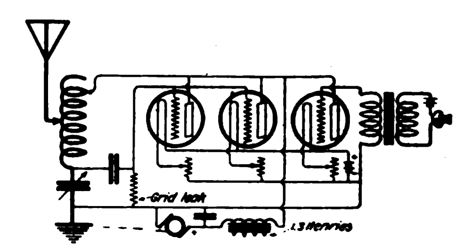
W. F., Troy, Ala.:

We gather from your letter that you are unable to receive signals on either of your two aerials and blame this to lack of a good ground connection. If you have a connection soldered to the city water system and the rest of your apparatus is in the proper shape, you should get some indication of signals. A connection to the water system is, however, not always the best ground possible. If you are so located as to be in a position to erect a counterpoise, we would suggest that you do this. A counterpoise provides an antenna system of high efficiency, regardless of local terrian conditions.

* * *

E. N. W., New York City:

We print herewith your corrected diagram covering connections for three vacuum tubes and a radio telephone outfit.



You will probably be able to buy a 2,000 volt D.C. generator from the Electric Specialty Company, Stamford, Conn.

The fundamental wavelength of your antenna is approximately 243 meters.

* * *

F. H. M., Albany N. Y.:

The following formula will enable you to find the required condenser capacity for a radio transformer:

$$C = \frac{2W}{E^2 N \times 10^{-6}}$$

where C is in farads
W in watts
and N the spark frequency

* * *

J. J. A., Washington, D. C.:

It would be impossible for us to give you instructions covering the construction of a wavemeter having a range of 150 to 12,000 meters in these columns. Various articles have been printed from time to time within the last few months covering wavemeter construction. You should be able to get sufficient information from these to enable you to build such an instrument.

J. G., Tranquille, British Columbia:

Although the use of 110 volts D.C. is not to be recommended in case you are expecting to use an amplifier in conjunction with your detector, it can be done. A circuit of this sort was published in a recent issue.

In case you have only two tubes, it would be better for you to use the second as an audio frequency amplifier, rather than a radio frequency amplifier.

Marconi "Q" and "V24" valves are manufactured by the British Marconi Company. "VT1" and "VT2" valves are marketed by the Marconi Company and are identical with the Audions sold by the De Forest Company. The amplification factor of the "VT's" is about 7 to 1. We regret that we have no data available, giving the characteristics of the tubes manufactured by the British Company, but we presume that they are at least equal to the product of the American Company.

* * *

F. A. W., Woodhaven, N. Y.:

In a recent issue we published a correction covering the circuit diagram shown on page 15 of the April issue. The penciled corrections which you have made on enclosed drawing are O. K.

* * *

J. C., Jr., San Jose, Cal.:

The fundamental wavelength of your antenna is approximately 225 meters. In case your antenna terminates on one end at the house in which your radio set is located, it would be impracticable to attempt the conversion of your L antenna into a T antenna. The lead-in from the T antenna should be as nearly vertical as possible. We suggest that you cut off twenty (20) feet of the end of your antenna.

In the June issue of Wireless Age, several wavemeters were described, together with information which will enable you to construct one for short waves.

* * *

W. S., Port Williams, Nova Scotia:

In the construction of your two-stage audio frequency amplifier, you will find that the best and most convenient method for securing the correct negative grid potential will be by bringing the filament side of the transformer secondary to the slider of your rheostat and connecting the rheostat slider to the negative terminal of the six-volt filament lighting battery. Under these circumstances, in case Marconi "VT's" are used, a resistance of about two ohms will always be in circuit between the filament connection of the transformer and the filament itself.

If we have two oscillatory circuits inductively coupled, any change of coupling between the two circuits will change the wavelength of both circuits, due to their mutual inductance. The fact that the note of a received undamped signal changes when you vary the coupling in your receiving transformer is due to this effect and only in a minor degree to a variation of capacity in either of the two circuits.

We very much regret that we are unable to tell you at the present time what stations have been assigned the calls PTA, NSN, VAV, and WBF. We will endeavor to secure this information for print at a later date.

* * *

H. M., Newport News, Va.:

We regret that we have no actual construction of details covering the uni-control receiver invented by Roy E. Thompson. It is to be presumed, however, that the size of wire and the insulation is of slight import. If you are considering the construction of such an instrument, we suggest the use of No. 24 double cotton covered, or a No. 20/38 Litzendraht double silk covered.

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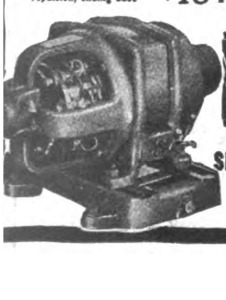

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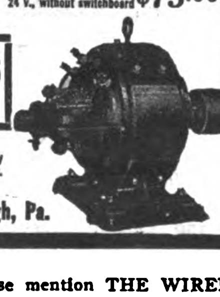

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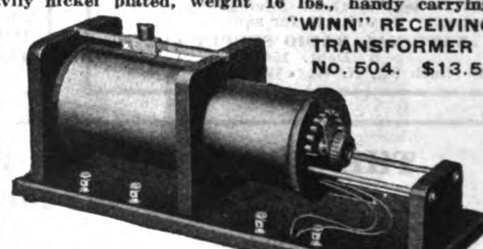

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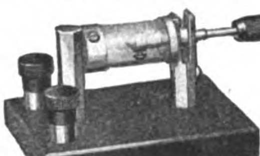

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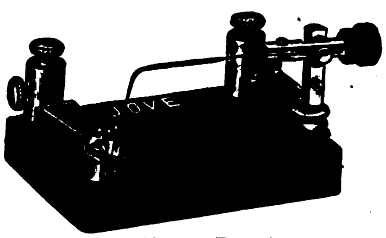

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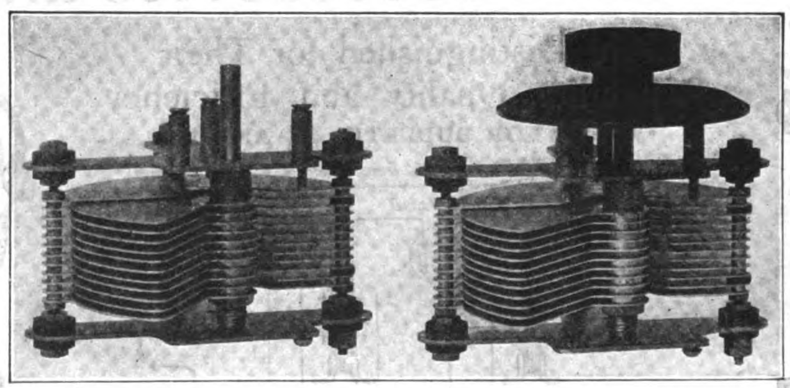

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Capacity	Unmounted	With Dial and Knob
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August, 1920 20 Cents

The WIRELESS AGE

Volume 7 Number 11

W. Harold Warren and Guests Receiving Signals from Stations 200 Miles Distant in a Radio Roller Chair on the Asbury Park Boardwalk

THE NEW YORK RADIO CENTRAL STATION

Description of the Massive Plant That Will Communicate With Five Nations

And Many Exclusive Features in This Issue

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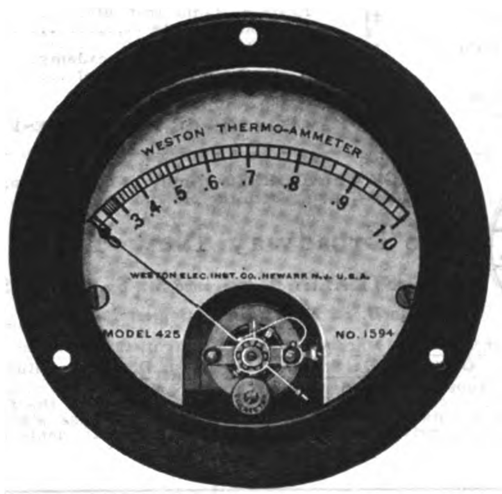
For Radio Service



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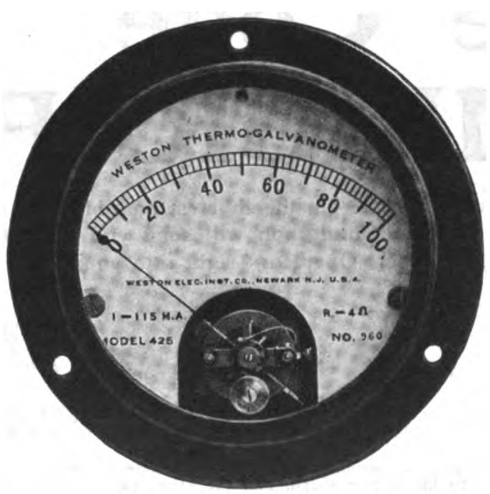

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Vol. 7 Contents of **The Wireless Age** for Aug. 1920 No. 11

Edited by J. ANDREW WHITE

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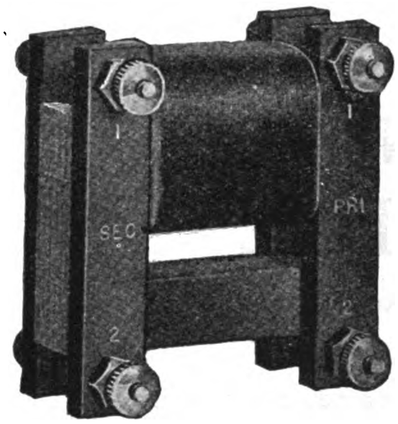

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Vol. 7. No. 11. August, 1920

THE WIRELESS AGE

WORLD WIDE WIRELESS

Television, a New Radio Development

FROM England comes announcement of two developments in wireless transmission, both picturesque, one indeed bordering upon the realm of the fantastic and marvellous. H. Grinnell Matthews, an English experimenter, avers that he has made encouraging progress with a "television" device which will make it possible to witness, almost instantaneously, events that are actually happening far away.

He also announces that he has successfully photographed sound waves and reproduced them from the photographs with the aid of electricity. This would make possible a practical "talking movie."

However, the television announcement was skeptically received by some American wireless experts. Dr. Alfred N. Goldsmith, secretary of the Institute of Radio Engineers, doubts whether this wonder is to come to pass.

"If an entirely new principle of sound and light transmission has been discovered," said Dr. Goldsmith, "it is possible that the scheme will be successful; but from the data at hand I should judge that these discoveries are not much more than the annual rediscoveries which are so common in radio work.

"Every little while some amateur 'discovers' something strange and marvellous in radio work—only to find that he has 'discovered' a fact already familiar to research workers. Therefore, unless something revolutionary in science has been unearthed in England, there probably is nothing new in these devices."

Dr. Goldsmith added that the transmission of images over long distances was not only possible, but that fairly successful experiments had been made with the process. The basis of image transmission is selenium, an element not unlike sulphur. Selenium, in the dark, is an insulator; but when light is thrown on it, it permits an electric current to pass through.

Radio Does Double Duty in Sky Piloting

SERMONS are being sent through the sky in Kansas now. Dr. Clayton B. Wells, a minister at Wichita, Kan., has his sermons sent broadcast every evening by a member of his congregation who has an amateur station at his home.

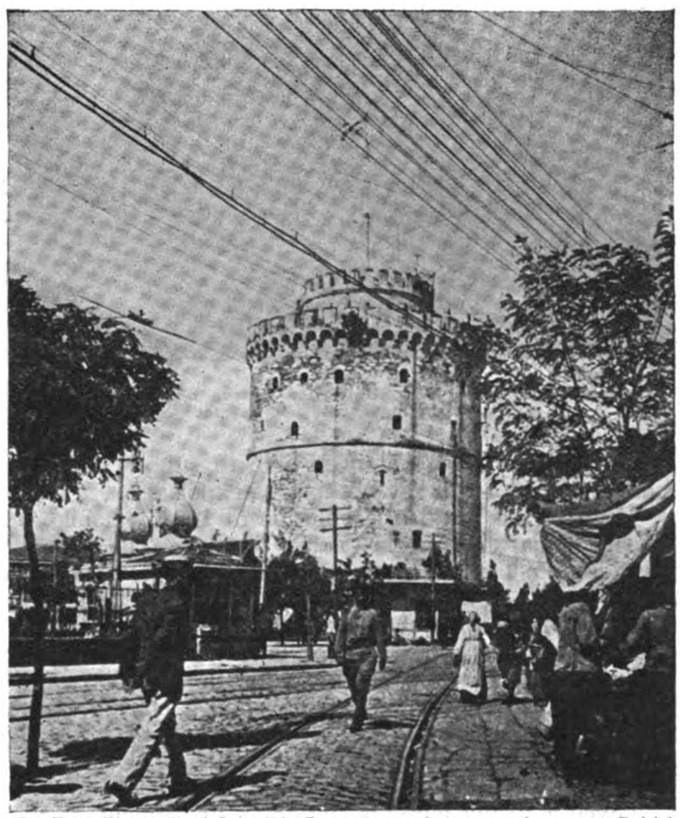
The idea occurred to C. A. Stanley, of Wichita, after sending out a "QST" one Sunday night as to how many station operators had attended church service that day. Of the 300 in his territory very few attended. He wirelessed them, inquiring if they would care to take the sermon every Sunday night.

From the cow country of the Texas Panhandle, the mountains of Colorado and the rural sections of Iowa came back a request to shoot out the sermons. Stanley proceeded to shoot and he has been sending out the sermons for several weeks. He attends the morning service and takes note of the sermon. The sermons are wirelessed between 7 and 7:30 o'clock in the evening.

Argentina Plans Elaborate Commercial Radio Service

RADIO service in Argentina is soon to be augmented and devoted to commercial uses, it is announced. The installations at present in use are employed mostly for Government despatches.

Radio stations are to be set up at the Patagonian ports of Gayman, Rawson and Puerto Gallegos and one at Buenos Aires. It is intended later to supplement them with others at Corrientes, Bahia Blanca, Comodoro, Rivadavia and Ushuaia. Stations already existing will be increased in power.



"La Tour Blanche" of Saloniki, Greece, one of the most important British wireless stations during the war. (See description on page 8)

Night Landing of Mail Plane by Means of Radio

WIRELESS calls for aid sent out by a government mail airplane which faced a descent in the dark, enabled the plane to make a safe landing. Delayed an hour by a wind storm on the last lap of a journey from New York to Chicago, the radio operator on the plane sent out calls while approaching Chicago to light the landing field and prepare for the machine's descent.

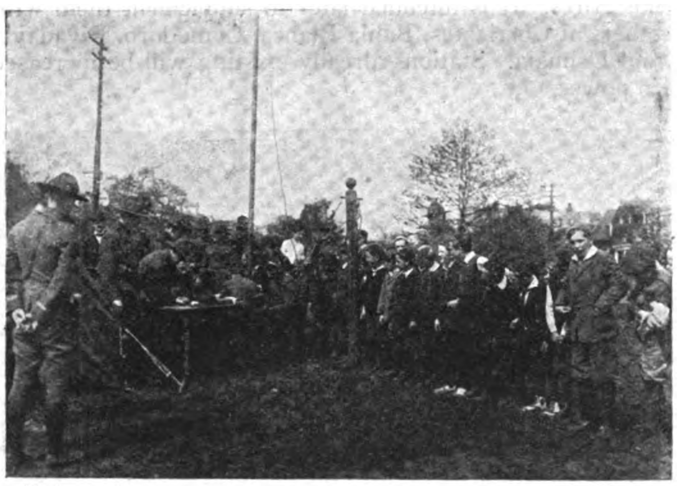
The message was picked up by the wireless operator at Great Lakes Naval Training Station and on several amateur wireless outfits and relayed to the landing field by telephone. The plane, which carried three passengers and 1,200 pounds of mail, landed at eight o'clock.

Radio Messages Sent From Old Tower That Once Served as Prison of Torture

ON the top of the "Tour Blanche"—the notorious "Bloody Tower" of Saloniki, Greece—the British erected a wireless station that enabled them to keep in touch with their ships in the Mediterranean and Aegean Seas. This was one of the most important of Allied "talking-points," which were spread over the earth's surface, and its messages, relayed to all posts of the Western World, played an important part in the final victory of the Allies.

This tower of stone has lived through a long and colorful history. Centuries ago it was built by the Turks, and it is said that it was used as a house of torture and execution for political prisoners. Under the Turkish régime in the Near East many Christians of European countries are supposed to have perished in this tower.

Saloniki, situated at the head of the gulf of the same name, is second only to Constantinople as a seaport. It has a spacious harbor—opened in 1901—where the imports for Macedonia, Albania and Serbia are received. Exports from this port consisted chiefly of grain, flour, chrome, manganese, hides and tobacco. In recent years these countries have been so depleted of men and products that they have not been able to supply their own industrial wants, to say nothing of exportation.



Underwood
Members of the New York University reserve officers training corps operating a field wireless set

Prior to the Turkish Revolution of 1908, Saloniki was the headquarters for the Young Turks. The city surrendered to the Greeks in the Balkan War, November, 1912, and is now a part of Greater Greece. Its present population, mainly Jews, is estimated at 174,000.

The strategic importance of Saloniki cannot be overestimated, and was one reason for the location of the British Wireless Station at this point. During normal times, it possesses railway connections with Constantinople, Vienna, and Paris, besides Nish, Uskub, and Monastir, in Serbia.

Given a strong wireless station to supplement its shipping and harbor facilities, it became a port of real naval value. From their keys in the old stone tower overlooking the waters of the Aegean, these British wireless operators could talk to their commanders and comrades all over the Near East. Strong radio stations were maintained by the British on the Island of Modros, at the entrance of the Dardanelles, on Lemnos, at Suda Bay in Crete, and on Malta. From these wireless posts, many instructions were issued to the British submarines, which had their base at Mitylene.

During the Allied occupation of the city, the old Turkish citadel became the headquarters for the press and censorship bureaus and the base headquarters for the American Red Cross. Many tons of food, clothes, and medicines were unloaded from the ships anchored at its docks, and transported by slow train, motor car, and pack-mule to the remote districts, whose people were hungry, sick and naked. The work of Red Cross doctors and nurses has improved the conditions of sanitation and health throughout the Balkans, and saved many lives.

French Scientist Predicts Synchronized "Voice-Movies" by Means of Radio

OUT of the void into every moving picture theatre, synchronized with all the movements shown on the film, will come in the near future the voices of the actors as they play their parts. Such is the dream of Professor Edouard Branly, expert on wireless telephony.

The success of the concert given by Mme. Melba at Chelmsford, England, to all the wireless telephone listeners in London, Paris, Berlin, Rome and Christiania, is his text. Soon, he declares, everyone will be able to stay at home and hear any concert he wishes, and for all the movies one orchestra will be sufficient.

He even goes further. Groups of motion picture theatres, he declares, will throw the same film on the screen at the same instant, while the actors will speak their parts into wireless telephone instruments thus securing the synchronization which is impossible with the talking machine, and in the days to come the movies will become the serious rivals of the theatre.

The only difficulty foreseen seems to be the breaking of the film while the voices go on without action.

Sweden Adopts Radiophone to Aid Fishing Industry

WIRELESS telephone receivers are being placed by the Swedish Government on fishing craft, so the fishers may be warned of bad weather and informed where good catches of herring may be expected. As no transmitters will be placed on the boats the fishers will not be able to communicate with other vessels nor with wireless stations on shore.

Marconi's Wireless Telegraph Company of London Declares Dividend

THE Radio Corporation of America, which recently succeeded the Marconi Wireless Telegraph Company, has received information from London that the Marconi Wireless Telegraph Company, Limited, the British company, had earned a profit of £1,220,000 in 1919, including £590,000 damages from the British Government. Directors of the British Company have declared a final dividend of 15 per cent. on ordinary and preference shares, together with a bonus of 5 shillings per share. New shares issued last December to former stockholders do not participate in the dividend and bonus. The statement showed that £955,000 was carried forward to surplus.

French Conducting Radio Research in the Pacific

VALUABLE experiments in wireless telegraphy are being conducted by the French war sloop Aldebaran, which has been cruising in the Pacific near the Chatham and Bounty Islands. Lieutenant Guierre, wireless expert, will probably submit the result of his experiments to the international wireless conference in Washington shortly. He states that the wireless "reception" in New Zealand from French instruments is of special interest to continental experts, as New Zealand is practically the antipode of France. It is claimed that the Aldebaran is carrying out for the first time a truly comprehensive system of measuring the strength of "receptions."

Submarine Wireless Perfected

THE last annual report of the Bureau of Standards states that members of the bureau's staff have developed very successful methods of communicating with submerged submarines by radio-telegraphy. With a single-turn coil or loop attached to the outside of the submarine, signals can be received as well when the vessel is submerged as when it is at the surface. It is also possible to transmit from a submerged submarine a distance of twelve miles. Thus it becomes possible for a ship and a submarine to exchange recognition signals.

A coil aerial is a satisfactory direction finder when submerged and readily receives signals transmitted thousands of miles, just the same as when used in the air. The navy has equipped its larger submarines with this apparatus.

Mother of Marconi Dies

MRS Marconi, mother of Guglielmo Marconi, the inventor, died June 15. She was an Irish woman and the widow of Giuseppe Marconi, of Bologna.

France Plans Extensive Wireless Service

THE success of the French Government's wireless service between the Continent and Algiers is assured. The Ministry of Telegraphs is preparing a scheme for the extension of the wireless service which will involve the erection of several stations and the inauguration of commercial as well as official wireless service between France and America, Germany, Italy and Constantinople. It is proposed also to erect stations in important French cities, thereby relieving the pressure of the land wires, and if the Government provides for it in the budget the French colonies and island possessions are to be linked up by wireless next year.

The first wireless extension to be attempted was communication with the United States, messages being sent from a station near Lyons and received by United States naval stations, where they are transferred to the telegraph lines. This service has been used for the last few months by several American newspapers.

Radio Banking Service on the High Seas

WIRELESS banking is a success aboard the ex-German liner Imperator. The Cunarder has established the first sea bank with a safe large enough to carry a huge amount of ready cash. Drafts on shore banks are honored and money transferred by radio.

Results of Marconi's Recent Radio Cruise

SIGNOR MARCONI, the wireless expert, has improved the wireless compass, according to the London Daily Mail, which will emit wireless warnings in a fog and by the aid of it he can tell which is on the port and which is on the starboard side of a vessel. The Mail's correspondent at Rome quotes him as follows with reference to his recent cruise in the Electra in search of new data to be used in the development of wireless:

"We steered the yacht the whole way," he said, "by the use of a wireless direction finder and kept away from the rocks off Cape Finisterre, northwest Spain, exclusively by its use. Most of the time we were able to locate our position by magnetic intersections on land stations.

"We made one fairly important discovery. I have evolved an improved wireless compass by which I can tell which is the port (left) and which is the starboard (right) side of a ship. It will emit wireless warnings instead of fogblasts." Senator Marconi went on:

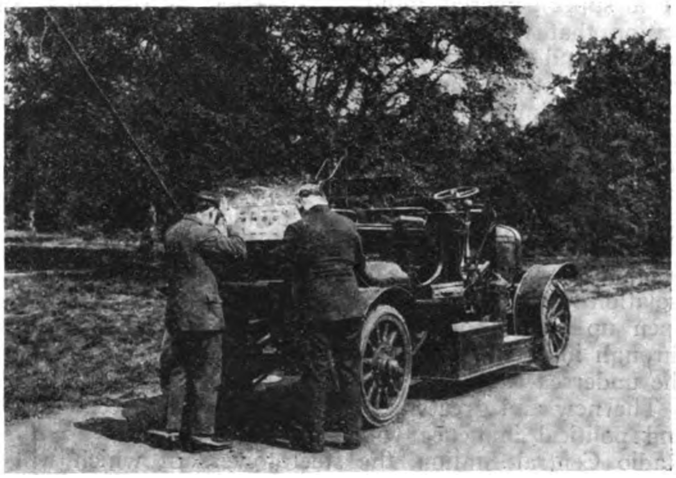
"I kept in touch with England for a time by wireless telephone, our instrument having a radius of 450 miles. I also conducted business by the same means between Seville and Lisbon.

"We had great fun on the way out, having musical evenings with Chelmsford, Essex. They put on the latest tunes on the gramophone at Chelmsford and we heard them plainly. We applauded and they thanked us.

"The wireless telephone worked splendidly throughout and was clearer than a land telephone.

"My cruise is only half finished. The yacht is at Spezia and I intend to return to England in her in about a fortnight. The voyage should result in several improvements and new inventions being patented."

Senator Marconi naturally is inclined to be reticent on this subject, but he gave the impression that he will shortly announce the perfecting of the existing wireless direction-finding gear, enabling ships to steer clear of one another by this means alone in thick weather. Also that, although the day when ships may dispense with the use of lighthouses is not yet, vessels may soon be able by simple wireless means to avoid rocks as Senator Marconi did. Senator Marconi is also probing the origin of atmospheric or electric storms and how to combat them. He encountered one when he was off Algiers.



Underwood
Firemen operating a wireless telephone installed on rear of fire tender

Manitoba to Use Radiophone

EXPERIMENTS conducted at the request of the Manitoba government with wireless telephone apparatus between Winnipeg and Portage la Prairie, 80 miles away, have been successfully concluded and a second step in the experiments is about to be taken, when conversations will be attempted between Winnipeg and Ft. William, a distance of nearly 400 miles. The experiments are being taken with a view to testing out a proposed system of wireless to be installed in northern Manitoba.

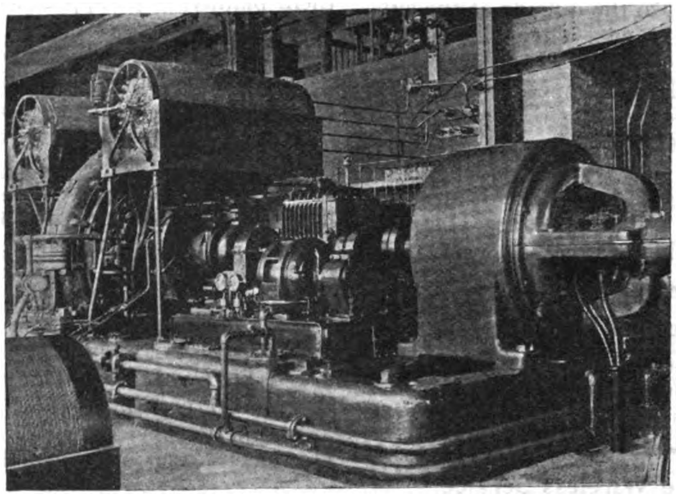
Mining districts and fur marketing centers are far scattered and sparsely settled. Land wires are costly to install and to maintain owing to falling trees in the bush country. It is proposed to establish some dozen stations at central points in as many districts of the northland, and these will in turn be given communication with the outside by a station of larger power at The Pas, which will work with another similar station at Swan River, 250 miles south of the former place, and in the well settled portion of the Province.

Should wireless telephony prove successful it is probable that the Manitoba government will assume control over this form of communication, just as it has the telephones, and that the wireless will be incorporated in the government telephone system. In this way the government may be able to give service to many isolated points, notably in mining sections east of Lake Winnipeg which cannot now be reached by land wires.

New York Radio Central Station

Details of a Super-powered Radio Station to be Erected Near New York for Communication with Five Nations

FOR more than two decades the wonders of wireless have so unceasingly intrigued the public imagination that it would appear little remained to be accomplished in developments of revolutionary character. Yet, once again, it is disclosed that a startling conception in wireless communication has been quietly brought to a point of realization. On the north shore of Long Island, near New York, the Radio Corporation of America is about to begin construction of a super-powered radio station that will simultaneously send to and receive messages from five great nations of other continents.



200-Kilowatt Alexanderson Alternator, which is part of the equipment of the Station

The bare announcement presages a new era in commercial radio communication. It is one conceived in the convention-defying spirit which, coupled with engineering skill, has brought about the expansion of wireless to its present status as a world-wide public utility. Instantly obvious is the fact that the plan will result in the contribution of an important means of breaking down America's isolation from the peoples of certain other continents and open up visions of communication possibilities which, through inherent limitations, could never be realized by the undersea cables.

The new and great medium of far-reaching economic and political influence will bear the name New York Radio Central Station, the steel towers of which will arise on a 6,400-acre tract, comprising nearly ten square miles of land lying east of Port Jefferson, with a long frontage on Long Island Sound. The preliminary engineering studies have been completed, contracts for all the construction materials are being let, and a force of radio experts, after months of preparation, will immediately take the big job in hand.

A definite idea of the ultra-modern character of this radio plant may be gained from the observations of Edward J. Nally, president of the Radio Corporation of America, under whose direction the world wide wireless system has emerged from an idea into a reality. "Everyone at all familiar with wireless," said Mr. Nally, "knows that at Nauen, Germany, and Bordeaux, France, are two of the largest stations in the world. Up to now they have been viewed with admiration; consider, then, the tremendous advance represented in this latest step; the New York Radio Central Station, in the aggregate, will be five times more powerful than either of these!"

He explained that there will be five complete transmitters, each one a duplex unit with a corresponding receiving station located nearby. All five transmitters and the five receivers will operate simultaneously and will transmit and receive messages over thousands of miles continuously during day and night.

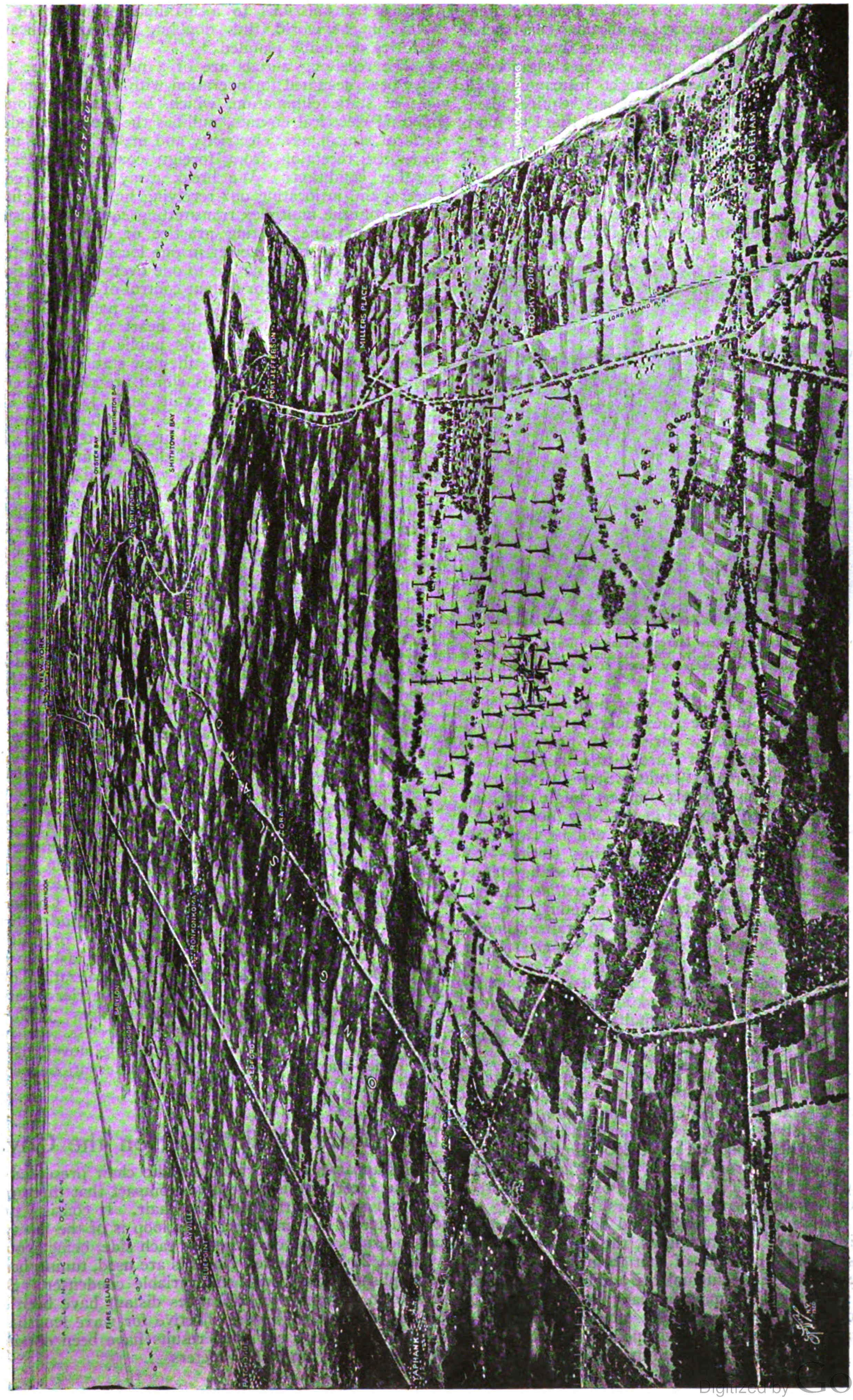
"New York will be the direct focal point of world's intelligence in an entirely new sense under this communication scheme," he continued. "As soon as the station is completed immediate message service will be established with France and Germany to supplement the existing commercial circuits; ultimately, radio from this station will connect up Buenos Aires and other points in South America, and ether-wave messages will be flashing to and from Poland, Sweden, Denmark and other European countries. Like the ripples that race in circles over a pond when a stone is dropped in the water, the electro-magnetic waves from this station will soon encompass practically the whole of the civilized globe. It is a plant that dwarfs all existing wireless stations into insignificance; a single unit will have power and range the equivalent of the largest wireless stations in the world today.

"The form of aerial construction, too, is wholly a new departure. From the central power house six spans of aerial wire will radiate out in a star pattern to a distance of more than one mile from the center. The wires of this huge antenna will be supported on self-supporting steel towers, each 400 feet in height, with the wires suspended at the top between 150-foot cross arms. Each of the six antennae will have twelve towers, forming so to speak, the spokes of a giant wheel fashioned out of seventy-two miniature replicas of the famous Eiffel Tower in France. Five of these antennae spokes will be used for regular service while the sixth is reserved for emergency operation.

"Far more impressive than physical appearance, however, will be the things the eye cannot encompass," Mr. Nally explained. "Appreciate," he said, "that in the wires forming each spoke of the gigantic wheel there will be generated a power equal to the greatest of present day trans-oceanic wireless stations; then comprehend, if you can, the fact that all five of these powers can if desired, be combined into one, for signaling. A telegraphic signal created out of such tremendous electromagnetic energy could encircle the entire globe!

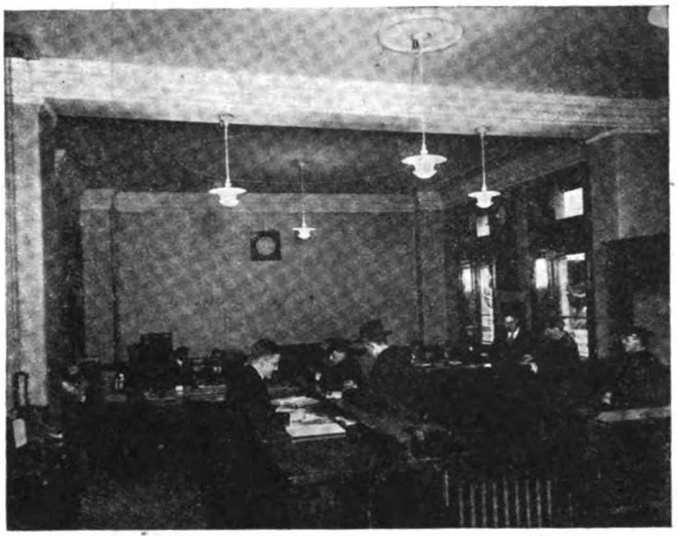
"But that is not all. The apparatus and system which will be installed for each of the five units will be the same as that at present in our New Brunswick (N. J.) station from which the voice of Secretary of the Navy Daniels was carried to President Wilson when he was at sea aboard the U. S. S. 'George Washington.' In a number of experimental tests the voice has been carried by this radio telephone over distances of 2,500 miles with complete success. This leads us to state very definitely that before long a direct wireless telephone service will be established with foreign countries."

Every exacting requirement of commercial radio message service will be satisfied fully in the apparatus and system of circuits with which the great station will be equipped. The generation of the energy required to span thousands of miles will be effected by Alexanderson alternators, powerful machines constructed by the General Electric Company, which have made it possible to carry the radio signals through space by continuous wave trains, instead of by the interrupted or discontinuous waves, generated by systems using the old-time "spark discharge" apparatus. Taken by itself, the Alexanderson alternator is an achievement rivaling the design of the new world-wide station. This machine is the concrete expression of an ideal which electrical engineers have



View showing the location and tremendous size of the New York Radio Central Station—It will cover 6,400 acres of land east of Port Jefferson, Long Island, with a long frontage on Long Island Sound. This most powerful station will have five complete transmitters, each one a duplex unit with a corresponding receiving station located nearby

held for many years, for it represents a perfected generator of high frequency electrical oscillations constructed along the lines of the ordinary power house dynamo. The problems solved by Mr. Alexanderson, chief engineer of the Radio Corporation, were thought insurmountable. Because the transmission of radio signals requires alternating currents of frequencies a thousand times or more in excess of those used in power engineering, it was considered beyond the range of practicability to obtain such currents from a dynamo. In the Alexanderson alternator equipment, the new station will have a source of energy proven as reliable as the power dynamo, yet creating a steady stream of electromagnetic oscillations, which will



The office in New York City, where Marconigrams for England, Norway, Hawaii and Japan are handled daily, will also handle the New York Radio Central Station's business by means of distant control

permit telegraphic signaling at very high speeds. So efficient and reliable has the Alexanderson 200-kilowatt alternator installed at New Brunswick proven itself, that leading radio experts of Europe have made special trips of investigation to the United States to view its performance; now this already famous single machine is to be duplicated and installed in the New York Radio Central Station; but this time there will be two 200-kilowatt machines for each transmitting station—ten in all. The achievement, from a radio engineering standpoint has nothing approaching a parallel: ten alternators, 2000 kilowatts, 3000 horsepower—an astounding force to concentrate in realization of a dream to transmit messages over the world to all points of the compass from a single source!

Mr. Nally emphasized another forward step in engineering which will be incorporated in the super-station. "We will utilize what is termed a multiple tuned antenna, which," he explained, "materially reduces the wasteful electrical resistance of the long, low, flat-top aerials formerly used. A great saving in power is thus effected; in fact for the same power input formerly used for a single station, six times the effectiveness at a distance is obtained. In other words, we obtain with this antenna the same effect at a distance with 200 kilowatts input, as would be obtained from the old type of antenna with 1200 kilowatts input. This new type of antenna is the equivalent of six independent radiators, all operating in unison at the same wave length and for the complete station with its five antennae units, the power required will be less than 20 per cent of that formerly necessary. The project, however, contemplates additional possibilities. To illustrate: We may, in many cases, utilize but one-half of a single spoke of the antenna system for communication service to a certain point. On this basis, the Long Island Station will ultimately permit simultaneous transmissions to a maximum number of ten points in the world, thus doubling the communication facilities originally planned.

"The receiving aerials are of a new type, too; they have been designed for operation with the Weagant system of static elimination, which, by a combination of opposed electrical circuits, nullifies the long-dreaded effects of atmospheric electricity and makes possible uninterrupted reception from foreign countries under all weather conditions. We break away from precedent once again, in locating our receiving units only eighteen miles from the multiplex transmitting equipment, instead of following the existing practice of establishing one transmitter and one receiver in one locality and restricting the service of the circuit to one oversea destination."

The arrangements for distant control of the New York Radio Central Station follow the same policy of concentration. In Broad Street, the heart of New York's financial district, the company's public telegraph office is being re-equipped to handle the new station's messages along with the Marconigrams which are now received for England, Norway, Hawaii and Japan. Thus messages for any of the five additional countries reached by the new station will be received in the New York City office and dispatched direct from a series of operators' keys and relays which will operate the powerful transmitting circuits located miles away out on Long Island. Messages from over the ocean will ultimately be received in the same manner, receipt and delivery of the actual messages being effected by the customary messenger boy service direct to the home or office of the user of the trans-oceanic wireless.

It is expected eventually to install apparatus for high speed transmission and reception, which will be under the supervision of a trained staff of operators, along with which there will be the usual staff of expert Morse operators, who will work those circuits over which high speed transmission is not taking place.

Countless details of great technical interest and engineering importance are embraced in the specifications for the station, prepared by combining the personnel of the Radio Corporation and the General Electric Company, an arrangement made possible by the recent merger effected by these interests and the absorption of the Marconi Wireless Telegraph Company of America. Even to the uninitiated in technical matters this gives assurance of perfection of detail in design; equally certain results will follow in the manufacture of the apparatus which has been delegated to the General Electric Company, while the construction of the station will be under direction of the engineering staff of the Radio Corporation. As Mr. Nally expressed it: "The great task is well begun and will progress steadily to a realization of a new conception of the conquest of the barriers Nature has erected between the brotherhood of races. With the speed, accuracy and lower cost of wireless, the new station will give to the world something novel, useful and epoch-making in the field of international communication."

The Board-Walk Chair on the Cover

THE apparatus comprising a radio chair presented on the cover of this issue is so compact that three persons can sit comfortably in the chair. It consists of a loop, detector and amplifier. The loop is of the flat type and measures eighteen inches on each side, being wound with No. 26 S.C.C. wire. No coils are used, tuning being accomplished solely with the variable condenser. Signals from stations over 200 miles distant have been received, and the set is most effective for wave lengths of 300 to 500 meters, but good results have been obtained at wave lengths up to 800 meters.

The Alexanderson System

Its Performance and Operation at the New Brunswick Station

By Elmer E. Bucher

Commercial Dept., Radio Corporation of America

(Continued from the July Issue)

THE antennae commonly used at high-power radio stations may be broadly classified into two types, viz., the long horizontal aerials which are suspended on comparatively low towers, and the vertical, fan or umbrella aerials which are generally supported at great heights. The flat-top antenna was adopted for long distance transmission because it was believed to have marked directional properties and would therefore provide maximum radiation in the direction desired and lesser degrees of signal intensity in all other directions.

Experiment has indicated, however, that this directional effect disappears at distances beyond 300 miles or so from the transmitter and thus the benefits of directional radiation are realized only in a limited area. Beyond this the flat-top antenna has been found to have comparatively high resistance. This may be said to be due to the long path through which part of the ground current has to pass to the far end of the antenna, which is a path of relatively high resistance. This resistance cannot be materially decreased by laying wires in the ground, for because of the inductive impedance of such long wires (at radio frequencies) a large percentage of the ground current will still pass through the earth. It is therefore evident that if the length of the ground path in a radiating system could be reduced, a considerable saving of power would be effected.

At any given wave length the radiation from an antenna has been found to be proportional to the square of the effective height and the square of the antennae current. The exact relation is $W = \frac{1{,}600.\ h^2 i^2.}{\lambda^2}$ This points to the desirability of a high antenna, but since the cost of building such a radiating system increases very rapidly with its height, the factor of economy requires that the money expended on a station be apportioned between the cost of the antenna, power apparatus, and maintenance in order to arrive at the lowest total cost for transmission over a given distance. It is obvious that if, by any means the wasteful resistance of the long, low, flat-top antenna, that is, conductive losses, leakage through insulation, etc., could be reduced, and if its radiation properties still could be maintained, then assuming equal power inputs into the two systems, a station using a long, low and relatively cheap antenna could produce the same signal strength as that from a high and costly antenna.

The multiple tuned antenna devised by Alexanderson brings about a marked decrease in the ground resistance of a flat-top aerial. His antenna can be compared to a station using a number of small antennae connected in parallel, the height of each of which is great compared with their horizontal dimensions. It follows from simple electrical principles that several antennae in parallel will possess a lower joint resistance than a long antenna of the same radiating capacity. The same result may be obtained from the Marconi flat antenna by bringing down leads from the flat-top, at regular intervals, to the ground through appropriate tuning inductances. With this construction it will be seen that the antenna charging current has a much shorter path through the down leads than it had with the former design.

The improved efficiency of the multiple tuned antenna has been amply demonstrated at the New Brunswick station where the resistance of the Marconi flat-top has been reduced from 3.7 ohms to 0.5 ohm with the consequent saving of power.

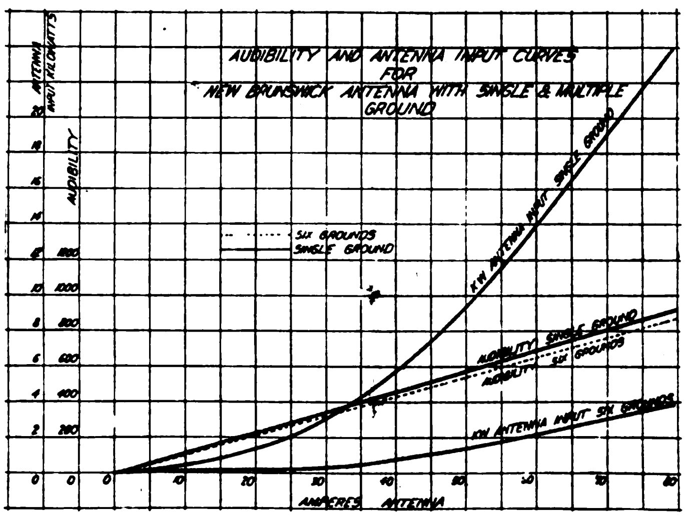


Figure 22—Curves showing comparative signal audibilities obtained from the Alexanderson multiple tuned antenna and the open-ended flat-top antenna

The curves of figure 22 show the results of a series of experiments conducted between New Brunswick, N. J., and Schenectady, N. Y., with the object of comparing the relative signal audibilities ampere for ampere in the old antenna with a single ground and the Alexanderson antenna with multiple grounds. The results show quite conclusively that with the same current in a flat-top antenna and in a multiple tuned antenna, substantially equal audibilities are obtained at the receiving station. However, the power required by the plain antenna for a given number of amperes is very much in excess of that fed to the multiple tuned antenna for the same total current. Thus as the curve shows, to put a total of 70 amperes in the branchces of the multiple tuned antenna with six grounds, requires but 3 kw., whereas with the flat-top antenna and a single ground, 18½ kw. are required. This is of course a very small proportion of the total output available at New Brunswick. The values shown in the curve should not be taken as indicative of those used in daily operation.

The points of distinction between the two types of antennae may become evident from the following comparative analysis. Thus the flat-top antenna with single ground is shown in figure 23. The equivalent circuit resolved into lumped or concentrated values of inductance and capacitance is shown in figure 24. The schematic circuit of the Alexanderson antenna is that of figure 25 where L_1, L_2, L_3, L_4, L_5, L_6 are current paths between the flat-top and the earth. The inductance of each down lead is made six times the capacitive reactance of the flat-top at the frequency of operation selected. The capacitive reactance of the flat-top is thus neutralized at six places. The circuit is therefore the equivalent of six independent radiators operating in parallel.

The equivalent circuit of figure 25 is that of figure 26, which is an artificial circuit comprising a number of parallel resonance circuits adjusted to the frequency of the alternator N. The branches L_1 C_1, L_2 C_2, L_3 C_3, etc., which are in shunt to one another are fed by the alternator. When each branch is tuned to the frequency of the alternator it will follow the well-known laws for parallel resonance. A large current will flow back and forth between the inductance and the condenser, and the alternator will simply supply power to compensate the resistance losses of the circuits. These large currents are directly due to the high voltages maintained across the inductance and the capacity, when the circuit is tuned for resonance. These voltages may be calculated when the value of inductance or capacitance and the current flowing therein are known.

If a parallel resonance circuit had no resistance, the conditions for parallel resonance would be strictly the same as for series resonance. These conditions are, however, very closely realized in the parallel circuit. In series resonance the e. m. f. on the condenser is equal and opposite to that of the coil and thus there is a large flow of current between the condenser and coil. There is also a large current flowing between the condenser and the coil in parallel resonance, but viewed from the standpoint of the feed or power supply circuit, the feed current is simply the difference of the currents in the condenser and the coil.

The resistance of a parallel-resonance circuit, in radio, is often treated as a negligible quantity. This resistance, however, assumes considerable importance in the multiple antenna as it determines the power taken from the alternator. Thus if the wasteful resistance of each branch in a multiple tuned antenna of six branches is 2.7 ohms, their joint resistance is $2.7/6 = 0.45$ ohm (assuming equality) and it is this resistance plus the radiation resistance of the entire antenna system through which the alternator works.

It is obvious that the alternator can be connected as in figures 27, 28 and 29 with the same effect as shown in figure 26. Thus in figure 27 the alternator terminals are connected in shunt to the parallel resonance circuits. In figure 28 the alternator output is fed to the antenna through the inductive transformer P S. In figure 29 an auto-transformer connection is employed.

In order to obtain resonance between the alternator and the several radiators of the multiple antennae of figures 25 to 29, the joint reactance or impedance of the down leads L_1, L_2, L_3, L_4, L_5, L_6, must be chosen to equal the capacitive reactance of the flat-top at some particular frequency. Hence with multiple tuning at six points the reactance of each down lead, for a given wave length (or frequency), must be six times the capacitive reactance of the whole antenna.

The method of computing the inductance in the down leads for a given wave length is as follows: We may take as a representative example the capacitance of the New Brunswick flat-top antenna, which is a long low aerial of the Marconi type. Its capacitance as measured is 0.066 mfd. Assume that operation is desired at 15,000 meters.

The oscillation frequency,

$$N = \frac{300{,}000{,}000}{15{,}000} = 20{,}000 \text{ cycles}$$

The capacitative reactance of 0.066 mfd. at 20,000 cycles

$$= \frac{1}{2\,\pi\,N\,C}$$

$$= \frac{1}{6.2832 \times 20{,}000 \times 0.000{,}000{,}066}$$

$$= 120.5 \text{ ohms.}$$

The inductance required to neutralize the capacitive reactance is found from the relation

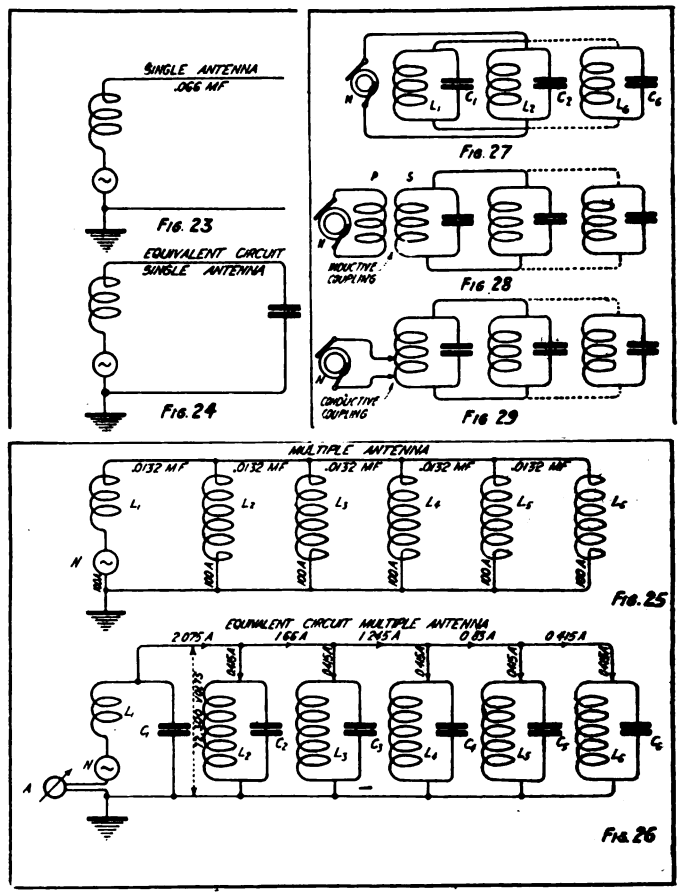
$$L = \frac{X}{2\,\pi\,N}$$

$$= \frac{120.5}{6.2832 \times 20{,}000}$$

$$= 0.000{,}958 = 0.958 \text{ millihenry}$$

The total inductance of each down lead should then be 6 x 0.958 = 5.74 millihenry; and the reactance of each down lead, 6 x 120.5 = 723 ohms.

Curves may be prepared to give the values of inductance required to tune the multiple antenna with various number of grounds at different wave lengths. If then the line coils be calibrated for different numbers of turns at different frequencies, it is a relatively simple



Figures 23 to 29—Fundamental and equivalent circuits of flat-top antenna and Alexanderson multiple tuned antenna

matter to set these inductances to the correct value for any wave length. A series of curves showing the inductance required to operate the New Brunswick antenna at various wave lengths are given in figure 30. These are cited merely as illustrative examples.

The term "feed ratio," for convenience, has been applied to express the ratio of the total current in the six radiators of the multiple antenna to that flowing in the down lead of the branch to which the alternator is coupled. Assume that equal inductances are inserted in each down lead. With all other conditions equal, the same current will flow in each of the six circuits when supplied with energy at the frequency which produces resonance.

Thus if the ammeter A, when connected in series with the station down lead, figure 26, indicates 100 amperes (at resonance), and the same current is obtained in each branch, the total antenna current is 6 x 100 = 600 amperes.

The feed ratio is then equal to

$$\frac{\text{Total Current}}{\text{Current in the station down lead}}$$

which in this case $= \frac{600}{100} = 6:1$

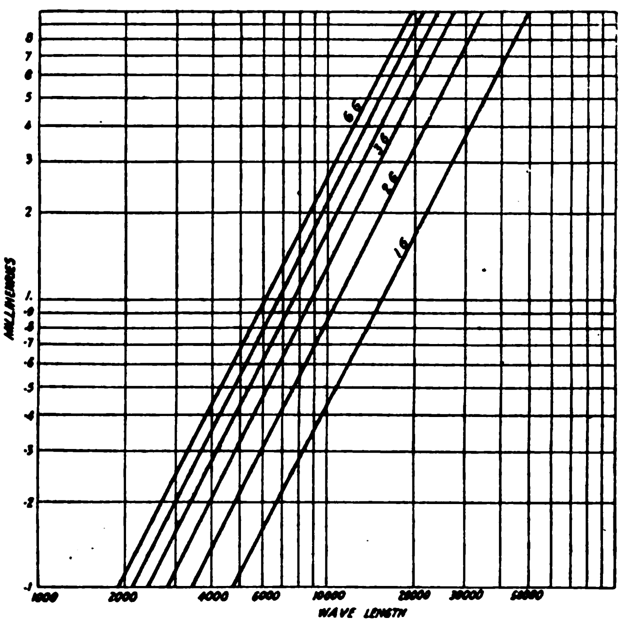


Figure 30—Graphs showing inductance required to tune the multiple tuned antenna at New Brunswick to different wave lengths

It is of interest to note that this feed ratio is only maintained when the inductance in all the down leads is equal. Assume, for example, that the inductive reactance in the branch through which the energy is supplied is decreased and the frequency of the alternator is raised for resonance. Assume also that the feed ratio previous to this change is 6:1, the wave length 15,000 meters, the frequency 20,000 cycles, and the inductive reactance at each down lead 723 ohms. If now the wave length is reduced to 14,500 meters, the frequency increases to 20,700 cycles. This represents an increase of 700 cycles, which is 3½% of the original frequency of 20,000. It may be shown that 1% change in frequency requires a 2% change of inductance for resonance. Hence the inductive reactance in the circuit for 20,700 cycles is 100%—7% or 93% of the value at 20,000 cycles; that is, 93% x 723 = 672 ohms.

Now if the five line coils to earth are left unchanged and since each has an impedance of 723 ohms at 20,000 cycles, or multiple impedance of 723/5 = 144.6 ohms, the impedance at 20,700 cycles obviously is 20,700/20,000 x 144.6 = 149.6 ohms. The new feed ratio is evidently proportional to the two impedances or 672/149.6 = 4.49:1.

The value of this determination lies in the fact that upon changing the wave length by tuning at the station down lead only, the new feed ratio can be computed, thus enabling the operator to ascertain the correct feed current necessary to maintain a given total value of antenna current.

After viewing the physical aspects of the antenna layout in figure 24 it might appear that a disturbing phase angle would exist between the currents in the radiating circuit embracing the alternator, and those in the radiators placed at increasing distances from the power source. It can be shown, however, that for all practical purposes the currents in all the down leads are substantially in phase. Thus in figure 31, the branch L_6 C_6, since it is a tuned circuit, operates at unity power factor and therefore may be treated as a non-inductive resistance of a value equal to

$$\frac{L}{CR}\left(\text{or } \frac{1}{R\,(2\pi N^2)\,C^2}\right)$$

If (at $\lambda = 15{,}000$ m.) $C_6 = 0.011$ mfd., $L_6 = 0.00574$ henry and $R_6 = 2.71$ ohms, then the impedance of any single branch to the e. m. f. impressed thereon is equal to

$$\frac{0.00574}{0.000{,}000{,}011 \times 2.71} \doteq 192{,}500 \text{ ohms approximately.}$$

Since the circuit L_6 C_6 R_6 is in resonance with the e. m. f. impressed at T_1 T_2, the current in it is also in phase with the impressed e. m. f., which may be considered to operate through a non-inductive resistance of approximately 192,500 ohms.

Let the inductance of the flat-top between the fifth and sixth branches be represented by L. The value of L is one-fifth of the total flat-top inductance without loading and in the case of the New Brunswick antenna is approximately 0.00013 henry. We then have in the last branch (L_6 C_6) a current which lags behind the current flowing in L_5 C_5 by the angle θ where

$$\tan\theta = \frac{2\pi N L}{R}$$

$$= \frac{6.2632 \times 20.000 \times 0.00013}{192.500}$$

$$= \frac{1}{11{,}780} \text{ (which is negligibly small)}$$

The phase difference between the sixth and fifth radiator is thus negligible. The phase difference between the currents in branch L_1 C_1 and branch L_6 C_6 is five times as great, but it is still of negligible importance. The currents in the six radiators are therefore in substantial phase, the effect of the inductance between branches is negligible, and the charging currents which are measured currents in the down leads can be considered to be in phase. Since the length of the antenna is but a fraction of the wave length employed and the phase difference is slight compared with the wave length, no appreciable directive effects will be obtained.

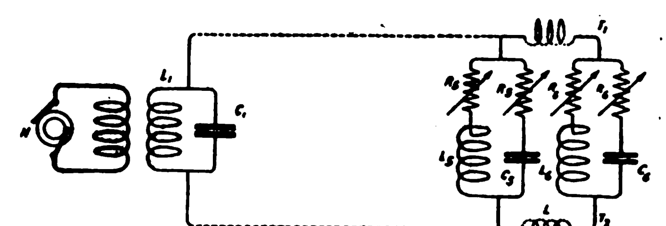


Figure 31—Equivalent circuit of multiple tuned antenna for computation of phase difference

The antenna voltage may be computed when the equivalent capacitance of one section and the current in the station down lead, or the total antenna capacitance and total antenna current are known. This is obtained from the relation, $E = \frac{1}{2\pi N C}$ or $E = \frac{1}{X}$ where X is the capacitive reactance of the antenna at some frequency.

Using these values, assume that I as measured by an ammeter in the station down lead is 100 amperes. Then since the capacity reactance to be neutralized by the down lead is one-sixth of the whole capacity or 0.011 mfd., then

$$E = \frac{100}{6.2832 \times 20{,}000 \times 0.000{,}000{,}011}$$

$$= 72{,}300 \text{ volts}$$

A current of 100 amperes performs the same functions in each of the remaining branches, so that the whole antenna is maintained at a voltage of 72,300 volts by six separate currents, all in phase, of 100 amperes each. Since the multiple impedance of the six branches has been shown to be 120.5 ohms, the total antenna current is 72,300/120.5 = 600 amperes. This is merely a further proof of the assumption made at the outset.

As previously cited, the branches of the multiple antenna follow (except in one respect explained later)

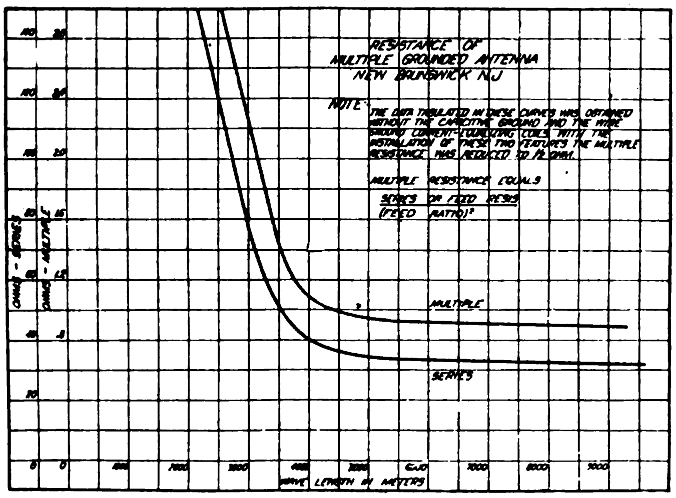


Figure 32—Comparison of multiple and "series" resistance of Alexanderson multiple tuned antenna

the laws of parallel resonance circuits with lumped inductance and capacitance, and the current supplied to any branch by the main or power supply circuit is at any instant the algebraic sum of the currents in the capacity and the inductance. If there were no resistance in the branch antenna it would have infinite impedance to the power supply at resonance, and no current would flow in the feed circuit after the initial e. m. f. has been applied. In the actual circuit there must, however, be some resistance and the energy for heating this resistance must be supplied by the alternator, that is, the alternator makes good this loss of energy.

The branch circuit of figure 30 at N = 20,000 cycles, C = 0.011 mfd., L = 0.00574 henry and R= 2.71 ohms, was shown to have an impedance of approximately 192,500 ohms. The antenna charging voltage at 100 amperes is approximately 72,300 volts. The energy current supplied by the power source to one branch is therefore 72,300/192,500 = 0.375 ampere. The power supplied to each branch is 72,300 $\times$ 0.375 = 27.1 kilowatts and to the six branches (assuming equality throughout) 6 $\times$ 27.1 = 162.6 kilowatts.

The foregoing method of computation while correct for parallel resonance circuits with lumped inductance and capacitance from which no radiation takes place, requires some modification when the phenomena of radiation from the multiple antenna is considered. Thus, in the multiple antenna, the radiation resistance, whatever its value, may be said to be common to all six antennae, whereas the ground and coil resistances belong to the different antennae individually. The combined circuit of the multiple antenna can therefore be represented by a radiation resistance common to all antennae which is in series with a group of six wasteful resistances connected in multiple.

Thus assume now that the radiation resistance of the individual radiators in the multiple antenna (at λ = 15,000 meters) is 0.06 ohm and the ground and coil resistance of each antenna individually, 2.63 ohms. A current of 600 amperes works through 0.06 ohm radiation resistance, while 100 amperes flow through each of the 2.65 ohm resistances. The consumption of power in radiation is $600^2 \times 0.06$ = 21.6 kw., and in each branch $100^2 \times 2.65$ = 26.5 kw., or 6 $\times$ 26.5 = 159 kw., in the six branches. The total consumption is therefore 180.6 kw.

The point to be brought out is, that if the radiation resistance of 0.06 ohm was added to the wasteful resistance in each radiator, and the energy consumption computed therefrom, the result would be too small. Thus assuming that the total resistance of each antenna was taken as 2.65 + 0.06 or 2.71 ohms, the power in each radiator would be 27.1 kw. and in the six branches, 162 kw., but, as just shown, the correct value, when the radiation resistance is treated properly, is 180.6 kw.

The multiple antenna may be treated in another way. With a total power consumption of 180 kw., the power supplied to each antenna is 30 kw. and the energy current consumed by each oscillating circuit at 72,300 volts is 0.415 ampere. Thus while the total oscillating current is 600 amperes the energy current which flows horizontally from the power source is 2.075 amperes. This distribution is shown by the arrows in figure 26. In other words the energy fed to the system by the first tuning coil in the form of 100 amperes at say 1800 volts is transformed in the first oscillating circuit to 72,300 volts (in the case of the particular problem cited) and distributed as in a transmission line from which 0.415 ampere at 72,300 volts is drawn at five places.

When the inductance in each of the down leads has been adjusted to provide resonance with the alternator and the feed ratio has been determined, the multiple resistance of the Alexanderson antenna can be computed from simple measurements taken within the station house.

The process is as follows: Measure the current in the station down lead at resonance and then measure the

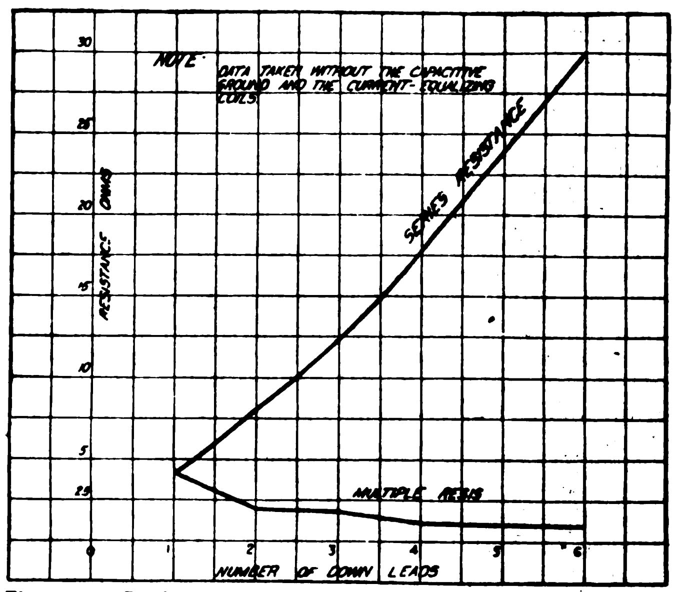


Figure 33—Graphs showing "series" and multiple resistance, New Brunswick antenna with different numbers of down leads

open circuit voltage of the alternator (at the transformer secondary). The voltage divided by the current gives the "series" resistance of the antenna from the standpoint of a load on the alternator. This resistance is evidently the combined resistance of the alternator and the "series" resistance of the antenna system. The resistance of the alternator must be obtained from a separate measurement and subtracted from this value to give the "series" or load resistance of the antenna system.

Thus if the open circuit voltage of the alternator transformer is 2000 and the current in the down lead is 100 amperes, the resistance of the alternator plus the "series" antenna resistance is obtained from R = E/1 or R = 2000/100 = 20 ohms.

Assume that the alternator resistance (from the standpoint of the transformer secondary) as obtained from previous measurements is 2 ohms; then the series antenna resistance (considered as a load on the alternator) is $20 - 2 = 18$ ohms. The multiple resistance of the antenna is then equal to

$$\frac{\text{Series Resistance}}{\text{Square of the Feed Ratio}}$$

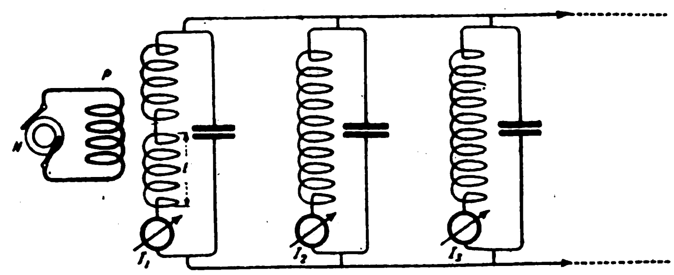


Figure 34—Fundamental circuit of multiple tuned antenna for determining the distinction between "series" and multiple antenna resistance

which in the problem above $= \frac{18}{6^2} = 0.5$ ohm. Proof of this formula is given below.

A set of curves showing the comparative values of these two resistances at the New Brunswick station for wave lengths between 2500 and 9000 meters are shown in figure 32. Thus at $\lambda = 8600$ meters, the series resistance is 32.5 ohms and the multiple resistance 0.9 ohm. It is the latter value that must be used to compare the multiple tuned antenna with the common antenna with single ground. Curves showing the decrease of multiple resistance at New Brunswick with increase of the number of tuning points are given in figure 33. It is to be noted that the data for these curves and also that of figure 32 was taken without the capacitive ground and the current equalizers already described.

In making measurements as above, the transformer must be regarded in all respects as a part of the alternator, that is, the open circuit voltage of the transformer secondary, and the resistance of the alternator from the standpoint of the transformer secondary must be treated as the voltage and the resistance respectively of the alternator.

A proof of the formula Multiple Resistance

$$= \frac{\text{Antenna Series Resistance}}{(\text{Feed Ratio})^2}$$

may be had from the following simple analysis. Reference should be made to the equivalent circuit figure 34, which is assumed to be made up of a number of radiating systems in parallel, all tuned to resonance with the alternator N.

Let E = open circuit voltage of transformer secondary.
Let I = current in the station down lead at resonance.
Let Ra = the effective alternator resistance from the standpoint of the secondary.
Let r = the "series" resistance of the external or antenna circuit considered as a load on the alternator.

Then $E = I(Ra + r)$

from which $r = \frac{E}{I} - Ra$

(Ra is obtained from a separate measurement.)

The power consumed in the "series" or load circuit external to the alternator is then,

$$W = I^2 r.$$

Consider now the resistance of the complete antenna from the standpoint of several radiators in parallel:—

Let F = feed ratio.

Then FI = total antenna current in the several radiators.

Also let Ra = multiple resistance of the several radiators in parallel.

Then, the total energy in the several radiators is equal to the product of the multiple antenna resistance and the square of the total antenna current, or,

$$W = (F\,I)^2\,Rm.$$

This energy obviously is the same as that consumed in the circuit external to the alternator, which as shown before, $= I^2 r$.

$$\text{Hence } (FI)^2\,Rm = I^2 r$$

$$\text{from which } Rm = \frac{r}{F^2}$$

That is, the antenna multiple resistance is equal to the "series" or "alternator load" resistance divided by the square of the feed ratio. Expressed in terms of all the factors involved.

$$Ra = \frac{\frac{E}{I} - Ra}{F^2}$$

It is thus possible to compute the multiple resistance of the Alexanderson antenna from a few measurements made within the station with instruments used in ordinary power work.

Accurate measurement of the current in each down lead is essential, prior to making the above measurements, as equal divisions of current, due to physical factors surrounding the station, cannot always be obtained. Only in this way can the true feed ratio be determined.

The multiple antenna can, under some conditions, be

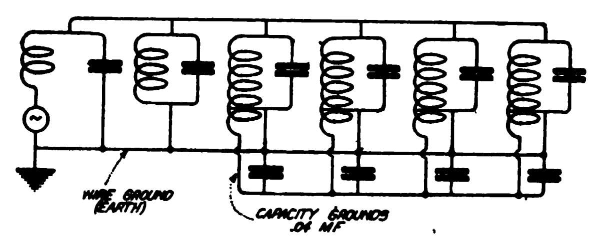


Figure 35—Equivalent circuit multiple tuned antenna, New Brunswick Transoceanic Radio Station

used to advantage with unequal currents through the down leads although, in general, equality of currents gives the lowest resistance. This is apparent from the fact that with unequal division some of the current has a longer path to travel than with equal division, making that particular branch of higher resistance. This also is obvious from the fact that if a given amount of current is to be passed through parallel conductors their joint resistance will be less if the division of current is in inverse proportion to each path.

Unequal division of current is an advantage under two conditions. First the "series" or "load" resistance of the antenna can be adapted to the voltage of the alternator, if the alternator voltage cannot be adapted to the antenna resistance. Second, by allowing unequal division of current the wave length of the system can be changed in a much simpler manner than when equal division is maintained. Each change of wave length clearly requires a change in the inductance of all the down leads to maintain equal current division. If the inductance in all down leads is not the same, the current will divide itself in inverse proportion to the inductance of each path.

Further consideration will reveal that for wide changes of wave length it may be advisable to disconnect some of the down leads.

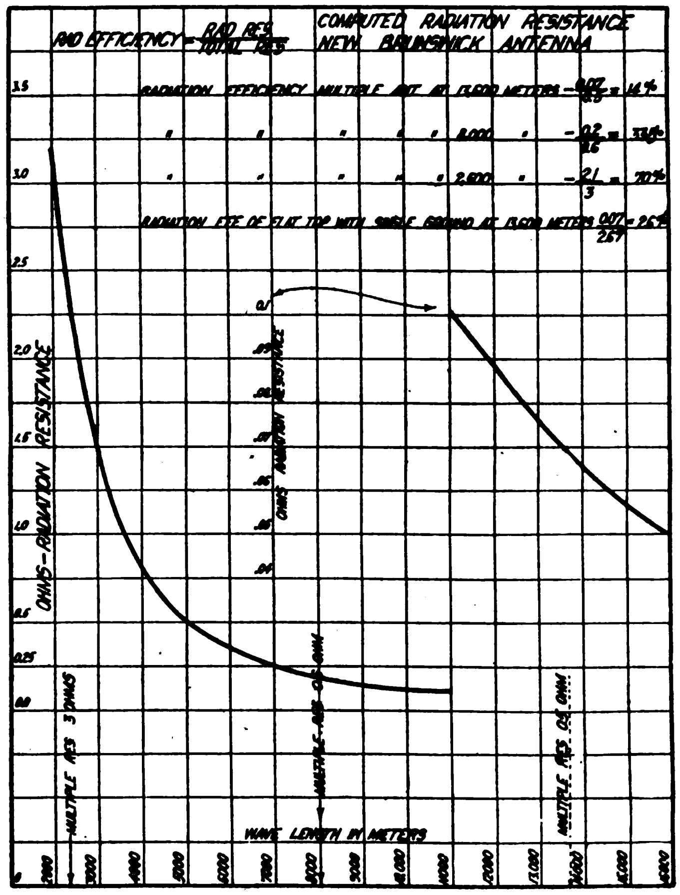


Figure 36—Computed radiation resistance multiple tuned antenna, New Brunswick Transoceanic Radio Station

In order to compute the amount of inductance that is necessary in each down lead at some given wave length, the capacity of the antenna must be measured by the ordinary processes and its capacitive impedance, calculated. This of course, must be computed for each wave length. The capacitive impedance for any other wave length can be obtained from this value, since impedance is directly proportional to wave length. The inductive impedance of each down lead should then be adjusted, previous to tuning of the alternator, to a value six times the capacitive impedance of the antenna, if six tuning points are used. The inductance of the down leads to the tuning coils can be estimated roughly and the value allowed for when placing the tap on the ground coil.

The inductance of the tuning coils should be computed for different numbers of turns at different wave lengths and plotted in a series of graphs as in figure 30. This will simplify the operation of obtaining the correct inductance for any wave length. In case there are no means at hand of calibrating the tuning coils, the required number of turns may be selected by trial. The supposed number of turns required can be estimated roughly and connected in all six down leads, but an allowance must be made in the case of the station down lead for the inductance of the alternator (or for the inductance of the secondary coil of the transformer). The speed of the alternator may then be varied until resonance is found. If the number of turns selected tune at too long a wave length too much inductance has been inserted in the down leads, and if it tunes at too short a wave length not enough inductance has been added.

A general description of the earthing system at the New Brunswick station has been given. In the early experiments it was found that when connection was made from the tap on the down lead inductance to the wire ground, the inner wires carried the greater proportion of current, due to the fact that they offered less impedance than the outer wires. A more equal current distribution was obtained by inserting the equalizing coils between the line inductances and the earth wires as shown in detail figure 15. These coils are in inductive relation and are connected to pairs of the buried wires as there shown. The effect was to increase the impedance of the wires nearest the center and therefore to force practically the same amount of current in the outside wires as in the center wires. This lowered the antenna resistance from 0.9 to 0.7 ohm.

A still better distribution of the earth currents was obtained by installing the counterpoise already shown in figure 16. As is shown schematically in detail A, figure 16a, the section of the coil above the ground connection may, for purposes of illustration, be considered as positive with respect to the ground and the section below the point at which the ground is connected may be considered as negative with respect to the ground. The capacitive ground may therefore be considered as a combination of a forced and a tuned oscillation circuit. It

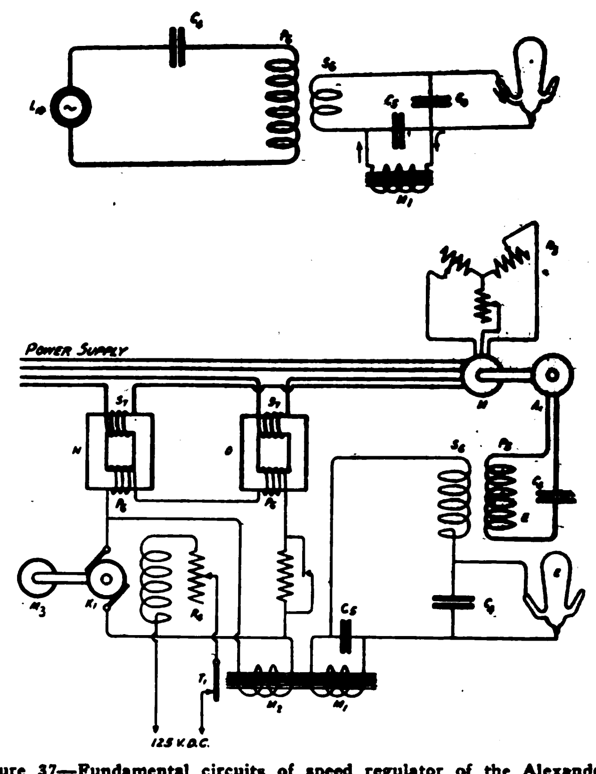


Figure 37—Fundamental circuits of speed regulator of the Alexanderson radio frequency alternator system

has the effect of drawing the current from the ground more uniformly, than with the wires lying on the ground or buried beneath the surface. The addition of the counterpoise in the case of the New Brunswick station reduced the antenna resistance from 0.7 to 0.5 ohm.

By suitable tuning, the total current through the down leads may be distributed between the capacitive ground and the wire ground in any desired ratio. If the wire ground is disconnected and the capacitive ground is tuned to take all the antenna current, the capacitive ground then takes on the characteristics of a tuned circuit. In this case the wire ground may be connected to the zero potential point on the coil (which may be found by experiment), under which condition it forms a path to earth for the lightning discharges with no other appreciable effect upon the system. An efficient ratio of current in the wire and capacitive ground is half of total in each. The capacitive ground may be installed in separate units at each tuning point, or may be connected together as a single unit as shown in figure 16.

Taking into consideration the counterpoise and buried wire ground, the equivalent circuit becomes that of figure 35.

It may be well to point out here that the design and construction of the grounding system for the multiple antenna may undergo considerable modifications in future high-power installations. It is probable that the system can be considerably simplified and yet provide a lower

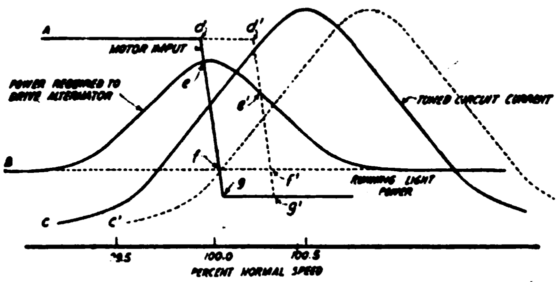


Figure 38—Graphs of Alexanderson speed control system

antenna resistance than that obtained at the New Brunswick station.

An antenna with a single ground and effective height equal to that of the New Brunswick aerial, can be assigned at the wave length of 15,000 meters a radiation resistance of 0.06 ohm and a total resistance of 2.71 ohms. This is, in fact, about the values that would be obtained in practice. The radiation efficiency is therefore 0.06/2.71 or 2.21%.

As a multiple tuned antenna the resistance of the New Brunswick aerial is slightly under 0.5 ohm, and the radiation efficiency is 0.06/0.5 or 12%. The radiation efficiency of the multiple antenna at this wave length is therefore 12% against 2.21% in the individual antennae.

The radiation efficiency of the multiple antenna is very much higher at the wave length of 8,000 meters which has been found the most suitable for radio telephony. Thus the radiation resistance of the New Brunswick antenna at 8,000 meters is 0.2 ohm and the multiple resistance 0.6 ohm. The radiation efficiency is 0.2/0.6 or 33%.

It is important to note that the New Brunswick antenna may be operated at the wave length of 2,500 meters, although its natural wave length as a flat-top antenna is 8,000 meters. Operation at such short wave lengths obviously would not be possible with the antenna in its old form. The multiple resistance of the New Brunswick antenna at 2,500 meters is 3 ohms, and the radiation resistance is 2.1 ohms. The radiation effficeincy is therefore 2.1/3 or 70% whereas with a single ground antenna the resistance at the same wave length would be about 5.4 ohms, and the radiation efficiency, 2.1/5.4 or 40%.

A curve showing the computed values of the radiation resistance of the New Brunswick antenna, at various wave lengths, is given in figure 36. The multiple resistance as actually measured at the wave lengths of 2,500, 8,000 and 13,600 meters is pointed out. The radiation efficiency at these three wave lengths should be noted, and also the comparative efficiencies of the common antenna with the single ground and the Alexanderson antenna with multiple grounds, at the wave length of 13,600 meters.

Although the radiation efficiency of all types of antenna decreases with increases of wave length the smaller absorption obtained at the longer wave lengths offsets this decrease. Efficient wave lengths for trans-oceanic communication have been found to lie between 10,000 and 20,000 meters.

As pointed out in the July Wireless Age, in order to secure a constant output at the alternator and to prevent a diminution of the received current at the receiving station, the speed variation of the radio frequency alternator, when signaling, must be maintained within one-tenth of one per cent. It is evident that the governing mechanism to maintain such constant speeds must come into such a critical state, at the motor speed to be maintained, as to cause a high percentage of change in itself for a low percentage change in speed.

The circuits of the Alexanderson speed regulator have been shown in the fundamental station circuit, figure 19. They are shown separately in figure 37. L_{10} is an armature coil which supplies a constant voltage at the frequency of the alternator. C_4 and P_5 are a capacity and an inductance which are tuned to a frequency slightly above that at which the alternator is to be worked. The coil S_6 is coupled closely to P_5, but not so closely as to affect appreciably the tuning of the resonant circuit. E is a rectifier (of the G. E. Tungar or Mercury Arc type) which is shunted by a condenser C_4 of 0.16 mfd. capacity.

M_1 is an auxiliary control coil of the voltage regulator. The latter through the contacts T_1 acts to control the voltage of a generator K_1. C_5 is a condenser of 1 mfd. shunting the coil M_1. Care is taken that the circuit S_6, C_4, C_5, is considerably off resonance with the frequency of the circuit L_{10}, C_4, P_5, in order that the speed held by the regulator may be changed with the greatest simplicity.

N and O are variable impedances connected in the two phases of the power supply lines. They contain the D. C. control coils P_6 and the variable impedance coils S_7. R_3 is a liquid rheostat connected in the circuits of the rotor.

The generator K_1, which is driven by the motor M_3, is provided with field current from a D. C. source of constant voltage which is varied by the rheostat R_4.

In regard to the functions of the impedances N and O, it may be said, in general, that with zero current in the control coils P_6, their impedance becomes a maximum. If on the other hand the current through P_6 is such as to saturate the cores, their impedance becomes a minimum. Any intermediate value of D. C. control current will vary the A. C. impedance of the coils S_7 accordingly.

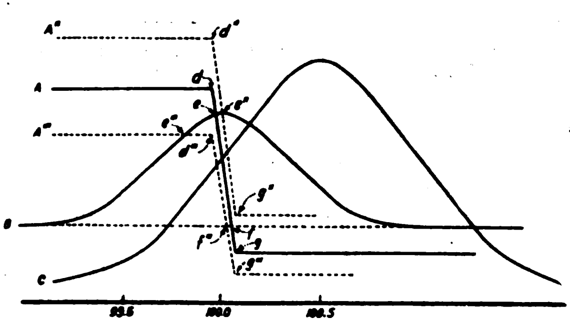


Figure 39—Additional graphs showing certain characteristics of the Alexanderson speed control system

It will now be shown how the motor input may be varied inversely as the current fed into the coil M_1 from the resonance circuit brought from a coil in the armature. Since the circuit L_{10}, C_4, P_5, is resonant to a frequency slightly above that of the alternator, it will develop an increased current as the motor M speeds up. This will send a D. C. component through the coil M_1 which assists that flowing in coil M_2; this causes the voltage regulator proper to maintain a lower voltage at generator K_1. This in turn decreases the current through the coils P_6 and therefore increases the impedance in the power supply circuit, tending to decrease the speed of the motor. When the speed falls slightly the rectified component through the coil M_1 decreases, thus causing the voltage regulator to maintain a higher voltage on the generator K_1 and therefore increase the control current through P_6, and thus again decrease the impedance in the power supply circuit. A given mean current is thus maintained through the control coils P_6, the value of which is determined by the value of the current through M_1. The speed of the driving motor is thus held constant.

A series of graphs showing the phenomena involved in the action of the speed regulator are shown in figure 38 and figure 39.

In curve A, figure 38, the "motor input" is plotted against "percent variation of normal speed" with the normal line voltage and frequency and with the resistance R_3 (in the rotor circuit of the motor) properly adjusted to provide the required power. The flat part of the curve to d, indicates the motor input with maximum field on generator K_1, figure 37, which is the result obtained with zero current in the coil M_1 of the voltage regulator. It should be noted that the motor input with the speed less than 99.95% normal is well above that required to drive the alternator with the sending key closed. The motor will therefore increase its speed up to point d, where the speed regulator takes hold. From here the motor input drops off rapidly because of the increasing current in coil M_1 (of the voltage regulator) until its curve intersects curve B which represents the power required to drive the alternator at point e. Here the motor input and the power required to drive the alternator are equal and the speed will remain constant.

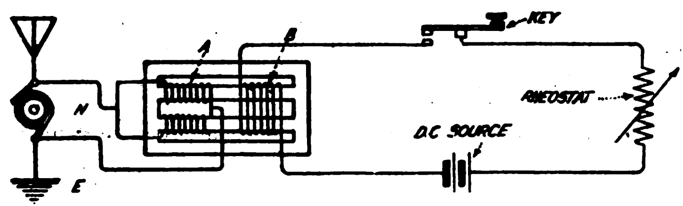


Figure 40—Magnetic amplifier in simplified form

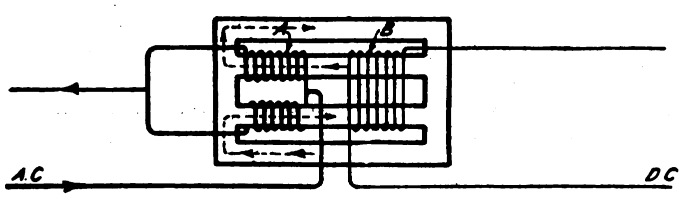


Figure 41—Showing inductive action of amplifier windings upon the control winding

When the key is opened, the power required to drive the alternator drops off to that indicated by the dotted line and the surplus of power supplied to the motor speeds up the alternator until the motor input has dropped off to a value equal to that required to run the alternator light. This condition is represented at the intersection f at 100.05% normal speed.

Point g represents the point at which the speed regulator has decreased the motor input the maximum amount possible, with minimum field on generator K_1; and for any small increase in speed above this point, the input will be the same as at g. Since here the power required to drive the alternator is greater than that supplied to the motor, the motor will slow down until equality is obtained as at point f with the key open, or as at point e with the key closed. With the speed at point f when the key is closed, the speed will decrease to point e, and when the key is opened again, it will increase again to that represented by f. This speed variation being less than 0.1%, no inconvenience is suffered.

If, however, the characteristics of the speed regulator are such that it lags in action, the speed may fall below e, before the regulator can effectively increase the power input. This will cause a greater variation of speed than would otherwise obtain. "Hunting" may then take place and result in a speed variation greatly in excess of the allowable variation for constant alternator output. This is prevented by properly designing the whole set

The speed held by the regulator at a given alternator frequency may be changed to some other value by retuning the circuit L_{10}, C_4, P_5 through variation of its capacity or inductance. This will change curve A figure 38 which will then maintain the same relation to the curve C, thus providing a different speed at which the power required to drive the alternator will equal the motor input. These conditions are represented in dotted lines in figure 38, e′ and f′ representing the speeds held with the key closed and open respectively, and d′ the point at which the speed regulator takes hold.

To obtain proper regulation the speed regulator must be adjusted so the point e will be on the left or lower side of curve B, for on that side of the curve an increase in speed will incur an increase in load (as resonance in the alternator antenna circuit is approached) which automatically will tend to keep the speed down. On the other hand if the point e lies on the high side of the curve B an increase in speed will decrease the load which will tend to cause still further increases of speed. This is prevented only by the fact that the speed regulator causes the motor input to fall off faster than the load falls off Because of the fact that better regulation is secured on the low side of the curve, it is called the stable side, and the high side the unstable side.

If the power supplied to the driving motor is increased, such as by an increase in line voltage or frequency, or by a change in the setting of the motor circuits (such as a decrease in the rotor resistance of an induction motor) the curve for motor input will rise as to A″, figure 39. If the power supplied to the motor is decreased the curve of motor input will fall as to A‴.

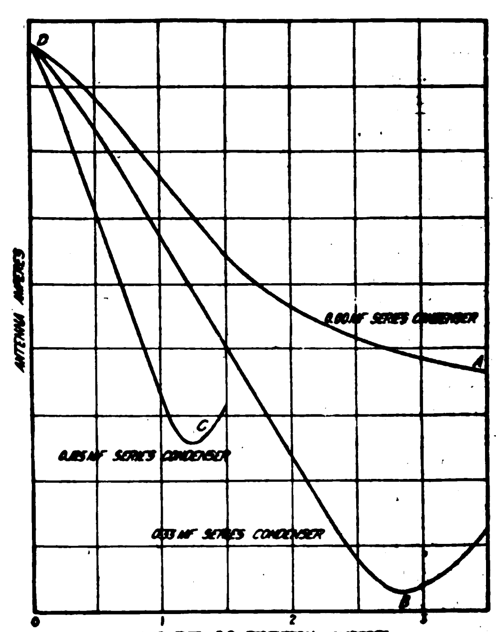


Figure 42—Control characteristics of the magnetic amplifier

The motor adjustment must be maintained so that point g on the motor input curve will be kept well below the power required to run the machine light (as shown by the dotted lines) and also point d must be kept well above the power required to drive the alternator at maximum tune of the antennae. In case point g is not well below the power required to run the machine light a surge in line voltage or frequency might increase it to g″ where it would be greater and thus cause the alternator to run away when the sending key is left open a short interval. Also if point d is not well above the power

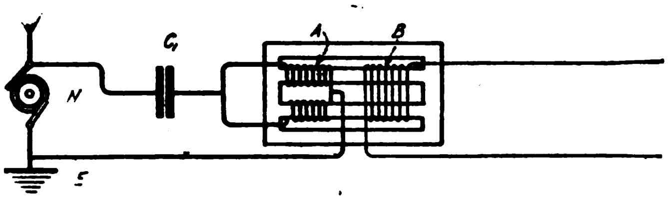


Figure 43—Magnetic amplifier with series condenser

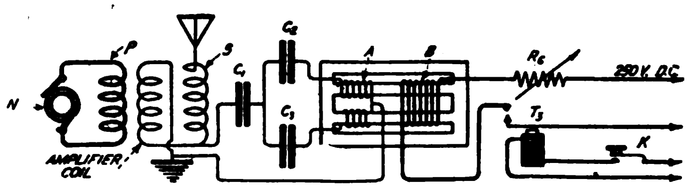


Figure 44—Magnetic amplifier with series and short-circuiting condensers

required to drive the alternator at maximum tune a slump in line voltage or frequency might decrease it to d‴ and thus cause the machine to slow down to e‴ when the key is closed, with a consequent falling off in signal strength and a swing in the pitch of the received note.

If adjustments are made so that the conditions outlined above are realized, no difficulties are encountered in maintaining a uniform speed at any desired alternator frequency.

This device already has been described as a variable impedance connected across the terminals of the radio frequency alternator for the purpose of controlling the power input to the antenna circuit. Its characteristics are

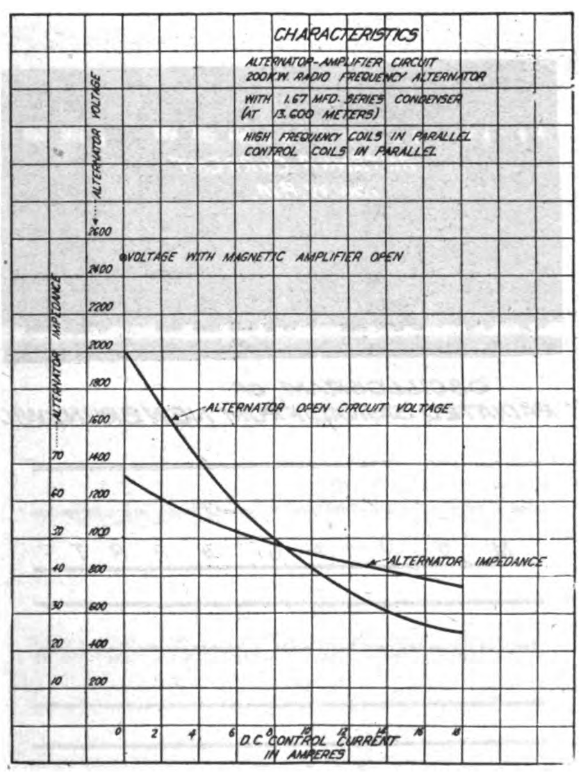


Figure 46—Characteristic of alternator-amplifier circuits, 200-kilowatt Alexanderson radio frequency alternator

such that a relatively small current in an excitation winding is enabled to control many hundreds of amperes in the antenna system. The amplifier performs two functions: When the sending key proper is open the alternator is placed on short circuit and the antenna system detuned. The joint effect of these two phenomena is a reduction in antenna current to 9% of its normal value. When the sending key is closed, the alternator assumes substantially its normal voltage, the antenna system returns to a state of resonance and the alternator output flows into the antenna system.

The great advantage of the amplifier over other methods of modulation is that it gives a non-arcing control of the large currents required in high-power radio transmission and therefore permits rapid telegraph signaling. In fact the amplifier has been operated experimentally at speeds in excess of 500 words per minute with perfect success.

An idea of the fundamental actions of the amplifier can be gained from the circuit, figure 40 where the two windings designated by A and B are wound on a common iron core. The windings A are connected in parallel and shunted across the radio frequency alternator N. The coil B is an excitation winding which includes both the positive and the negative branches of the flux produced in the windings A, and hence, no voltages are induced in B by the radio frequency currents flowing in A. This is illustrated by the reference arrows in figure 41, which show the direction of flux in the amplifier coil at a particular half-cycle of the impressed current. It is clear that the tendency to induce an e. m. f. in one side of the control coil by one branch of A is counteracted by an opposing e. m. f. in the other branch.

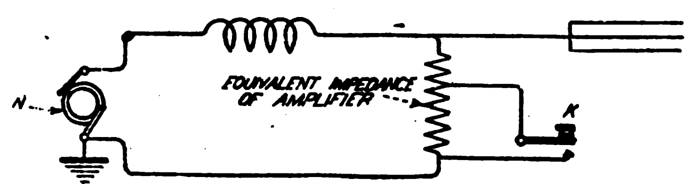


Figure 45—Equivalent circuit of Figure 44

It is apparent that should the flux produced in the core by the coil B be sufficient to saturate it fully, the impedance of windings A would become that of a coil without an iron core. On the other hand, with zero current in the winding B, the core will be magnetized by the windings A, and the impedance of A will thus become a maximum. In general, in order to obtain large flux variations in the windings A, the opposing ampere-turns in B must be approximately equal to those in A. Utilizing the alternator control circuit to figure 40, the problem is to obtain a minimum impedance in the windings A when the circuit to the excitation or control winding is closed and thus short circuit the alternator; and to obtain a maximum impedance when the control circuit is open, so that the alternator may assume within reasonable limitations its normal voltage. In this way the necessary variation of the antenna current for telegraphic signaling is secured.

The characteristics of a magnetic amplifier operated in a given instance as in figure 40, are shown in the curve A figure 42, where antenna amperes are plotted against different currents in the excitation or control coil. The curve A shows incomplete modulation of the antenna current, but it should be mentioned that with this circuit it is possible to secure more complete modulation with stronger currents in the control winding.

A more sensitive control of the alternator output to the antenna system can be secured by the series condenser C_1 of figure 43, for by the use of this condenser a much smaller control current is required to effect a given variation in antenna current. If the capacitance of C_1 is chosen to neutralize the inductance of the windings A for some definite value of excitation current in the control coil B, the impedance of the circuit C_1, A, becomes a minimum. The impedance at any lower excitation is determined by the difference between the inductive

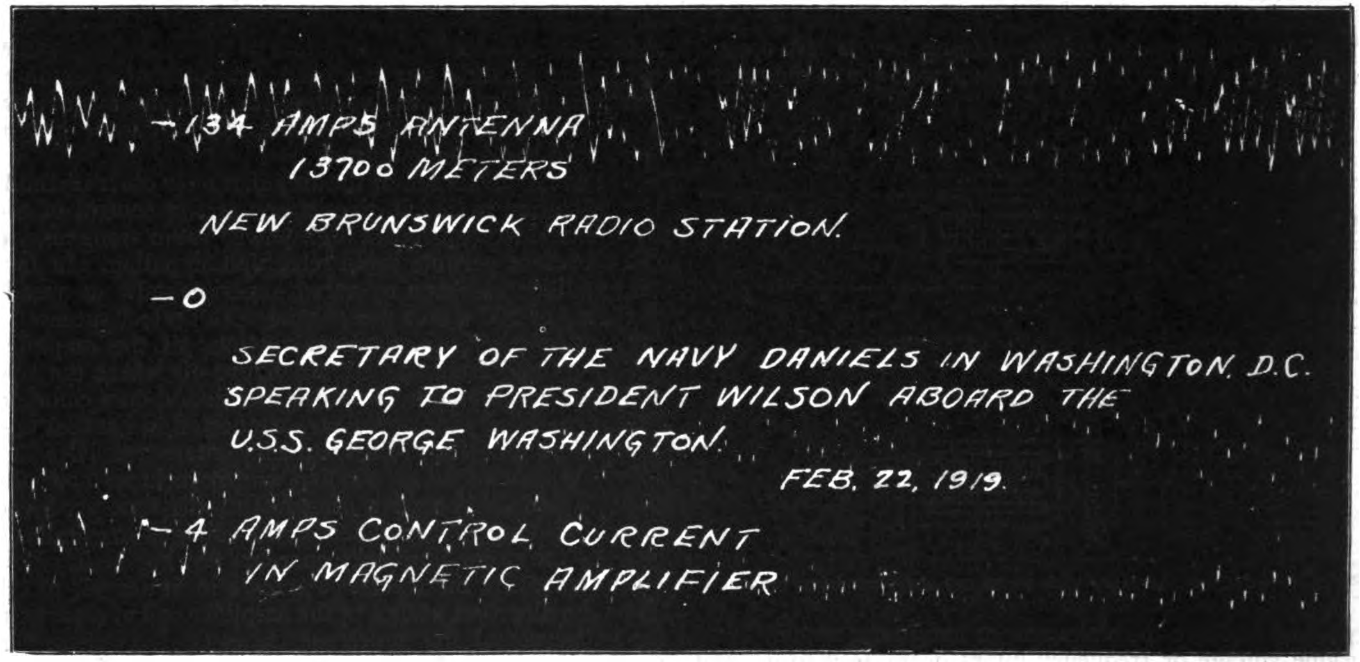


Figure 47—Oscillograms of control and antenna currents using a 200-kilowatt Alexanderson alternator set for overseas radio telephony

reactance of the amplifier coil and the capacitive reactance of the series condenser. However, the smaller this difference the lower will be amplifier excitation which gives minimum impedance and therefore minimum alternator voltage.

The increase in sensitiveness obtained from the series condenser is well shown by the curves B and C of figure 42. The curve A, as already mentioned, shows the antenna currents for different control currents, without the series condenser C_1. The curve B shows the control obtained with a series condenser of 0.33 mfd. and the curve C with 0.125 mfd. The curve B shows almost complete modulation of the antenna current. Although it is a matter of principal importance in radio telephony it is pointed out here that the curve B indicates a linear proportionality between control and antenna currents almost throughout its range. This is an essential requirement for satisfactory speech reproduction in telephony. The excessive control indicated at the right of point B with the larger values of control current is a condition easily avoided in practice.

In the final form of the magnetic amplifier, the condensers C_2 and C_3 are inserted in the amplifier windings A, as shown in figure 44. Their function is as follows: If telegraphic currents were introduced into the control coil B with the condenser C_2 and C_3 absent, a short circuit current would flow between the branches of A without producing any flux variations to the radio frequency current. This, however, is prevented by choosing values of C_2 and C_3 to have a low reactance to the radio frequency currents and a high reactance to the audio frequency currents. These condensers have no appreciable effect upon the tuning of the amplifier circuit.

In the commercial set the constants of C_1 are selected for the particular frequency at which operation is to take place, and it is therefore only necessary to vary the control current in the coil B until the most complete modulation of the antenna current is obtained. In the event that the alternator is worked at some frequency different from that originally contemplated, a value of C_1 can be found for some definite value of control current in B, at which a minimum impedance in the amplifier coils is obtained.

In summary of the foregoing the equivalent circuit of figure 44 will be seen to be that of figure 45 where the telegraphic key K when closed reduces the impedance of the amplifier and therefore the impedance of the amplifier-alternator circuit. This simultaneously detunes the antenna circuit and reduces the alternator voltage.

Characteristic curves showing the variation of alternator voltage, and change of alternator-amplifier impedance with different values of current in the excitation winding (for the standard 200 kw. set), are presented in figure 46. Thus with zero current in the control circuit the alternator open circuit voltage is 2,000, and approxi-

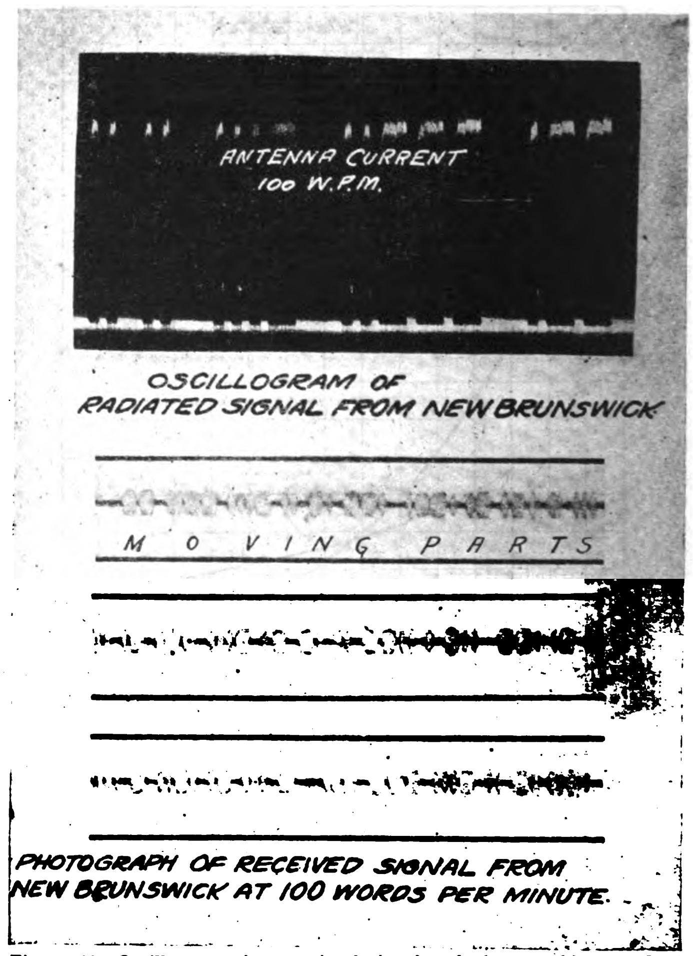


Figure 48—Oscillogram of transmitted signal and photographic record of received signal from New Brunswick Station at 100 words per minute

mately 500 volts with 18 amperes in the control coil. Similarly with zero current in the control coil the alternator impedance is 67 ohms and it drops to 37 ohms with 18 amperes in the control coil. Theoretical considerations of the circuits involved and actual test show that this drop in alternator impedance reduces the alternator voltage and detunes the antenna system to the extent that no more than 9% of the total normal current flows in the antenna system (when the current in the control winding is zero).

In explanation of the control current of 18 amperes (fed by a 250-volt source) in the case of a 200 kw. installation, it may be said that the same variation of alternator output might be obtained with much smaller values of control current. The larger value is purposely used to permit rapid signaling, that is, it permits the magnetic amplifier to function without lag.

Since the magnetic amplifier provides a linear control of the antenna current and functions with small values of control current, it is applicable as a modulation device in radio telephony. When telephonic currents of suitable amplitude are passed through the control coil B, figure 44, similar variations of the antenna current will be obtained, provided the amplifier characteristics are selected to give linear proportionality; otherwise inaccurate speech reproduction will result. It has been amply demonstrated in practice that such characteristics are readily obtained from the amplifier. Thus the curves B and C, figure 42, both show the desired linear proportionality between control currents and antenna currents, but the curve B shows the most complete modulation of the antenna input.

The perfection of control provided by the magnetic amplifier has been well demonstrated in a series of tests made on the 50 kw. Alexanderson alternator. With a telephonic control current varying in amplitude by 0.2 ampere, the antenna current was changed from 5.8 to 42.7 kw., a variation of almost 37 kilowatts.

Figure 47 is an oscillographic record taken on the 200 kw. set at New Brunswick, N. J., with Secretary Daniels, of the U. S. Navy Department, at Washington, D. C., speaking to President Wilson aboard the U. S. S. George Washington at sea. The satisfactory operation provided by the amplifier is here again well demonstrated.

When the Alexanderson System is used in radio telephony, the control circuit of the amplifier is placed in the output circuit of a bank of vacuum valve amplifiers. The input circuits of the amplifier bank are controlled by three preceding steps of vacuum tube amplifiers, which in turn are actuated by the microphone.

In a number of experimental tests made with the telephone set at New Brunswick, the voice was projected to European stations. At distances up to 2,500 miles very satisfactory results were obtained.

Universal, Honeycomb and Lattice Coils

By O. C. Roos

FELLOW I. R. E.

(*Continued from July* Wireless Age)

It is intended in each instalment to "overlap" slightly in regard to the reiteration of basic lattice winding principles involved in order to save the reader the trouble of referring in detail to the previous instalment where these fundamental laws of lattice winding are introduced. As these laws have hitherto been unpublished it is believed that a good educational purpose will be served.—*Editor.*

Resumé of First Instalment

Unsystematic practices in vogue in naming various universal wound coils noted.

Classification of universal, and lattice coils.

Methods of hand-winding.

Typical winding chart for a step-lattice coil.

General shape factors indicated.

Multi-lattice coils with one or several wires, and use in wavemeters or direction-finder loops.

Laws of lattice pattern-formation.

General approximate inductance formula.

High frequency lattice transformers with ferro-dust dielectric cores.

Synopsis of Second Instalment

Development of lattice layer on a plane, to show true value of "swing-angle," G.

Simple analysis of relations thus exhibited.

First working formulas shown, giving, K the "cross-step" or simply "step" and swing-angle, G and their general connection with tuning efficiency, P of the coil, where $P = \frac{1}{R}\sqrt{\frac{L}{C}}$

Change of swing-angle with diameter illustrated.

Effect of same on properties of lattice "cells."

Distribution of L, C and R as effected at different layers, by this factor.

Suggestions for conditions of tests to secure better average checks on coil constants.

Effect of wire thickness on properties of coil.

Cross-spiral (or simply "spiral") lattices and their general relations to cross-step lattices.

Peculiarities of lattice coils in relation to derivation of design formulas.

Effect of swing-angle G on lattice-coil tuning efficiency, qualitatively considered.

Method of converting single wire uni-lattice into single wire multi-lattice coils.

General method of designing multi-lattice coils approached.

There is a certain angle, the "swing angle," made by the winding "cross-step" with either circumference of the cylinder faces. It directs the winding zig-zag and experience indicates should not be more than 30°. In figure 15 this is discussed in detail.

To the left in figure 15 we have a coil frame, with a wire "swinging" or "stepping" from O at the "right" of the frame to S at the "left." Let the plane XOY be tangent to the cylindrical frame along the element NO. If we draw OY in this plane at right angles to NO, it will be tangent to the circular face OVB. Let the line OR in the plane XOY represent the wire at a "swing angle" equal to G. Then if the wire OR and the plane is allowed to roll on to the cylinder clockwise, with the line OY always touching OVB, the winding OR will lay on the helical line OS, and will have a "swing angle" of G degrees.

To make the matter still clearer, look at it from another point of view. Suppose that the cylinder NOVB were turned with its ends reversed and then rolled clockwise along the line BO^1Y^1 to the right. If we "inked in" the lines on the plane XOY they would all print themselves on the plane $X^1O^1Y^1$, in their exact relations at the left and we would see why the angle G of the "swing" is the same from point O to point S on the winding. Of course X^1O^1 and Y^1O^1 are perpendicular. NS is the "angular" swing, NO is the width W, and O^1S^1 may be called the "cross-step" instead of "linear swing," for accuracy and brevity.

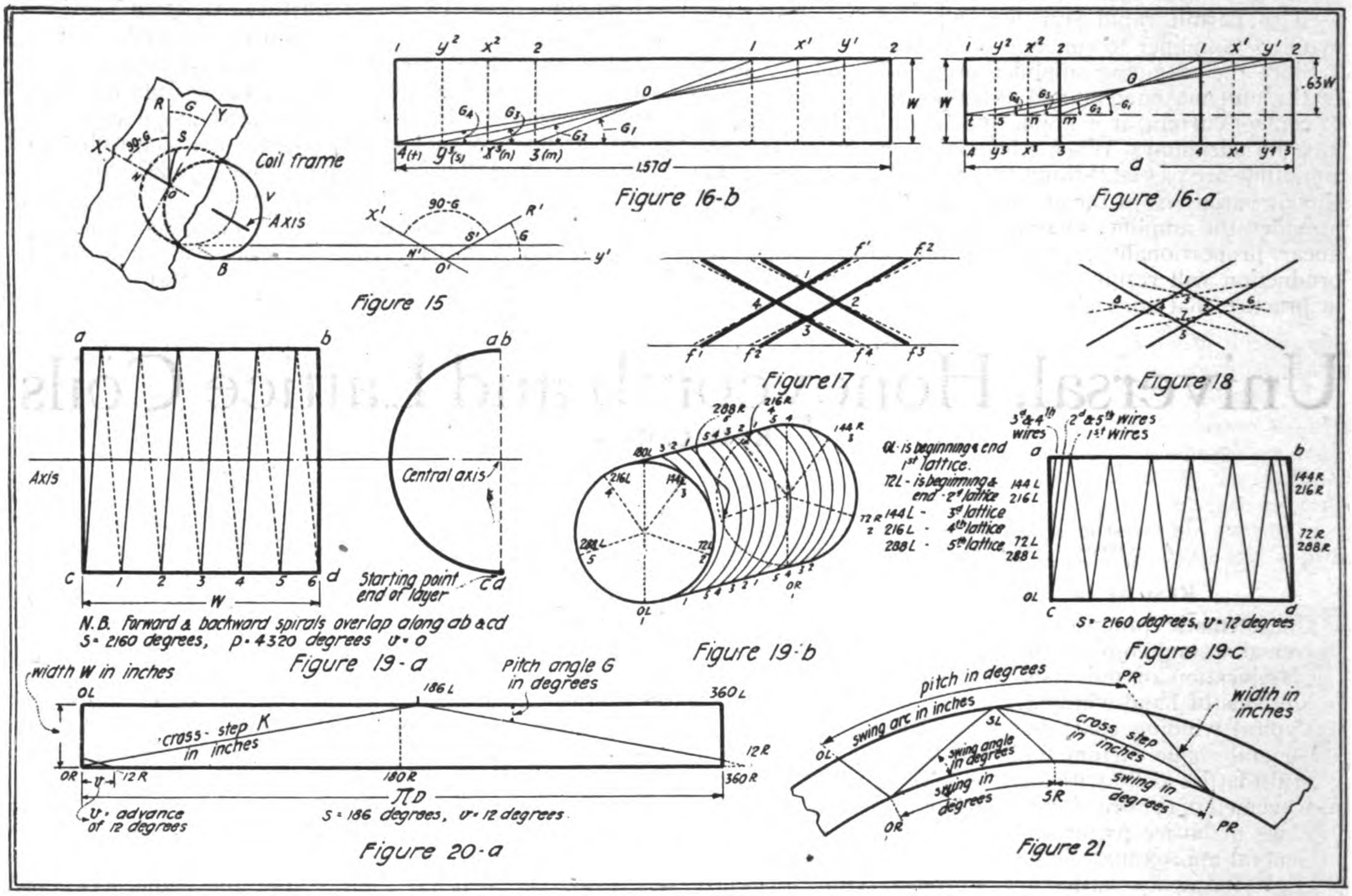
The actual "helical" or "screw" pitch in linear measure is the axial distance along the cylinder traveled during one turn of the winding, like that of any helix, but cannot be greater than W the width of the coil, hence the latter is assumed given and the swing angle calculated from the following two simple relations.

First: $K = \frac{Rds}{360}$

Where K = length of swing—O^1S^1 in figure 15—and therefore equals the "cross-step" or "step" "K."

s = angular swing, in degrees.

d = diameter of winding at a given layer. (N.B. We do not say "diameter of frame.")



Figures 15 to 21—Diagrammatic details of coils showing dimensions, method of winding, angle of pitch and general design principles

Second: $G = \sin^{-1} \frac{W}{K}$ which means that "G in the angle whose sine is $\frac{W}{K}$" and any book of trigonometric tables gives us G as soon as we know W and K. G must be less than 30 degrees. You ask—"why?"

First—It saves wire.

Second—It raises the selective power or tuning efficiency P of the coil, thus cutting down the damping; since

$$P = \frac{1}{R} \sqrt{\frac{L}{C}}$$

From purely manufacturing considerations it is not common practice to build a "step-lattice" coil with the "swing" much greater than 180 degrees.

The sine of 60° = $\frac{1}{2}$, hence $\frac{W}{K}$ must be generally less than $\frac{1}{2}$ or W is less than $\frac{K}{2}$. In the best lattice coils its average value is less than $\frac{K}{6}$. This is shown in figure 16a, where cross-steps K, of constant angle (S) but varying length, are laid out.

Figure 16a is a plane section of a lattice coil. The diameters of four "layers" are indicated by pairs of lines, at left and right. The exact properties of lattice "layers" will be given later. The four lines at the left are 2-3, X_2-X_3, Y_2-Y_3 and 1-4. The winding cross-section at right and left is 1234. If we take .63—the ratio of the diameter of any layer to its semi-circumference—of the width W, and lay out the swing-angles G_1, G_2, G_3 and G_4 by joining m, n, s and t at the left to 1, X_1, Y_1 and 2 at the right, we will find these angles are accurate. Figure 16b proves this; as it is nothing more than figure 16a with the various layers rolled out or "developed" on a plane. The lettering is kept similar to that of figure 16a. The "similar" angles G_1, G_2, etc., in both sketches are exactly equal.

These two figures show that the cell walls of lattice coils slowly change direction as the coil grows in diameter, somewhat like the pitch of a propeller blade. This means that there is a slight mechanical loss of rigidity in lattice "cells" whose linear dimensions are large and flattened as in figure 17a, especially when used with a small diameter of wire.

The wire f_1f_1 is called the "cross-step," and the swing angle G which it makes with the face of the coil, changes as shown in figures 16a and 16b, so that the cell-walls do not receive the support of the "steps" except at a fraction of their length. The dotted lines show the next outer set of "steps." This is shown, greatly exaggerated, in figure 18, where 1, 2, 3, 4 is a cell in one layer and 5, 6, 7, 8 is a cell on the next outer layer. Here is the real "secret" of the lattice coil. The greater the difference between the swing angles of successive layers, the smaller the distributed capacity of the coil, and the more economical it is of wire; since when G is small the time-constant is good. This change is slower near the outer layers, where, however, the effective radial capacity per unit length of coil is also smaller, for electrical reasons.

Since G becomes smaller as the coil diameter increases the inner layers are relatively inefficient in producing a good time-constant. Therefore it is not a fair test to use the whole coil to get the selectivity or tuning power P, which is measured by $\frac{1}{Ro}\sqrt{\frac{Lo}{Co}}$ where Ro, Co and Lo are the radio frequency resistance, capacity and inductances respectively. The whole coil shows up too well!

If the winding were stopped at half the total "layers" to be wound, or else a "tap" taken there, a test for Lo, Co and Ro to represent the uncompleted coil would give a more just average result. The former method is preferable on account of capacity dead-end effects present in the latter method.

It is important to remember that, the thicker the wire, the greater the change of swing-angle with a given change in number of circuits of winding and the less the distributed capacity always provided the spacing between "cell-walls" centers is kept equal to a constant multiple, say 3, of the diameter of wire. Otherwise, these wires of increased diameter in themselves have greater capacity and will neutralize a large part of the above advantage.

Spiral Lattices

It has been stated that for mechanical reasons "swings" or "steps" of more than 186° as given in figure 8 are usually avoided, except when the coil has a ratio of $\frac{d}{W}$ like figure 13 or else is small in diameter.

In these circumstances we may save wire and utilize the rapid change swing-angle G for small diameters—figures 17 and 18—by making the swing angle so small that many turns will be completed before the winding makes one swing. In this case we have a "cross-spiral"—instead of a "cross-step"—when the winding returns with 720° pitch, i.e. two turns or more to the starting point, or just beyond it, making a uni-lattice pattern if the pitch is exactly two turns, i.e. the winding starts a second layer at the original starting point. See figure 19a.

Now if the advance is an exact submultiple of 360° we have, a bi-lattice spiral for an advance of 180°, a tri-lattice spiral for 120° advance and an N-fold lattice spiral if the advance is $\frac{360}{N}$.

A penta-lattice spiral is shown in figure 19b with advance v equal to 72°. We could wind this as a five-wire uni-lattice spiral by starting separate wires at 0°, 72°, 144°, 216° and 288°. By choosing the turns in each lattice we can design an excellent unit for replacing five separate wavemeter coils.

In figure 19b we have the conditions in figure 19a modified to show five separate windings, giving as many lattices, each lattice formed from a cross-spiral. Colloquially we abbreviate "cross-step" and "cross-spiral" into "step" and "spiral" respectively. This spiral lattice or rather "five-spiral lattice" is shown in the forward swing of its first "layer," but for simplicity it is drawn in isometric projection and as though its wires each has only two instead of six complete turns or 2160° to a swing. The left face, nearest the reader, is lettered OL-72L etc., to show the starting points of the first to the fifth wires, as indicated on the top and bottom cylindrical elements 180L-180R,-OL,OR, by the series of numbers 321,54321,54, and 1543215432 respectively.

In figure 19c we get a side view of figure 19b showing, however, the twelve turns made by the first wire on the pitch of 4320°, the forward and backward spirals crossing at the starting element and 180° away. A five-wire spiral-lattice with 10 terminals is the result, although only the beginning and ending of the second, third, fourth and fifth spirals are here indicated.

We have to note, in figure 19a, that $\frac{d}{W} = 1.00$ and the angle G is too small here, to exhibit much change as the new layers are added. The layout of figure 19a is satisfactory, provided the "axial" or "helical" pitch 1-2, 2-3 etc., is at least thrice the diameter of the wire used.

The winding starts at OL—calling OL, OR the zero or starting element—and ends on OR. It immediately returns on the back swing of six turns (not shown) with a total "angular pitch" of 4320°, or twelve turns, to its starting point OL, and therefore, has no spiral "advance," or "step-advance," as shown in figure 1 or in winding-chart figure 8. The layers simply repeat from OL; as no "advance" of any kind is necessary for such a coil, which is therefore of the uni-lattice spiral type.

There is nothing to prevent efficient multiple-wound spiral lattices being used for couplers or wavemeters, etc.

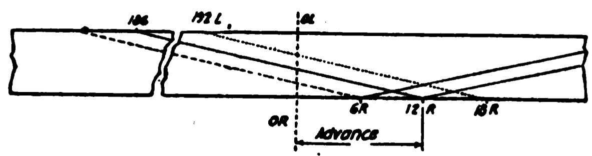


Figure 20b—A uni-lattice coil with swing 186° and advance 12°

There is a positive advantage in it, up to four separate lattices, as the change in G for separate layers of the same lattice is greater, making the cell shape more efficient. These corresponding "layers" for any particular lattice would really be four layers apart radially, and would have their distributed capacity correspondingly reduced, without reducing the inductance too much.

It is perfectly practicable to have these "intermediate" wire layers—in this case, 3 layers—replaced by an insulating lattice of moisture-proof hard cord. Such insulating lattices have been used in the past for different purposes. In regard to the mechanics of the thing, it is a fact that in one case, a coil of about four feet diameter was successfully wound out of small diameter rope. Furthermore, the use of large multi-lattice coils of bare and insulated wire for direction-finder loops is today being looked into, as a promising variation both mechanically and electrically.

Winding Peculiarities of Lattices, in Relation to Derivation of Formulas

There are several unobtrusive points about lattice coils which must be constantly kept in mind.

First: There is no "bedding" of wires at one level in the hollow or trough formed by the two adjacent wires underneath on the lower level. This is shown in the first diagram of this article.

Second: The question "what is a lattice winding level?" is answerable only by accepting a convention. The position of the wires in a "level" is only the same at certain repeated elements of the cylinder constituting the winding. The positions of wires in each level in a "layer" alternate from side to side and the levels themselves have their wires transposed radially in a peculiar way as one mentally passes a plane through the axis and rotates it while examining the winding.

Third: There are small or large projecting bands to be allowed for in calculations of length. These do not occur noticeably in form-wound coils, but lattice coils are not only form-wound, but when constructed of coarse wire with large diameter and few turns, they may be with advantage wound by hand and may purposely have as much as 2.5 per cent of wire added to aid in "tapping" the coil at the wire "bends"—say at a two-inch length of arc projecting from the face of the coil.

Fourth: The length of the wire in a lattice coil is based on the turns per "double level" or "layer," which is the design-unit. It is not convenient to use the "turns per level." This will be shown as being due to the alternate changing of upper to lower levels and vice versa which is illustrated graphically further on in this article.

Turning back to figure 20a we have the elements of the above peculiarities simplified. The perfectly practical winding-plan of figure 8 is given in sketch form. The symbols of figure 1 are applied, with a swing (s) of 186 degrees and an advance (v) of 12 degrees. The development shown in principle in figure 15 is used in figure 20a and the length, say, OL-360L represents the length of the circumference. The swing angle (G) depends, of course, with given cross-step K, on the width of the coil in a "step lattice" winding. In a spiral lattice winding it also depends on the axial width, or rather in this case, the axial length of the coil frame, provided the "cross-spiral" is constant in length. The term "cross-step" or simply "step" for ordinary use, is so much more convenient than the descriptive term "linear swing" (ls) that no excuse is needed for dropping the latter, except as a purely descriptive term. The length of a series of steps is that of a helix of the same angular development. This is obvious if we imagine all the odd or even steps, turned symmetrically to themselves and fitted to the other set, arranged as parts of a broken helix on the coil cylinder considered as extended. The result is a perfect helix, which we treat under the popular generic name of "spiral."

Since the advance v, travels forward by its own length during a certain number of applications of the pitch to the circumference, it must itself be contained in the pitch an exact number of times. Therefore, when the pitch is traveled over once by the advance we have a pattern or a complete lattice "layer." By "slipping" back the starting point when the "pitch" has gone beyond 360° as shown in figure 20b, we form a bi-lattice.

A uni-lattice coil with swing 186° (therefore pitch 372°) and advance 12 degrees, is shown in figure 20b in the full lines. If the swing 186L-12R is "slipped" back to 6R, losing 6 degrees or half the advance, it will come around again, arriving at, say, the swing, 192L-18R, if continued, giving the beginning of a bi-lattice pattern. To continue this bi-lattice, however, this again is slipped back 6 degrees to 12R and the next "circuit," which is defined as a revolution of the winding around the coil frame, starts at 12R, as it would have done originally, with a uni-lattice winding. Here we have the single wire bi-lattice winding. If we started a separate duplicate uni-lattice winding at 6R, and kept it separate, we would have a double or two-wire bi-lattice coil.

In figure 21 we have a value of s of about 30°. We are purposely showing the coil as wide enough to give a swing angle of 35°—an excessive amount. About 10° is good practice for coils about five inches external diameter. This figure also shows the winding surface more in detail than does figure 1.

Synopsis of Third Instalment—September

1 Laws governing width of coils in terms of "pitch" and "advance," Charts for layout of two types, "odd" and "even" lattices. 2—General relations involving "levels" and "layers" in lattice coils. 3—General properties of lattices in regards to shifting and transposition of wires. 4—Studies in "radial" and "axial" transposition with resultant "banking" of wires and "levels." 5—Detailed graphical analysis of above. 6—Handwinding and tapping of lattices with allowances for same. 7—Changes of swing-angle as related to diameter of wire. 8—Classification of results in preparation for examination of design-factors and formulas. 9—Tabulation of symbols, design-factors and formulas. 10—Selection of 12 coil-problems for mechanical design and comparison of windings. 11—Discussion of same. 12—Solutions of problems. 13—Lines of design development indicated for cross-step lattice coils. 14—Comparison of "cross-step" and "cross-spiral" design factors in lattice coils. 15—Conclusion of analysis and illustration of flexibility of lattice coil nomenclature suggested in this article. 16—Concluding remarks on etymology of nomenclature vs. practical utility in description and specification.

An Impedance Curio

WE ARE all prepared to find an increase of impedance when a condenser shunts a coil. This has been solved for the rejector circuit consisting of a pure capacity and a resistive inductance, about 1892. There are still, however, some very interesting properties of such circuits which have not been published, especially for the case where the capacity has leakage. In all these cases, however, we are prepared to see a sudden change in the reactance of the rejector circuit from condenser to inductor characteristics.

There is another, and a simpler but far stranger experiment on reactive shunts which is shown in figure 1. It seems to contradict the laws of Kirchoff until mathematically investigated. It has been correctly solved by A. Russell and discussed by Howe, Campbell and Still. The writer's work has been done independently of these investigators. In figure 1, x is a pure reactance, S is a pure variable resistance in shunt to x, r is a pure resistance in series with x.

If we apply an alternating sinusoidal potential of amount V to x at C and B and read the current in G and then shunt x by S and repeat the experiment the second reading will of course be greater.

You will probably say this must of course occur in all circumstances! Don't be too sure! Let us restore the series resistance by reconnecting the potential source through Y to A again and then repeat the experiment varying the resistance S from O to infinity.

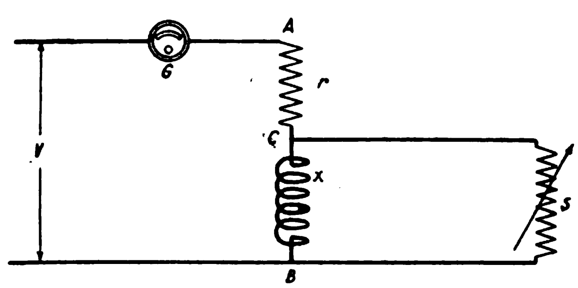


Figure 1—Circuit of the reactive shunt under discussion

Before we do this let us take some actual values. Let x = 10 reactive ohms; let r = 5 resistive ohms. Then the impedance with S open, figures out as 11.18 ohms. For convenience we will assume V equals 111.8 volts, giving a current in G of 10 amperes.

Now reduce S to zero and "short" x with it. The current in G is 22.36 amperes. Increase S and the current in G decreases as would be expected. If we observe carefully we will note that this decrease is unusually rapid. The majority of even experienced engineers would say that we could never reach as small a current as 10 amperes in G unless S became infinite. This is incorrect, however paradoxical the statement may seem!

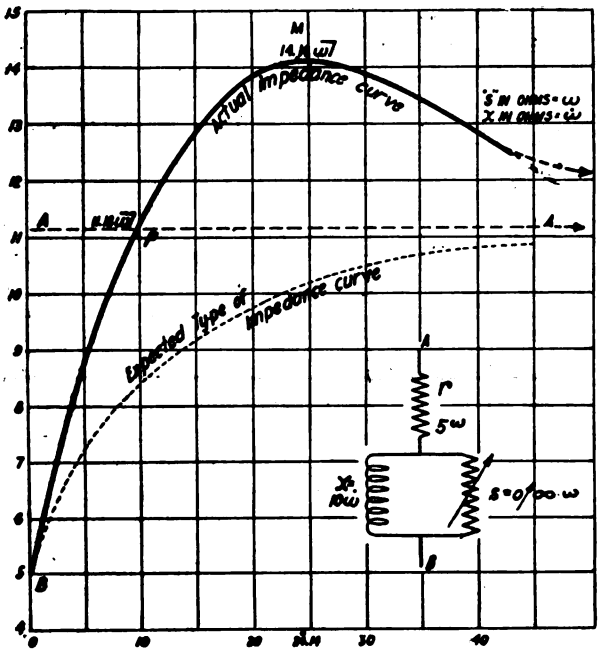


Figure 2—Graph showing actual and expected impedance curves

The obvious proof is, first, that of experiment. Let us increase S to 10 ohms—i.e. to $\frac{x^2}{2r}$ ohms—G now shows 10 amperes! In other words, S makes no difference by its presence, except to change the current phase!

Stranger things follow when S is still further increased; for G shows still less current! S has actually raised the impedance to a value such that the effective value of r has been doubled while the reactance, however, has not been changed, i.e., $Z=2r+jx$ at its maximum. This value for S giving a maximum value of $Z^2=4r^2+x^2$

$$\text{is } S = \frac{x^2}{2r} + \frac{x}{2r}(x^2 + 4r^2)^{1/2}$$

$$\therefore S = 24.14 \text{ ohms when } Z \text{ or } Z^2 \text{ is a maximum}$$

$$\text{and } Z^2=100+100$$

$$\therefore Z = 14.14 \text{ ohms}$$

The current in G is now 7.86 amperes.

After this the circuit behaves normally, i.e. when S is gradually increased from 24.14 ohms to ∞ the current in G gradually increases to 10 amperes; since Z equals $r + jx$ when S equals $\frac{x^2}{2r}$ or infinity.

It is possible to solve the problem graphically, but it is advisable, at this point, to plot the graph of the impedance between A and B in figure 1 with S as independent variable.

The graph is shown as the curve BFMR. The interesting points are, first—the impedance at F, or the "final" value of 11.18 ohms which the circuit has when S is opened and second, at M, when S equals 24.14 ohms and shows the maximum impedance always greater than the final value, in this case by 2.96 ohms. The curve is, of course, asymptotic to the line AFA.

The clearest method of showing the relation of the elements which go into the formation of the impedance curve shown in figure 2 is to consider this impedance curve resolved into its two components, R and X, which are the equivalent resistance and reactance respectively.

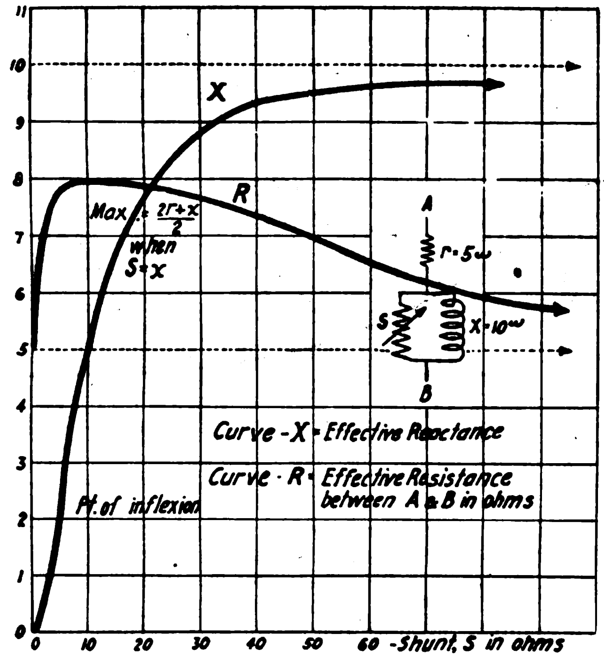


Figure 3a—Graph showing effective reactance and resistance curves

Their values are:

$$R = \frac{r S^2 + x^2 (r + S)}{S^2 + x^2} \text{ and}$$

$$X = \frac{S^2 x}{S^2 + x^2}$$

They are plotted as curves R and X in figure 3a in terms of varying shunt resistance, S.

R has a maximum value when $S = x$.

$$\text{In this case } R = \frac{2r + x}{2}$$

Now the relation $\frac{R}{\sqrt{R^2 + x^2}}$ gives the P. F. (power-factor) between the points A and B of figure 2 and similar figures. The special points F and M noted in figure 2 have been also noted in the P. F. curve shown in figure 3b, plotted in terms of the shunt resistance, S.

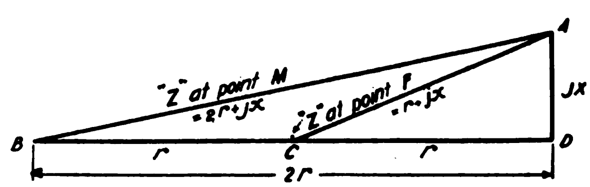


Figure 4—Values of impedance at points F and M in Figure 2

It is easily shown that the P. F. is always 100 per cent. at $S = 0$ and that there is a point of inflexion at about 8.43 ohms for S.

It is worthy of note that the series resistance r is the important element in producing this maximum. The larger r, the greater the difference between the points F and M as can be seen by an examination of figure 4, where OC gives the impedance shown at point F on the graph in figure 2 and AC gives the maximum impedance shown at point M.

On the other hand, the increasing value of the maximum takes place at decreasing values of S. This makes a sharper and higher maximum.

By examination of figure 4 we find that in figure 2 the maximum impedance ordinate OM is related to the "final" impedance ordinate OF by the equation

$$(OM)^2 = (OF)^2 + 3r^2$$

This shows clearly the greater difference between OM and OF as r gets larger.

Of course, when r is small, we approach the problem of the impedance of a resistance and reactance in multiple,

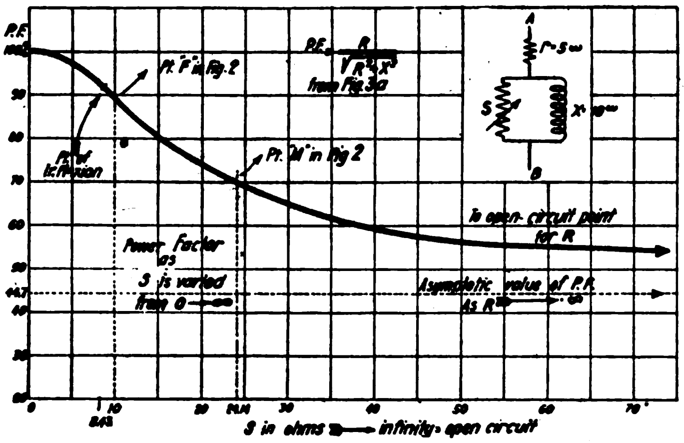


Figure 3b—Graphic curve plotted in terms of the shunt resistance

which exhibits nothing abnormal. Its graphical solution is important in order to solve the circuit of figure 1 graphically and will now be taken up. Before going into details, however, the ground will be prepared for the a.c. graphics by first solving for d.c. multiple resistances, graphically.

The graphics of two parallel resistances r and R, with direct current is simply the geometrical interpretation of the expression for their combined resistance $\frac{rR}{r+R}$

Figure 5 gives the well-known solution for this. Take

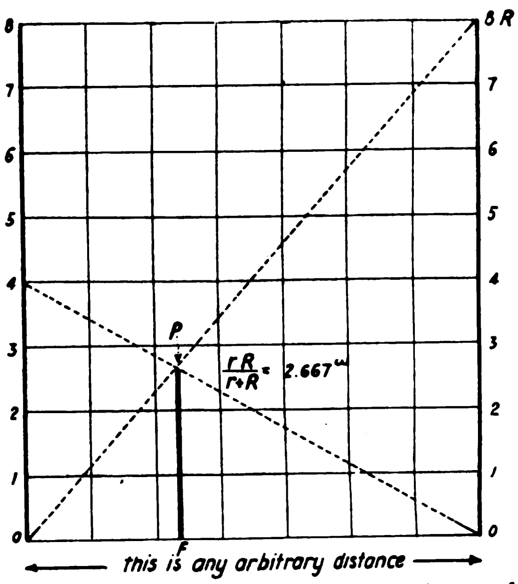


Figure 5—Chart giving the value of the multiple resistance of the two branches

any desired horizontal distance on the axis of abscissas and erect two ordinates at its ends. On these are laid off the values of r and R respectively. Join the points, say, 4 and 8 ohms to the opposite bases of ordinates, by the lines RO and rO. Their intersection marks a point P whose distance from the axis of abscissas gives the value

$$\frac{rR}{r+R}$$

or the multiple resistance of the two branches. It clearly and instantly demonstrates why such a multiple resistance is always less than the smaller resistance. This value, given by the line FP in figure 5 can itself in turn be used with a third parallel resistance laid off either on OR, Or or any other vertical line, as before, etc. Hence the graphic law corresponds to the most general case possible.

If OR and Or were similar reactive ohms, i.e. from

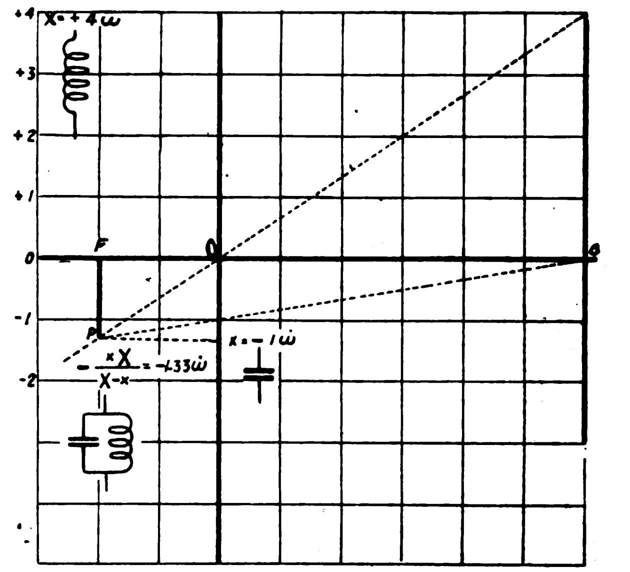
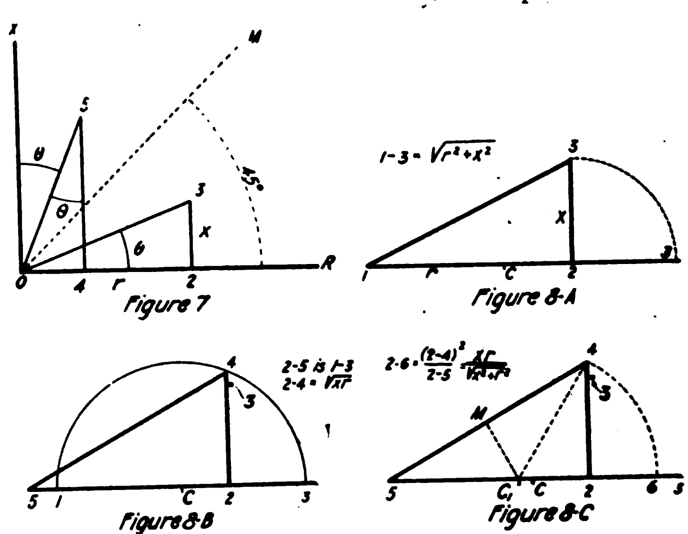


Figure 6—Diagram showing the value of the equivalent capacitive (or negative) reactance

either condensers or inductors, the same laws would apply in figure 5.

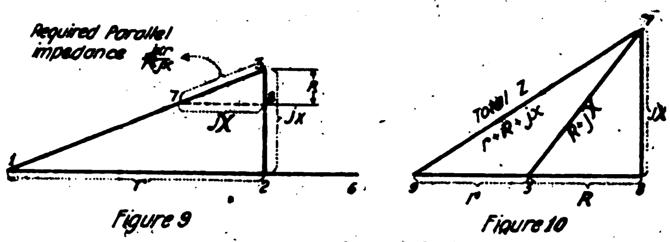
As a matter of fact, the general graphical law holds true, with all combinations of condensers and inductors using the extended diagram with either Or or OR negative in the above construction, but it is mechanically inconvenient to apply, as can be seen by inspecting figure 6 where it is used. Here the process is exactly the same. Lay off OX the inductive reactance and ox, the capacitive react-



Figures 7 to 8 c—The two impedance triangles and graphical solution of the mixed reactances in multiple

ance on opposite sides of the axis of abscissas O-o. Prolong the lines drawn through OX and ox till they meet at, say, P. The negative ordinate FP now represents the equivalent capacitive (or negative) reactance $\frac{Xx}{X\text{-}x}$. It is easy to see why FP grows enormously when ox approaches OX in value, i.e. when we approach the undamped resonant frequency of a branch resonant circuit. The values of FP go clear off any drawing-board to the left; as OF enlarges proportionately to FP, and suddenly as ox and OX pass through parallelism, come back again as enormous positive values or inductive reactances to the extreme right of OX.

We are now ready to find the graphical solution of mixed reactances in multiple but cannot use either figures



Figures 9-10—Graphical solutions of the impedance curio

5 or 6. Let the combined impedance of a reactance x and a resistance r in parallel be Z.

$$Z = \frac{r^2x^2}{r^2+x^2} + j\frac{r^2x}{r^2+x^2}$$

where the equivalent resistance $R = \frac{rx^2}{r^2+x^2}$ and the equivalent reactance $X = \frac{r^2x}{r^2+x^2}$

The impedance triangles of r and x in series and in parallel are worthy of comparison; as their phases bear a simple and easily remembered relation to each other.

In figure 7 we have the two impedance triangles for comparison. The triangle 023 is the series impedance triangle and—omitting a constant factor for the moment—045 is the parallel impedance triangle. It has the same shape as 023, but displaced through the angle 305. It is evident that the parallel circuit behaves as if the resistance and reactance changed places; since, for this case

$$Z = \frac{xr}{x^2+r^2}(x + jr)$$

instead of $Z = (r + jx)$

The graphical problem is to get the geometrical value of

$$Z = \frac{xr}{\sqrt{x^2+r^2}}$$

The solution is given in figures 8a, 8b and 8c: In figure 8a we lay off r equals 1-2 and x equals 2-3. Then swing 2-3 around as a prolongation of 1-2. The line 1-3 is of course $= \sqrt{r^2+x^2}$. Figure 8b is the same as 8a but with c as the midpoint of 1—3 as a diameter we describe a semicircle and prolong the line 2-3 until it intersects this semicircle at 4. The line 2-4 is a mean proportional between 1-2 and 2-3 or between r and x. Hence we now have $2\text{-}4 = \sqrt{x\,r}$. In figure 8c we now combine 1-3 and 2-4 so as to get $2\text{-}6 = \frac{xr}{\sqrt{x^2+r^2}}$ which is our answer—by proceeding as follows:

Lay off 2-5 equal to 1-3 and join 5 to 4. Erect a perpendicular at the midpoint M of 3-1 and let it cut the line 2-5 at C. With C′ as a center and radius equal to C′-4 describe an arc cutting 2-5, prolonged, at 6. The line 2-6 is the required geometrical measure of the combined impedance. This is surely different from the methods used in figures 4 and 5! It is far easier to do than to talk about, however!

In figure 9 we have the promised final graphical solution of the impedance between A and B in figure 1 by the application of figure 8a to an impedance triangle x + jr corresponding to the triangle 045 in figure 7.

In figure 9 we use the distance 2-6 found in figure 8c and lay it off as 3-7 along the line 3-1 in figure 8a, where 3-1 represents $\sqrt{r^2+x^2}$ Hence 3-7 equals 2-6.

The ratio of $\frac{2\text{-}6}{3\text{-}1} = \frac{xr}{x^2+r^2}$ and when applied to x + jr, gives the parallel impedance triangle, if we remember

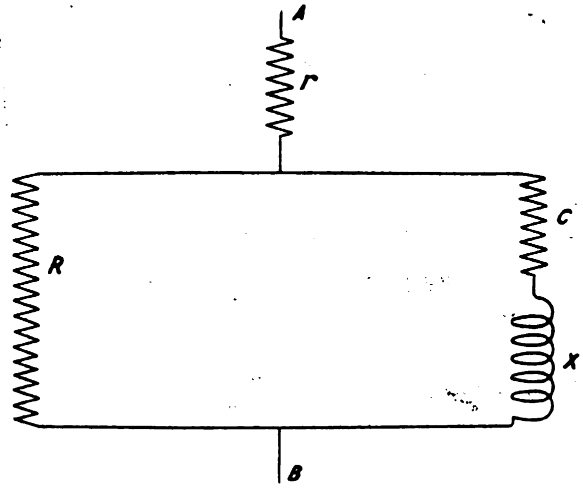


Figure 11—Circuit used in Campbell's solution

that the combined resistance R and reactance X are interchanged in phase relation, as shown in figure 7, when compared to the series impedance triangle 023.

So we take the portion 3-8 from 2-3 or x and call it R and similarly take the portion 7-8 parallel to 1-2 or r and call it j X. Thus the "parallel Z" = R + j X and in figure 10 by adding the series resistance r to the impedance triangle 387 we have solved our problem completely by graphical methods.

Now we are ready to take these results on the general resistance, r, and reactance, x, in series or parallel and apply them to figure 10 which is to be considered as representing the arrangements shown in figure 2.

It is the line 7-9 in figure 10 whose paradoxical behaviour we have been examining in figure 2. The greater the value of r the greater the departure from the usual behaviour of parallel impedances.

In closing this article I wish to call attention to a serious error on the part of Mr. A. Campbell who gave in the London Electrician for May 6, 1910, p. 157 a solution of the circuit shown in figure 11. He gives between A and B the impedance for a resistive inductance CX shunted by a pure resistance R and in series with a pure resistance r. It is in my notation given as

$$Z^2 = \frac{[r(R+C) + RC]^2 + (R+C)^2X^2}{(R+C)^2 + X^2}$$

On inspecting this formula it looked unsound, and I became certain of its incorrectness when C is put equal to zero, when we have the case we have just investigated.

According to Campbell, for this case

$$Z^2 = \frac{r^2R^2 + R^2X^2}{R^2+X^2}$$

whereas the correct formula is

$$Z^2 = \frac{(RX^2 + R^2r + rX^2)^2 + R^4X^2}{(R^2+X^2)^2}$$

The absurdity of the previous formula is evident if we let r equal 0, in which case we get a true result

$$Z^2 = \frac{R^2X^2}{R^2+X^2}$$

but by adding r in series to this true result we do not get Campbell's shorter formula! The correct general formula for figure 11 is

$$Z = \frac{(R+C)CR + RX^2 + (R+C)^2r + yX^2 + jR^2X}{(C+R)^2 + X^2}$$

and solution for the critical points of this equation is in progress.

—O. C. R.

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

Operating Suggestions for the Radio Amateur

By J. H. Tolley

FIRST PRIZE, $10.00

THIS prize contest which THE WIRELESS AGE announces on "Operating Suggestions for the Radio Amateur" is timely and should result in a benefit to all stations if even only a few of the suggestions brought forth are tried out by station owners. As pointed out in the contest announcement, a great percentage of the amateurs operating stations either have given the interference problem little thought or are indifferent to the interference and inconvenience they may be causing to brother amateurs or professionals by unprofessional methods of operating.

Enough has been said of the necessity of proper tuning of the transmitter and we will confine our remarks to the handling of it after the proper adjustments have been made. In the first place before attempting to do any telegraphing the student should know the code thoroughly, the practice work should be done on a buzzer set and continued until there is no hesitation in making any character desired. The spacing between letters and between words is very important. If the student will bear in mind that he is in fact writing when he telegraphs and strives to make his characters spaced exactly as they would appear in writing or in print, it will result in fewer twenty-eight letter words at the receiving station. The study of the proper spacing is as important to the beginner in telegraphy as is the study of tempo to the beginner in music. Until the student is able to take a newspaper and send a hundred or two hundred words without hesitation or stumbling and with uniform spacing between words he should not attempt to turn loose his skill upon the much abused ether. I have been chuckling lately when I see articles in the newspapers and magazines referring to strange signals undecipherable being heard and the possibility of their being signals from Mars. Confidentially, I feel sure that they are caused by some of the new crop of amateurs who reverse the process and learn the code last. Even after learning the code it is an excellent plan to do but little sending and much listening. This is the best way, too, in which to attain efficiency in receiving. Pick out some station which operates in a short business-like way and avoids saying or repeating the same thing over and over. Study his style of handling messages or conversation and note how he gets over the ground in comparison with the operator who insults your ability to receive by repeating numerous times.

Telegraphing is the same thing as carrying on a conversation by word of mouth providing always that the static or interference is not breaking it up, and numerous repetitions or lengthy explanations are as unnecessary there as in conversation by word of mouth. The international abbreviations used in handling traffic should be committed to memory, at least the ones in most common use, so that the meaning of each will be recognized immediately upon hearing it. A copy of this list should be posted in a convenient place also, so that a glance will be sufficient to read any abbreviation heard and not recognized. If this plan is followed out, it will be but a short time before the entire list is committed to memory.

It is not necessary that you do some transmitting every time you sit down to the apparatus either. Make it a practice to listen for at least five minutes after sitting in before you do any sending. This will give you an idea of what the conditions are like, and if the air is already crowded there is little use in getting in yourself and adding to the confusion. Just what idea underlies the practice of some stations calling others frantically and insistently only to say "Good evening, how do you get me," when they receive an answer, I am unable to say, but note that it is common practice. It would seem that if there is nothing more important to transmit it would not justify the interference and hard feeling caused. If the need of practice is felt, why not do it upon the buzzer set instead of turning it loose upon the heads of those engaged in trying to get through legitimate information.

When sending messages, use the regulation form. This will help the operator on the receiving end, as he is probably expecting that you will do this, and the use of Bohemian methods will probably decide him that he will see less of you until you learn something about the game. The old timers especially dislike to work with revolutionary newcomers and if you wish to stand in with them and become one of the gang with a standing, copy their style and graduate from the ranks of those responsible for the invention of the sandwich and the stove cover.

Avoid the long call. A half dozen times is as good as a million if the other fellow is not getting you, and if he is getting you, one is sufficient. In signing your own station-call the same advice applies. If he is getting you, once or twice is enough. If he is not getting you a million repetitions do no good. Above all do not be one of the expert alibi artists. If you fail to get what is sent you ask for repetition and stop there. An explanation comprising two hundred words of why you did not get the twenty-five words sent you is uncalled for and of no interest to the operator at the other end. The only thing of interest to him is the fact that you wish him to repeat. This last applies not only to amateurs but to a great many operators earning their livelihood as such. They waste their own time and others by going into lengthy explanations as to why they are asking for repetition, sending seventy or eighty words of this useless stuff when the message missed is possibly of only twelve or fifteen words and could be sent over a half dozen times while they are establishing an alibi.

If you know that your speed in receiving is limited to about fifteen words per minute, you invite trouble by sending to another station at a rate of twenty-five words per minute for the reason that in all probability he will answer you at the same rate of speed and you will then be called upon to exercise your ingenuity in establishing an alibi, which an incredulous and contemptuous operator at the other end clearly sees through. Try always to make good copy, and follow the professional form of writing messages; that is, place the message number, operator's signs, check, date, address, etc., on the sheet in the same manner as is done in professional work. It is bad practice also to write too close behind the sender for the

(*Continued on page* 41)

Operating Suggestions for the Radio Amateur by "Sparks"

By H. S. Pyle

SECOND PRIZE, $5.00

WITH the present rapid growth of amateur radio telegraph stations, there being hundreds now where there were scores before the wartime closing, the time is fast approaching when the interference problem will grow to such a state that the handling of traffic at any distance on two hundred meters, will be absolutely impossible, whereas it is merely difficult now. The only method of side tracking such a condition of affairs, lies in efficient control of traffic and operators in such a way as to reduce interference to the minimum, and such regulation had much better come from the amateurs themselves, rather than from a disinterested government committee. Control *must* be had, and it is the purpose of the writer to endeavor to point out a few ways in which such control may be had, from experience gleaned from eleven years of amateur, commercial and government radio-telegraphy operating.

The chief cause of interference with long distance work on two hundred meters, seems to be from what is known as "local" interference; that is, interference within a few miles of the station attempting the distance work. Generally the cause is the use of too much power, by the interfering stations, for local work. The law distinctly states that—"the least amount of power necessary to effect reliable communication shall be used—" and amateurs are *not* exempt from existing laws. As a rule this use of surplus power is merely thoughtless, or the station may not be equipped with any method of reducing power. This should by all means be done, either by the use of impedance coils, or what is a far more satisfactory method, the use of a low power transmitting unit, designed only for short range local work. Several excellent articles describing such a set have appeared in recent issues of the Wireless Age and any of these, if operated on a shorter wave than two hundred meters, will make an ideal local transmitter, with non-interfering characteristics. The use of a shorter wave length than two hundred meters, has not been as fully emphasized as it should be in the amateur world.

It is of great advantage to commercial and naval stations to be provided with a means of changing their wave length and no up-to-date installation will be found without some such wave-changing device. If it is desirable to use an antenna of 160 or 180 meters natural wave length, the use of a shorter wave cannot be effected efficiently, but in local work, efficiency need not be the prime consideration as distance is not the object in view. In such cases, then, the series condenser is wholly feasible, and it is suggested that the amateur operator, particularly in cities where a large number of good stations are located, read up on series condensers and their proper usage, in one of the many excellent handbooks obtainable from the Wireless Press. A wave as low as one hundred meters will be very satisfactory for all communication with other stations in the same city, or even nearby neighboring cities. The Canadian amateur before the war, was restricted to fifty meters, yet their stations, while hanging up no real distance records, did good work on this wave. Use a wave at least twenty-five meters below two hundred, and as little power as necessary to "get across" and if you are sharply tuned, as you should be, not nearly so many complaints of interference will be logged against you. It is a simple matter, should you want to talk over a fishing trip with your friend a few blocks away, to call him on two hundred meters, where he is very likely listening, and tell him to come down to a hundred and fifty and listen for you.

Leaving the question of wavelength and power, much can be done with the actual handling of the key—or rather not handling. First, be certain of what you are about to say, before you attempt to make it on the key. Don't just "ramble along" using a great deal of unnecessary words to say some simple thing. In this connection it cannot be too strongly urged, that the amateur operator become familiar with a large part of the Phillips code, which greatly simplifies and shortens transmission. Calling a station, seems for some operators, to be almost a rite. A common occurrence is the use of the attention sign three or four times before commencing a call, and following that with a long winded call for the station, "DE" several times and a long string composed of your own call letters—usually a couple of "AR'S," "K's" and anything else which may catch the operator's eye while his glance wanders over the code chart follows.

It is surprising how few amateurs, comparatively, know the correct forms for calling, acknowledging, answering and sending a message. This is a great cause of unnecessary interference. The conventional methods for each of these transmissions take into consideration the least number of parts necessary to intelligently communicate, eliminating all unnecessary signaling.

A further cut in the conventional call, which specifies three times for each group of call letters (station called and calling station, preceded by attention sign and separated by "DE") may be made by shortening the repetition of call letters, for nearby stations, putting in a short snappy call and then quitting. If the station called is there and not otherwise occupied he will answer such a call as readily as a long drawn one, which causes all listening operators to sit back in disgust and think of you as a "ham." It used to be possible to learn efficient methods of operating by listening to the old commercial and naval men handle business, but the commercials are no more and the navy has found it necessary or seen fit, to make almost all of their stations student training stations and nothing can be learned from them. In fact it is advisable not to pattern your transmission after that which you hear today, but by far the best method is to obtain a copy of the regulations now in force governing radio communication, which may be obtained from the Superintendent of Documents, Washington, D. C. These contain all the forms authorized for use and practice of them on a buzzer with actual message forms as reproduced in the book is the best possible training to carry into your actual operating.

One rule of the utmost importance is perhaps the most generally disregarded of them all. I refer to the provision for listening in before transmission. It is obvious that if a station is engaged with another, he cannot handle your message at the same time, and it should be the amateur's "religion" to listen a few moments before calling a station. He may be copying a station whom you cannot hear—wait long enough to make certain that he is free, then put in a short call. Remember, too, that local men may be copying long distance stuff unknown to you and you may break them up with some inquiry of a totally superfluous nature. If you are asked to stop sending in such a case, don't become grouchy—give the other man a chance. Try to get through with your local chatter by nine P. M. Almost every one can do this, and it is becoming generally recognized that the hours after that are for long distance work. Any amateur who persists in "chewing the rag" needlessly long after nine o'clock may soon find himself held in much scorn by other amateurs, which may result in more stringent action from a local club.

In closing, the whole "sermon" may be summed up in the well worn, but nevertheless suitable phrase: "Give the other fellow a chance."

Radio Amateur's Ten Commandments

By H. P. Roberts

THIRD PRIZE, $3.00

YE SHALL reap what ye sow.

2. Ye shall at all times "Listen In" before using that transmitting set of thine.

3. Transmit not for the purpose of hearing thy spark, unless thou connect not thine antenna.

4. A "Ham" will not enter into the kingdom of oscillation heaven, therefore be ye not a "Ham."

5. Write ye first upon a manuscript that which thou wish to transmit.

6. Ye shall keep a systematic record conscientiously, which shall be known as ye "Log."

7. Ye shall pound with thy fist clearly and distinctly without undue haste.

8. Ye shall at all times be courteous, remembering that some of the weaker sex, which God hath given us, do likewise understand that which thou sayeth.

9. Ye shall have thy transmitting set ready to instantly answer when thou art called, neither shalt thou depend upon thy memory, for it be mortal and subject to mistakes, wherefor shalt thou copy all messages of length.

10. Thou shalt transmit with proper form, waves and power prescribed by thy government.

Our text for today, brethren, is upon the ten commandments and is as follows:

Concerning commandment 1: If you wish consideration and lack of QRM, when you want to work long distances, give the same consideration to the other fellow when he wants it. If you continually "99" some other fellow, and think you own the air, you will be regarded as a ham-bug, and be treated so by others.

Concerning commandment 2: If you call a number on the telephone and the operator tells you the line is busy, you hang up and wait. When the radio circuit is "busy," just "hang up and wait" for your turn. You will in the long run get your message off quicker, for when the other fellow is through, he won't interfere with you.

Commandment 3 states that this "other fellow" is not at all interested in hearing your spark squeal test signals; he really is not in the least concerned with how clear your spark sounds, so why not just take off your antenna clip, when you want to "fuss" with it.

Commandment 4 warns you not to be a "ham," and you know you don't want to be one. If you can't copy 20

words a minute, and John Jones is always in the habit of sending at that rate, don't try to talk to John Jones; talk to Jack Smith, who can only send ten words himself, or get busy and practice your speed tests on a buzzer. Don't use the poor overworked ether, to learn the code on.

If you will heed commandment 5, and write on a blank, first, what you want to say, and how you want to say it, you will save much time in transmitting it, and also have a permanent record of what you did say to Jack Smith on the night of December 1, 1919, when "8XYZ" in Bingville, writes to you later, saying he heard your signals on that night, and wants a verification.

Commandment 6 tells you to try and operate your station as nearly as possible like a commercial station. Commercial operators must be efficient, and if the amateur will try to follow in their footsteps, they will be much better operators, and accomplish a good deal more.

Commandment 7 simply tells you to use "horse sense"; to take time enough to send each letter, each dot and dash, distinctly, and *not* to send so quickly and so haphazardly as to require repetition of your whole message, and loss of time. Again, follow in the footsteps of the commercial man, and listen to how he sends. He was once an amateur and he has simply had more practice and experience than you. For instance, watch how he sends his C's. Do you notice how he holds on to the first dash much longer than the second; That is not merely the operator's "fist," but it is his attempt at clearness, to make a distinction between the letter C, and two N's sent right together. He has many other little tricks which it will pay you to learn. Listen to them next time you hear him.

Commandment 8 advises you against losing your temper. We are all of us trying to coach the beginner along, and when he does get on the circuit, and is doing his best, and necessarily taking more time than you or I, just when you or I want to do some work ourselves, be a little patient. You and I were as bad or worse than he, at one time. *Be courteous—always.* You'll find it will get you much farther. Besides it may be some good looking young lady, trying to master the code, and then think how you'd feel if she looked you up in "Hoyle."

Commandment 9 gives us good advice. When you are ready to answer someone, and the "line" is OK, just remember that every other fellow also knows at that moment that the "line" is not busy, and he is liable to be getting ready to send, so don't throw your switch, and then start your rotary gap, and make other little adjustments before sending; while you're doing all this, some other fellow may have started sending, without your knowledge, for your switch is on "transmitting" side. Don't throw your antenna switch, unless you are all ready to hit the key, the instant it is thrown.

Commandment 10 is one we must follow. It is not optional. Uncle Sam requires us amateurs to use *not more than 200 meters.* Don't use 205. He requires us who are within five miles of a Government station to use not more than ½ kw. Don't use 17/32. He requires the rest of us to use not more than 1 kw. Don't use 1 1/10. Obey the law. Don't give the radio amateur a bad reputation. It reflects on us all, and when we want the Government to help us, we want to show that we have treated the Government square. Do you know that your government is giving you privileges far beyond the hopes of amateurs in other countries? *Be on the level!*

Prize Contest Announcement

The subject for the new prize contest of our year-round series is:

"A FEW CAREFULLY THOUGHT OUT SUGGESTIONS CONCERNING THE DISTRIBUTION OF WAVE LENGTHS AND USE OF POWER FOR LOCAL, INTER-CITY AND LONG DISTANCE TRANSMISSION AND POSSIBLE METHODS OF ACCOMPLISHMENT."

Closing date, September 1, 1920.

Contestants are requested to submit articles at the earliest practicable date.

Prize Winning Articles Will Appear in the November Issue.

As a result of a long series of more or less formal inter-allied radio conferences and, more directly, as the result of the deliberations of a Wave Length Regulation Committee appointed by the Secretary of Commerce, it is very likely that ere long a new radio law will come into existence which fixes the range of wave lengths for amateur stations between 175 and 250 meters. It is to be noted that, generally, all spark stations will be held between 175 and 220 meters and that 220 meters to 250 meters is to be used strictly for undamped wave transmission and modulated undamped wave transmission.

Due to lack of appropriation, it has never been possible for our Department of Commerce to exercise strict control over amateur installations. As a result amateurs have, in the past, had a band of wave lengths equal or superior to that which is to be offered by the proposed law. Should this law be passed, it is very likely that it will be very much more rigidly enforced. Spark stations would then fall in a very much narrower band of wave lengths than has been the case. Interference, even with the present "free for all" arrangement has become a very difficult problem and will soon become a very much more difficult one. This has been apparent to a great many amateurs for a long time, and it is gratifying to note the keen interest which has been taken by amateurs everywhere in recent WIRELESS AGE *prize contests, which have directed amateur thought toward the limiting of interference by self regulation, self control and practice of a little unselfishness.*

PRIZE CONTEST CONDITIONS—Manuscripts on the subject announced above are judged by the Editors of THE WIRELESS AGE from the viewpoint of the ingeniousness of the idea presented, its practicability and general utility, originality, and clearness in the description. Literary ability is not needed, but neatness in manuscript and drawing is taken into account. Finished drawings are not required, sketches will do. The contest is open to everybody. The closing date is given in the above announcement. THE WIRELESS AGE will award the following prizes: First Prize, $10.00; Second Prize, $5.00; Third Prize, $3.00, *in addition to the regular space rates paid for technical articles.*

All manuscripts should be addressed to the Contest Editor of THE WIRELESS AGE

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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New License Tests

CHIEF Radio Inspector L. R. Krumm announces that after July 1st, applicants examined in his office for commercial radio operator's license will be tested in their transmitting ability in sending Continental Code.

Applicants for Commercial First Grade Operator's licenses will be required to send 100 satisfactory code characters in succession in a five-minute test at a 20-word-per-minute speed.

Applicants for Commercial Second Grade Operator's license will be required to send 60 satisfactory code characters in succession in a five-minute test at 12 words per minute speed.

The transmissions by the applicant will be received by the examiner and will also be graphically recorded on a tape recorder as a check against transmissions in case of doubt.

Radio schools training men who expect to take these examinations are requested to prepare their students for this transmitting test and include a test therein before they give the student the usual letter certifying that they have satisfactorily passed the course, and for which the applicant is allowed a 10% experience mark in this office. The transmitting test given the applicants will include characters, numbers and signals of all kinds used in the usual transmission. The conditions under which the applicant is tested are made as nearly similar to actual conditions as possible, the applicant hearing his own note in his receivers and otherwise working under no unusual conditions.

After July 1st, examinations for Commercial operator's licenses will be given on Mondays, Wednesdays and Fridays only, except on holidays. The examination is given at 9 A. M. in Room 603, Custom House, New York, and applicants should appear promptly with whatever documentary evidence they may have indicating their radio experience and training. Reservations for places should be made in advance as the facilities are limited and it is expected will be completely utilized on each day.

The Radio Club of Hartford, at its monthly meeting, decided that the first annual radio convention of southern New England would be held in Hartford. A committee was appointed by Vice President Edward L. Belknap, presiding, to decide upon the date of the convention and make all necessary arrangements. The committee, consisting of Hiram P. Maxim, chairman, Louis W. Batchelder, Walter B. Spencer, K. B. Warner and J. L. Belknap, will report at the next meeting.

David Moore of Farmington, a charter member of the club, was present at the meeting and told of his experiences as a ship's radio operator during a trip around the world, from which he has just returned. He left New York last October, going through the Panama canal and then to Japan, the Philippines, Singapore, Java, Sumatra and the Cerebres Islands. He returned by the way of the Suez Canal, visiting Malta and Gibraltar.

At the recent meeting of the Lynn, Mass., section of the Essex County Radio Association, the following officers were elected: President, Roger Osborn; vice president, Harry L. Sawyer; treasurer, Herbert Young; secretary, Herbert I. Stickney; advisory board, Roger Osborn and Kendall Redfield.

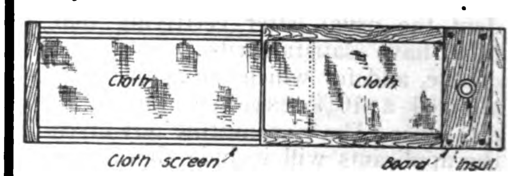
Plans were made to hold a dance soon, using music from a wireless receiver and loud speaking telephone to be demonstrated also at the coming General Electric field day.

F. Clifford Estey outlined the plans for the coming season and requested that all Lynners interested in radio work get in touch with the secretary. Mr. Estey is president of the Essex County Association and urged amateurs to send wireless messages of interest to newspapers and magazines to the secretary by wireless and also to keep in touch with members by wireless.

A Simple Lead-In

By Emil Otto

ALL amateurs living in the city have experienced the difficulty of constructing a suitable lead-in. The erection of the antenna seems to have been a simple problem when compared to the trouble of bringing the wire lead-in into the room. Landlords balk at having their walls and sashes drilled full of large holes and think they have gone far enough to allow the amateur to erect an antenna. Drilling window panes is a further task, as anyone will find if he tries.



After working some time with the problem, I came upon this solution: Upon a narrow screen such as is used for ventilation with a cloth netting instead of the usual wire, fasten a small board at one end with wood screws and drill a large hole for your entrance insulation. For insulation use a medium electrose tube for transmitters and a porcelain tube for reception. Hammer a small nail under the screen after it is in the window and it will not fall when the sash is lowered.

This screen has many advantages. It is cheap, portable, adjustable to any window, can cause no comment from the landlord, and above all, functions as it was intended and gives the operating room draughtless ventilation which is perhaps more important than the lead-in itself.

Operating Suggestions for the Radio Amateur

(*Continued from page* 32)

reason that if a mistake is made in sending it is written down and must then be erased. Writing a word or two behind the sender will result in better looking copy.

Avoid joining the ranks of the "QRA'S." They are already overcrowded. I refer to the operator who whenever he hears a strange call must open up and inquire "QRA O M." He is probably not O M to you anyway, being a stranger. Up to date call lists are to be had at a very low cost and reference to one of these is to be preferred to the QRA method.

Don't copy the style of the operator who affects a swing in his sending. It is odd of course, and attracts attention, but so do the guests at Mattewan and many other things which most people are shy of. *The best method of finding out what to avoid is to take note of what causes you to froth at the mouth when you are trying to get through something and are prevented by other stations interfering. Take careful note of what might have been eliminated by them and avoid just that yourself in the future.*

A word of warning in conclusion. The Government regulations are not strict and interference is bad. If conditions continue to grow worse, it is an unavoidable conclusion that the Government will take steps to improve matters and whatever form such legislation may take, it will surely place further restrictions upon amateur transmission. So, in justice to yourself and the many amateur station owners who strive to improve matters, get behind offending stations when you locate them, and if you cannot induce them to mend their ways by argument, apply a little pressure. Exclude them from your clubs and meetings; refuse to work with them, and if necessary explain matters to the government inspector and ask him to get behind the unmanageable one. In doing this, you will be doing it as much for yourself as anyone else. If you do nothing about it but let the newcomers play as they will, you also will be partly to blame, when stricter laws take from you some of the privileges now allowed.

Close Your Ground Switch

Radio amateurs should never fail to close the ground switch when leaving their apparatus. For an aerial attracts lightning and a thunder storm may come up when the operator is absent. If it does, and the lightning is led into the house, the amateur will find all his apparatus out of business, wrecked beyond repair, to say nothing of the responsibility of the house being set on fire.

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.

H. S., Brooklyn, N. Y.

You should be able to secure transil oil for use in your oil condenser from the Service Department of your electric lighting company.

* * *

F. P. B., Portland, Oregon.

Wiring diagram of a double rectifier and filter enabling the use of alternating current for plate supply of vacuum tubes, as well as dimensions of units used in this filter, has been printed in recent issues of this magazine. We hope to be able to publish in the near future an article giving constructional data to cover a step-up transformer 110 to 500 volts.

The current capacity of any rectifier tube is limited. If your rectifier tube will supply, say, 20 watts at 500 volts and your audion takes only 10 watts in the plate circuit, it will be possible for you to use two audions with one pair of rectifier tubes. If you use 4 audions you will need 4 rectifier tubes; 6 audions, 6 rectifier tubes, etc.

The more tubes used, the greater will the range be. Usually it is not the practice to use more than six tubes in multiple. Where tubes are connected in multiple, all grids are connected together, all plates together, and with the commercial type of vacuum tube, all filaments to the same lighting member with a separate rheostat for each filament.

Copper wire is best for an amateur aerial. Amateurs generally seem to use phosphor bronze. Phosphor bronze wire was originally used in wireless installation because of its great tensile strength—it being required that once an antenna had been erected, it would maintain its position permanently, regardless of heavy weather. The conductivity of phosphor bronze wire, however, is at best only about 75 per cent. of that of copper. In-as-much as the amateur is not particularly concerned about the continuity of operation of his outfit and in-as-much as his spans are usually short ones, copper wire is entirely satisfactory. For 200-meter work a "T" antenna is good, if you are so located that it is possible for you to erect one. Next to this, perhaps the best antenna for general amateur use is the inverted L type, although it will usually be found that greater range is to be had with a vertical wire antenna, than with either of the above. For a given fundamental wavelength the vertical wire gives the greatest effective height.

* * *

R. D. McC., East Palestine, Ohio.

You may obtain condensers suitable for use in the super-heterodyne receiver as described in the February WIRELESS AGE from the Adams Morgan Co., Montclair, N. J. Condensers supplied by this concern have a capacity of .01 mf. and an insulation resistance upward of 25,000,000 ohms.

You may use any type of detector tube as the detector in the above mentioned outfit. This also applies to the oscillator, but considerable care will need to be taken in the selection of the tubes for the amplifier for a noisy tube in the first stages of the amplifier will cause considerable trouble, due to the amplification of the noise as it passes from stage to stage.

* * *

M. M., Toronto, Canada.

N S N are the call letters of the U. S. S. Conner. W B F is the call of the Tropical Radio Company's station at Boston, Mass. We are unable to locate stations "P T A" and "V A V."

* * *

C. R. T., Scranton, Pennsylvania.

We presume that if you are going to build a lose coupler to operate on wave lengths between 1,000 and 25,000 meters, you expect to use a regenerative receiver of some type. The design of a receiving transformer for use with a straight detector is usually somewhat different both mechanically and electrically. If you will let us know just what type of outfit it is you have in mind, we will be glad to make suggestions as to its construction.

* * *

W. A. Clutier, Iowa.

If you intend to use the 250-ft. antenna for receiving only, the Radio Inspector will have no objections to make. If you should desire to do transmitting, it will be necessary for you to put up an antenna which is slightly under 100 feet in length.

* * *

Captain A. G. B., Edinburgh, Scotland.

With reference to the article by Mr. Charles R. Leutz in the January Issue which describes a detector and four-stage resistance coupled amplifier, we regret to say that the diagram, as well as our correction became somewhat mixed. The alteration as suggested in the April issue would short the "B" battery, as you have stated. It was Mr. Leutz's intention to use the same system of obtaining reaction as he described in his long wave receiver article printed in the September issue. As you have stated, and to use your words, the connection should be as follows:

"Delete connection of negative terminal of "B" battery direct to positive terminal of filament battery and substitute for it a connection from negative terminal of "B" battery to the terminal marked "wing."

The condenser referred to at top of page 26 of the January issue as C2 is that one which is placed in shunt to the plate resistance of the detector tube and therefore, as stated by Mr. Leutz, allows the high frequency oscillations to pass around the resistance, but, being generally of such small value as to force the audio frequency pulses through the resistance itself. We would be glad to learn of work which you are no doubt doing with circuits of this type.

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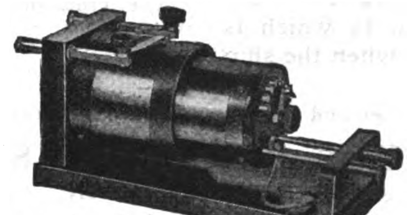

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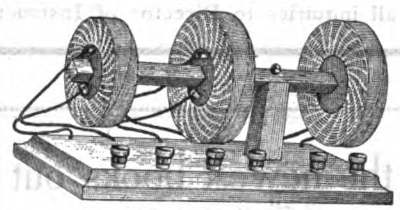

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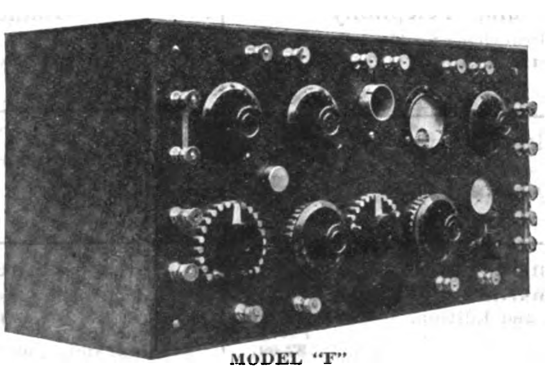

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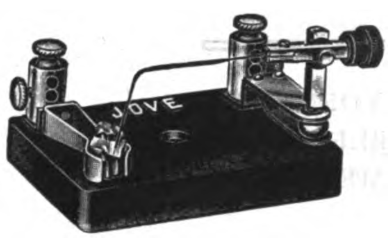

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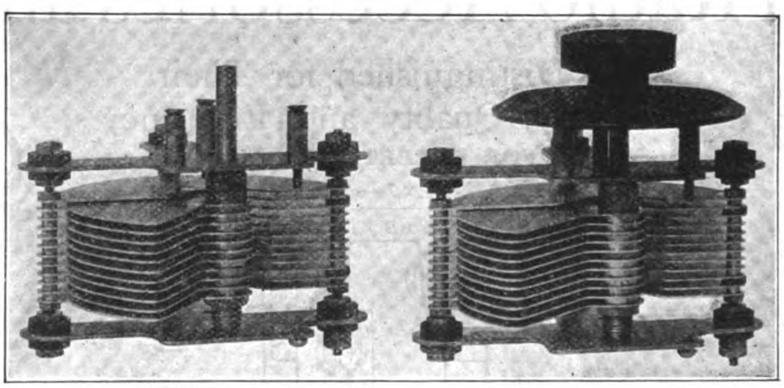

THE ATLANTIC RADIO COMPANY VARIABLE CONDENSER, illustrated above, is made in two capacities—.0005 Mfd, and .001 Mfd. The rotary plates are rounded on one end, affording a straight-line capacity—a valuable feature in wave meter work. The condenser is furnished unmounted only, but with the addition of Dial and Knob, if desired. Dial is moulded composition, scale in white—0-100 reading. Bakelite Knob. We can guarantee this condenser in every way as to quality, reliability and satisfaction. The low price is decidedly an innovation.

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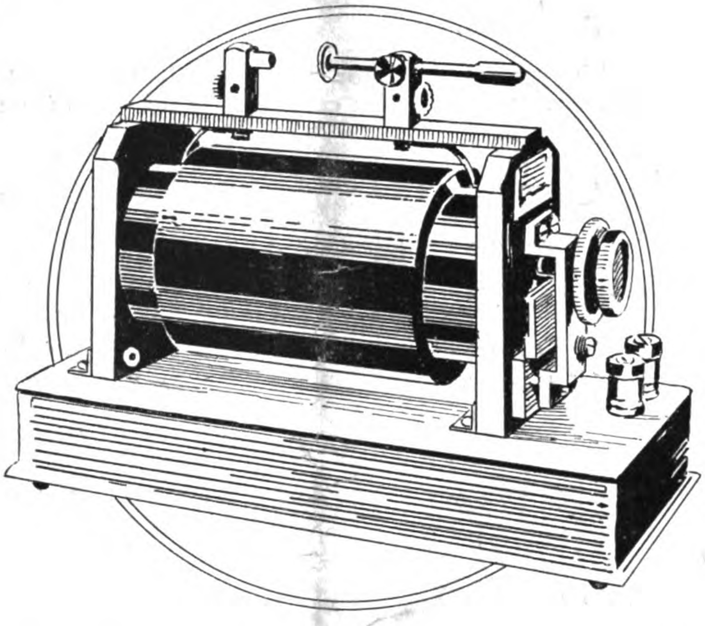

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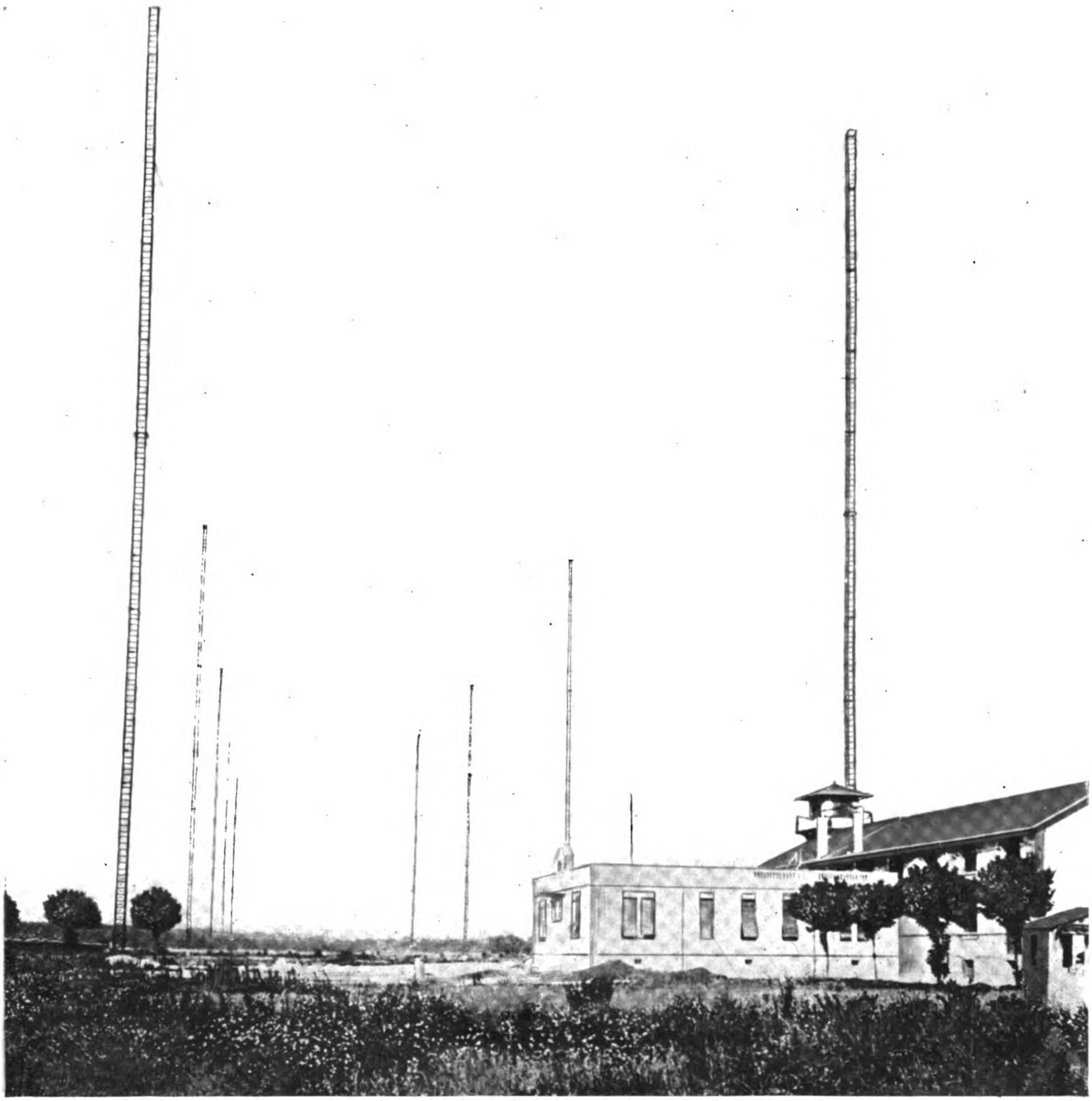
The WIRELESS AGE

Volume 7 Number 12



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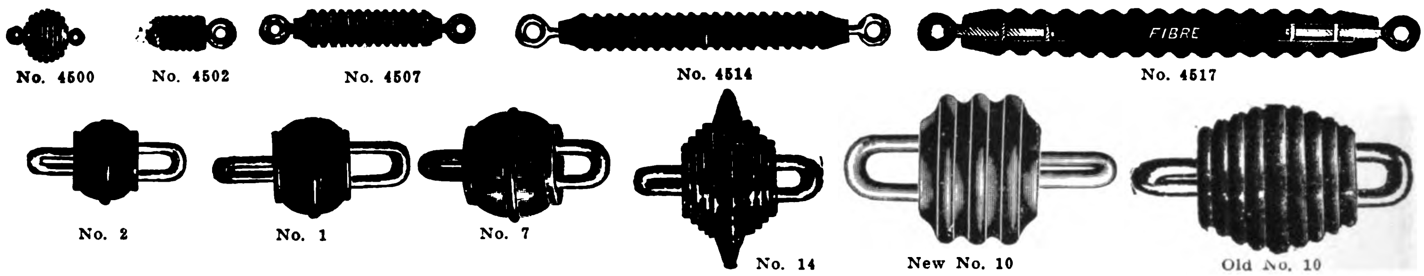

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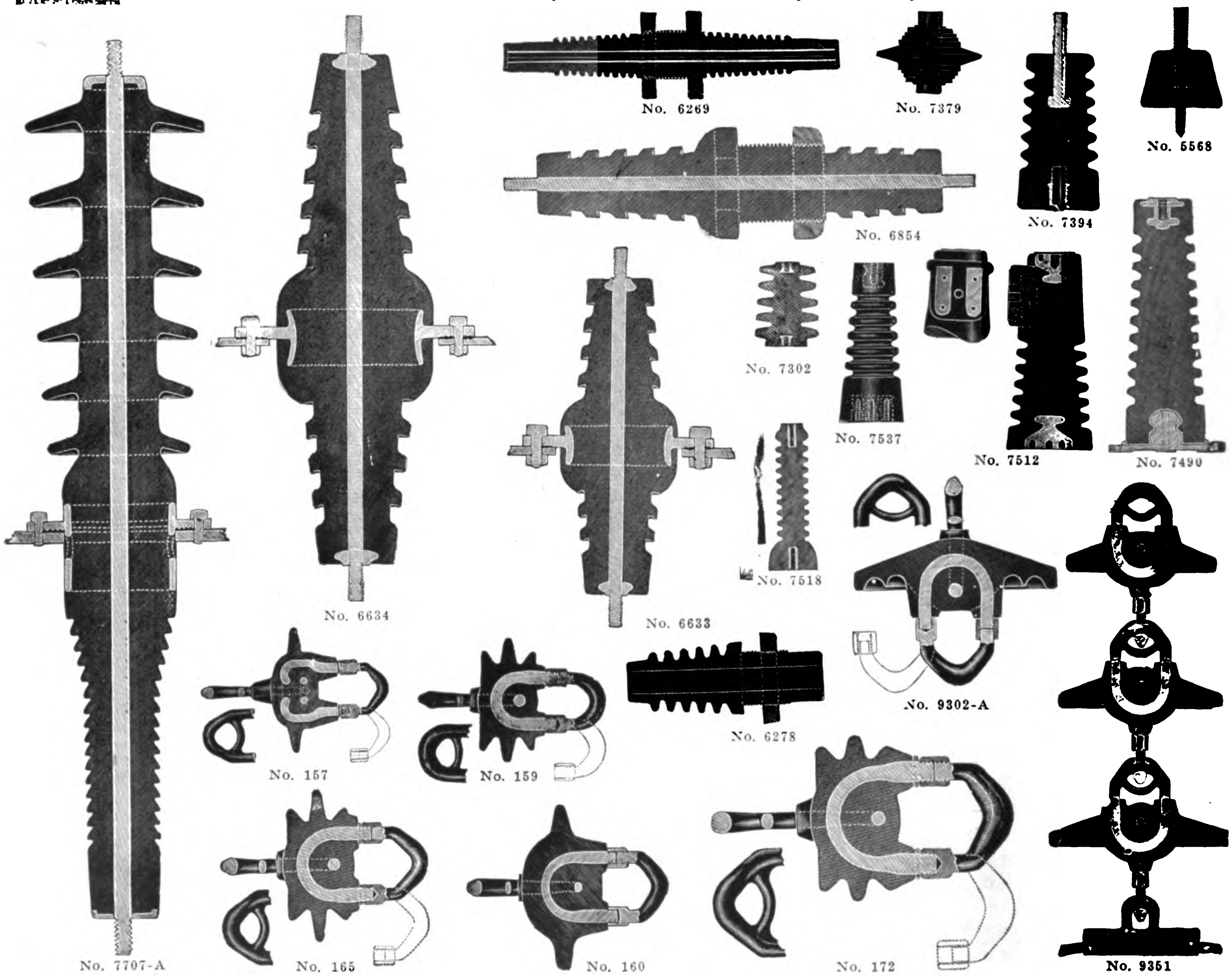

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Vol. 7 Contents of **The Wireless Age** for Sept. 1920 No. 12

Edited by J. ANDREW WHITE

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Owing to the fact that certain statements and expressions of opinion from correspondents and others appearing in these columns from time to time may be found to be the subject of controversy in scientific circles and in the courts, either now or in the future, and to sometimes involve questions of priority of invention and the comparative merits of apparatus employed in wireless signaling, the owners and publishers of this magazine positively and emphatically disclaim any privity or responsibility for any statements of opinion or partisan expressions if such should at any time appear herein.

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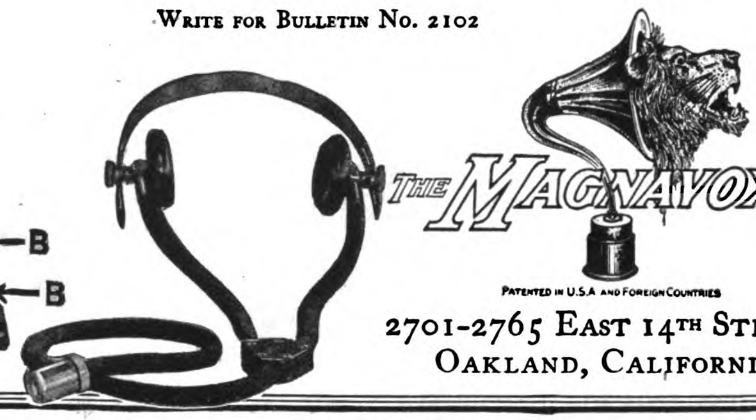

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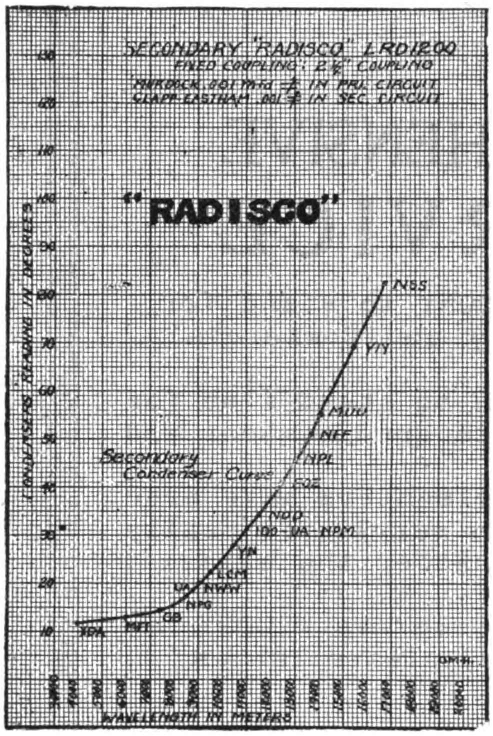

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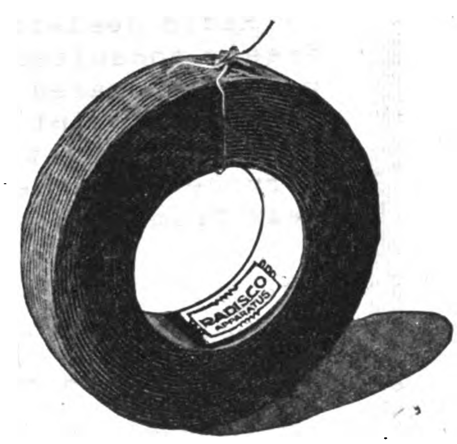

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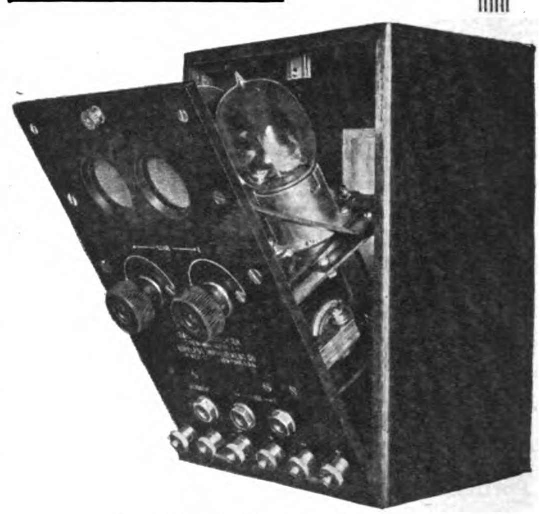

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Radio Engineers and Manufacturers

47A 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. 8)

Vol. 7. No. 12. SEPTEMBER, 1920

THE WIRELESS AGE

WORLD WIDE WIRELESS

International Yacht Races Reported by Radio

IN the international yacht races radio and seaplane and dirigible were used by the Evening Post and for the first time a detailed report was given by wireless from the air.

Beyond all doubt future yacht races and such events will be viewed from above, and wireless telephone and telegraph will transmit the story to the printed page. They will be watched from the air because from above the view is comprehensive and all-embracing; they will be reported by radio because all the air is a sending medium.

In the seventeen years since the last race for the cup wireless has become a perfect working machine and the seaplane carrying wireless equipment has been perfected. Today we are able to report the yacht races from a seaplane equipped with a radio outfit direct to land, to receive the signals loudly and with the utmost certainty and to send immediately acknowledgment of receipt by radio to the seaplane.

For the 1920 series of races a staff of three men—a reporter, a photographer and a wireless operator in a large seaplane, equipped with wireless, sent the story into the offices of the Evening Post. The machine was a large converted flying boat of the Curtiss H-16 type, with two Liberty motors and a 96-foot wing spread. It was equipped with a trailing aerial 500 feet long and a transmitting set with a sending radius of more than one hundred miles. Reports were sent direct to the offices of the Evening Post, where they were transcribed by operators and set into type.

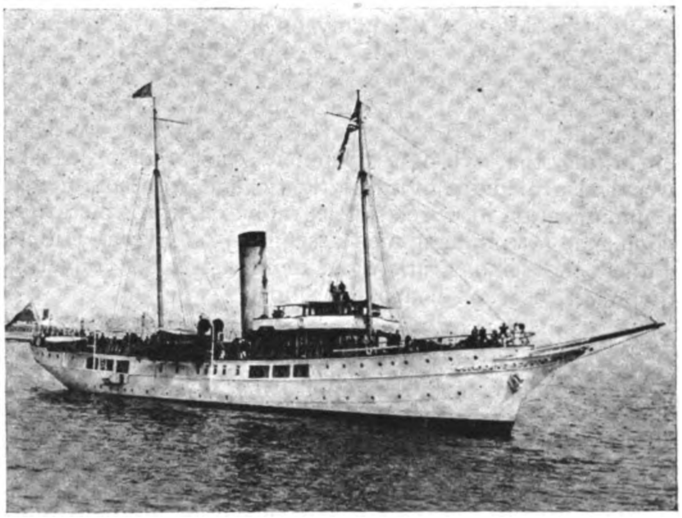
The receiving set was very sensitive, highly selective and capable of giving loud signals to facilitate copying without headsets.

The antenna used consisted of a number of parallel wires stretched above the roof of the building to a nearby building and running into the sporting editor's office. Appropriate ground connections and lightning protection switches were provided. The installation was carried out by the Radio Corporation of America. The actual receiving set and its adjuncts were specially assembled for these tests by the research department of the corporation. The receiver itself is a highly selective coupled instrument of the type used by the United States Navy. The received signal passed into a powerful multi-step amplifier using vacuum tubes for the amplification.

Those carrying on the tests were not content to use the ordinary methods of receiving wireless signals, which require the operator to wear clumsy telephone receivers strapped to his head. An additional amplifier of very special design was provided, which increased the volume of the signals in a loud speaking telephone receiver until it was very easy to read them all over a large room without wearing any telephone receiver whatever.

Some idea of the loudness of the signals can be gained from the following unusual results. Land and ship stations were easily read at a distance from the receiving set. The time signals regularly sent out from Arlington, Va., several hundred miles away, have been read three floors below the receiving set in the same building. While the signals from a distant ship station were thundering out, one of the attendants of the set remarked, "I'd rather listen to a hot battle in France than this racket."

The West Street, New York, station of the Radio Corporation of America was used for answering the airplane's messages on a special wavelength. This station is admirably suited for the purpose, being normally used in carrying messages to and from ships. The Radio Corporation made the necessary alterations and additions in the West Street station whereby the signals of that station would be readily received on the airplane but without interfering in the least with the usual harbor radio traffic.



Indicating the changed conditions in communication since the international yacht races seventeen years ago, this view of Sir Thomas Lipton's yacht Victoria, with wireless antenna strung from her masts, illustrates the modern marine practice of communicating by wireless

A loop telegraph wire was then connected between the receiving set in the Evening Post building and the West Street station, and the control key of the West Street station placed next to the receiving set. Thus the receiving operator in the newspaper building controlled the transmitter in the West Street station, although he was a considerable distance away. This novel departure neatly met the requirements and had the further advantage that it could be used for "duplex" working if desired.

The procedure in handling traffic was along the following lines: The seaplane sent its report of the yacht race to the Evening Post building. The receiving operator sent back his answer to the airplane from the West Street station, controlled over a telegraph line.

Results of Radiophone Experiments at Signal Hill Station

DISTINCT wireless telephone messages were exchanged July 24 between the Marconi Radio Station at Signal Hill, St. John's, N. F., and the steamer Victorian over a distance of 1,250 miles, according to announcement made by the manager of the station.

He said that the Victorian reported giving a wireless telephonic concert for passengers aboard the Olympic and other steamers and that thanks were returned by the same means from some of the ships.

The concert was repeated several hours later, with favorable results. The Victorian also was in constant telephonic intercourse with stations in England.

Highly successful conversations by wireless telephone took place July 25 between the station on Signal Hill, at St. John's, N. F., and the steamer Victorian, 600 miles distant and bound for Sydney with the Imperial Press Conference aboard. Keen interest was shown by the citizens of St. John's, who saw Marconi's original wireless telegraph experiments nineteen years ago, and the progress of the Victorian with daily bulletins of the telephonic concerts and other communications was eagerly followed.

The delegates were officially welcomed by wireless telephone to this side of the Atlantic when Premier Squires, in the name of Newfoundland, speaking into the transmitter, greeted Lord Burnham, Chairman of the delegation, on the Victorian.

The conversation lasted five minutes. Lord Burnham acknowledged the greetings and on behalf of his associates thanked the Premier for his welcome and complimented the Marconi Company on its great achievement.

The voice sounds from the ship came perfectly and every syllable was audible, said Mr. Squires, and he expressed the opinion that the experiments would mark an epoch in the history of wireless development by demonstrating that wireless telephony can become just as practical a medium of transatlantic and transcontinental communication as wireless telegraphy. During the afternoon many prominent men assembled on Signal Hill to witness the demonstration and took part in the conversation with those on board the ship.

When Chelmsford, England, was giving a wireless telephone demonstration to Denmark at 5 P. M. on August 2, the experimental station on Signal Hill, St. John's, N. F., picked up the sounds and heard, without interruption, the words uttered by H. J. Rounds, the manager at Chelmsford, who was talking with the operator in Denmark.

Mr. Rounds was heard to tell Denmark that Melchior would sing. Signal Hill kept in touch and heard distinctly four songs sung in Danish, as well as the conversation that followed between Denmark and Chelmsford. Chelmsford and St. John's are 2,673 miles apart.

Radio Compass Directs Airplane to Ship

GUIDED entirely by radio compass signals, a naval seaplane F-5-L left Norfolk and flew 95 miles on a "bee line" to pick up the battleship Ohio at sea, with no knowledge at the time of taking the air of the vessel's location. The seaplane then navigated its return to Norfolk entirely by radio compass.

Navy Department officials to whom the flight was reported said it was the first time radio compass apparatus had been used to direct aircraft to a ship.

Marconi on Radio-Pictures

"VERY interesting and very important," Senator Marconi described the discovery of how to transmit pictures by wireless, made by Mr. Th. Andersen, a young Danish watchmaker.

"I have not followed the experiments, but I know it can be done," said Senator Marconi. "Pictures were sent over telegraph wires several years ago, and what can be done by wire can be done by wireless. It will be of great interest to watch the progress made. The two chief uses to which the discovery can be put are the quick transmission of photographs for newspaper and police purposes."

Chicago Talks to Catalina Island, 3,000 Miles Away

WIRELESS telephone communication between Chicago and Catalina Island, thirty miles off the coast of California, was established, when William Wrigley, Jr., owner of the island, talked to his representatives in Chicago. Twenty-seven hundred miles of land lines and thirty miles of wireless were used.

The telephone was tested for the first time when conversations were held between people in Chicago and the island. Voices were as audible as those in ordinary long distance telephone calls, it was said.

"It was wonderful," said Mr. Wrigley, who talked thirty-five minutes. "The only thing to mar the conversation was Mr. Patrick asking me the score of the Cubs' ball game, and the Cubs lost."

Radiophone Messages Between England and Denmark

AN ATTEMPT was made on July 31 to send wireless telephonic messages from Chelmsford, England, to Copenhagen. The conditions for the attempt were not absolutely favorable, the air being laden with electricity, but still the attempt was a success. The first message was a greeting from Queen Alexandra to the Scandinavian people. There followed other messages and finally the opera singer, Melchior, sang the Danish, Norwegian, Swedish and British national songs, in all of which not one word was lost.

Japan Links Warships and Airplanes by Radiophone

THE Japanese navy has established a wireless telephone service between warships and airplanes on the wing. According to the naval authorities improved wireless telephone apparatus is now installed on board all the warships belonging to the first squadron and will be extended to all the other warships within the present year.

Alaska Canning Industry Uses Radio

"THE PIONEER," largest floating cannery in the world, has left Washington for Alaska for the canning season. Besides carrying canning equipment, the barge has a complete wireless outfit, and quarters for crew and cannery workers.

California Issues First Franchise for Radiophone Service

THE first franchise for wireless telephone service to be granted by any city was approved by the council of Avalon, Calif. The new system is to connect the island with all mainland long-distance exchanges.

French Lafayette Station Finished

ONE of the largest and most powerful wireless stations has just been completed near Bordeaux, France. It was begun by Americans according to American plans, and was half finished at the time of the armistice. Now it has passed into the hands of the French Government and will be used to send messages half way round the world.

The antennae are carried on eight metal towers 240 meters high and cover a space a kilometer and a half long and 400 meters across. Each tower, which is supported on three legs, weighs 550 tons, a quarter of the weight of the Eiffel Tower.

This Lafayette station, as it is called, uses an alternating current of 11,000 volts, with a frequency of fifty cycles, which can develop Hertzian waves up to 23,000 meters. The distance at which messages can be picked up is estimated at 20,000 kilometers—about half the circumference of the earth.

Radio Corporation of America Completes Organization

THE Marconi Wireless Telegraph Company of America, which operated from 243 Washington St., Jersey City, with the New Jersey Corporation as agent, filed a certificate of dissolution in the office of the Secretary of State August 2, by which it ceased to do business in New Jersey.

Former United States Attorney-General John W. Griggs was president of the concern which has been absorbed by the Radio Corporation of America.

Radio-Controlled Moving Target for U. S. Warships

THE once famous battleship Iowa, which played no small part in the destruction of Cevera's fleet at Santiago, is being prepared at the Philadelphia navy yard for a unique target experiment.

Proceeding unmanned but under her own steam and controlled by radio, probably from seaplanes, the old sea fighter will become the objective of the big guns of the Atlantic fleet superdreadnoughts in Chesapeake bay late this summer.

This will be the first time American warships have used a moving craft for a target except in actual war.

It is expected the practice will give the gunpointers of the Atlantic fleet an opportunity to test their ability under conditions as nearly like those to be expected in battle as can be obtained.

Smoke screens will be thrown around the Iowa during the runs and the course will be changed at will through the radio control system, necessitating a change in range on all the firing ships, exactly as would occur in action.

Graded System Likely to Settle Radio Operators' Difficulties

THREE independent plans for a system of graded licenses for radio operators are being worked out, it is understood. The leaders of the wireless operators, in accepting the proposal made by Admiral William S. Benson, chairman of the Shipping Board, for the extension of the life of the present agreement ninety days, have communicated with the various locals of the association. In the meantime they are endeavoring to work out a system whereby years of experience will be rewarded with better pay and the amount of work done will have some relation to the wage received.

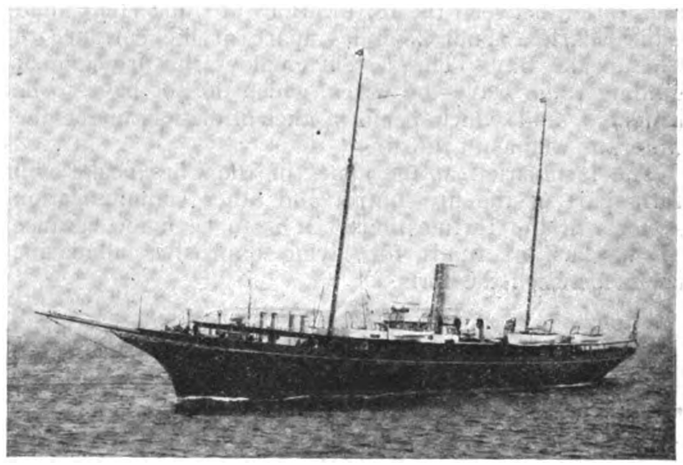
The Shipping Board has referred the matter to Eugene Chamberlain, Commissioner of Navigation. The American Steamship Owners' Association was not consulted by the Shipping Board prior to the suggestion of an extension of ninety days in the life of the agreement. It is known that the shipowners are opposed to the granting of increases in wages to the operators, although they are not unsympathetic to the desire of the wireless men to better their condition.

The radio operators are working out a plan, which will be submitted to Commissioner Chamberlain for due consideration.

It is reported that the three wireless companies, which are under contract to the shipowners and the Shipping Board for furnishing sets and operators, are laboring on a plan which they think will solve the problem now facing the shipping interests.

The Shipping Board, in conjunction with the Commissioner of Navigation, is understood to be active in regard to the scheme. It is said that the governmental board feels that the radio service should be encouraged and that there ought to be some stimulus for an operator to remain in the service after he obtains the position of a chief operator. At the present time he could not make more than $125 a month if he confined himself to radio work.

The shipowners do not feel disposed to grant the demands made by the operators recently. The wireless men wanted an eight-hour day, with provision for overtime pay, increases of $75 monthly for chief operators and $50 for assistants, assurance that the operators would not be required to perform additional services on board ships and that they would be permitted to leave the vessels when they were in port. By figuring overtime on a rather liberal scale the shipowners figured that a chief operator, who did not have to be more than twenty-one years old, might draw as much salary as a first mate on a large freighter. They were not consulted by the Shipping Board, but it is understood that they have been asked to write to Washington and inform the Commissioner of Navigation what their views of the situation are.



The modern equipment of yachts like J. P. Morgan's Corsair, illustrated above, includes a complete wireless outfit

While it is felt that a strike among the radio men has been largely dissipated by the conference with Admiral Benson, the possibility has not been entirely removed.

At the present time there are only two classes of operators, chief and assistant. It is thought that the salaries of the operators should be increased with the performance of certain years of service. For instance, it is believed that the Commissioner of Navigation will recommend a certain percentage of increase every few years.

No statement has been made by the president of the United Radio Operators' Association since he returned from Washington, where the conference was held. It is thought that it will be several days before the system will be worked out to such a point that there can be an intelligent discussion of its merits and defects.

Wireless Signal Lamp

A WIRELESS signal lamp has been devised for various kinds of war work which enables the users to keep up communication under conditions where it would be difficult or imposisble to stretch telephone or telegraph wires. A barrage fire, for example, would be no hindrance to signaling by this new apparatus. It can be used between a ground station at the battle front and an airplane a considerable distance away, flying over enemy territory.

Maine Fisheries Company Uses Radio

A RADIO station has been established at Rockland Highlands, Maine, by the East Coast Fisheries Company. Primarily it was erected so that the company might communicate with its steam trawlers.

Wired-Wireless System Installed at Chesapeake Capes

ARRANGEMENTS are being made by the signal corps at the request of the chief of coast artillery, to install the new "wired-wireless" system of radio communication between the fortifications at Cape Henry and Cape Charles, about 28 miles apart, at the entrance to Chesapeake Bay. The system employs the principle of guiding radio waves by wires, which do not have to be insulated, and which perform their function under the water, as well as in the air.

The installation at the capes of the Chesapeake will form part of the fire-control and other communication systems at the fortifications. It is to be made because of the lack of funds for laying expensive submarine cables between the forts.

Marconi Radio Service Between Argentina and England

THE Government of Buenos Ayres made public, July 31, a decree allowing the Marconi Company to install and operate a wirelss high-power station to be used exclusively for communication between Argentina and Great Britain.

Wireless Wanderings

FLAT on his back an indolent philosopher held forth on the joys of "wireless travel," as he called it.

"We have been reading about the yacht races reported by wireless telephone. Then comes a successful experiment with transmission of pictures by wireless. Next we will have the wireless movie.

"When that time comes I shall be able to enjoy my penchant for foreign travel without the suffering of seasickness.

"I'll hire a movie aeroplane equipped with a wireless motion picture transmitter and start the flyer on his way. I'll lie here on my back and watch the panorama of the earth unfold on a screen mounted on the ceiling.

"When the aeroplane passes over a place that looks interesting I'll signal for the aviator to descend and get close-ups with the wireless movie machine, and start the wireless telephone to working so that I can hear what is going on."

Whether philosophers are optimistic depends on the philosophers. The indolent variety usually are. But even granting the optimism, the forecast is not so impossible as it may sound.

Grandparents of the present generation who might have dared to indulge in speculations on flying, wireless telephony and wireless telephotography would have been considered insane.—N. Y. Evening World.

Radio Message Explains Mysterious Blast off Jersey Coast

THE mystery of the explosion twelve miles off Avalon, N. J., July 28, was solved when Captain George Painter, of the motor schooner Mackintosh made explanation after arriving at Atlantic City from Beaufort, S. C., with a load of fish. They found that the 1,000 tons of oil discharged from the Cabrille, grounded on the Brigantine Shoals, was ruining the fishing. The engineer ignited a bundle of waste and threw it into the sea. The whole sea "caught fire" and as the flames streaked from oil pool to oil pool there were loud explosions and the Mackintosh had to escape as fast as possible.

When it became impossible to locate the tanker Kehuku it was believed that she had blown up. But this report was dissipated when a wireless announced that she had passed the Jupiter lightship off the coast of Florida.

Moonshiners Using Wireless

THE fight against the illicit still in southern West Virginia will never result in victory for state and Federal prohibition officers because of insurmountable difficulties encountered.

The layman does not realize the difficulties of enforcement officers, according to one revenue agent operating in the Charleston district. In one instance the resourcefulness of the moonshiner has surrounded his business with the protection of a wireless system. A complete wireless telegraph outfit has been installed in the mountains near the West Virginia, Kentucky and Virginia lines, through which distilling plants are notified by a code of signals from confederates when danger threatens.

Apparently meaningless wireless messages have been picked up in Charleston by William H. Moore, a wireless student, believed to have been sent by moonshiners "in distress."

The new method of protection not only has worried but has seriously handicapped raiding officers, who swoop down on a spot where a still was reported to be in operation, only to find the outfit missing.

It is said that several of these radio stations are located convenient to railroad towns and are used by confederates of moonshiners when a suspicious stranger or an officer known to the clan is seen in the town or about to leave on a mountain raid. One of these outfits is reported in the Pound section of eastern Virginia, where moonshine formerly flowed freely, but following a general raid Corburn and nearby towns are reported dry as the proverbial bone.

So far as known these are the first moonshiners in the country to adopt a wireless system in connection with their business.

Pictures Transmitted by Radio

A DANE, Th. Andersen, has made an important invention by means of which pictures and sketches can be transmitted by wireless over long distances, for instance from Europe to America.

The invention has been tested by experts who pronounced it to be of great practical value, especially for press illustrations. The apparatus is of the most simple construction and easy to work. Any wireless telegraph or telephone system can be used for transmission and the cost of working is said to be very low.

One Copenhagen newspaper has published two photographs sent by means of the new invention, one of them being a portrait of Chancellor Bauer despatched from Berlin.

The New Radio Station at Lyons

Disposition and Housing of the Installations

By Lieut. Leon Faljau

EDITORIAL

LIEUT. FALJAU'S account of the Lyons radio station in this issue invites comment regarding several points.

The arcs in use at Lyons are, in many ways, of interest to Americans. For their power they are as great an improvement over previous types of the same output as the Curtiss turbine was over the reciprocating types of engine. The French have installed the Elwell design of the Poulsen arc while the U. S. Navy so far has favored the Federal company's type. Altho the latter has an iron weight efficiency vs. power output only about 10 per cent. that of the former, a greater conversion efficiency over a wider range is claimed for it. Elwell engineers collaborated in the installation of these arcs after designing them. Whatever may prove to be their "survival value" the Lyons station is a tribute to American engineering initiative in this respect.

The generous spaces allowed for future additions are very noticeable in this station and are in line with the American tendency, as the multiplex idea is approached in large stations, to regard the station proper as a central generating station, controlled by substations.

The French have gone to some trouble to keep the mechanical and electrical features of the antenna up-to-date. Their method of securing better current distribution in the antenna and the concomitant increase in mechanical stability is worthy of study.

The double system of speed control of the 20,000 cycle generator set is ingenious. It naturally invites comparison with the Alexanderson system, which regulates even more closely.

The "blanks" of sending are those intervals during which the "choking" resistance of the antenna is in circuit. This has the advantage in some cases over the compensating wave, that the change in full sending current is more rapid—the presence of resistance assisting the changes through decreased time-constant. The compensating-wave system may require more time to achieve the required resonant rise on the sending interval, and a 200-word a minute sender may not afford the time needed. One may "chop" a wave mechanically as rapidly as desired, at some cost of broadened tuning, but one may not control its growth except by purely electrical means. It is a question for careful judgment, as to which of the two systems can be evolved so as to finally outstrip the other in sending speed. American practice of 50 to 200 words a minute for commercial service augurs well for immediate expansion of projected commercial systems of world chain stations, to challenge the ubiquitous cable.

Those who laid the ground work of radio engineering before it came to be listed in academic curricula will note the confidence with which attention is drawn in Lieut. Faljau's inventory of special features, to the original design of the antenna loading-coil. It is a hyperboloid of revolution, having the radius of top and bottom turns equal to its height. Surely the designer must have heard of the constant flux coil known a generation ago and clearly indicated in Gray's "Measurements in Electricity and Magnetism," not to mention numerous similar works.

Gray, applying Maxwell's equations, shows that a new diameter required for an additional turn to n turns on a coil, must follow such a law that the resultant field will continue to "follow" the coil profile. This means an increasing diameter. Years ago the General Electric Co. used an hyperboloid choking inductance in its lightning arrestors.

The general fact that the flux area increases as it leaves the coil, and even swings around at a critical distance from the coil-face, was shown by Gray and others to allow a maximum coupling, with a given flux in the primary, of a secondary of critical diameter, at the critical distance. The Campbell mutual inductance standard is based on this principle. Two primaries are placed at the critical distance on opposite sides of a secondary of the critical diameter. The condition of a maximum coupling causes the accidental errors due to unknown displacement of the secondary coil to be practically zero. Whatever residuals are present cancel out.

American firms long ago saw the advantages as regards improved time constant and coupling qualities in the hyperboloid, but they cut it in two on account of mechanical considerations. As the tapered or conical coil it has been tried out as early as 1906, but the production engineer will have none of it.

The Lyons station is a tribute to French thoroughness and sense of refinement and to American initiative in showing the world that the high frequency alternator was practical before the quenched spark was applied to radio.

THE Lyons radio-station situated at Villeurbanne, France, n.e. section of the larger city, back of the Rhone dikes, now affords the appearance of a large transformer substation.

As a matter of fact the energy supplied to it by the Jonage lines, as 50-cycle three phase current, is transformed there into high frequency energy and distributed throughout the world to different correspondents by means of one or another of the four arrangements now in operation, viz:—

A spark station of 150 kw. Arcs of 200 kw. Arcs of 450 kw.

The new 150 kw. Bethenod alternator of 20,000 cycles.

The station, properly speaking, comprises the machinery hall where are assembled all the transmitter installations, an adjacent office building, where among various divisions is found the receiving and telegraphing room and an annex, situated at the north of the main hall, containing the 200 kw. arcs.

The machinery hall shows in plan, the aspect of a

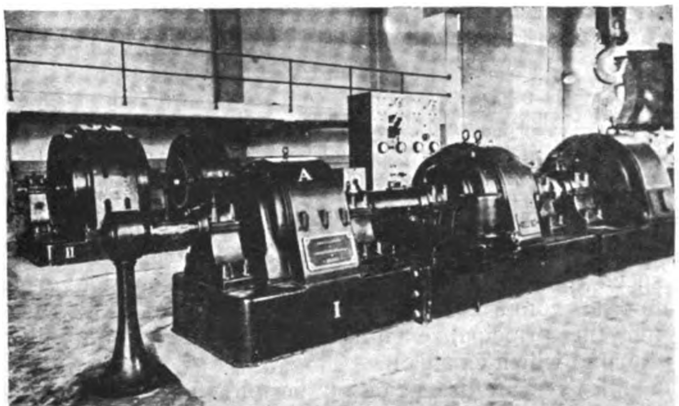


Figure 2—The two sets for the spark station

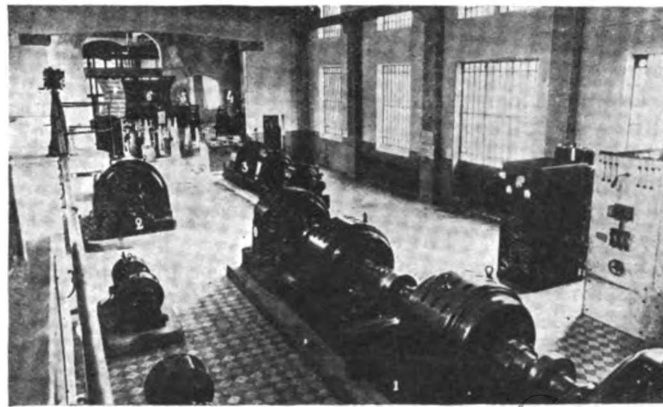


Figure 5—The Bethenod Set, marked as No. 3, in background; at the rear-right (No. 4), are the four Tesla coils

vast "T" and the small sketch herewith attached shows the arrangement of the apparatus in this hall.

The rear of the hall is partitioned off, forming in this way a large section containing the apparatus constituting the damped wave set. On this side are found the Jonage supply—at 3000 volts—to the transformer group, the two groups of 450 hp. feeding the damped wave set; their excitation auxiliaries and on a platform, the switchboards. At the middle is placed the high frequency group, the dc. set which furnishes it with the necessary driving current and its own switchboards. The large

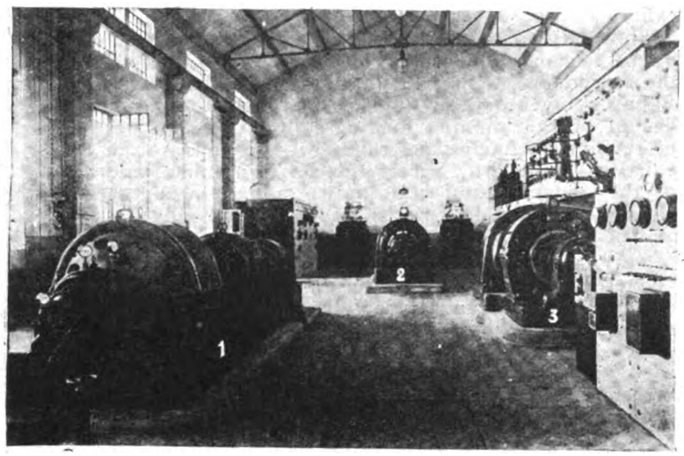


Figure 4—At the back, the spark sets and the transformers. In the foreground, the Bethenod Set. To the right, the 3-phase motor-generator set driving the H.F. set

antenna, loading-coil of which we will again speak, occupies an emplacement which is at this end, under the cupola.

We thus come in our progress, to the transverse part of the "T" where are on one side, two arcs of 450 kw., the group of 680 hp. which supplies them and various switchboards; on the other side—an emplacement still vacant which will certainly come to be occupied by new apparatus—a new alternator according to all probability.

All the accessory apparatus, pumps, compressors, rheostats, contact-makers, etc., are mounted in the basement, being controlled, for the most part, by switchboards in the hall.

The operating room is conveniently arranged in the neighboring building. Two large tables there, hold the manual or automatic sending apparatus, the tape-punching machines and the receiving systems. A desk-switchboard carries the cut-outs and the switches for the 110 volt dc. supply which works the various relays (key and turbine types) and the contactors. Finally, an indicating signal transmitter, of "marine type" connects the hall of machines, to take care of orders to start, stop, etc.

The installation thus shows in its entirety the qualities of fitness, order and thoroughness of a modern electric station, and also allows for new and necessary arrangements which will be necessary in order that the station may measure up to the progress made in the radio art.

The spark-set has been out of commission for some time already, and without doubt it will be shortly dismantled. As for the 200 kw. arcs erected rather hastily in an independent building, they are from now on almost entirely to be replaced by those of 450 kw. I will therefore intentionally pass over the description of these old-fashioned installations, in order to devote myself at some length to the new arcs and the alternator.

The 450 kw. Arcs

The arcs are two in number and can be put alternately into service during the time that the work of maintenance requires the shut-down of either one of them. They are of the Elwell type and are made up in the following manner:

At the center of a double walled bronze chamber, which a current of water cools, are situated the pole pieces of an electromagnet. It is in the air-gap of these pole pieces, whose diameter is greater than 32 cm. that the arc starts between an anode of copper and a cathode formed of a carbon cylinder, 6 cm. in diameter, mounted in a revolving tube. The current which starts the arc, supplies the electromagnet, and the action of the switches allows any desired field to be obtained, by putting more or less of the field-winding turns into action. The cathode is grounded, the anode, insulated from the arc chamber by a quartz cylinder, is connected to the antenna loading inductance and the whole is shunted by a battery of condensers.

At the side of each arc is found a desk-switchboard, for the controls for the contactors of the field-switch and the water and gas cocks. That for the contactors, "shorting" the series resistance, is placed in the circuit first to provide "choking" and then to let the set function. The same 110-volt dc. current serves to work these controls and it may be broken at different places in the station when safety requires the complete cessation of transmission. No false manipulation need be feared.

The sending is effected by short circuiting an inductance of small size interposed in the antenna, and thereby producing variations of the transmission wavelengths. The longer wave is the signal wave. It is the working wave, and the shorter wave—the compensation wave—corresponds to the sending intervals.

The sending-key, which has to make or break the "short" of that inductance, is a powerful and delicate relay. It comprises a primary electric relay, worked by the sending-key in the receiving-room, this relay then acts on a double pneumatic system of small inertia, working an arm carrying contactors. The arc produced at the break between the silver contacts is extinguished by

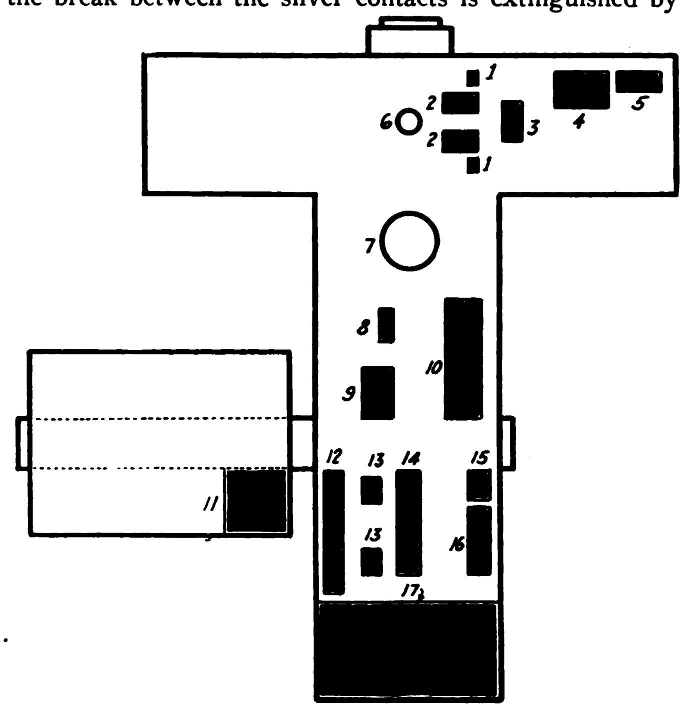


Figure 1—1—Desk switchboards for arc. 2—450 Kw. arcs. 3—Switchboard for same. 4—680 H.P. group. 5—Excitation group for same. 6—Telegraphing inductance. 7—Large antenna loading-inductance. 8—Switchboard for starting up H.F. group. 9—Group of convertors. 10—High frequency group. 11—Reception and sending room. 12—Switchboards for the damped wave set. 13—Exciter for these groups. 14, 15—Switchboard for starting up the Convertor Group 9. 16—Transformers. 17—High tension room for the damped wave set

an intense air current. These keys permit a sending speed of 2500 words per hour. The excitation group in itself comprises an independent motor of 14 hp. driving the principal exciting dynamo and the auxiliary dynamo which excites it.

This system of excitation permits perfect regulation of voltage at the arc terminals.

A desk-switchboard placed near the arcs carries all the measuring apparatus pertaining thereto, and the controls of the starters and of the field rheostats which are located in the basement. The arc current is furnished by a dynamo of 6 poles—separately excited—capable of giving 450 amperes at 1000 volts. An asynchronous motor of 680 hp. is employed to drive it.

THE BETHENOD ALTERNATOR

For some time the radio post has had the high frequency alternator constructed under the supervision of the S.F.R. and the Alsacian Society, as the result of very satisfactory trials, and it is now in regular service.

The high frequency group proper, comprises a con-

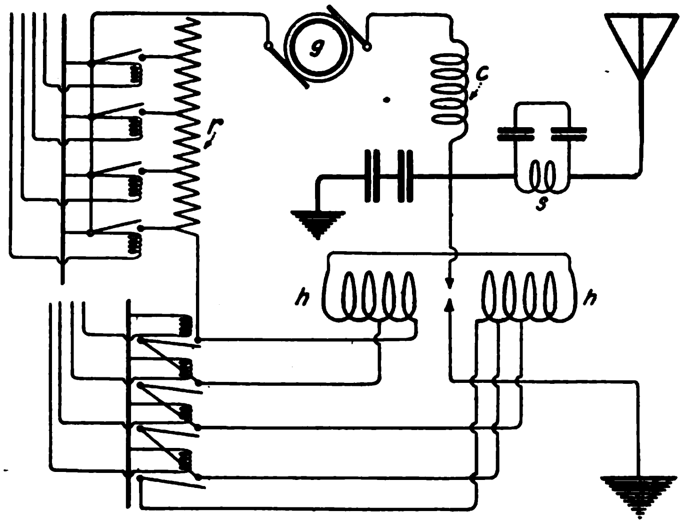


Figure 3—Scheme of arc connections

tinuous current driving motor of 450 hp. coupled to two single-phase alternators, of 1000 and 20,000 cycles respectively. The first of these two machines is intended to function during the telegraphic blanks in transmission in order to keep constant the work of the group and consequently its speed; as a matter of fact, experience has shown that it acts sufficiently like a fly wheel through the mass of its rotor, and so its windings are not connected in. It may be used, in addition, to supply a musical spark-set in case the 20,000-cycle machine migh be broken down.

This 20,000-cycle machine is a homopolar alternator with revolving inductor. The rotor is unwound, is about 1 meter in diameter and revolves at a speed of 3000 r.p.m. Excitation is furnished by a winding, normal to the axis carrying 110-volt dc. The magnetic circuit is formed through the body, the rotor and the stator. The stator carries four pairs of coils, parallel mounted, each connected into the primary of a Tesla coil; the four secondaries in series-parallel are connected into the antenna. The method of sending consists in short-circuiting every one of the four stator windings, the short-circuiting current then being about 60 amperes in each of these sections.

The great difficulties encountered in construction are caused by the necessity of maintaining the speed of the group perfectly stable, from the balancing of the machine at 3000 r.p.m., and from heat-rises which hysterisis and eddy current losses produce, and which are difficult to eliminate.

The alternator-poles have been made with their cores very finely laminated—.01 mm. The pole faces being very much reduced—4 mm—the air-gap had to be reduced in proportion. At normal speed it does not exceed 3 mm.

A pump maintains the circulation of cooling-oil through the rotor, by a hollow shaft and around the stator. Another four-cylinder pump keeps up a vacuum in the body of the machine between the stator and the rotor. Finally a system of grease lubrication under pressure supplies the bearings.

Regularity of performance is assured by two systems. One regulator, mechanically driven by the group, acts on the excitation of the driving motor, and on the other hand, the voltage at the mains of the dynamo, supplying this motor, is itself maintained constant by a second regulator, of the Thury type, acting on its excitation. This last supply dynamo with 6 poles, and separately excited, capable of giving 750 amperes at 500 volts, is driven by an asynchronous 750 hp. motor depending on the 3000-volt, 55-cycle current of the supply net-work of Jonage.

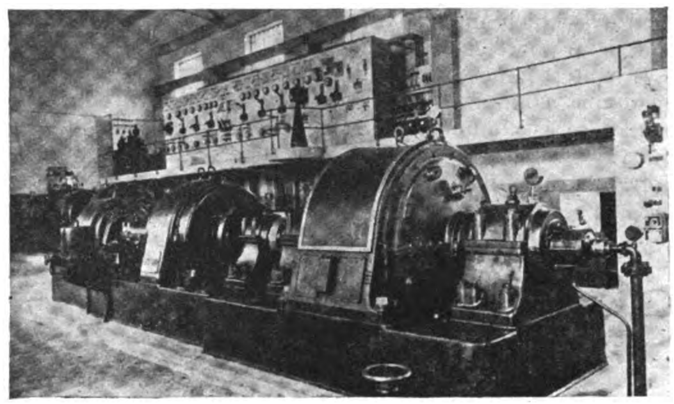


Figure 6—The Bethenod Set. From left to right, alternator giving 1000 cycles, driving motor, 20000 cycle alternator

In spite of the complexity of its mechanical elements, the group is very easily handled. It has—above all high power systems used to date—the advantage of giving a perfectly pure sustained wave. Checks by the Dufour oscillograph—recently effected—proved the form of the voltage sinusoid to be very regular. Though the machine requires careful watching it gives a steadiness of performance unknown to the arc, which requires frequent stops to change carbon, fix up the arc-chamber, etc.

THE ANTENNA

The antenna is a formidable rectangular sheet raised to a height of 180 meters above Grand-Camp. It is supported by two rows of four masts, arranged to follow the long sides of a rectangle, having nearly 1 kilometer length and 240 meters breadth, oriented practically east

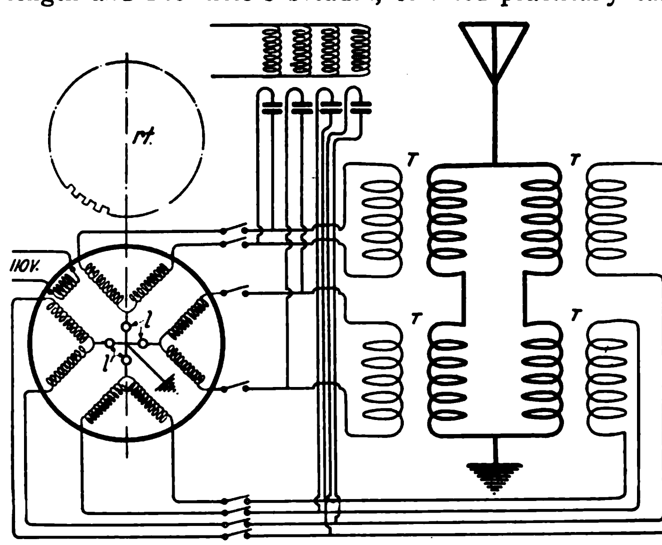


Figure 7—Scheme of alternator (20000) arrangement. rt—toothed rotor. l—lamps for grounding the mid-point of the stator windings. T—Tesla coils

to west. The two masts placed at the end of the sheet and at the entrance to the station are 200 meters high, the ten others are brought up to 180 meters.

The antenna surface is formed of twenty cables suspended parallel to one another. The respective distances between these cables increases from the ends automatically toward the station, which gives the double advantage of permitting an equal current distribution over the length thereof and of buoying up the centre of the sheet, thus diminishing the stresses in the supporting cables. On the east side all the cables fall directly toward the stations and are joined in a "crow's foot" to the cupola, which tops the hall over the large inductance.

The high powers put into action require considerably high insulation of the sheet and of all the metallic parts which hold it. The sheet is insulated from the masts by long chains of insulators. The masts themselves are insulated from the soil and rest on marble slabs and the guys which support them are sectionalized in various places by porcelain egg insulators.

In spite of these precautions continual maintenance of insulators is found to be necessary and the problem of insulation is complicated every day by the use of continually growing powers. When the 200 kw. arcs function one can still measure 100 volts between the soil and the last section of the guys below.

The antenna loading coil, studied and constructed through the efforts of the station officers, has the original form of a large hyperboloid of two meters in height. The largest section, that of the bases, is four meters in diameter. There are 28 turns of a copper band formed of thin laminations, insulated from each other, to reduce their high frequency resistance. Thanks to the carefully calculated action of this inductance the flux across any section is constant. Its rise in temperature is found to be much diminished and its efficiency considerably increased.

Such is, in a few words, the large station which connects continuously, France and America, and whose "press" is received even in the extreme Orient.

Before closing this brief description, I have to thank General Ferrie, to whom we are indebted for permission to publish these lines and for the series of photographs of his station and I ask my readers to join with me in giving homage to the commanding officer who has been capable of endowing our country with the model station which every day attracts the flattering curiosity of foreign delegations.—O. C. R.

Should all (Radio) Men be Created Equal?

By Edward T. Jones

EDITOR'S NOTE: In this article a wireless man with the broadest experience discusses a vital problem of present day commercial operating. In no sense is it propaganda for any interests, nor is it inspired by individual or associated employers. The manuscript came through the mail in the regular way and was submitted voluntarily by the author, who wishes to advance the art and asks that what he says be taken in all sincerity as the uninfluenced viewpoint of one who has made radio operating a vocation and rises to protest at the unsound conditions which have recently developed. It is published in the belief that these discussions will result "for the good of the service" and the Editor extends a wide open invitation to all interested to submit their views for publication.

RADIO OPERATORS! Radio Operators!—the constant cry of the shipping concerns.

The situation reminds one of the day the United States began to mobilize men for the great test against Germanism. Never before have we experienced such a boom in radio circles!

Three commercial radio concerns have opened service stations at fourteen points; namely, Boston, New York, Philadelphia, Baltimore, Norfolk, Savannah, New Orleans, Galveston, Seattle, Portland, San Francisco, San Pedro, Honolulu, and Cleveland to care for Shipping Board vessels under their supervision and in accordance with contracts entered into with the U. S. Shipping Board.

Transatlantic operating room of Radio Corporation of America, where expert commercial operators are employed

Competent men were needed to man these important posts and the list of old timers was practically exhausted. Then came a further drain upon the few pioneers, for the Shipping Board called for Radio Supervisors at each of the points mentioned.

Yet we hear a lot these days about wireless operating and the lack of good future.

The future depends entirely upon the individual. We who have worked our way up can look back and realize the path we have traveled. It is a straight and narrow path, and not an easy one, for its ascent meant the use of much midnight kerosene and the acquisition of tough palms. Too few endeavored to follow.

Sliding Wage Scale Best

The average pay today of a Wireless Operator is $125 per month, against the pre-war scale of $40, $50, and $75. The pay is attractive, but the question arises whether efficiency and improvement of the service as a whole will result from planting a man aboard a ship at $125 per month and holding him stationary.

Experience Counts for Naught These Days

According to the present wage scale when a young man emerges from a radio school with a license—and few are so feeble-minded that they can't pass the present Wireless Examination—the sweet graduate proudly walks over to a commercial radio company and hangs up his hat with those who have been actively engaged in wireless telegraphy five or more years.

It's all wrong. Some form of sliding scale should be adopted. I do not care to attempt fixing a maximum wage per month, but I do believe that a man without any experience in commercial wireless telegraphy should not receive more than $75 per month to begin. Let him then show his mettle, experience the hard knocks familiar to all old timers, and gradually attain the stature of a *man* and—after a certain length of faithful service—automatically have his salary raised.

There should be:

Something to look forward to.

Something to be proud of.

Something by which the shipping concern can have guaranteed Service, with a capital S.

Understand, I am not placing a limit to the salary a top-notcher should receive; I believe he should be paid in comparison to other officers of the vessel with whom he ranks. But it is worthy of emphasis that in the daily performance of their duty the other officers of the vessel constantly furnish guarantees of their ability and faithfulness, whereas the operator's primary duty is in connection with the safety of life at sea—and his test of sincerity, faithfulness, and ability, only comes at a critical moment. It is when the vessel is in distress that the wireless operator is of ***prime importance.*** What guarantee has the ship owner that he will perform his duties faithfully?—without experience.

Lengthy experience equips a man to handle most any situation; for that reason alone he should be paid a higher salary. There is no other vocation that classes the beginner and the expert alike, paying the same figure of compensation from assignment until death.

SECOND GRADE TICKETS

Consider the man with a second grade ticket. Does he deserve the same salary as a man holding a first grade ticket? On a one-man ship it matters not, according to the present ruling. On any ship a second grade man is not worth more than $50 per month to begin. Actually he is serving an apprenticeship with pay. In many other trades, board and lodging would be the sole return.

OPERATORS BETTERING THEMSELVES

Maybe this is the reason why out of every ten men you will find about two who keep up with the radio game, through magazines, books, or otherwise. In fact, lately, due to the ever increasing demand, wireles operators appear as a class of world tourists only, for it is generally known that most operators make one trip per vessel. Why should they worry? All ships pay $125, and it matters not where one goes; it is easy anywhere to secure a billet.

Not until some arrangement is arrived at whereby justice shall be meted out to all, and wireles operators strive for the betterment of the art by devoting their spare time to personal improvement through study, shall we receive the recognition our skill merits.

Let me give an example of present day conditions:

An operator from a certain vessel came in one day and reported his "machine" sparking. I immediately asked whether it was the motor or the generator. After a little pause he said that it was at the *left end!*

In no uncertain tone I inquired how was I to know what was on the left end of the "machine" on his particular ship!

That is but one among numerous instances. Many men, like this one, take a student's course or learn the questions and answers to the Wireless Examination, and know there is a motor and a generator in the "machine," but fail to observe which is which.

When you mention vessel assignment to this type of youngster, he invariably wants to know first of all, where she runs, how long is the trip, if the grub is good, if there are shower baths. When you finally convince him that the vessel is OK, likely as not he says in effect: "All right bring it in. Let's take a look at it." The average may not be half this bad, but we actually have one man in this district who insists that he will not sail without a private bath.

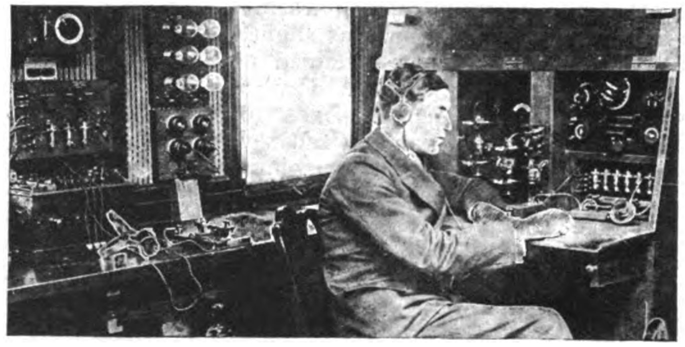
Our concern, however, is with those who are worthy of the traditions of the sea. Which brings us back to the subject of salary, with a view toward establishing a maximum salary for old timers and men of ability in conformity to the pay of ship's officers with the same rank.

For beginners I advocate the following wage scale:

Second-class license	$50.00	per month
First-class license, first six months..	75.00	per month
First-class license, second six months.	100.00	per month
First-class license, end of 18 months.	110.00	per month
First-class license, end of 24 months.	125.00	per month

And so on, according to the salary arrived at as the maximum, with allowance for 15% increases for an extra grade license governed by the periods of actual service as provided in the table.

I expect yells of "Murder!" from those at whom this paper is directed; which matters not, since my object is placing radio telegraphing on a higher plane, and there are many in the game who are fair-minded.



A corner of the operating room of the Radio Corporation of America showing some of the control instruments

When men start in at a small wage and something is placed in front of them as a goal, better service is a certainty. Higher efficiency requires general betterment and the men will actualy strive to do well so that when their time is up another addition of winged demons will find their way into the pay envelope. The employing company will also be given a fair chance to study and judge the men in their employ and weed out the unfit. The man with the ability will gradually rise and it's a certainty that the Company will not fire him because he has arrived at a large salary. Why? Because men like him are scarce as hen's teeth. If you don't believe it, inventory yourself and see whether or not you are fit to man a good healthy shore station job with its several Morse lines and radio schedules, not overlooking the other qualities necessary for such a position. Less than one out of every 100 men aboard ship today are capable of actually manning a good live hot shore station roast. Still they wind-jam about what they can do and what they have done.

In the next few years radio is going to be changed entirely; probably to undamped apparatus. How many self-styled operators will be ready to speak with understanding about the new gear? How many will keep tab on all the radio periodicals, study, and strive to perform their duties as a man in the radio profession should? Those who will have done these things will be the ones ready and willing to give to those who have been in the game before them and who are possessed with ability, the right to a better salary.

There is a need right now of a common sense agreement. What have you to say, old timers?

Universal Honeycomb and Lattice Coils

The details of checking the classification of the formulae for lattice windings are so numerous that the third instalment of this series could not be completed for the September issue. It will appear in October.

Radio Operator's Story of the Comus-Lake Frampton Shipwreck

WITH a calm sea and a cloudless sky affording ideal conditions of navigation, the Southern Pacific steel passenger steamship Comus crashed into the steel United States Shipping Board freighter Lake Frampton at 3.15 A. M. July 12th about eight miles off Atlantic City, New Jersey.

The freighter sank in ten minutes, carrying to death an oiler and a fireman. The Comus's bow was slightly damaged but the liner sustained no other marks of the impact. Few of her sixty-four passengers, most of them women, were panicky and several aided in rescuing the remaining thirty-two officers and men on board the Lake Frampton.

The story of the shipwreck is here described by H. L. McCeney, the Radio Operator of the Lake Frampton:

I was asleep in my bunk on the morning of July 12th when a crash which occurred at 3:15 A. M. threw me out. Running to the deck I heard the alarm bells giving their signals. I tried to reach the captain to get orders as to the transmission of any possible message, but the only orders the captain issued were: "Abandon ship immediately." We were going down rapidly.

The Lake Frampton listed to port so much that it was impossible to launch the life boat on the starboard side. However, the life boat on the port side was rigged up and about fourteen of the crew got into it and the lines were cut to allow it to float away. There was no chance for me to reach the life boat so I climbed to the starboard side of the ship which was high in the air at the time, and when I thought the ship was settling, slid down t' side into the water. It was quite dark and visibility was poor. After being in the water a while I swam toward the life boat, but it kept drifting away because the crew aboard had no oar-locks with which to control the direction of the boat. As it was impossible to reach it I swam toward the Comus, which lay off about one mile distant.

H. L. McCeney, radio operator aboard S.S. Lake Frampton, as he appeared on landing after the sinking of his ship

Reaching the Comus almost exhausted, I was hauled aboard in between decks through one of the square portholes, and from there carried to the baker's sleeping room, where warm drinks and dry clothing were given me. After being aboard an hour, the first operator of the Comus, Louis J. Gallo, took me to the wireless room. I had been reported missing, though I was one of the first to be rescued, but being on the lower deck, no report had been made on my rescue.

The collision and sinking of the Lake Frampton happened so suddenly that there was no opportunity to use the wireless apparatus in securing aid. From the time of the collision to the settling of the boat, about 15 minutes elapsed. The second operator on the Comus, E. L. Chesbro, was on watch at the time when the crash came. Gallo immediately came on deck, without being properly clothed, and sent Chesbro to get orders from the captain while he took the watch in the radio room.

The captain placed Chesbro on the bridge to operate the flash light and other signals to aid in rescuing the men from the sea, and consequently he did not return to the wireless room for over a half hour, so Gallo sent a message to the steamship company reporting the collision and stating that the Comus would stand by until daylight to aid in the rescue of the Lake Frampton's crew. Other stations stopped when Gallo interrupted with "QRX" and Captain Powers of the Lake Frampton later sent: "Lake Frampton rammed and sunk at 2:20 A.M. Oiler and fireman missing." Several ships and some naval stations who were calling for particulars were also worked. After all rescue work had been attended to and a thorough search had been made for the two missing men, the Comus steered for New York.

The first operator aboard the Comus, who was aboard the Sister Ship Proteus when she was sunk in 1918 by the Tanker Cushing, south of Diamond Shoals off Cape Hatteras, said the collision was quite similar to the collision of the Cushing.

Some Electrical Guides for Wavemeter Design

By Oscar C. Roos

FELLOW I. R. E.

SYNOPSIS OF PRESENT INSTALMENT

General requirements of a wavemeter as compared with a receiver—wavemeters and receivers vs. "stiffness" of circuits—physical definition and examples of stiffness—effects of stiffness—general design relations in wavemeter coil and condenser—unilattice detector connection—general arrangement—anti-capacity switches—relation of wire in coil to wavelength—low coil capacity—spiral short-wave coils, sectionalized coils—use of spacers in winding—points concerning "bank winding" vs. universal winding—uses of bilattice universal winding in wavemeters—fixed multiple inductances—economy of wire in inductances—phantom antenna in wavemeters—general remarks on material to be used.

ANY receiver where the presence of the detector does not appreciably change the resonant wave length of the tuning circuit, may be considered to be a wavemeter, if it has a permanent calibration.

Such a wavemeter is shown in figure 1. In place of the usual crystal there is shown a thermionic relay FGP, as a resonance indicator. Its presence does not perceptibly change the resonance period of the oscillating circuit CL. This may be stated in a more technical way by saying that its reactance at radio frequencies must be between 50 and 1,000 times that of the coil L or the condenser C which has an equal reactance at resonance. For example, if L is 300 mh. and C. is .000337 mfd., at resonance the reactance of L is 9,425 ohms, which must balance 9,425 reactive ohms in the condenser in a negative or opposite phase. This occurs at 600 meters or 500,000 cycles. If the condenser C tunes down to .000085 mfd., giving about 300 meters, the effective capacity of the detector and its related series condenser C′ and grid leak R should not be greater than .000002 mfd. in order to avoid increasing the wavelength at 300 meters resonance by more than 1 part in 85.

With increasing wavelengths to be measured, this effect diminishes proportionally to the increase in wavelength, so that at 600 meters the detector has increased the wavelength by only 1 part in 170.

Reconsider the above problem from the standpoint of an inductance of 150 mh. or one-half the previous value. Our tuning condenser at any given wavelength would have twice its former capacity, and hence the relative disturbance in calibration due to the detector would be half its former value, i.e. at 600 meters it now amounts to one part in 340. To get down to 200 meters, we may have to cut down the value of L once more. This will give us, to get 600 meters, L = 37500 cm. and C = .0027 mfd. Now there are many condensers giving a capacity range of wavelength of four times the minimum. To do this, the minimum capacity must be 1/16 the maximum or .000175 mfd. In using this capacity, corresponding to 150 meters, the detector will make a difference in the wavelength of one part in 175 or about ½ per cent. Any further reduction of L to decrease this detector effect is unnecessary and is positively harmful, as it decreases the ratio of L to C, whose square root is a measure of the "stiffness" of the circuit, and this broadens the tuning.

EXAMPLES OF STIFFNESS

Stiffness in a wavemeter circuit is measured in resistive ohms and when large, it gives to an electrical circuit a slow, very persistent oscillation, such as a stiff spring exhibits when released suddenly. Take the above circuit as an example. When tuned for 600 meters its stiffness—the square root of L_h divided by C_f—is equal to the square root of .0003 henry divided by .000,000,000,337 farad = 942 ohms approx. This is the best tuning circuit, and by contrast with it, the last circuit above considered—having L = 37500 cm. and C = .0027 mfd.—has only 1/8 of its stiffness or sharpness of tuning between 600 and 150 meters. There is an advantage in having less coil resistance in proportion to coil inductance or what is known as a better "time constant" in the .0003 henry coil. The 37500 cm. coil always shows that its tuning is broader unless very special and expensive refinements are introduced in the design of the coils to reduce their resistance to the lowest possible degree. This

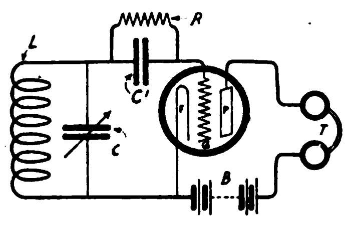


Figure 1

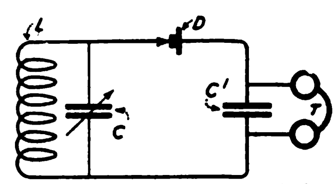


Figure 2-B

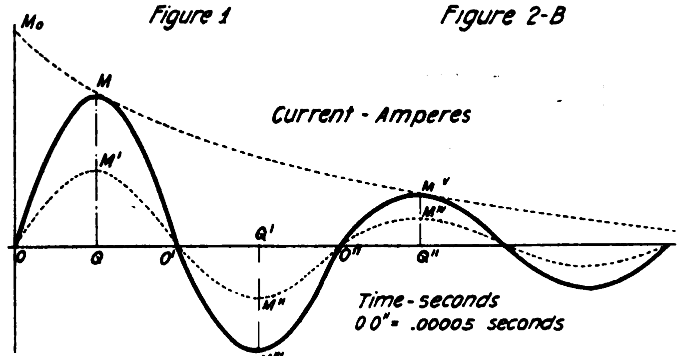


Figure 2-A

Electrical effects of stiffness in radio circuits

point will be again brought up. When the 300,000 cm. coil is used, its stiffness at 600 meters is divided by 1.73, the square root of three, to get the stiffness at 200 meters. When the 150,000 cm. coil is used—the stiffness is .71 of what it was with the 300,000 cm. coil or about 680 ohms.

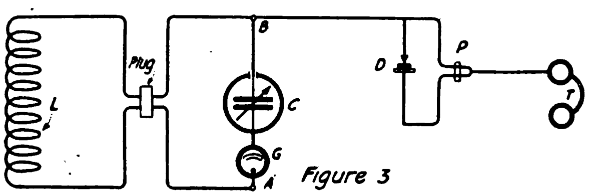
EFFECTS OF STIFFNESS

The user of a wavemeter naturally wants to know why so much attention is paid to "stiffness." The reason is that the property of stiffness in a measuring circuit reduces the change in resonant frequency that occurs when resistance is introduced into a theoretically free or undamped circuit. Hence, you often hear the expression "free period" of a circuit or "undamped" period or wavelength as contrasted with the "damped" or "natural" period or wavelength.

The greater the stiffness the less the effect of coil and condenser or wiring resistance on the "undamped" wavelength. Take the above 600 meter circuit L = 300,000 cm. C = .000337 mfd. It is fairly stiff, as we find that we may introduce about 150 ohms and yet only reduce the undamped frequency so that the "natural" wavelength is 608 meters instead of 600 meters. If we had L = 150,000 cm., C = .000674 mfd., and introduced the same 150 ohms the difference in wavelength would be four times what it was before—the natural wavelength or resonant wavelength—which is the same thing—would be 632 meters instead of 600.

If one introduces enough resistance—about 1,100 ohms—the first of these two circuits would cease to oscillate or "tune" at any frequency. In the case of the second circuit, 550 ohms would be enough to stop all oscillations. The experimenter should remember that inserting resistance has the same effect on wavelength that increasing inductance has, but the latter sharpens tuning while the former broadens it twice as fast. Hence the importance of low resistance to prevent great stiffness of circuit. In other words the resistance ohms must be low, the stiffness ohms must be high.

"But what is stiffness from the standpoint of something that can be physically measured or seen directly?"



Elements of typical wavemeter circuit

you may ask. Figure 2A is an attempt to answer this question.

It is intended to show that stiffness is physically an inverse measure of the first maximum current value in a damped electrical oscillation, from a discharged condenser. Figure 2A is the curve given by a Braun tube oscillograph of the current-time oscillatory discharge curve. The first maximum ordinate QM is inversely proportional to the stiffness when the resistance present has not appreciably changed the "undamped" wavelength.

The current QM is found by dividing a certain percentage of the voltage on the charged condenser by the stiffness of the circuit in ohms. If we have the discharge frequency in figure 2A of 500,000 cycles, so that the time represented by OO″ is one five hundred thousandth of a second (1/500,000), with L = 300,000 cm. and C = .000337 mfd.—the current maximum, QM, will be one ampere with proper resistance in the coil and, say 1,000 volts on the charged condenser. If we halve L and double C the stiffness is doubled and the new current maximum QM′ is one-half ampere. Similarly Q′M″ and Q′M‴ etc., are proportional to QM and QM′, so that in one sense, the stiffness of two circuits of the same period may be compared at any pair of current maxima, such as $Q''M^{iv}$, $Q''\ M^{v}$.

In figure 2B an extreme instance of stiffness is shown schematically in an ordinary wavemeter circuit, using a crystal detector in series with a head telephone. Figure 2B is inoperative unless the path through detector D and telephone T is reduced in stiffness, by shunting the latter by the condenser C′. The stiffness of such a path may easily approach a megohm with high impedance phones of 30,000 ohms at audio frequencies in series with the very small equivalent capacity of the detector D. This detector does not pass enough current to work well, until condenser C′ is shunted across the phones. It should be noted that some phones have sufficient capacity in their own windings to require across their terminals a very small condenser.

It is now evident that the most important precaution concerning wavemeter design—permanence of calibration—cannot be solved absolutely, on account of the inevitable changes in the detector. Practically any desired degree of accuracy at a given range can be obtained, as shown above, by making the circuit stiff and yet keeping the resistance down in the coil L and the reactance as high as possible in the detector.

General Design Relations in Wavemeter Coil and Condenser

It is important to have proper "overlap" from one range of wavelengths to another. With several detachable coils and a tuning condenser, it is necessary to have the first 10-20 degrees of the second range coincide with the last 10-20 degrees of the first range, and so forth in the remaining ranges.

The change of wavelength with fixed capacity and change of coil may be called l. It usually varies between 2 and 4. In a similar way the change in wavelength with fixed coil and variation of capacity may be called g. Calling the relative overlap "p" and recollecting that $g > 1$ and $h > 1$.

$$p = \frac{g-h}{g-1}$$

The above formula shows that letting the larger of two coils approach the smaller $h \doteq 1$—which means that h is greater than and approaches unity—and $p \doteq 100$ per cent.; in other words the overlap approaches unity as the coils approach each other in value. The value of g lies usually between 2 and 8. A good average overlap is given with

$g = 4$, $h = 3.4$, hence $p = 20$ per cent.

The less the overlap, in covering a given total range, the fewer coils and less wire are necessary.

It is very important to know the effective capacity of the wavemeter wiring itself. This may be as much as .000040 mmfd. in a portable wavemeter and more in others. It reduces the capacity range, g, given above, by as much as 65 per cent., with large values of g. The effective range is always less than the free range of the condenser.

Unilateral Detector Connection

The precautions regarding detector capacity illustrated in figures 1 and 2B give a sensitive detector connection, but do not give the sharpest tuning possible. The unilateral connection of the detector shown schematically with other improvements in figure 3, gives a response about one-seventh as loud as that given in figure 2B, under similar conditions, but much sharper. The energy caught in the detector is really that rectified in the radio frequency current from the fixed or high potential side B of the condenser C, through the detector D and phones T, and out into space as dielectric flux between the other side of the condenser C which is grounded to a metal shield S joined to the movable plates of C.

The phones T must not be near the shield S during calibration or use of the wavemeter. For this reason a detachable connection for the phone cords is suitable at P, in the form of plug and jack or else a clip. Both the detector D and plug P should be placed as far from S as possible. When this is done the continual change in capacity of phones due to change in position of observer is negligible. This is reduced to a minimum by above precautions and is well below the capacity allowance in the detector path, discussed under figure 1.

General Arrangement

The wavemeter should be capable of use as a transmitter or driver either by buzzer or triode (vacuum tube with three electrodes). With the latter we are not concerned here, but connecting a battery and buzzer in series to the binding posts A and B figure 3 gives a source of variable wavelengths.

The thermo-galvanometer or hot-wire instrument G should be inserted between the point A and the condenser

C. On no account should it be inserted between the point A and the coil L, as it would register the direct current in the buzzer. The advantage gained in the arrangement of figure 3 is that only oscillating current passes through G, which thus gives a relative measure of the efficiency of different buzzers, if run at a given audio and radio frequency with the same battery.

Anti-Capacity Switches

It is necessary to avoid ordinary cam-switches or the usual form of plugs and jacks for making connections. Both these forms of connection add appreciably to the capacity of the wiring and still further reduce the effective condenser wavelength range. At wavelengths of less than 600 meters they do not constitute the best practice. There are cam anti-capacity switches having less than .000002 mfd. capacity which are good down to 50 meters.

Where solid parts must be used as a dielectric instead of air for mechanical reasons, it is well to machine away as much of the solid as possible. This is especially true in tube and plate construction, where between 50 and 80 per cent. of the material may be removed, to reduce the dielectric loss. By doing this the capacity of a plug connector on a wavemeter detachable coil may be kept down to less than 1 mmfd.

If great refinement is required, it is better to evade the use of detachable coils and to use for all wavelengths the same set of fixed inductances arranged in different series-parallel combinations to get different ranges. A low-capacity drum-switch makes the necessary changes in the combinations and can be so designed that 80 per cent. of its volume is air dielectric. This will be taken up again under the subject of wire economy in design.

Relation of Wire in Coil to Wavelength

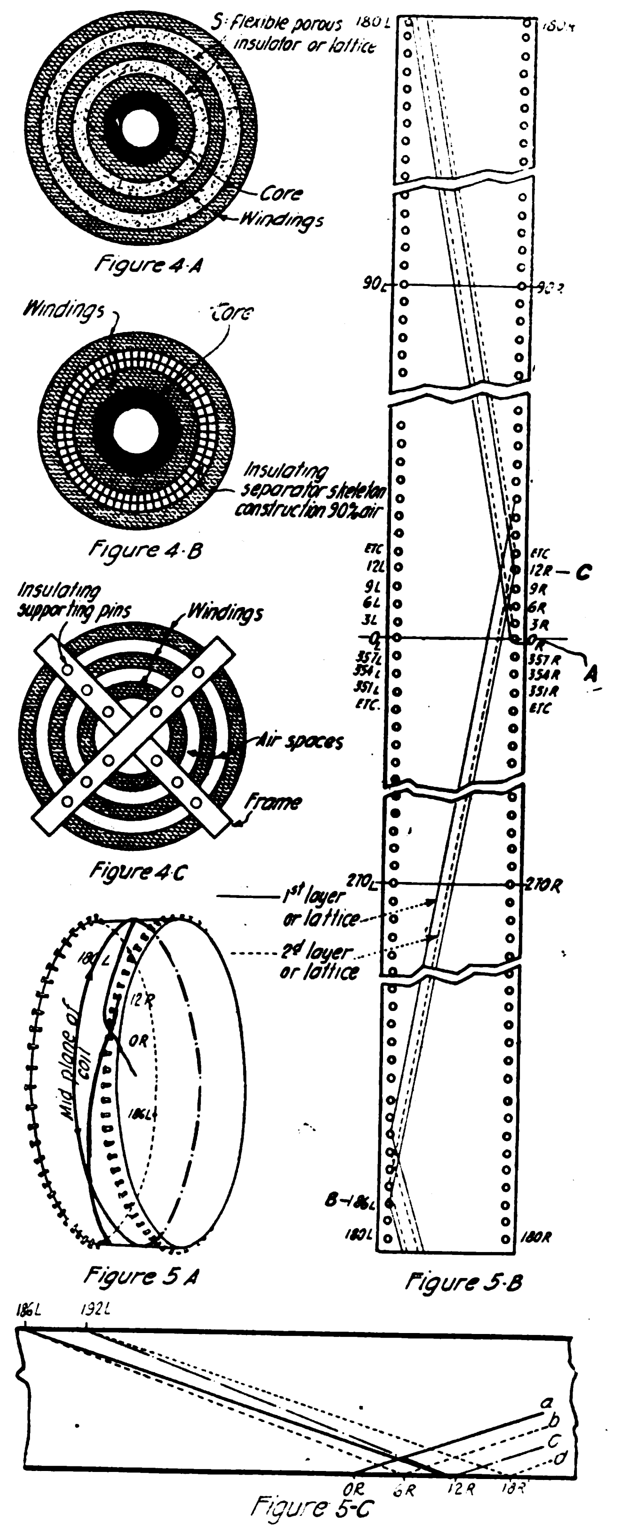
Both theory and practice warn against developing local oscillations in wavemeter coils, by tuning them to circuits oscillating near the exploring coil's fundamental frequency. Since a coil can vibrate at this frequency when unattached to any other device, its tuning value is nil at this frequency, unless for wavelength checking.

In a plain or cylindrical winding the wire length should not exceed 4 per cent. of the shortest wavelength at which the coil is used, e.g. if this be 100 meters, not more than 13 feet of wire should be used. This means a small coil if the wire is to be used efficiently, by being wound in many turns, but the coil does not pick up as much energy at a given frequency as if only one or two larger turns were used, giving smaller inductance. We find also that with the latter arrangement there is an advantage of greater sensitiveness in "picking up" an oscillating field threading the coil L, which has, usually under these conditions, also smaller distributed capacity, relative to inductance. By making these few turns of very low resistance, fairly sharp tuning can be preserved, if the coil capacity is kept low.

Low Coil Capacity

We have a safe rule for maximum length of wire advisable for a given coil-inductance and wavelength. If we reduce our coil capacity factor we may safely use more wire, more turns and get greater sensitiveness in the wavemeter. There are lattice wound coils with 330 meters of wire having a fundamental of about 1,700 meters which give great satisfaction, even though their length of wire is as much as 20 per cent. of their fundamental wavelength. This is possible because their distributed capacity is only about 13 mmfd. By using the bi-lattice winding, which will be described further on, this distributed capacity may be reduced to 10 mmfd.

In short-wave coils the best form is not the universal winding, but the sectionalized spiral coil, as with a given coil sensitiveness or reception factor, the coil capacity is less. This sensitiveness or reception factor is a measure of the emf. induced in a coil of area A having an inductance L and N turns and applies to any receiving loop or coil. The wavelength received, using a loading condenser, is λ, and the coil radio-resistance or resistance at radio frequency, is R. Calling the reception factor, "F,"



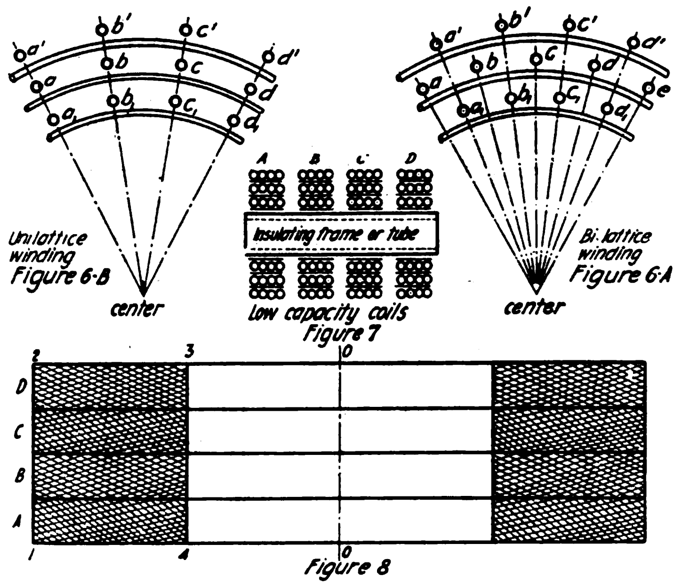
Methods of securing low coil capacitance

$$F = \frac{NAL}{R\lambda^2}$$

It is evident that for best coil efficiency, and sensitiveness, the same type of coil cannot be used in a high grade instrument for short and long wavelengths. Even the repeated use of the same windings in combinations of fixed coils for all wavelengths does not give as good a result on waves around 200 meters as the coils described below.

Spiral Short-Wave Coils—Sectionalized Coils

The best form of short wave coil is indicated in figures 4A, 4B and 4C. The common feature of construction therein is the pancake form, giving a ratio of thickness to depth of winding of not more than 1 to 4, and having the windings divided radially into three or more concentric rings separated by a porous or "latticed" dielectric. It is not generally known that a honeycomb or lattice dielectric equivalent to 50 per cent. air volume or better can be made from fine strips of flexible dielectric or from "strings" of same. Portable wavemeters for as low as 60 meters with a 4-Coil range of 60-3600 meters, were used by the Navy during the World War, having their short wave coils sectionalized as in figure 4A by coarse blotting paper S, shown by cross-hatching. The mean diameter of the coil was about 3½ inches, depth of winding 1¼



Low capacitance coils, lattice type—figures 6-A; 6-B; 8. Morecroft type, figure 7

inches, and width varied between 1/16 inch—taking one turn per layer of Navy Standard, 3-16-28 Litz—and ⅜ inch. The separations are shallower, as they occur nearer the circumference of the winding. From 3/16 inch near the center they decrease to 3/32 inch near the circumference. This tends to equalize the capacity effect of each section, as the potential drop is sharper near the center of the coil.

This sectionalizing reduces the inductance, but reduces the capacity to a greater degree, and the sharpness of tuning is improved. If two or three Litz wires are wound in parallel and there are 2n or 3n turns per layer where $n = 1, 2, 3, 4$, etc., we may reduce the resistance still further and thus sharpen the tuning. We should not have "n" greater than 3, giving 9 wires or 3 "turns" per layer, using the pancake coil, as we would have to enlarge the diameter of coil to keep the relative depth of winding the same. Wavemeter coils are best made of not more than 5 inch external diameter, for portable use.

When a coil is used for 200 meters wavelength or less, special care should be taken to avoid dielectric losses, and to get very low resistance. Figure 4C shows a means of accomplishing this. Here we have a coil sectionalized by air spaces, by the use of a coil frame. This method is hardly worth while for the experimenter who requires for 60 meters only about 5 turns, 3.5" mean diameter of Navy Standard Litz. He may just as well use a separator of blotting paper, using one turn per layer, but if he uses two or three Litz in parallel radially, i.e. one over the other, he will at the same time reduce the capacity between "turns" and also the resistance. The coil frame is electrically preferable, except for rough outside usage, to solid end-faces.

Use of Spacers in Winding

Detachable coils used between 200 and 600 meters give excellent results if a "spacer" or blind cord, to reduce capacity between turns, is wound simultaneously with them and removed before the wire is fixed in place with insulating adhesive. It is understood that a flexible dielectric separator is necessary between every layer. This reduces the capacity still more.

Points Concerning Bank Winding vs. Universal Winding

A knowledge of bank winding is assumed and also of the universal winding known as "honeycomb," which is one kind of lattice winding. Bank winding must be done by hand and cannot conveniently go above 6 banks, using Navy Standard Litz, for engineering reasons. The coil capacity is twice as great as that of the "honeycomb" winding but is about 20 per cent. more economical of wire for a given inductance and shape of winding cross section.

The universal winding can be built up into a true pancake form, rigid and dependable. Several shallow coils "universal-wound" may be used in the frame coil, shown in figure 4C schematically. But a shallow bank-wound coil of two banks is easily wound and is electrically satisfactory for medium waves, of about 450-950 meters. At longer waves it wastes wire compared with a universal coil of same distributed capacity.

If the best result is desired, regardless of cost, the experimenter should use the universal winding, either "bi-lattice" or "honeycomb" ("uni-lattice"). If he winds his own universal coils on any of the several "jigs" shown for that purpose in current technical periodicals, he has the satisfaction of knowing that they are superior to the machine wound product in at least one important respect, from his point of view—they have at every "swing" or "cross-step" of the winding, which occurs about every 180 degrees in lattice coils, a small semicircle of projecting wire which is of great assistance for "tapping" the coil, especially when of solid wire.

Uses of Bi-Lattice Universal Winding in Wavemeters

By a simple change in relative positions of adjacent "turns" or "circuits" in a universal wound coil, these coils have alternate lattice patterns which are "staggered" and the capacity thus reduced about 15 per cent. compared to the uni-lattice type. This effect can be obtained on a universal winding-jig used for "honeycomb" (uni-lattice) hand-wound coils, as follows: In figure 5A we have the schematic diagram of a drum intended to have a double row of radial pins 3 degrees apart at its right and left sides near the "faces." These pins are pushed upward as each layer is wound. Starting at A on the right at 0 degrees and turning the coil, the winding passes to 186 degrees on the left at B, a swing of 186 degrees coming back at 360 degrees plus 12 degrees or 372 degrees on the right at C. To follow the winding it will be convenient to adopt the following symbols.

From the right hand starting peg at 0 which we call Or, all pegs or pins, as the case may be, are called OR, 3R, 6R, etc., to show the number of degrees over which the winding has passed on that side. The symbols OL, 3L, 6L, etc., are similarly used for the left side. Let the pins, 0, 6, 12 etc. both R and L be one color and those on 3, 9, 15, etc. another color.

The lattice pattern indicated in figure 5A, is shown more in detail in figure 5B and the difference between a single wire bi-lattice and a double wire bi-lattice is indicated in figure 5C. In lattice coils it is better to call one revolution of the wire as laid down in a series of "cross-steps" a "circuit" instead of a turn.

Starting at OR in figure 5B we make a circuit plus 12 degrees at 12R. With 29 more circuits we have a "layer" before we arrive at OR again. This would be a uni-lattice coil. We make however, a 2-wire bi-lattice coil by winding simultaneously, another winding starting at 3R. Then we have a 2-wire, bi-lattice step-wound coil in contradistinction to possible spiral wound forms. (See article on Lattice Coils in General in July "WIRELESS AGE.") If the usual pitch is less than 360° (instead of 372° as above) we divide it—not 360° as above—by the advance, v, to get the "circuits" per "layer." If we had started in figure 5B at 6R instead of 3R or 9R we would have had the type of winding shown in figure 6A, which is more efficient.

The most efficient winding is obtained where the wires in figure 6A examined in sets of four, such as a^1 b a_1 a form a square. This does not give the best inductance-volume efficiency, but the tuning efficiency factor

$$\frac{1}{R}\sqrt{\frac{L}{C}} \text{ is greatest.}$$

In figure 5C we see the winding design factor come into play, turning a uni-lattice coil into a single wire-bi-lattice. The choice is made on leaving the last step (186L) before making a circuit at 12R. Passing from 12R along wire "a" gives the uni-lattice winding, but going back or "slipping" half the advance or 6° we start a bi-lattice at 6R and wind exactly as before, making a second "circuit" if we do not "slip" at 18R–"d." But we must again "slip" to 12R and we have for one more "circuit" the original lattice. So we build up two lattices with one wire. If we had "slipped" back 9° to 3R for one circuit and no degrees to 12R on the next, then 9° more to 15R, etc., we would be reproducing the 2-wire bi-lattice pattern in figure 5B with a single wire.

The staggering of the wiring to reduce mutual capacity in the bi-lattice coil is shown in figure 6A where the layer a′b′ etc., and the layer a_1b_1 etc., have the same circumferential positions at the pins, but where the layer a, b, etc., is displaced 3 degrees from both the above layers. The ordinary uni-lattice winding or honeycomb construction is shown for comparison at figure 6B.

ECONOMY OF WIRE IN INDUCTANCES

The smaller the "swing" or the angle passed over in one "cross-step" in a universal coil, the lower the inductance; the greater the copper waste per turn, but the less the capacity up to a certain limit. The ideal "swing" for wire-saving alone, would be close to 180 degrees, but not very close; as the capacity would increase too much. The mathematical solution for best pitch is impracticable and the experiment derivation of a formula is contemplated, which depends on the swing, s, and the width, w, of the winding compared to its depth, t.

FIXED MULTIPLE INDUCTANCES

To save wire, the arrangement of several low-capacity coils, as shown in figure 7 has been used in receivers and wavemeters. In most cases the various sections A, B, C and D were not all used throughout the scale; as they should be, to get the greatest economy in wire, other things being equal. With the coils in figure 7 the equivalent of 4 detachable coils can be obtained by the following combinations, secured by a properly designed drum switch.

Let "+" mean "in series with"
Let "—" mean "reversed normal series connection"
Let "×" mean "in multiple with"

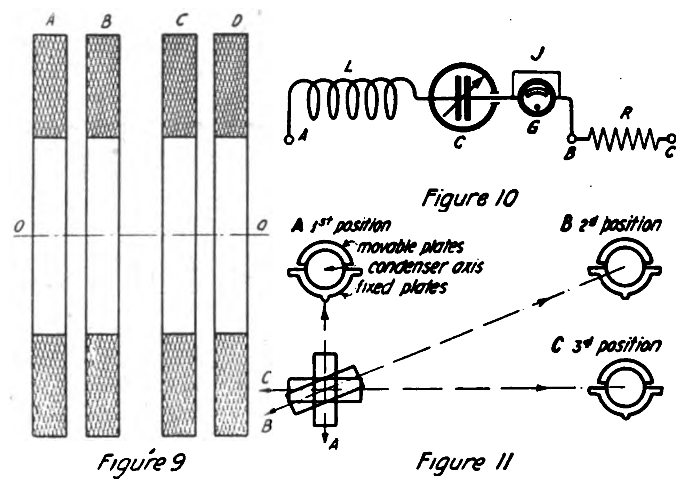
There are four ranges obtainable as follows:

Range I — A × B × - C × - D
Range II — A × B × C × D
Range III — A × B + C × D
Range IV — A + B + C + D

In Range I, A C oppose, also D and B oppose, B and C also oppose, but the system can be used even when the mutual action between B and C is but a fraction of that between A and B or the similar pair C and D.

The range in wavelength of such instruments as the above is as high as 1 to 25. This is not as good as a range of 1 to 60 obtainable in four coil instruments, of the detachable type. There is a saving of about 30 per cent. of wire over the detachable coil type of wavemeter, having approximately the same range and overlap.

It is necessary to remember that although in range I the windings have a large capacity relative to their inductance, i.e., small "stiffness," yet the coil efficiency is



Refinements in wavemeter design

good on account of the lower resistance with windings in parallel. In other words the efficiency factor $\frac{1}{R_1}\sqrt{\frac{L_1}{C_1}}$ is large where L, C and R are average inductance, capacitance and resistance per centimeter.

It is obvious that a multi-lattice coil permits the starting or stopping of a new possible winding at any point in the coil. In figure 5B, we might start several windings according to coupling requirements, at 2R, 4R, 6R, 8R or 10R at various "layers" of the coil and stop them at any others.

The fixed coil type has an overlap of 83 per cent. in some cases, whereas 17 per cent. would be sufficient, if only receiving measurements are usually to be taken. The wire expense for a given range may be thus reduced by about 80 per cent; as this expense is roughly proportional to the overlap in a given range. With four coils the range would roughly increase inversely as the cube of the overlap; i.e. if we cut the overlap from 80 per cent. to 40 per cent. by using larger coils, the range of the instrument will increase about 8 times.

When the overlap is more than 50 per cent., different degrees of tuning are practical, and when driving another circuit, the character of the waves at a given wavelength may be changed with respect to damping. Otherwise large overlap is a positive defect in its heavy waste of wire.

The best compromise between overlap, coil and condenser-range and economy of wire in a given total range has been analyzed practically, but must constitute another article. It is sufficient to show how pancake universal wound coils can be adapted to the construction indicated by figure 8.

In figure 8 four coils A, C, B and D are placed together to form a unit, whose resultant cross section of winding is a square 1, 2, 3, 4 giving the best "time constant" or greatest inductance for a given length of wire. This "Maxwell" coil is obtained when 1-4 is one-half the coil radius.

When these coils are moved apart axially, as shown in figure 9, if the spacing between them is varied, a wide range of overlap and range without disconnecting the coils may be obtained. With wider range there is, of course, less overlap. Separating the coils increases the overlap and reduces the range.

Phantom Antenna in Wavemeters

The circuits in the wavemeter should be arranged so as to permit its use as a "phantom antenna," by "shorting out" the indicating instrument G by the "jumper" J and by inserting external resistance R as shown in figure 10.

This can be easily done by a 12 point D.P.D.T. anti-capacity cam-switch, so that the first position is "receiving," second position is "dummy-antenna" and third position is "transmitting." Navy Portable Wavemeter Type 614-A was thus designed by the writer.

Exact fundamentals can be obtained with such wavemeters of coils or antennae without approximations due to "single turns" of coupling-wire or large series condensers.

General Remarks on Material to be Used

Condenser leakage paths should be at least one inch. Unemployed windings should be avoided or "shorted." Fixed coils as shown in figures 8 and 9 should if possible, be arranged with their mid-planes passing through the condenser axis. This mid-plane is the weakest part of the coil field. The greatest distance consistent with small wire-capacity and inductance should separate coils and condenser. Of the three condenser positions shown in figure 11A,B,C—the first is the worst and the second the best as far as coil-action on the condenser is concerned, but low capacity in the winding requires the use of the arrangement A in most cases. Hard rubber not exposed to the air is better than bakelite or similar compounds electrically. Its progresive surface leakage is against it, especially as it decomposes gradually under the influence of moisture and light. For general use Bakelite and Formica are satisfactory. Pyrex condenser mountings for very fine work are excellent.

The above are some of the considerations which in the main have been experimentally confirmed and form the nucleus of a systematic engineering treatment of various special wavemeter problems. From actual cases, tables have been compiled, which it is hoped to give in these columns.

Transmitter for Use on Direct Current

DURING 1915 and 1916 amateurs in the vicinity of New York City were familiar with the spark of two or three stations, such as "2 PM," which at that time were using what Walter S. Lemmon terms a resonant converter in a device which he has recently perfected.

The figure represents an arrangement of sending circuits of a radio transmitter in which a synchronous spark gap and an associated rotary controller are used; the rotary controller or commutator serving to make and break a direct current circuit. The source of D. C. is connected through an adjustable resistance R (whose function is to limit and control the supply energy) to an oscillatory circuit containing the commutator C, inductance I (which is the primary of the transformer) and the condenser L. It will be observed that the direct current source is so connected to the oscillatory circuit as to apply the direct current energy to two circuits, one of which contains the commutator and the other of which contains the inductance and capacity. In other words, the oscillatory circuit is, in its relation to the direct current source, made up of two parallel paths, one of which, containing the inductance and capacity, is capable of absorbing energy from the direct current source when the direct current through the commutator is interrupted; and the other of which affords a very low resistance path for the direct current when the circuit through the commutator is closed, which path also provides a short circuit for the oscillatory circuit.

With the parts thus arranged, a rotation of the commutator will periodically interrupt one parallel path causing the direct current to be shunted into the other parallel path containing the inductance and capacity, thereby storing energy in this portion of the circuit. When the commutator brush has passed over the insulation segment and comes upon the next conducting segment, the closed circuit is completed and the stored energy will discharge itself through the closed circuit, and if the circuit through the commutator remained closed, would, because of the inductance and capacity in the circuit, give rise to damped electrical oscillations. If, however, the speed of rotation and the design of the commutator is such, that the circuit is made and broken at intervals, which corresponds substantially to the natural frequency of the oscillatory circuit, then the change of circuit connections will be effected substantially without sparking and an alternating current of constant amplitude will flow into the transformer primary. Consequently, energy in the form of a constant amplitude alternating current may be taken from the circuit through the instrumentality of the transformer secondary which may be included in the ordinary spark gap circuit of a radio signaling system.

The closed resonant circuit contains a telegraph key and the secondary S, is included in the spark gap circuit which is inductively associated through the transformer with the antenna. In this case, a synchronous spark gap

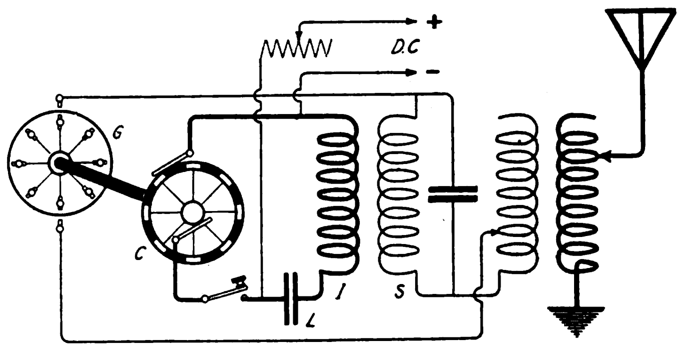


Figure 1—Diagram of connections for direct current transmitter

is used in the spark gap circuit. This apparatus may have any well known form, and should be driven in synchronism with the commutator. By way of example, a rotating disk G, is mounted on the same axle with the controller C, and carrying radially arranged spark points co-operating with two fixed spark points located at extremities of a diameter of the disk. The rotating disk G, may have the same number of spark points as the rotating controller C has pairs of segments and hence where these two devices rotate at the same speed, only alternating half waves of the alternating current are used for sparking. Both half waves of the alternating current can be utilized, thereby producing two sparks per cycle by doubling the number of spark points on the disk, G, or by rotating the disk G at double the speed of the controller C.

Modulator for High Power Work

A MEANS of controlling the great powers in accordance with vibrations of the human voice has been worked out by E. F. W. Alexanderson. In a previous article which was reviewed in this magazine, Alexanderson described a system of modulation in which a comparatively large amount of energy might be controlled by means of the feeble current set up in an ordinary telephone transmitter, wherein the amount of energy transmitted to the antenna from a local source of high frequency current was varied by means of an electron relay device controlled by the current from a telephone microphone in such a way as to vary its conductivity.

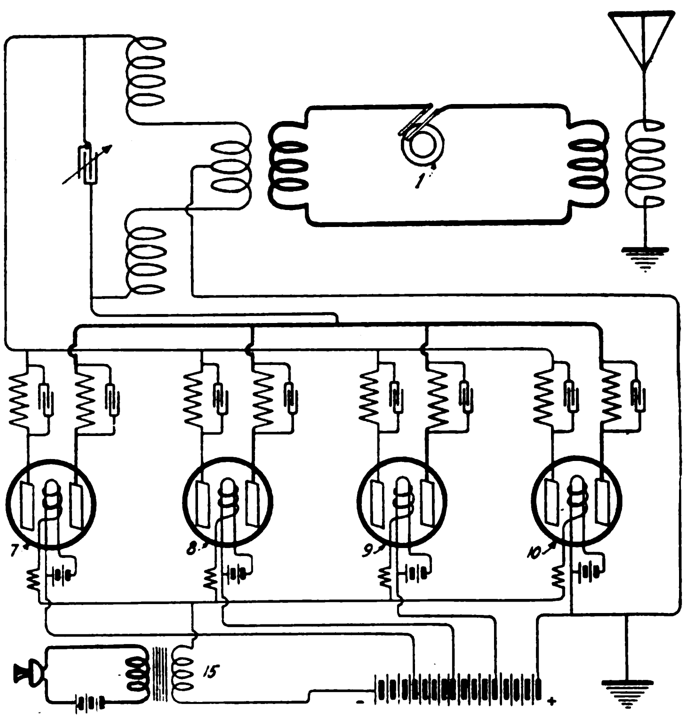


Figure 1—Circuit diagram showing hook-up

With this arrangement, in order to produce the desired variation in the antenna, the absorption of a considerable amount of the total energy of the local source in the relay circuit was unavoidable, the greater part of the energy being absorbed in the relay itself. Hence the amount of energy which might be effectively communicated to the antenna was limited by the absorptive capacity of the relay used. At the present time this capacity is limited by difficulties which appear to be inherent in the manufacture of apparatus of this type. The energy which may be controlled in such a system might be increased by connecting several relays in parallel, in which case the amount which could be controlled would vary directly as the number of relays used. By connecting the relays in parallel with resistance in series, in accordance to Alexanderson's latest invention, however, the amount of energy which can be controlled will vary substantially as the square of the number of relays used.

The drawings herewith show diagrammatically a system of connections whereby the desired result may be accomplished. A source of high frequency energy is connected through the usual transformer with the antenna. The primary of an oscillation transformer is also connected in series with the source of radio frequency energy and the primary of the transformer. The terminals of the secondary of the oscillation transformer are connected to the anodes of a series of electron tubes or relays through resistance as shown. These relays also contain filaments which are provided with a source of current for heating them. The filaments are surrounded by a grid as is usual, and the grids are all connected to one terminal of the secondary of the microphone transformer and to the other terminal is connected a battery. The filaments are connected to various points in this battery. One end of the battery is preferably grounded. The primary circuit of the microphone transformer includes a battery and the microphone. The filaments are also connected to the middle point of the secondary of the oscillation transformer 5. An adjustable condenser is preferably connected across the terminals of the secondary of the oscillation transforme, although in some cases the capacity of the relay tubes may be of sufficient order as to make this unnecessary.

With the arrangement here shown, it will be seen that the current in the antenna will vary in accordance with the current through the primary of the oscillation transformer. The amplitude of the current in the primary will in turn depend upon the current flowing in the secondary. It will be apparent that a certain portion of the energy from the source will be diverted to the secondary circuit and absorbed in the resistances and relay device therein. The system may be so designed and adjusted that the energy thus absorbed will in general bear a certain ratio to the total amount of energy derived from the source 1. Hence, by varying the amount of energy absorbed in the secondary circuit the amplitude of the antenna current will be varied in substantially the same proportion.

In a form of relay indicated in the present case, there will normally be a flow of negative electricity from the filament to the anodes but no flow of current in an opposite direction. The amplitude of the current flow through the relay may be varied by varying the potential impressed upon the grids. If a large enough negative potential is impressed thereon, the flow of current will be stopped altogether. If a positive potential is impressed upon the grids, the current flow will be increased. For convenience of description, let it be assumed that the potential of the grid is such that little or no current will flow through the relay when the high frequency potential of the secondary of the oscillation transformer is applied to the electrodes. The negative potential of the grids of the relays 8, 9 and 10, with respect to their filaments will be progressively greater. If now a current wave is produced in the microphone transformer of such a direction as to overcome the negative potential of the grids, current will begin to flow first from the relay 7 and will gradually increase to a maximum value. If the potential of the current wave is great enough, it will gradually overcome the negative potential of all of the grids and the current will begin to flow successively in relays 8, 9 and 10. When the voltage impressed upon the grids from the microphone transformer begins to decrease, the reverse action will take place, that is, current will cease to flow first in relay 10, next in relay 9 and so on, until the impressed potential falls to zero and no current will flow, as in the beginning. The relays may be so designed and the potentials applied thereto so chosen that when the current in relay 7 reduces its maximum, current will begin to flow in relay 8 and when the current in relay 8 reduces its maximum, current will begin to flow in relay 9 and so on.

Relay devices of the general type shown herein vary somewhat in their characteristics and in some cases the proportionality between the current flow and the voltage impressed upon the grid is constant only over a somewhat limited range. In such cases it may be desirable to so choose the potentials applied to the grids that before the current in one relay has reached its maximum, current will begin to build up in the next relay and so on. In this way the system may be so designed that the current flow therein will be substantially proportional to the voltage variation in the transformer 15 throughout the entire range.

When the current first begins to flow in the relay circuit the greater part of the drop in potential will occur in the relay itself and hence the relay will be called upon to absorb most of the energy of the secondary circuit. As the current increases, however, the drop through the resistances will increase and the proportionate amount of energy absorbed by the relay will decrease. The maximum energy which the relay will be required to absorb will be when the current has reached one half of its maximum value and the relay is consuming one half of the voltage. When the current reaches its maximum value in the relay the amount of energy which the relay will be required to absorb will be practically negligible, the principal drop being in the resistance.

Suppose, for example, that it is desired to control in the secondary circuit a maximum of 10 kilowatts of energy which may be represented by .5 ampere at 20,000 volts. If we do this with a single relay and secure a gradual regulation of the energy from no load to full load, the relay will be called on to consume a maximum of .25 ampere at 10,000 volts or 2.5 kilowatts. It will also be required to absorb energy during the entire period during which the change from minimum to a maximum takes place.

Suppose now it is desired to control a maximum of 160 kilowatts of energy which is represented by 8 amperes at 20,000 volts. If we use four relays as indicated in the drawing each relay will be called upon to take 2 amperes. The maximum amount of energy which any one relay will be called upon to absorb will be 1 ampere at 10,000 volts or 10 kilowatts. The change from minimum to maximum in each relay, however, will occur in one-quarter of the time required in the case where a single relay was used. Hence the average amount of energy absorbed will be only one-quater of 10 or 2.5 kilowatts. Thus it will be seen that four relays of the same capacity will be able to control 16 times as much energy as the single relay.

In the type of relay here shown there is an appreciable capacity between the anodes. This results in considerable current flowing through the relay between the anodes when the system is not being used for transmitting signals. As a result a large amount of energy is needlessly wasted in the resistances. In order to avoid this it may be desirable to shunt each of these resistances by a condenser. This will cut down the high frequency alternating current but will not interfere with the unidirectional flow of current through the relay between the cathode and anodes. It will of course be understood that the resistance may equally well be inserted in series with the cathode instead of in series with the anodes. In order to prevent the grids from consuming an unnecessary amount of current when they become highly positive, resistances may be inserted in series therewith.

Direction Finder

A NOVEL electromagnetic-wave navigational system developed by James Urskine-Murray and James Robinson, has been disclosed recently.

The direction of propagation of electromagnetic waves emitted from an external source may be determined by varying the orientation of a conductor in an oscillating field produced directly or indirectly at a receiving station by the waves. This conductor may conveniently be a closed coil in series with a condenser forming a tunable circuit and connected with a suitable receiver. Owing to the fact that the strength of the received current or signal varies more rapidly when the coil is turned in the neighborhood of the position of zero or minimum induced current, it is usual to determine the direction of the waves by varying the orientation of the coil until this condition is obtained. The orientation of the axis of the coil for minimum signal then indicates the direction of propagation of the waves.

This method has the disadvantage, firstly, that it is impossible to read the signals when on the position of minimum strength and secondly, that it is not suitable for use in aircraft or any other situations in which extraneous noises make it difficult to determine the actual minimum of the signals, since these are, in general, very weak in the neighborhood of the minimum and may appear to die away altogether at a substantial angular distance on either side of it.

Again, if an attempt is made to determine the minimum by turning the coil from side to side between the positions of equal signal strength, these are very difficult to distinguish owing to the gradual increase of strength as the coil is moved away from the minimum, rendering it impossible to make a direct comparison of two reasonably strong signals. The Murray-Robinson invention provides a means whereby the intensity of the signals at two points, one on either side of the minimum, may be directly compared by cutting out signals of intermediate intensity.

The invention provides means whereby the rotatable coil of a directive reception device and its pointer or indicator are free to move with respect to each other within determined limits, contacts being provided to constitute the limiting stops and also complete the receiving circuit.

The pointer is movable relatively to the rotatable coil over a certain angle which is determined by the positions of the stops and its position determines the limits of the angles which the rotatable coil can form with the direc-

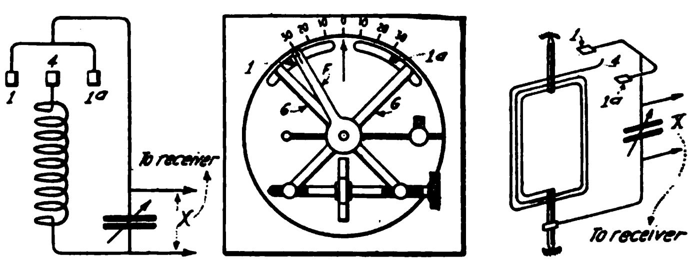


Figure 1 Figure 2 Figure 3

Circuit, plan view of indicator, and diagram of loop in position

tion line of the signal. The invention is equally applicable to a direction finding system comprising an electromagnetic coupling device, such as a radio-goniometer, in which case, the indicator stops determine the limits of the angles which the rotatable coil or condenser can form with the two fixed limits of the apparatus.

It will be seen that by this invention, signals will be audible only when the rotatable element is in contact with either of the studs or contacts and that if the pointer or indicator be moved until equal intensity of signal is observed at two stops—the minimum intensity direction line must dissect the angle contained between the two positions as the intensity of the incoming waves varies according to the distance from the source and other factors—the distance apart of the stops is preferably adjustable.

In order that the construction and action of the invention may be more clearly understood, reference is made to the accompanying drawings in which figure 1 is a diagrammatic representation of the wiring as used either directly on a loop aerial or the movable coil of a radiogoniometer. Figure 2 is a plan view of one form of indicator in accordance with this inventor, showing the mechanical details of construction. Figure 3 is a diagrammatic perspective view corresponding with figure 1.

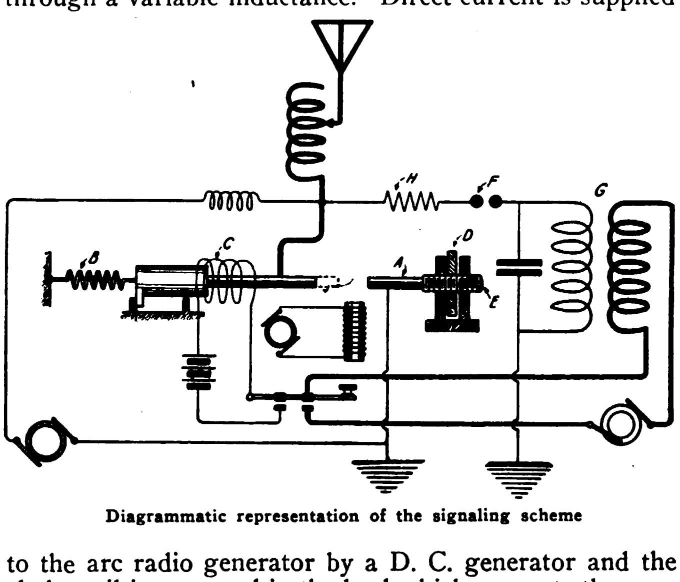
In figures 1 and 3 the two contact stops 1, 1^a, are jointly connected to one side of the tuning condenser the other side of which is connected to the aerial coil or rotatable radiogoniometer coil, the circuit being completed by contact 4 and either of contacts 1, 1^a. The receiver or amplifier is connected in any suitable method as by leads X across the condenser.

In figure 2 a rotatable disk is mounted on a base, provision being made to clamp it in any desired position by means of a clamping screw. A scale marked off in degrees is provided on the base around the disk. Two contact arms G are centrally mounted on the disk and their distance apart is adjustable by means of a left and right hand screw having a central bearing. A contact arm F rigidly connected with the rotatable aerial coil or rotatable radiogoniometer coil and forming one terminal of its winding, is rotatable about the same axis as the disk between the contact stops.

In using such an apparatus as a direction finder, the pointer—and with it the rotatable aerial or radiogoniometer coil—is rotated about the common axis of the apparatus until the pointer is midway between the contact stops. The disk is unclamped and rotated, carrying with it coil, pointer and contact, while the pointer is simultaneously oscillated between contacts 1 and 1^a until a position of the platform is found at which signals are of equal intensity with the pointer in the two limiting positions against the stops 1 and 1^a. If the pointer is then set midway between the stops it will give the direction of the electromagnetic waves producing the signals, and the actual bearing of the transmitting station can be readily ascertained.

Methods of Signaling with an Arc

CONSIDERABLE attention has been given by prominent radio engineers to the problem of controlling the arc generator with nicety at telegraphic speeds. L. F. Fuller discloses still another method of interrupting and re-establishing the arc by varying the length of the arc gap. The drawing printed herewith is a diagrammatic representation of the signaling scheme. The transmission system comprises an arc oscillation generator including the electrodes between which the arc is formed. One of the electrodes, preferably the negative electrode A is grounded and the other is connected to the antenna through a variable inductance. Direct current is supplied



Diagrammatic representation of the signaling scheme

to the arc radio generator by a D. C. generator and the choke coil is arranged in the lead which connects the generator to the negative electrode of the arc. The arc is subjected as usual to a strong transverse magnetic field produced by magnet coils located adjacent to the arc. These coils may either be separately excited or arranged in series with the generator and the negative electrode.

Signaling is accomplished by igniting the arc and subsequently extinguishing it by increasing the distance between the electrodes, the distance being preferably increased by moving one of the electrodes. In operation, the length of the arc gap is increased to such distance that the arc goes out and subsequently the length of the gap is decreased to its proper oscillating arc length and the arc is re-established by a spark or other means. These operations are performed automatically and at telegraphic speed, and signaling is accomplished with a transmission key in the usual manner.

Secured to the negative electrode and insulated therefrom is a solenoid core which is movable in a direction to increase the length of the arc gap by a spring and is movable in the opposite direction by the effect of the current flowing in the solenoid C. The solenoid is arranged in series with a battery and a signaling key, which, when depressed, closes the circuit and causes the negative electrode to be moved to shorten the arc gap to its proper oscillating arc length. An ear projection on the core of the solenoid makes contact with the stop as the core moves forward and stops the electrode so that the proper oscillating arc gap is produced. A second stop halts the electrode on its backward movement. As the electrodes wear, the length of the arc is adjusted to preserve the proper oscillating length by a nut D engaging the screw E, secured to the normally stationary electrode A, the nut being placed between two stops in such a way that the electrode is moved longitudinally by rotation of the nut.

Connected across the arc is a spark circuit containing a spark gap, the secondary of the transformer G and the capacity which shunts the secondary. A stopping resistance H is arranged between the spark gap and the antenna side of the arc to prevent direct current sufficient to maintain an arc across the gap F from following the radio frequency current across the spark gap and passing through the secondary. The primary of the transformer is in series with the alternating current generator and a switch connected to and insulated from the key. When the key is closed the electrodes are brought together and simultaneously the circuit through the primary of the transformer is closed, producing a high potential in the spark circuit and producing a spark across the spark gap which sets up radio frequency surges which ignite the arc. When the key is released, the spring B by virtue of the energy already stored up in it, increases the length of the arc up to that point where it is extinguished.

Improved Oscillator

F. K. VREELAND describes an improvement in electrical oscillators of the vacuum tube or electron relay type, whereby a greatly improved operation is secured, particularly in the matter of purity of the wave form. He has previously described a method and shown apparatus for generating sustained oscillations by utilizing either an electrostatic or an electromagnetic field excited by the oscillations to control the flow of energy in a vacuum tube or other sensitive gap in such a manner that increments of energy are supplied to the oscillating circuit in synchronism with the oscillations. One form of the invention specifically described utilizes "the effect of an electrostatic field upon the discharge of cathode particles in a vacuum tube" as a means of electrically communicating energy in a tube in such manner as to add energy to the oscillating circuit in synchronism with the oscillations.

In recent years great improvements have been made in thermionic tubes, whereby the effect of an electrostatic field set up between the cathode and a third control electrode, or grid, controls in a highly efficient manner the flow of energy between the cathode and the anode. This apparatus is so associated with an oscillating circuit that the oscillations act through the control electrode to produce the electrostatic commutating field and the variations in anode current thus produced supply high energy to the oscillating circuit.

In the vacuum tube oscillator as ordinarily employed today, a three electrode thermionic tube with its appropriate source of direct current energy is coupled to an oscillating circuit with a feed-back connection, whereby the flow of energy through the tube is controlled by the

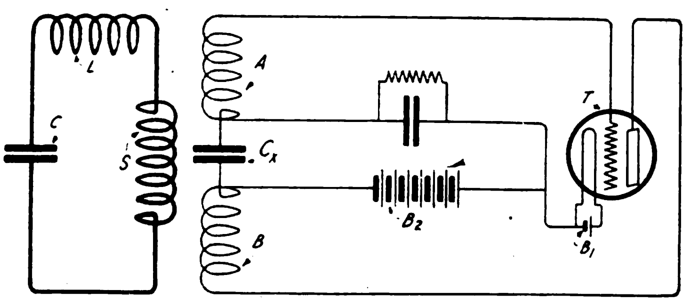


Figure 1—Showing inductive coupling of the oscillating circuit to the generator circuit

oscillations, and energy is supplied to the oscillating circuit in synchronism with the oscillations. Ordinarily the oscillating circuit is directly connected to the thermionic generator tube, the feed-back connection being associated with this circuit in any one of several ways.

The result of this arrangement is an oscillating current whose wave form is very far from sinusoidal. This is due to the fact that the wave form of the energy supplied is not itself sinusoidal, and the disposition and the proportions of the oscillating circuit are such that it is incapable of smoothing out harmonics. As a consequence, when it is desired to secure an approximately pure wave form from such a device it is usual to employ filters or other equivalent devices to sift out overtones.

Vreeland's invention provides means whereby a current wave of great purity may be secured directly without the use of filters or other extraneous apparatus.

An oscillating circuit when fed by a source of energy whose wave form is not sinusoidal will execute approximately pure sinusoidal oscillations only if its inductance and capacity reactances are large with respect to the other impedances of the system with which it is associated. The thermionic tubes ordinarily employed possess, usually, a high and sometimes a very high impedance and it is usually impracticable to construct an oscillating circuit of sufficient reactance to be a "stiff" oscillator when connected directly to such a tube. By means of the present invention it is possible to use an oscillating circuit of moderate capacity and inductance reactance which is nevertheless capable of oscillating with very pure wave form. The requisite stiffness of the oscillating system is secured by coupling the oscillating circuit to the tube and its associated circuits by a stepdown coupling whereby the effective impedances of the tube circuit, as affecting the oscillating circuit, are greatly reduced and the distortions of wave form of the energy supplied are minimized.

In the drawing, figure 1 shows the circuit arrangements of one embodiment of the invention in which the oscillating circuit is coupled to a generator circuit by an inductive coupling. Figure 2 shows an arrangement in which an electrostatic coupling is employed.

In the arrangement of figure 1, T, is a three-electrode thermionic bulb having the usual hot filament with heating battery, anode and grid or control electrode. The tube or generator circuit includes the inductance coils A

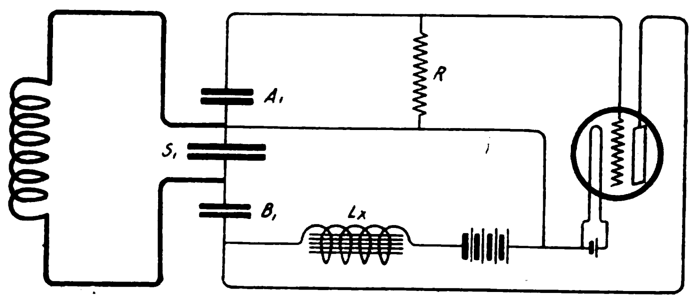


Figure 2—Showing electrostatic coupling

and B, the latter connected to the anode and the former to the grid which by their mutual inductance accomplish the usual feed-back function, the anode and grid being connected to points of opposite potential and the filament to an intermediate point. The generator circuit is completed through a stopping condenser Cx across which the anode battery B-2 is connected.

The oscillating circuit is connected to the generator circuit through inductive coupling of the coils A and B to the secondary coil S, having a relatively small number of turns, whose circuit is closed through the main capacity C and inductance L of the oscillating circuit. The coil S is preferably closely coupled to the coils A and B. By virtue of the step-down action of the transformer A, B and S, the oscillating circuit may be made a stiff oscillator with moderate values of inductance and capacity reactances while the close coupling provides an efficient energy transfer.

By a close coupling is meant a coupling whereby the coil S embraces the major portion of the field of the coils A and B, thus making the generator circuit practically aperiodic and subject to the frequency control of the oscillating circuit. The effect on the oscillating circuit, however, is equivalent to a loose coupling, inasmuch as the inductance of the coil S is small compared to the inductance L. The oscillating circuit is therefore effective in selecting oscillations of its own frequency to the practical exclusion of other frequences, notwithstanding the relatively small absolute values of its reactance while the reactances of the coils A and B may be made comparable to the tube impedances, thereby providing an efficient energy transfer. Figure 2 shows a purely electrostatic coupling. Here the generator circuit includes condensers A-1 and B-1 of reactances comparable to the tube impedance, and a third condenser S-1 of relatively small reactance which serves as a step-down electrostatic coupling between the generator circuit and the oscillating circuit including the coil.

EXPERIMENTERS' WORLD

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

A Laboratory Radiophone

By Allen H. Wood, Jr.

THE amateur of today is fortunately in an advantageous position to build and successfully operate a radiophone. Formerly, inability to buy vacuum tubes and other constructional parts proved a serious handicap to the wireless enthusiast, and rather than go to the necessary trouble of locating and building the various parts of a radiophone, he devoted his time and money to the construction of conventional spark transmitters. Many of the amateurs would gladly have devoted the time and trouble necessary to construct the apparatus, but information was lacking in regard to details. Conditions have so changed that at present, all the necessary material and information for the construction of a wireless telephone is readily obtainable.

The radiophone hook-ups offer three distinct forms of communication: voice, buzzer modulated telegraphy, and continuous wave telegraphy.

It is the aim of this article to give a detailed description of a radiophone embodying the three forms of communication mentioned above. This phone will radiate about .5 of an ampere and with the average antenna will have a speaking range of thirty to forty miles depending upon local circumstances. The telegraphic range of the same set will be much greater in the case of buzzer modulation and still greater when continuous wave radiation is employed.

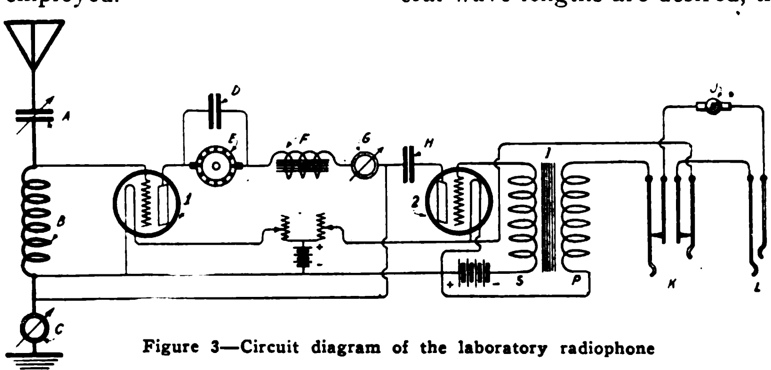


Figure 3—Circuit diagram of the laboratory radiophone

The arrangement of the apparatus can be made according to individual taste, but figure 1 indicates an arrangement which has proven very satisfactory. Whatever design or arrangement is determined upon, keep in mind that the shorter the leads, the better the results.

The various instruments are mounted on a 1/4 inch bakelite panel and enclosed in a wooden cabinet. Dimensions of panel and cabinet are omitted as they will vary with personal taste.

Some source of high-potential direct current is necessary, preferably a motor-generator, but vacuum tube-rectified alternating current or storage batteries can be used. Two Western Electric VT2 bulbs should be used if possible, but Marconi Class II tubes may be substituted.

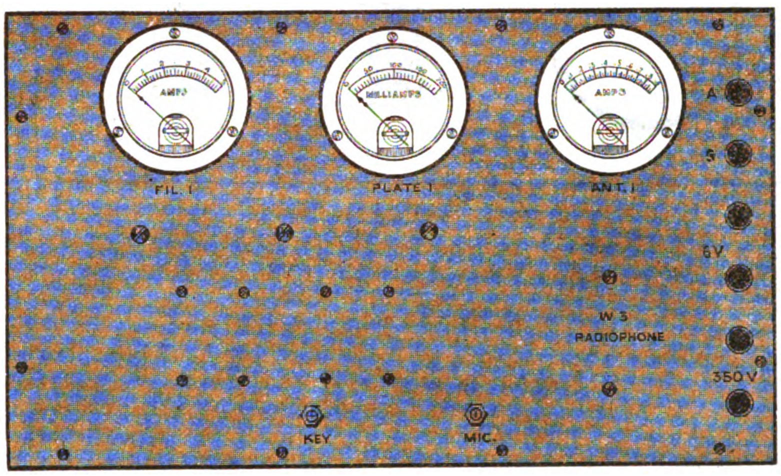


Figure 1—Front view of panel

An antenna condenser is shown in the wiring diagram, figure 3, but this is not necessary if the phone is to be used on one wavelength only. If several wave-lengths are desired, the condenser becomes a necessity. A balanced condenser of .001 mfd. capacity is a satisfactory instrument to use in this position.

The antenna inductance is wound on a bakelite tube, 3 inches in diameter, 5 inches long, with 1/4 inch walls. Cardboard tubing, soaked in shellac and baked may be substituted if the bakelite tubing is not available. For the average amateur antenna, twenty-eight turns of heavy Litzendraht will be sufficient inductance, to keep the phone below 350 meters. The wire should be spaced 3-16 inch from the adjacent turn. If bakelite tubing is used, a thread can be cut on the outside diameter just deep enough to support the wire. A tap is soldered onto the fourteenth turn, and a lead brought out.

Three meters are used. A hot-wire meter of 0 - 1 amp. range for the antenna current, a milliammeter of 0 - 200 milliamperes for the plate current, and an ammeter 0 - 5 amperes for the filament current. Weston meters are suggested, but any meter with correct ranges and constants may be used.

Two closed core transformers are necessary—the transformer employed in the plate circuit, and the microphone transformer. A complete description of the construction of these coils is given in figure 2.

Two jacks are introduced, one for the microphone, and the other for a key to be used with the buzzer modulation. If undamped telegraphy is also desired, a condenser of .0005 mfd. capacity should be inserted between the grid and the antenna inductance, and shunted by a key. When the key is open, the tube is paralyzed by the negative charges on the grid and will stop oscillating. As soon as the key is depressed, the negative charge is dispelled, and the tube is at liberty to function again. If this condenser and key are used, it is well to keep in mind that while using the microphone or buzzer modulation, the condenser in the grid circuit should be shunted, either by a small switch, or by screwing the key down.

A battery of about 20 volts potential is placed in series with the secondary of the microphone transformer in order to keep the curve of the modulator bulb at a proper point to prevent modulator - blocking and resultant speech distortion. The polarity of this battery is important, and extreme care should be taken that the negative side is connected to the transformer and thence to the grid of the modulator tube. Any one of the numerous block B batteries of 22.5 volts potential on the market can be used.

The condenser used in the plate circuit, indicated on the wiring diagram as H, should be constructed of mica and copper foil, mounted between two strips of bakelite. The capacity is .01 mfd. This condenser is a standard size and can be obtained from any dealer of radio supplies.

The tube sockets should be fastened to a bakelite shelf and mounted in the rear of the panel. Two holes or a small door directly over the tubes should be cut in the cabinet. This will help to disperse the heat and also give the operator access to the bulbs in case a change is necessary.

A six-volt storage battery is used to light the filaments and supply the microphone current. Filament rheostats are unnecessary, but if their use is desired, it is advisable to use 8 or 10 volts instead of six.

All connections should be made of No. 16 bare copper wire covered with rubber or cambric tubing, and all joints should be securely soldered.

When the set is completed and ready for trial, shunt a condenser of about .001 mfd. across the antenna and ground leads. As the resistance of this condenser is low, this will serve to test the phone and will allow the operator to see whether his set is functioning properly before it is connected to the antenna.

When the bulbs are lit, the radiation meter should indicate about .8 amperes when the plate current is 100 milliamperes, and the filament meter indicates about 2.9 amperes. Plate current in excess of 100 milliamperes is apt to prove disastrous to the bulbs and consequently the current should not be allowed to go beyond that point.

Change the tubes back and forth until the best oscillator is determined upon. In nearly every instance where two tubes are used, one will be found to be the better oscillator.

If for some reason everything seems to be dead, check up wiring and polarities again. Another cause of failure to oscillate is due to not enough filament brilliancy. Sometimes .1 ampere difference in the filament current marks the dividing point between success and failure to oscillate.

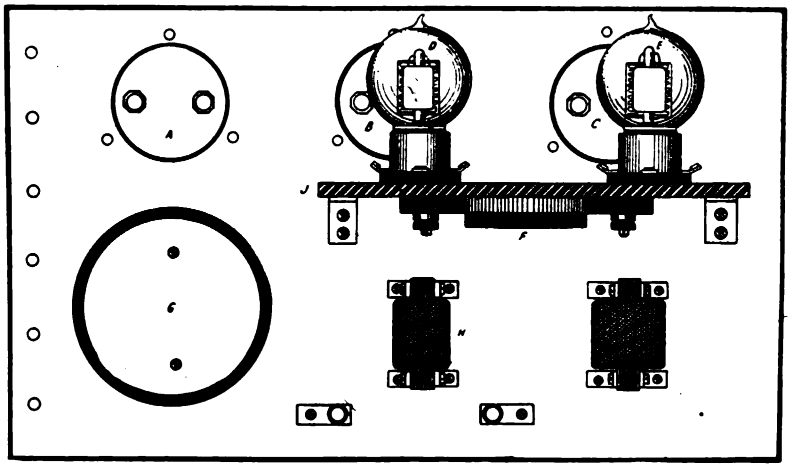


Figure 1—Rear view of panel showing location of instruments

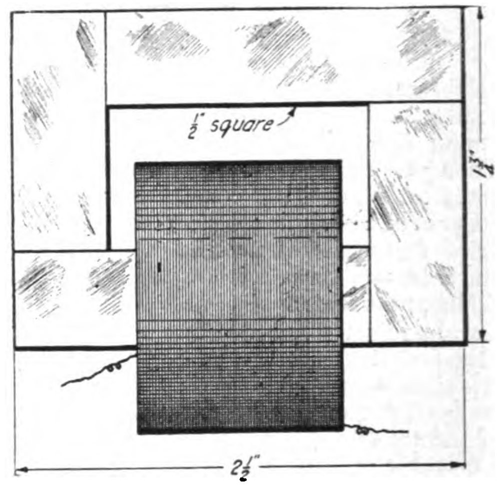


Figure 2—Dimensions and construction of coils

When the operator has satisfied himself that the phone is functioning correctly, the condenser is removed and antenna and ground substituted. The radiation drops to between .4 — .5 due to the increased resistance.

Good modulation is indicated by a slight falling off of the antenna current while speaking into the microphone.

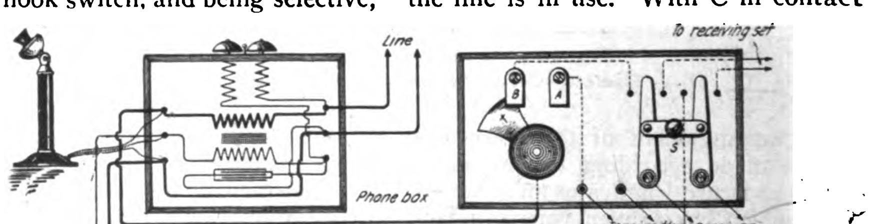
When a buzzer is used, reduce the plate voltage and filament current, as the buzzer will cause a heavier plate current to be drawn than will the microphone.

A radiophone similar to the one described above has been in use for six months and has given unfailing performance and satisfaction, and it is to be hoped that we will hear many more phones in operation when the radio season opens again next fall.

A Telephone Extension

By Eugene S. Pearl

A GREAT many amateurs, whose radio rooms are located at a distance from the Bell telephone installed in their homes, would greatly appreciate an extension telephone at their wireless table, which would enable them to answer a phone call from their radio rooms, instead of having to leave while communicating with some amateur by radio. By referring to the diagram, an arrangement is shown which will accomplish this object. The upper part shows the regular phone box with its desk telephone; the lower part shows the addition to be made. The switch "S" is an ordinary pole changing switch that is used to connect the headphones with either the detector or telephone circuit. The switch C takes the place of the telephone hook switch, and being selective, it enables the wireless operator to obtain several combinations not possible with the regular telephone.



With switch-blade C in contact with B the headphones will be in circuit, causing no indication at central, thus permitting the operator to hear when the line is in use. With C in contact with A and B there is a regular telephone circuit. With C in contact with A alone the transmitter is in circuit alone.

An Efficient Wavemeter

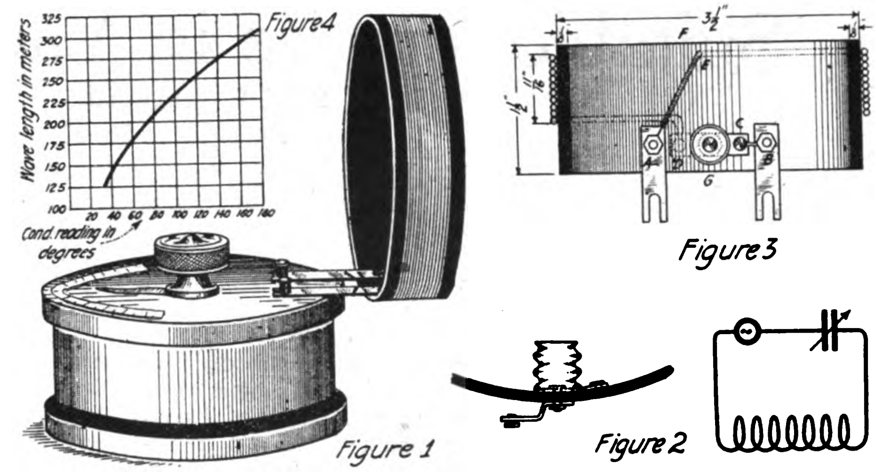
By E. Singer

THE instrument herein described is a wavemeter of simple construction, consisting of an inductance in series with a capacity and an indicating device as shown in the diagram.

The capacity used is a Murdock 23-plate condenser. The inductance consists of 20 turns of No. 20 double silk covered wire wound on a piece of tubing whose outside diameter is 3½ inches. The length of the tubing is 1½ inches, with the winding starting at ⅛ inch from edge F. The end of the winding goes through a small hole at E and terminates on the brass strip A. The other end of the winding terminates on the outside of the tubing on the lug of the socket marked D. The dotted double line represents the two ends of the winding. The line running from E to A and from C to B are wires on the inside of the tubing.

The strips A and B are made of brass 1/16 inch thick, 1½ inches long and ½ inch wide. They are held to the tubing by 6/32 screws ¼ inch from edge G. The strips are connected to the tubing directly opposite the binding posts on the condenser, as shown in the photograph or sketch.

The indicating device consists of a receptacle for a miniature lamp with the porcelain portion removed and the socket proper mounted on the tubing as shown in figure 2. The center contact screw holds the socket to the tubing. The lamp used is a 2.5 volt Mazda lamp. The socket is mounted midway between the two strips. The wire CB connects lug C with strip B. The coil was given one coating of shellac after it had been wound.



Constructional detail and graphic chart

Indicator Mounting

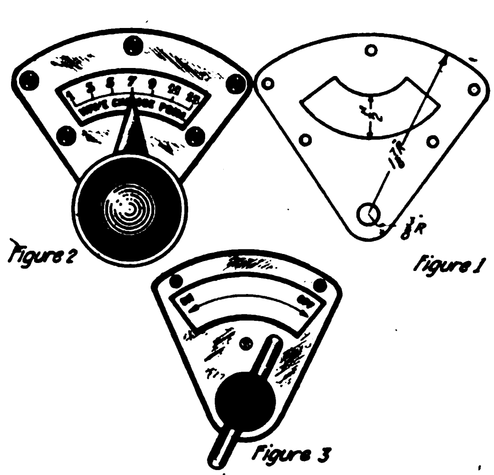
By D. R. Clemons

IN the designing and construction of panel and cabinet types of radio instruments it is necessary that scales or other position indicators be used with the controls. Stamped lettering is not easily provided where the equipment is limited. Neither do scales or dials always apply to the position given them. When made to order they are too costly.

Recently a number of calibration and position indicators were desired. They were to be of uniform dimensions and design, yet having indicating lettering and directions each different from the other. By using uniform mountings and placing suitable indicators back of them, a very attractive arrangement was secured.

In the following figures the hard rubber plates were cut from discarded battery jars. After laying off the design on a piece of rubber, the opening was removed by drilling small holes within it, breaking out the piece and sandpapering the edges. Screw holes were drilled after the plate was grained by stroking it across coarse sand paper.

For each plate a piece of celluloid was cut to the same outside dimensions as the plate. With drawing instruments the scales and lettering was drawn within a space corresponding in size to the opening—heavy opaque drawing paper being used. The celluloid lies between the scale and the rubber plate all three being screwed to the panel front as shown in figures 2 and 3. The celluloid protects the lettering. It really is a small window. Such mountings function and appear well with the instrument. Three different patterns are shown in the drawings.



Dimensions and construction of the indicator mounting

Second District Call Letters of Amateur Stations

(*Continued from July* WIRELESS AGE)

Letters.	Power.	Name and address.
2SA	21	J. P. Holder, 467½ Quincy St., Brooklyn.
2SC	50	Jos. J. Stantley, 1 Hampton Court Ter., Jersey City, N. J.
2SD	50	O. Dickinson, Albertson St., Hyde Park, N, Y.
2SE	500	Chas. P. Van Duzer, 34 Marion Ave., Tompkinsville, N. Y.
2SF	36	Alan S. Kollock, 9133 120th St., Richmond Hill, N. Y.
2SG	90	Fred T. May, 143 High St., Montclair, N. J.
2SH	500	H. S. Schanck, 92 Main St., Keyport, N. J.
2SI	50	E. F. Pfluger, 682 East 233d St., New York City.
2SJ	36	K. W. Schlitz, 28 Jefferson St., Brooklyn.
2SL	12	Barnet Trotsky, 308 West 147th St., New York City.
2SN	1000	N. C. Cowper, 454 Merrick Rd., Lynbrook, N. Y.
2SO	400	J. E. Johnston, 1379 Clay Ave., New York City.
2SP	600	G. Bleilevens, 318 33d St., Woodcliff on Hudson, N. J.
2SR	490	R. I. Gratzner, 802 West 181st St., New York City.
2SS	300	G. E. Burghard, 1 East 93d St., New York City.
2 SU	440	G. Fink, 315 Lenox Rd., Brooklyn.
2SV	250	J. DeJonge, 218 DeMott Ave., Clifton, N. J.
2SW	250	S. P. Suffin, 1412 Charlotte St., New York City.
2SX	50	Geo. H. Sutton, 323 Crooks Ave., Paterson, N. J.
2SY	30	H. Wm. Muller, 203 East 71st St., New York City.
2SZ	1000	J. D. MacKnight, Y. M. C. A., 1st St., Troy, N. Y.
2TA	24	F. Grunaller, 873 Broadway, Brooklyn, N. Y.
2TC	90	J. B. Milkiewitz, 876 East 179th St., New York City.
2TD	50	T. M. Dugan, 14 Elm Pl., Red Bank, N. J.
2TE	440	Victor H. Bentzig, 165 Woodmere Pl., Richmond Hill, N. Y.
2TF	1000	G. E. Franklin, 1 Cherry St., Schenectady, N. Y.
2TG	485	G. K. Thompson, 139 Maplewood Ave., Maplewood, N. J.
2TH	50	Thos. F. Hunter, 599 Monroe Ave., Elizabeth, N. J.
2TI	25	Jas. A. Francis, 133 Bank St., Newark, N. J.
2TJ	1000	J. P. Thornton, 922 Central Ave., Westfield, N. J.
2TK	1000	R. Frank, 271 Palisade Ave., Union Hill, N. J.
2TM	250	J. Mindick, 158 Columbia Ave., Newark, N. J.
2TN	12	L. P. Hanser, 1477 Bushwick Ave., Brooklyn, N. Y.
2TO	500	R. S. Otto, 730 Sherman Ave., Plainfield, N. J.
2TP	1000	H. G. Mustermann, 112 Morgan St., Union, N. J.
2TS	250	T. E. Schreyer, 72 Ridgewood Pl., Staten Island, N. Y.
2TT	12	A. Rechert, 181 Waverly Pl., New York City.
2TU	50	H. A. Kienzle, 501 East 84th St., New York City.
2TW	500	J. M. Sackheim, 516 West 174th St., New York City.
2TX	50	J. P. McClary, 88 Front St., Keyport, N. J.
2UA	800	R. W. E. Decker, 7 Odell Ave., White Plains, N. Y.
2UB	500	J. A. Bergner, 1421 East 10th St., Brooklyn, N. Y.
2UC	500	C. B. Urban, 515 St. Marks Ave., Westfield, N. J.
2UD	1000	Uda B. Ross, 586 West 187th St., New York City.
2UE	440	J. A. Erhard, 311 Maple St., West Hoboken, N. J.
2UG	1000	L. E. Bonduaux, 924 East 169th St., New York City.
2UH	18	H. L. Bock, 252 West 149th St., New York City.
2UI	100	Harold J. Illich, 715 Tilden St., Williamsbridge, N. Y. C.
2UJ	550	A. H. Knights, 862 Hewitt Pl., New York City.
2UL	50	C. L. Wood, 305 Willow Ave., Lyndhurst, N. J.

The Construction of a Portable Antenna Suitable for Use in Vacation Days

By F. C. Brockman

(FIRST PRIZE, $10.00)

THE antenna equipment described here is simple, easily erected and light enough to be carried by one person. It consists of two masts, each 21 feet high, a single wire antenna 75 feet long, a counterpoise of the same length, and four reels for the antenna, counterpoise, and guy ropes. The principal dimensions are given for those who wish to follow them. Minor dimensions are omitted as the amateur usually has a stock of odd parts which he can contrive to use.

Figure 1 shows the construction of a mast section. It is made of spruce, poplar, white pine, or some other available light wood of sufficient strength. Its length is 7 feet, which is convenient. Longer sections become cumbersome, while shorter sections require more joints, which often introduce weakness if improperly made. A 6″ piece of 1⅜″ O.D. by 1¼″ I.D. seamless steel or brass tubing is shown at b. It is pinned to the mast by an iron or brass pin of ⅛ to ¼″ diameter as at e. Provide three 5/16″ holes, d, spaced 120 degrees apart and with their centers ⅜″ from the open end of the tube. These holes receive the hooks on the ends of the antenna and guy ropes. A 3″ piece of standard size tubing 1¼″ O.D. by 1⅛″ I.D. shown at a, can readily be purchased. Take a light cut off the smaller tube to make it fit into the larger one snugly. This had better be done in a lathe if one be available, otherwise it can be worked down with emery cloth. Force the tube onto the end of the section, drill diametrically and countersink for a pin, c, made of iron or brass wire about ⅛ to ¼″ in diameter. Rivet the ends of the pin and file flush with the tube. Paint the section an olive drab color, leaving the inside of the large tube and the outside of the small tube clear. If they are of steel give them a thin coat of oil occasionally to prevent rust.

Make six such sections and you will have two masts each 21′ high. They are all alike and therefore interchangeable, which facilitates erection. The sections are carried in one bundle. Procure a double book strap or bundle carrier having a suitcase handle and straps fitted with spring buckles. Use this in the middle of the bundle and one single book strap with spring buckle near each end. By using additional straps the four reels and the stakes may be attached to the masts and the whole outfit carried by one person.

Figure 2 shows the construction of the antenna and insulators. A harness hook or snap hook which will fit into the holes d in the tube b of figure 1 is shown at a. Six of these hooks are required, two for the antenna and four for the guys. An insulator, b, is made preferably of XX black dilecto, 3/16 by ⅜″, although hard rubber will do as the strain is not very great. Links, c, are made of No. 9 iron wire bent into U-shapes with the curved part of sufficient diameter to work easily in the eye of the hook a, and with the ends flattened. Four of these links are needed. Clamp one end of an insulator between the ends of a link, with a hook in place, drill two holes and rivet together with iron, brass, or copper wire about 1/16 to ⅛″ diameter as at d. Do likewise with one end of the other insulator. Rivet the other two links to the remaining ends of the insulators.

For the aerial wire secure 75′ of No. 18 lamp cord, although bare stranded wire of the same size will be considerably lighter. Loop the ends through the links on the insulators as at e, figure 2; twist them back on the main wire and solder, using a rosin and alcohol flux, as acid fluxes will soon eat through the strands and cause a break. Secure a 25′ piece of the same flexible wire, loop one end through one insulator link as at f, figure 2, twist back on the lead and also around the aerial wire and solder. Good soldering is essential as the energy handled is small and none must be lost in bad joints. Solder a spade terminal such as is used on automobile ignition cables to the free end of the lead for connection to the instruments. The aerial wire is now complete with its insulators, down-lead, and hooks for securing to the masts.

The counterpoise is shown in figure 4. It consists of 75′ of automobile ignition cable or some other flexible stranded cable with heavy rubber insulation. Solder a spade terminal to one end and double the other end back for about one foot and tape securely so as to insulate it.

Figure 5 shows a guy rope. It is made of 30′ of 3/16″ braided shade cord. One end is tied to a harness hook, a, the other is looped through a 3″ tent slide, c, by means of which the guy may be made taut. If tent slides cannot be obtained, a piece of hard wood 3″ long, ½″ by 1″ in section, and fitted with two 1/4" holes 2" apart may be used, or an ordinary cord tightener as used on a drop light will do very nicely. Four of these guy ropes are needed.

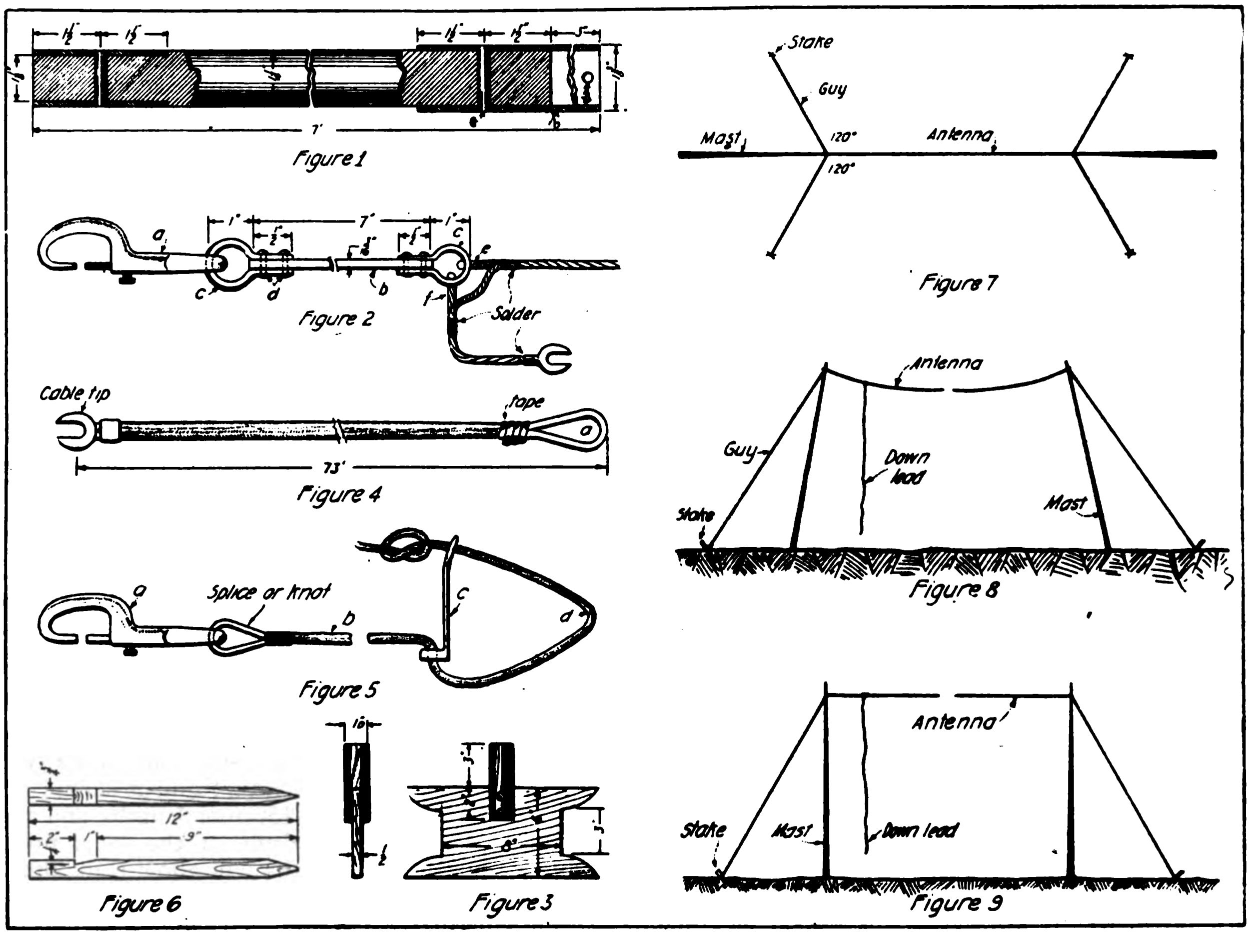
Figure 6 shows the stakes to which the guy ropes are fastened. They should be of hard wood. The loop of the rope is hooked under the notch to prevent its slipping off the end of the stake.

Figure 3 shows the reel. One carries the antenna, another the counterpoise, a third carries one pair of guy ropes, and the fourth carries the other pair of guys. The reels are made of 1/2" hard wood as shown in the figure.

One person can very easily erect this antenna, although two or more can, of course, do it more quickly. First choose a suitable place, reel out the antenna so that the free end points away from the station with which communication is to be carried on, and find two points about ten to fifteen feet from the ends of the antenna, and on lines which make approximately 120 degree angles with it and drive stakes leaning away from the antenna. Then lay three mast sections at each end of the antenna with their bases pointing away from it. Join them together, hook the antenna and two guys into the holes in the topmost sections and loop the other ends of the guys over the stakes. Grasp the mast a little below the middle and raise it till it stands at an angle, leaning towards the antenna. Repeat this with the other mast. Then take up on the guy ropes and adjust the position of the masts till they are vertical.

Figure 7 shows diagrammatically the parts laid on the ground. Figure 8 shows the masts leaning against the guy ropes. Figure 9 shows the antenna erected.

Set up the apparatus near the down-lead, reel out the counterpoise, laying it under the antenna. Loop the far end under the mast to keep it stretched out and running parallel to the antenna.



Views showing construction and method of erecting the portable antenna

The Construction of a Portable Antenna

By A. Hazleton Rice, Jr.

(SECOND PRIZE, $5.00)

The camper of today takes the marks of civilization with him wherever he may go. He wants to keep in touch with the world no matter how far from its centers of civilization he may roam, and he turns to science for the gratification of this whim.

Through the development of radio telegraphy and telephony during the war, the seemingly impossible has not only been accomplished, but has become routine in operation, making it entirely feasible for the camper to include in his list of necessities a well designed radio outfit.

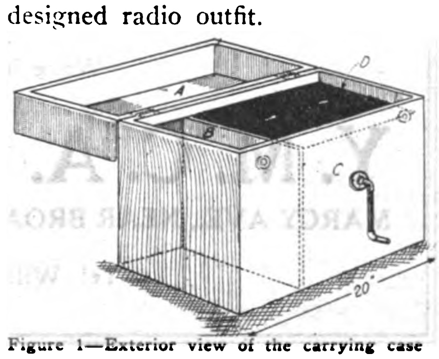


Figure 1—Exterior view of the carrying case

A radio station, to be of any value on a camping trip must be light in weight, efficient in operation, and easily moved from place to place. All of these characteristics are largely dependent upon the antenna, which must be portable, if it is to meet the requirements of the most exacting amateur. The antenna which will now be described is easily carried about, can be raised or reeled in without much difficulty, and incidentally may be so designed as to include the receiving set as well.

Supports are dispensed with, for at best they are cumbersome affairs on a canoe trip or when it becomes necessary to pack everything on one's back.

The most desirable method of suspending a portable antenna, then, is from a natural support, such as the limb of a tree, the roof of a house, or, as will probably be the case, between two trees the right distance apart.

The dimensions given, therefore, are suggestive only, as the requirements of the individual will vary greatly.

The carrying case should be built of ½" oak or birch, as shown in figure 1. The cover should be hinged at the

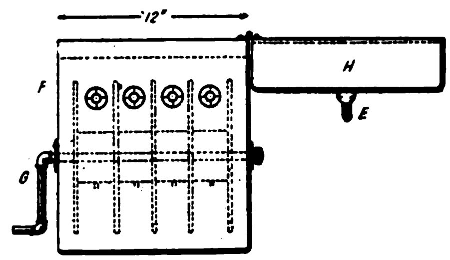


Figure 2—Interior diagram of carrying case showing drums

back and two hooks and screw eyes are used to keep it securely closed when it is being carried about. The case, when completed, should be stained some dark color; fumed oak is perhaps the best in appearance and durability.

A comfortable leather handle should be fastened securely to the cover.

Several wooden drums 3½" in diameter by 2" long and a number of flanges of ½" stock and of proper diameter should then be turned out on the lathe. The number will depend entirely upon the number of wires to be used in the aerial and the diameter of the flanges. Litz wire is the most flexible and will reduce the size of the carrying case materially; the so-called "Belden" cable and lamp cord, although flexible, are much more bulky. When the wire to be used has been decided upon, 100 feet should be purchased and reeled up roughly on a spool having a diameter of about 3½" and 2" in length. In this way an estimate of the size of the flanges required may be made.

By actual experiment, two wires have been found to be as efficient as four for receiving, and the reader is advised not to carry more than this number for his antenna, each of which should be 100 feet in length. This length will give the antenna a fundamental wave length suitable for 200 to 800 meter work.

In addition to these, a 60-foot length of wire is required as the lead-in. This length should prove ample for all practical requirements.

If a two-wire aerial is decided upon, three drums will be required for the wire alone, together with the necessary flanges to keep each in its proper place.

In addition to this a fourth drum, of the same size, is necessary upon which to wind the hoisting "rope" which, in order to persist in our policy of flexibility, may consist of a heavy linen "fish" line such as is used for big game fish. A 100-yard length is necessary and it should be cut into two 150-foot lengths and reeled onto the drum at the same time. These lengths will allow a maximum height for the antenna of 75 feet, which is more than ample; the average being about 40 feet.

After the flanges and drums have

been turned out they should be carefully drilled through their centers to fit a ½" brass pipe which is to be used as the arbor. The arbor should be sufficiently long to extend through the front and back of the carrying case and a sufficient number of threads should be turned on each end to enable the drums to be tightened so as to prevent rotation by the use of large nuts and washers. A pipe cap should be screwed on the arbor at the rear and two brass elbows and short lengths of pipe may be screwed on at the front as shown to form a very rugged handle. Brass pipe flanges of suitable size may be used as the bearings and should be screwed securely to the outside of the carrying case.

Similar flanges may also be used as guides for the wire and ropes when reeling and unreeling, but they should be carefully smoothed up on the inside with a round file and emery paper. They may then be screwed to the end of the case; the center of each being about opposite the center of its respective drum and on a level with the maximum height of the coils.

Each end of each antenna wire should be provided with a "snap" hook which makes it an easy matter to fasten them to screw eyes in the spreaders. These hooks should be tied to the wire by use of the familiar bowline knot. Screw eyes should also be fastened to each drum on the reel so that when being reeled up the wires may be merely inserted through the "portholes" from the outside and snapped onto the drums.

The lead-in wire should have a tap securely spliced and soldered at about 3 feet from the end, and securely soldered on each branch is a clamp like those used on transmitting helices.

Each spreader, when extended, allows for a span of 3 feet between wires, and should be of sufficient diameter to withstand the strain. One inch square, straight grained material is suggested. Each half of each spreader is 18½" long, and the two halves should be hinged. When extended, two pieces of strap iron may be bolted opposite the hinges to maintain rigidity. In folding the spreaders, however, it should only be necessary to remove one bolt. A screw eye should be fastened to each end of the spreaders, both front and back.

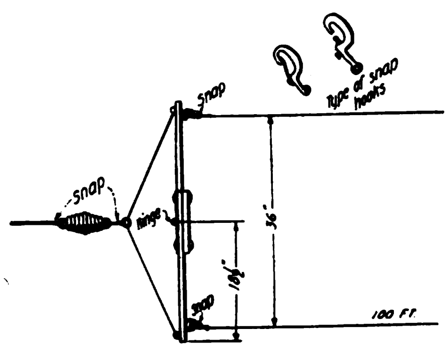


Figure 3—Antenna construction and rigging

With the addition of short lengths of line fastened at each end of the spreaders and two electrose ball insulators the antenna is now complete and ready for erection.

This is easily accomplished. A desirable spot is chosen; preferably a place having but a few trees with branches well above the ground. Ropes and wires are then unreeled and unfastened. Each rope is fastened to an insulator which, when used as a weight, can be slung a considerable height. There is usually a good tree climber in the party, in which case the problem is much more easily solved. After the ropes have been thrown over their respective supports the spreaders are fastened to the insulators; the antenna wires bared at one end; the lead-in wires clamped on; the antenna wires snapped into the screw eyes on the spreaders and we hoist away. Reference to the drawings will undoubtedly make it all clear.

A word on "grounds" may not be amiss, for portable aerials and portable grounds usually go hand in hand, and the one is as essential as the other.

Don't drive a short iron pipe into the ground and expect results. You won't get them.

If the experimenter is on a canoe trip, his one best bet for a ground will be in the water; a roll of chicken wire has been known to give excellent results when placed under water. Two additional lengths of wire may also be laid upon the ground directly underneath the antenna wires, thus acting as a counterpoise, and will give good results. By the addition of two more drums to the reel, these wires may be carried without inconvenience.

As shown in the drawing, the receiving set may be conveniently mounted on bakelite or hard rubber and fastened to the inside of the cover of the carrying case.

The ability to literally take your radio friends into the woods with you will more than repay you for time and labor expended in the construction of this little outfit.

Portable Mast

By C. R. Leutz

(THIRD PRIZE, $3.00)

THE following described portable mast was designed for Boy Scout use and was very successful in practice, although it required four men to erect it. However, a mast fifty-five feet high could not be expected to be raised quickly without four men.

It was decided that one large mast would be a better proposition than two small masts both from the point of bulk and from the standpoint of operation in service and the weight to erect. The type thought of was a built up hollow mast. A model mast was constructed and found very satisfactory and a large type was then planned in accordance with the model.

The height decided upon was fifty-five feet. An umbrella antenna at this height was suitable for 200-meter transmission and reception and also suitable to string a large antenna to some high surrounding point for long distance long wave reception. Out of the fifty-five feet, this mast was divided into five sections, four ten-foot and one fifteen foot.

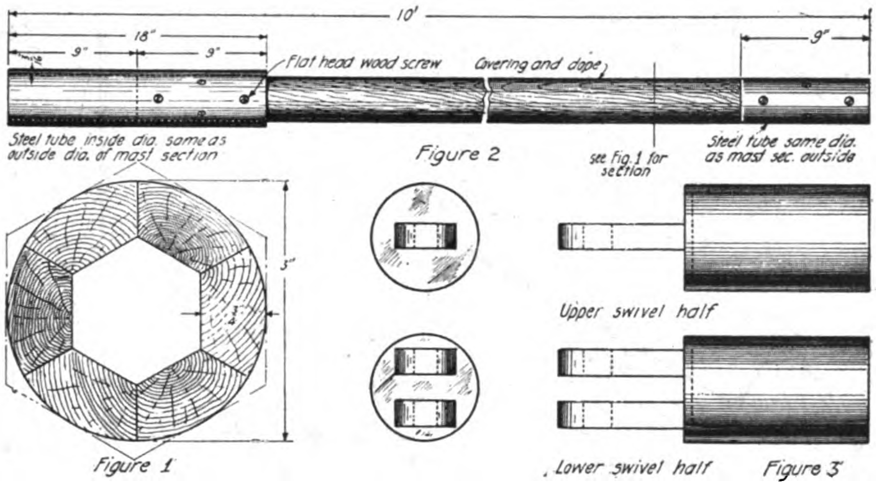
In the selection of the wood a strong light wood is most desirable, say clear spruce, poplar, basswood or whitewood. Figure 1 shows the cross section of one mast section, the lower fifteen-foot piece. This is built up of six pieces of wood that have previously been cut and planed in accordance with a template laid out on paper. The most successful manner to build these strips would be on a buss-planer if available, otherwise careful hand planing will have to be done.

Four or five octagonal shaped pieces the size of the inside diameter of the mast are cut to allow the six pieces to be assembled without falling apart. Gluing is done immediately with the best grade of flake fish glue. This glue is bought in sheets and should be cracked up and boiled in water to a consistency where it drops slowly on the end of a stick after dipping. After setting twenty-four hours the portion shown in dotted lines should be turned off in a lathe or planed off by hand, to approximate a circle. The pole may then be varnished or, first, preferably, covered with a layer of airplane linen and varnished at the same time. Valspar varnish will be found entirely satisfactory.

Figure 2 shows the middle section (one of four) fully assembled. Notice that on one end, the wood has been turned down 3/16" and 9" back and a piece of steel tube driven on and held with countersunk wood screws. At the other end, a larger piece of steel tube is slipped over the outside of the mast section and held there with wood screws. Nine inches protrude beyond the end of the section to receive the opposite end of the following section. Considerable trouble in making each section somewhat smaller than the next higher section will be experienced, but it is worth while if one has the time.

Tube fittings are not made for the joint between the last ten-foot length and the first fifteen-foot section, as a swivel joint is placed there in accordance with the sketch, figure 3. This consists of two iron castings to fit over the end of the first fifteen-foot section and the joining ten-foot section. The purpose of this section is obvious when studying the sketches.

Now, having the mast sections, tube fittings and swivel joint all complete,

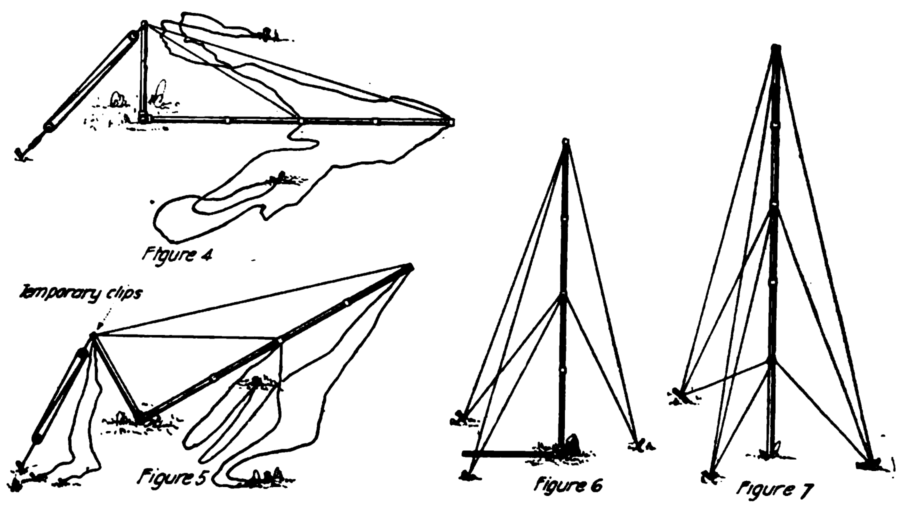


Construction and dimensions of the hollow wooden mast

there remains the guy wires and other accessories to lay out. At the top of the mast, twenty feet down and just above the swivel, an iron band should be placed around the mast and fastened to prevent slipping. Holes should be provided to fasten guy wires, which are, of course, the antenna wires as well. The guy wire lengths can be calculated and cut exactly to the required size. They should not reach to the ground, as there is an insulator and piece of rope at the end of each guy, as shown in the sketch. Four iron stakes with loose rings should be made, three for guys and one for the erection operation.

The four ten-foot sections are first placed in each other at the joints and laid out along a smooth stretch of land. The top and middle guy on one corner of the triangle is fastened at the temporary clips that hold the fifteen-foot section at right angles to the four ten-foot sections. A pulley is fastened on the top of the fifteen-foot section and this is used as a gin pole. The other sets of guys (two) are run out along the side of the pole to the stakes, their position being measured. The rope running to the pulley is then taken to another iron stake and the mast is ready for the first hoisting operation.

One man holds the left side guys and one man holds the right side guys while two men pull on the pulley running to the gin pole. The mast may buckle slightly but can be raised without difficulty. After the gin pole is pulled to within twenty degrees or so of the ground, the pole can be pushed to the ground. While one man is at one of the three sets of guys feeding out as required, a fourth man, or two, if available, should lift the fifteen-foot section up from the ground to a vertical position. There are three guys at the swivel joint, and once the mast is raised above the forty-five degree position considerable assistance can be given by pulling on the guys.



Method of erecting the antenna mast

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Prize Contest Announcement

The subject for the new prize contest of our year-round series is:

"CRYSTAL DETECTOR SETS FOR USE WITH INDOOR AND OUTDOOR ANTENNAE"

Closing date, October 1, 1920.

Contestants are requested to submit articles at the earliest practicable date.

Prize Winning Articles Will Appear in the December Issue.

During the winter months thousands of new amateurs will be setting up small sets and listening-in while many who have been among us for years will once more bring their old reliable crystal detector into use. We should like to hear something new in crystal detector design and hook-up. Here is an opportunity for you to help out the newcomer as well as the oldtimer.

PRIZE CONTEST CONDITIONS—Manuscripts on the subject announced above are judged by the Editors of The Wireless Age from the viewpoint of the ingeniousness of the idea presented, its practicability and general utility, originality, and clearness in the description. Literary ability is not needed, but neatness in manuscript and drawing is taken into account. Finished drawings are not required, sketches will do. The contest is open to everybody. The closing date is given in the above announcement. The Wireless Age will award the following prizes: First Prize, $10.00; Second Prize, $5.00; Third Prize, $3.00, *in addition to the regular space rates paid for technical articles.*

All manuscripts should be addressed to the Contest Editor of The Wireless Age

The guys are all the right length, and fastened to the insulators. The slack taken up by the ropes running from the other side of the insulator to the iron stakes make the mast vertical. This may seem like a difficult proposition, but if the mast is constructed properly, the total weight is only about forty pounds from the swivel joint up and can easily be lifted as described and in a surprisingly short time.

During experiments, four men raised a mast of this type completely in twelve minutes, and started to receive signals and then dismantled the mast and was under way in seven minutes.

Three upper sections were strapped together for one man, and one ten-foot mast and the lower mast strapped together for the second man. The third man carried the iron stakes, pulleys and rope and storage battery and the last man carried the apparatus. Surprising results were had when the mast was erected on top of high hills clear of surrounding countries.

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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Chicago Amateurs' Annual Report

CHICAGO now has 262 amateur radio stations, according to the annual report made to Washington by Charles C. Kolster, United States radio inspector for the Chicago district, and for the first time in the history of the local radio station the number of commercial radio operators seeking jobs exceeds the vacancies.

Until a month ago commercial operators were in demand, the vacancies outnumbering the applicants by fifteen. However, during the past month, twenty-eight applicants successfully passed the government examination, a number of whom have since been placed in positions.

Since October 1, 1919, when the government ban on amateur radio stations effective during the war was raised, 872 stations have been opened in the Chicago district, which takes in Illinois and eleven neighboring states.

While Chicago, St. Louis and Kansas City, all in this district, are well represented among the amateurs, the smaller cities and rural districts have their share of radio fans. Boys from all parts of the state and even from neighboring states come into Chicago to take the examination, not waiting for the time when examinations will be given near their homes.

There is no enthusiast like the radio fan. Their cheapest equipment costs about $250, and in some cases their plants represent an investment of several thousand dollars. Right now there would be double the number of amateurs in the district if the apparatus were obtainable. Manufacturers report that they are as far as eight months behind in filling orders.

In order to pass the examination as amateurs, applicants must have a thorough knowledge of their equipment, know the regulations pertaining to national and international radio traffic, and be able to receive at least twenty words a minute in the code test.

Out of 533 taking the examination as commercial operators, since Oct. 1, 1919, only 228 were successful. The majority of the amateur stations can transmit messages only a few hundred miles. However, several in the district are known to have sent messages as far as Washington and intercepted messages at greater distances.

Honeycomb Inductance Coil Mounting

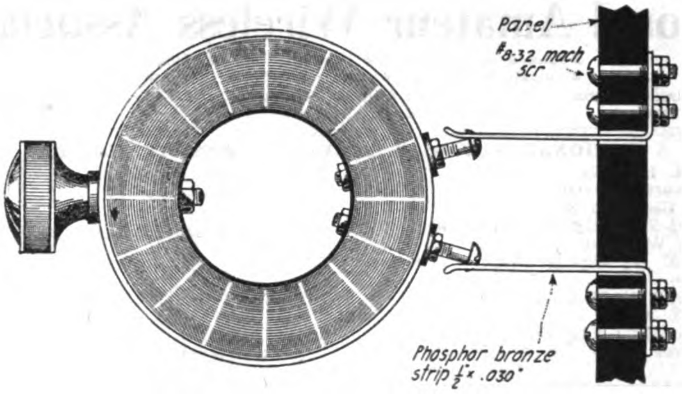
By Clyde J. Fitch

IN a recent issue of The Wireless Age I described the construction and mounting of honeycomb inductance coils. Since then I contrived the mounting shown in the accompanying drawing, which is so simple and easy to construct, that it should be preferred by experimenters. I have used this mounting and it works satisfactorily.

After the coil is wound and removed from the arbor, the holes for the brass machine screws are made by forcing round pointed wooden pegs, slightly larger than the machine screws, through the winding. The winding is then given a thick coat of orange shellac and baked till it is thoroughly dry. It will be thoroughly dry when all the odor has disappeared. The wooden pegs can now be removed and the machine screws inserted, using a fiber washer on each side of the winding. The two ends of the winding are each connected to a machine screw. The coil can now be inserted in the clips as shown in the drawing, the head of the machine screws snapping into the holes in the clips. This allows the coil to swing sideways, which will vary the coupling between two or more coils mounted side by side.

The hard rubber knob may or may

not be used depending upon the fancy of the builder. It will help to overcome the capacity effect due to the nearness of the operator's hand when the regenerative circuit is used, which is not exactly a disadvantage, as tuning is accomplished with the variable condensers alone.



Construction of the honeycomb inductance coil mounting

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. H. C., Wisconsin:

The only improvement we can suggest is to get a vacuum tube and use standard diagrams with regenerative connection. Your apparatus appears to be O. K. but it is not sensitive enough to receive long distance stations, or weak signals which amounts to the same thing.

* * *

C. M. G., Missouri:

1. In order to give you the exact size of the condenser for a one half kilowatt set it is necessary to know the frequency of the supply line, the secondary voltage of the transformer and the number of studs and speed of the rotary gap.

2. QSA means: Are my signals strong? Your signals are strong. QRM means: Are you being interfered with? I am being interfered with.

3. If you have a license for the station and one for yourself your brother can transmit under your supervision.

* * *

C. K., Ohio:

The size of the Audio-choke coil you speak of depends upon the impedance of the tube it is used with and too many factors must be known in order to properly design one. Would suggest that you use a secondary unit from a one or two-inch spark coil with an iron core, made of a bundle of iron wires, in the center. Simply try various coils until loudest signals are heard.

* * *

W. T., Tennessee:

1. The best answer we could give you would only be theoretical and until we find out what electricity is, it is almost useless to explain, in the true sense of the word, just how the current does flow from the plate to the filament.

2. The multi-layer winding gives greater inductance in a smaller space and less capacity for the same amount of wire than the single layer coil type.

3. The connecting of rectifiers in series is something that would have to be tested. While the idea is not new we can not say at the present writing just what the action would be. Why not try it and if successful write an article regarding your results?

4. Fahnestock Binding Posts may be ordered from the Fahnestock Electric Company, Meadow, N. Y. Hunterpoint 877.

5. In regards to bare tinned copper wire, would suggest that you get in touch with wire manufacturers listed in the advertising section of the "Wireless Age."

Operating Suggestions for the Radio Amateur

By Leigh M. Townley

I'M an amateur myself and this idea of eliminating jamming hits me just right. Previous to the war we had a system in our town which gave real operators a chance to work, new "birds" a chance to listen-in on the good stuff and lots of chance for them to CQ around and test. It is my belief that if this system were improved upon and enlarged to take in more than one town, it might be worked with success for the benefit of all amateurs and the improvement of working conditions in the air.

From 1915 to and through 1917 we had an epidemic of radio bugs. The big idea of everyone seemed to be that if your set was powerful enough to jam through the others you could work, otherwise you were out of luck. It was this condition of affairs that gave rise to our scheme.

All the amateurs, or at least as many as could, got together to discuss this problem. We had no radio club and no one seemed to be anxious to start one because of the great range of ages, nationality, religion, station in the social life of the town, yes and even the difference of sex of the amateurs. However after several meetings we devised this system.

Because there were so many of us in such a small space, promiscuous "flat chewing" must be done away with. Testing was limited to the last ten minutes in each half hour and the station's call must be signed. If important work was being carried on, testing must be postponed till the next test period. Four fellows, owners of 1 k.w. sets. were appointed to act in a sort of advisory capacity as control stations. They were numbered 1, 2, 3, 4 and took their seniority in order of their number so that if more than one happened to be on at once, it would be understood who was on command of the air. They had absolute QRT privileges over the stations in that vicinity and could pipe anyone down at will and could also give anyone "clear air" at will. Believe me, when one of these amateurs heard a QRT fired at him from one of those stations he never let a peep out again until told that he could by proper authority.

In this manner, if anyone has business to clear he would call the control station on at the time and request clear air. The control station would clear the air by a CQ—QRT and then tell him to go ahead. If, in the estimation of the controlling four stations, one station was requesting clear air more than was his right he was told to lay off for a while. This eliminated useless calling because the controlling stations kept a log of all the stations on at the time and should anyone start calling a station which was not on, the control would tell him so and tell him to QRT 'til that station reported on.

We found this system worked O. K. chiefly, because, if there were any offenders they were immediately discovered and a mad gang of radio operators is not pleasant to settle with. Then again it made the beginners come on when no business was being handled and no one cared if they CQ'd their set apart. This little idea seemed to improve the operating, because everyone wanted to handle real business, but no one wanted to ask for clear air and then fall all over themselves with the whole gang listening in.

While this scheme worked beautifully in a small city and the surrounding country it might not prove so successful on a large scale but it is my conviction that if all the radio clubs and associations of the country were to adopt this scheme, jamming and all its attendant evils would be materially reduced. At any rate a beginning has to be made and practical experience with the scheme here outlined will no doubt establish its value.

Book Reviews

The Year Book of Wireless Telegraphy and Telephony, 1920. Cloth binding, 1148 pages. Illustrated. Wireless Press. Price, $3.75, postpaid.

The eighth successive year of publication is marked by the issuance of the current edition of this standard reference work. The volume appears considerably enlarged in scope and with many novel features.

The section devoted to the Record of Development chronicles the many epochal events in radio during 1919 and completes the record from the year 1827 to the beginning of the present year. The very comprehensive section containing the National and International Wireless Laws and Regulations stands unrivalled and unique in its complete form, incorporating the full text of the International Radio-telegraphic Convention and the Safety of Life at Sea Convention, as well as the laws and regulations of all the countries of the world. In this section alone are 400 pages of information obtainable in no other single volume. Noteworthy among the additions to this section are small maps which show the position of the wireless stations in each country.

The Directory of the World's Wireless Stations occupies 386 pages and lists land stations and ship stations, giving call letters, range, wave-lengths, nature and hours of service, owner and message tariffs. The key list to the call prefixes of all nations are also included, together with valuable data on meteorology. Time and weather signals are dealt with internationally, complete information on all countries and a full interpretation of the symbols being included.

A new feature, and a specially valuable one, is a series of special articles reviewing the development of radio in the principal countries during the past year. Each resumé is written by an authority in the countries represented, which include France, Germany, Great Britain, Holland, Italy, Japan, Norway and the United States. The thought of eminent scientists is also expressed in general articles devoted to: The Progress of Wireless Telephony; Valve Amplifiers for Shipboard Use; Wireless Telephony and Its Application to Aircraft; Direction Finding; The Berne Bureau; and Radiotelephony and Aviation.

A patent section records the issues of the past year and segregates those relating to vacuum tubes. The useful data section has been exhaustively revised, giving tables and general information along with the terminology of radio and foreign equivalents.

Complete information about all the principal commercial radio companies is again included, along with biographical notes of the world's leading authorities on wireless. The literature of the art is catalogued in another section, inclusive of books and periodicals and the most important articles which appeared last year, according to the subject discussed. An amateur section and a code signal section concludes the volume.

Obtainable through the Book Department, The Wireless Age.

Radio Engineering Principles. By Henri Lauer and Harry L. Brown. Cloth binding, 295 pages. Illustrated. McGraw-Hill. Price, $3.50 net.

The purpose of this book is to record and explain the extensive developments in radio made during the war. It is devoted principally to study of the characteristics and use of the vacuum tube, but deals with the essentials of the older apparatus in which important principles are embodied. The use of mathematics is kept to the minimum and appears only when essential to clarify the theory. The volume, in fact, concerns itself only with instructing the reader in radio communication principles and the general means of utilizing these in practical work.

Obtainable through the Book Department, The Wireless Age.

Practical Amateur Wireless Stations. Compiled by the Editor of The Wireless Age. Paper, 136 pages. Illustrated. Wireless Press. Price 75 cents net.

This volume is announced as an experience book, containing the best suggestions of thirty-three experimenters on building, installing and operating experimental stations for radio communication. In a foreword its purpose is explained as that of presenting in convenient form the experience of practical workers in the art. The methods described as those which the authors have worked out and tried out themselves, and the same is true whether the chapter deals with a single piece of apparatus or a complete station. The selected chapters made their first appearance in THE WIRELESS AGE in the form of magazine articles, giving the volume the peculiar merit of standing as a record of results and final conclusions, presented without the restriction of viewpoint by prejudice or preference that obtains in the writings of a single author.

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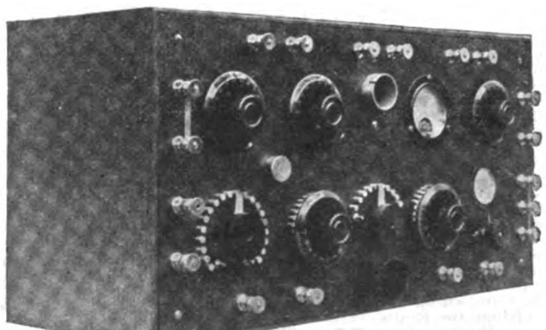

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