)ctober, 1919

The WIRELESS Age

Volume 7

Dancing to Music Wirelessed from an Airplane

Wireless in the A. E. F.

~ TO THE NAVY

)SE
INSULATION
"MADE IN AMERICA"

REG.
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‿EAN IN AIR

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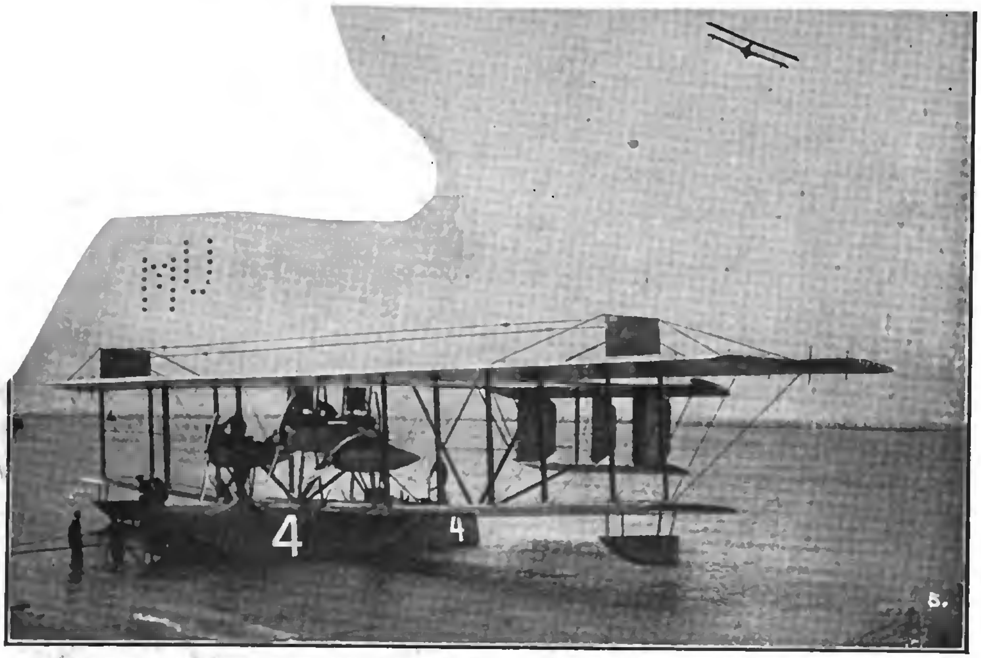
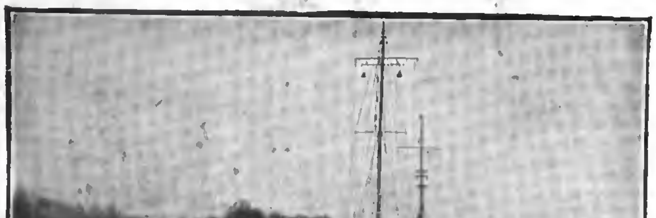
's

"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.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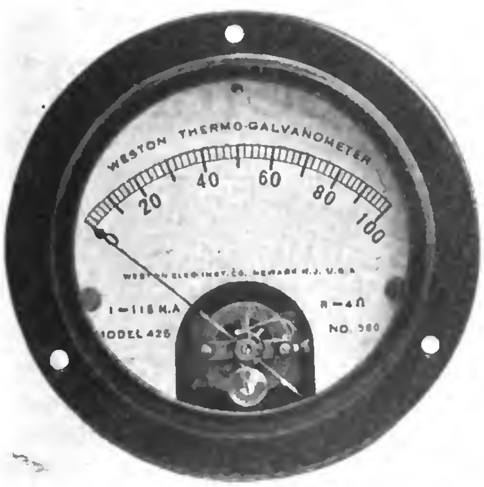
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The Wireless Age

Edited by J. ANDREW WHITE

Vol. 7 — No. 1

Contents for October, 1919

Index of Equipment

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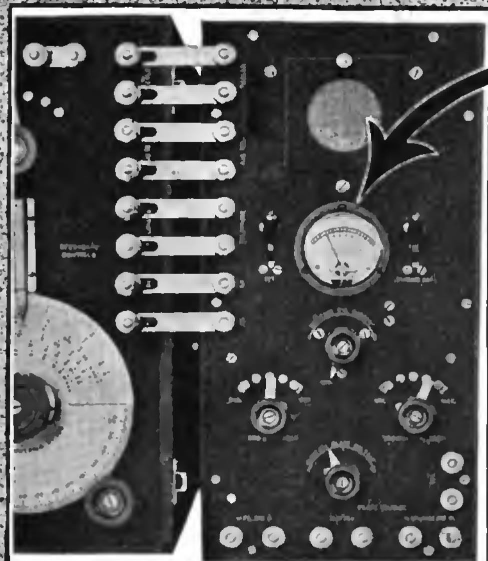

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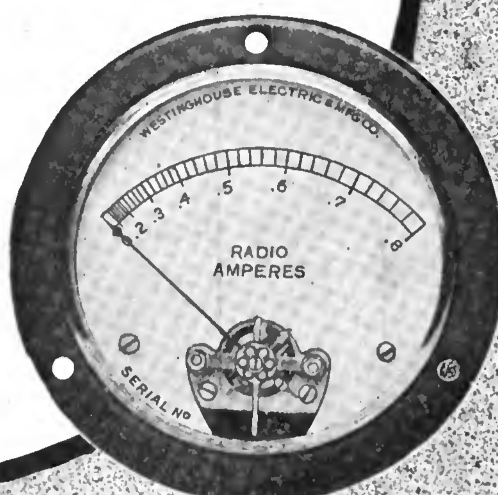

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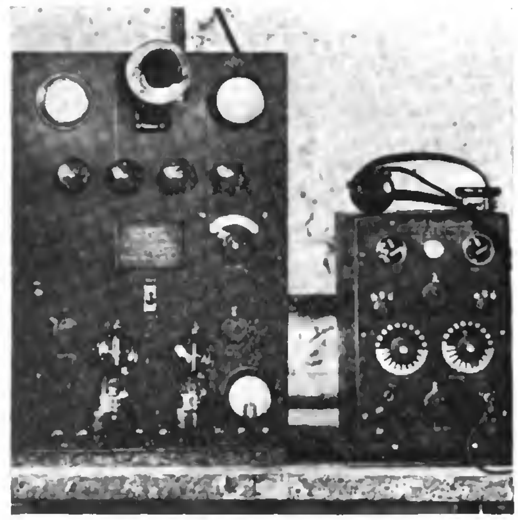
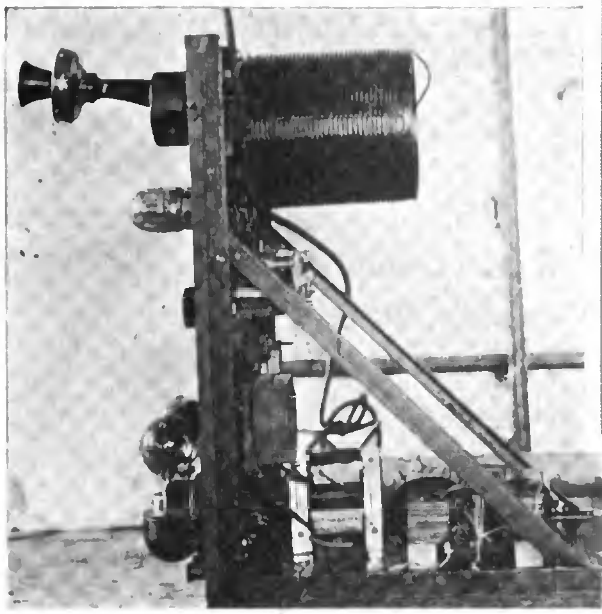
A NEW 'PHONE

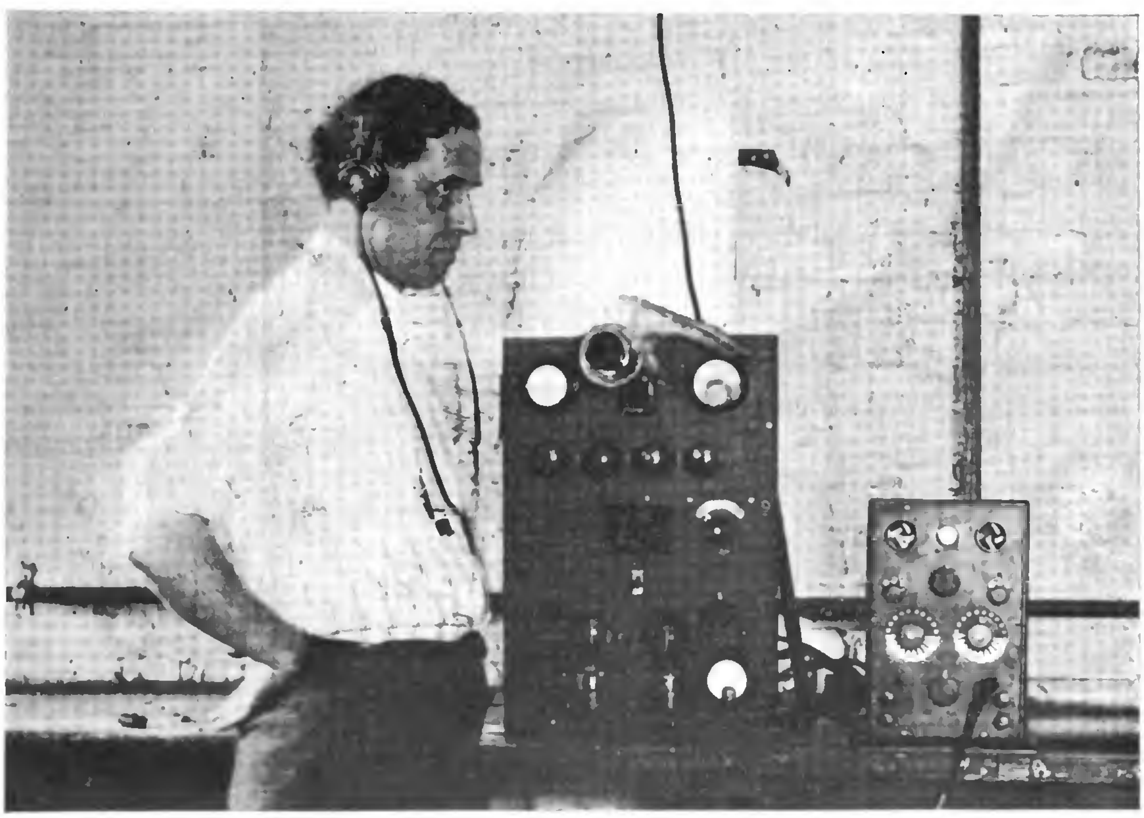




Above: The transmitter, and on the right the combination V. T. detector and amplifier

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 Freneh equipment proved satisfactory in most respeets, 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.

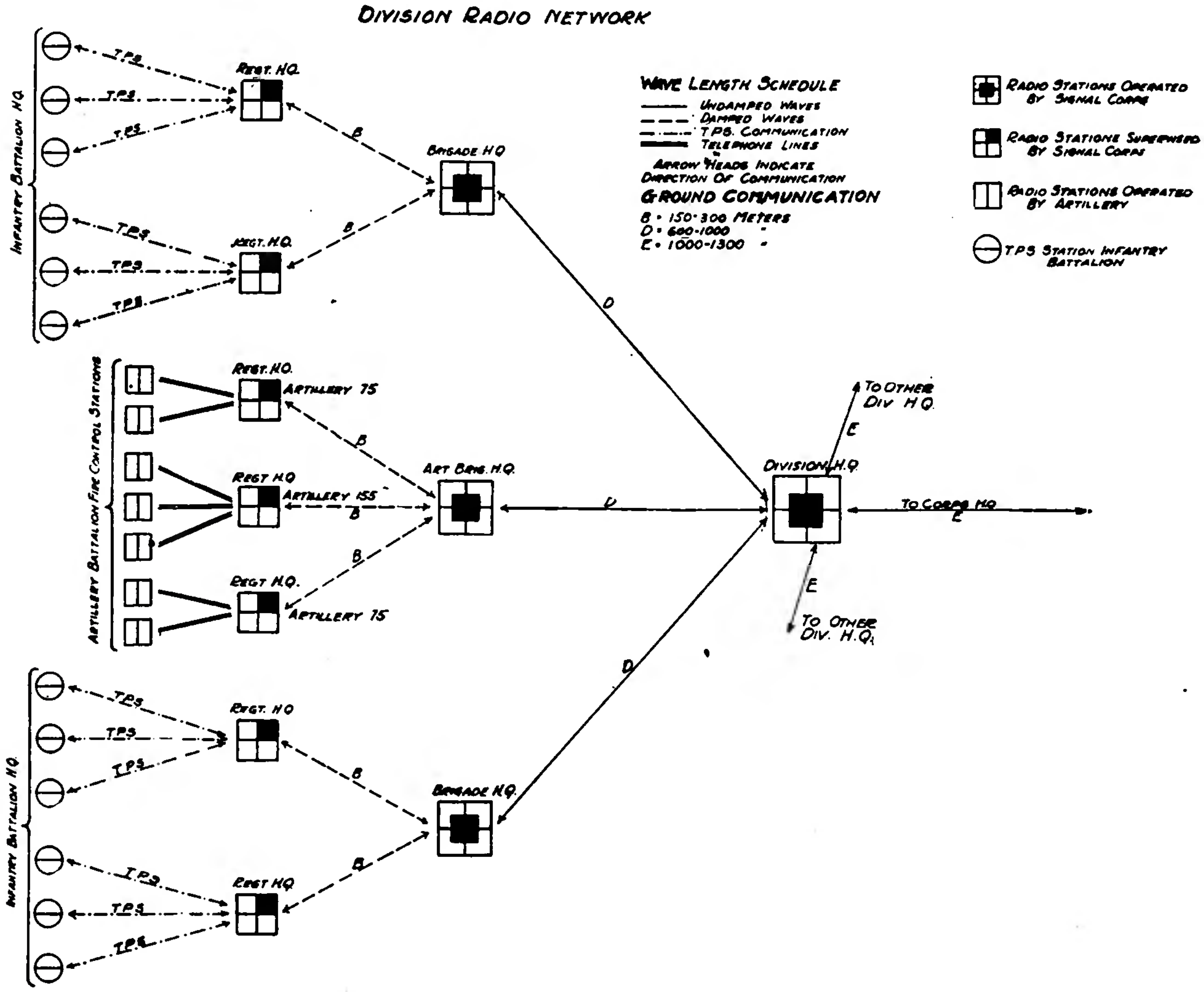
The French radio authorities, like ourselves, had the impression that vacuum tube sets were too complicated and frail for use except at considerable distances back of the line, and only the simplest spark sets were in use when our troops first went into the lines. Later, undamped wave sets were put in 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-

Division Radio Network



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:

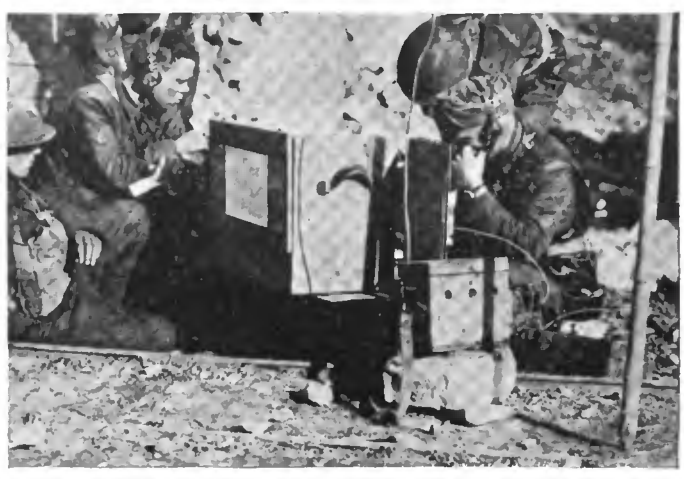
Ground telegraphy (T. P. S.) was provided for communication between regimental headquarters and battalion headquarters. The induction coil, plain antenna set, which will be described, was provided forward of divisional headquarters and down to regimental headquarters; undamped or continuous wave transmission 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.

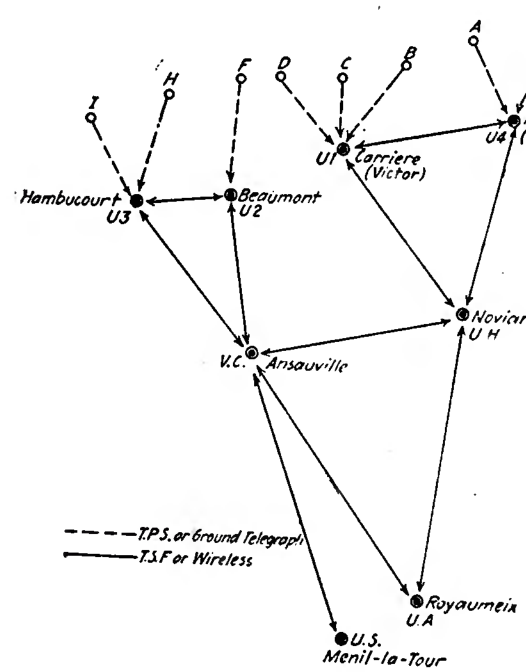
The equipment used for this service and wave-length assignment was a transmitting and receiving set known as Radio Set Type E-3. It was mounted on a Ford truck as shown in the photographs accompanying this article. These Ford trucks were originally ambulances, but were the only suitable vehicles available 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 wave-length 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 Maior 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.

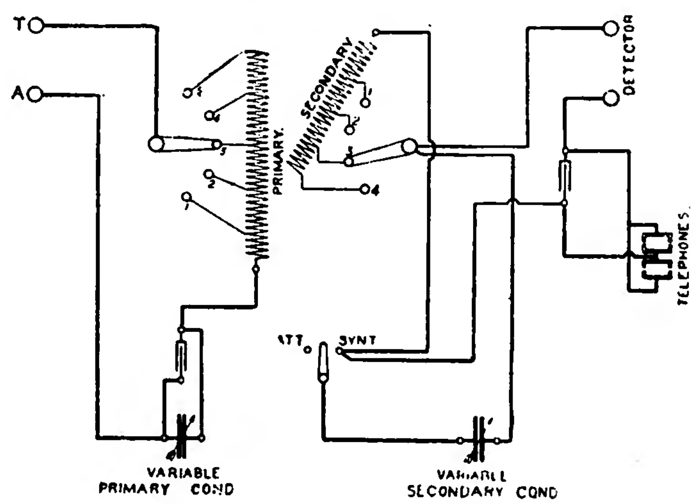
The radio liaison between division and army corps was allotted a wave-length range of 1000-1350 meters. This wave-length range was allotted to maintain radio liaison between a division and its adjoining divisions, between army corps headquarters and the army corps artillery headquarters, between army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

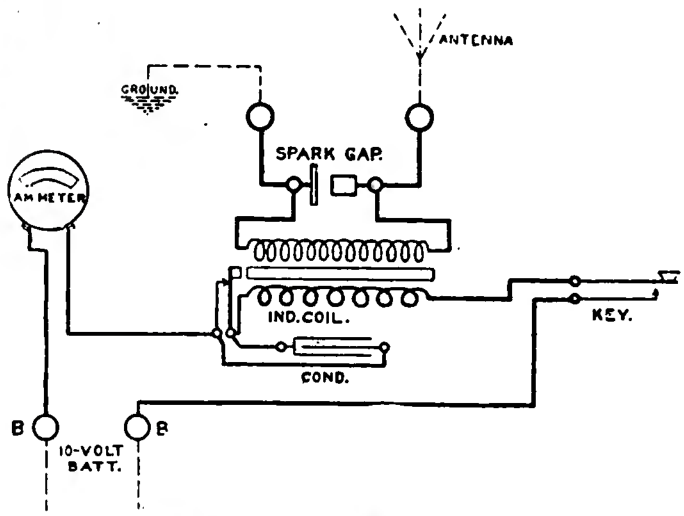
The Army Net included the stations at Army headquarters and the stations at the headquarters of each Army Corps, Army Artillery headquarters and Army Air Service headquarters. The Corps Net included the stations at Army Corps headquarters, the stations at the headquarters of the Divisions comprising 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

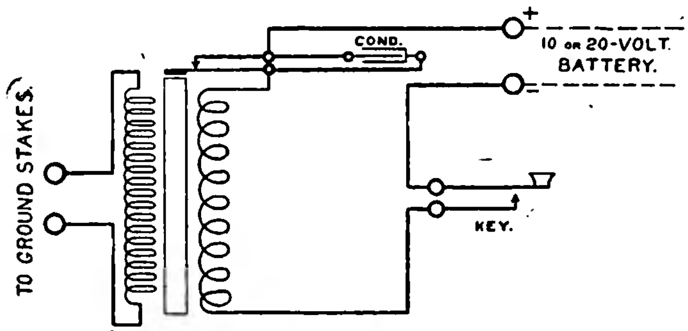
and illustrated by the accompanying photographs and circuit diagrams.

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.

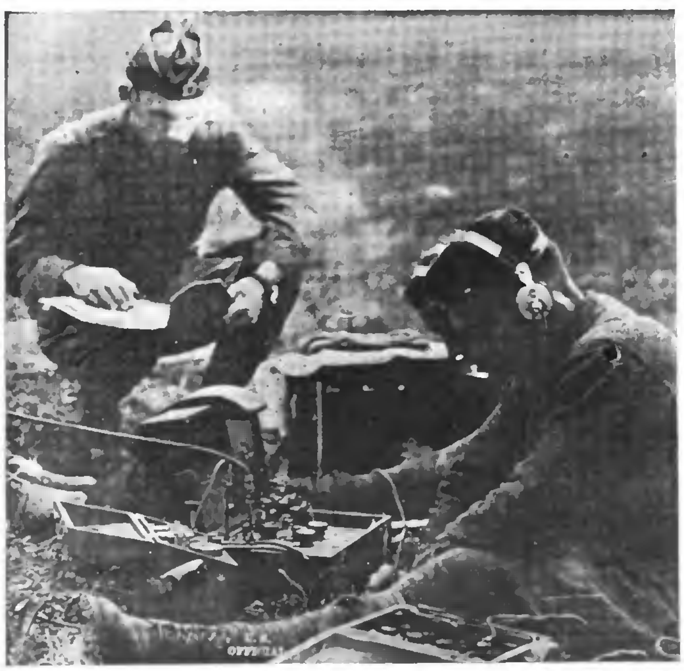
The Transmitting Set T. P. S. No. 2-bis, consists of a high power buzzer operated by a 10-volt storage battery with its secondary, as shown in the diagram, connected into a line of well insulated field wire whose ends for efficient operation were grounded by means of metal stakes at points varying from 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 alter-



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

nating 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

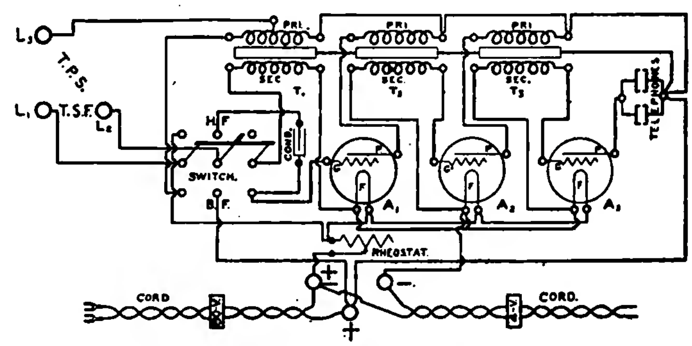


Receiving with Receiver Type A-1 and Amplifier Type 3 ter

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.

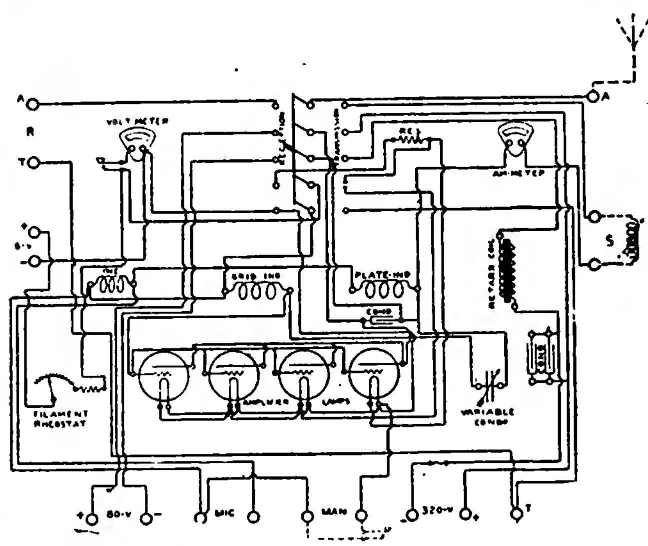
The American equivalents of the French T. P. S. transmitter and receiver are known as S. C. R.-71 and S. C. R.-72 respectively. The two-way American S. C. R.-76 T. P. S. set was a combination of the two above types, which eventually would have replaced the French equipment, but it was never available 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



Circuit diagram of Amplifier Type 3-ter

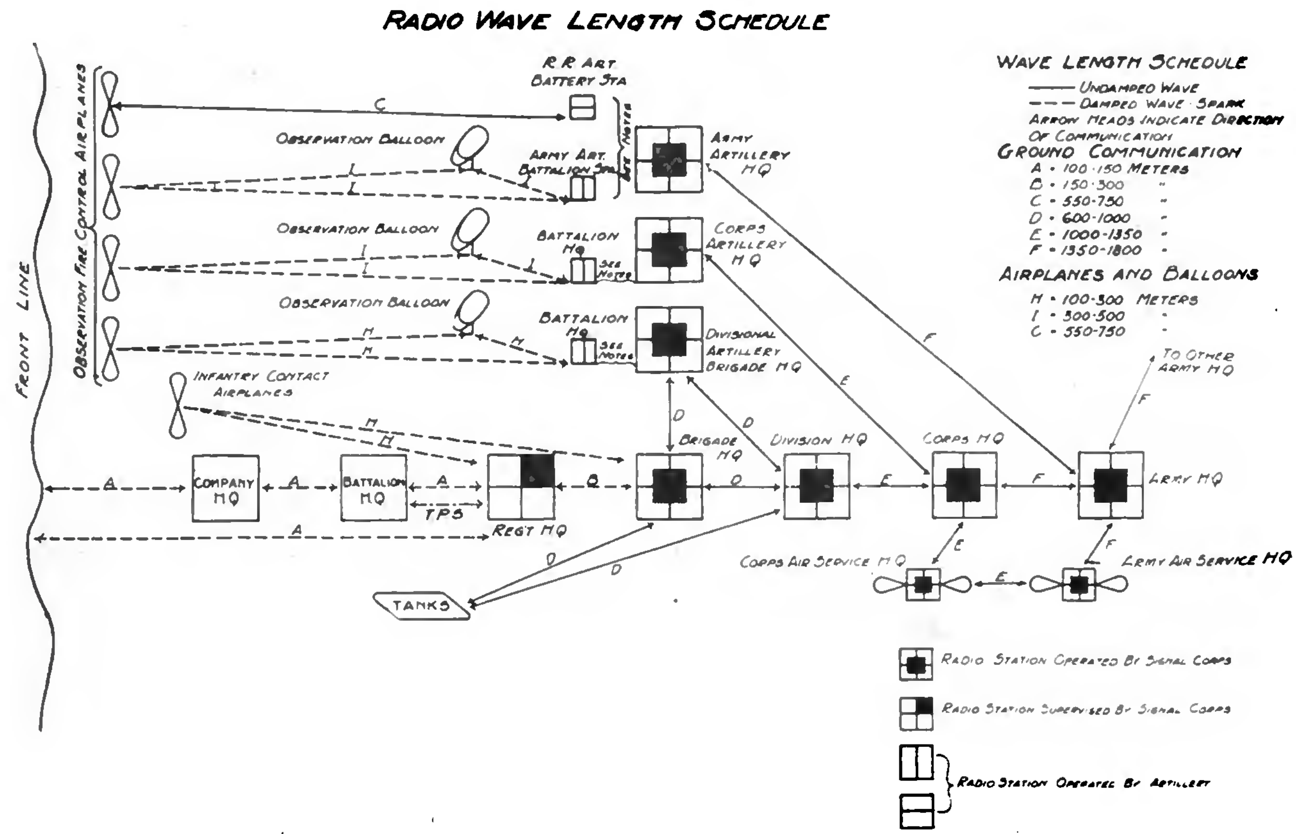
3-Ter. comprised three standard French vacuum tubes coupled by means of transformers—shown in the diagram—and supplied with current by storage batteries giving 4 volts for the filaments and 40 volts between plates and filaments. A rheostat in the filament circuit was the only means provided for varying 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



Circuit diagram of transmitter and heterodyne for Radio Sets Type E-3, E-3 bis and E-3 ter

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 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



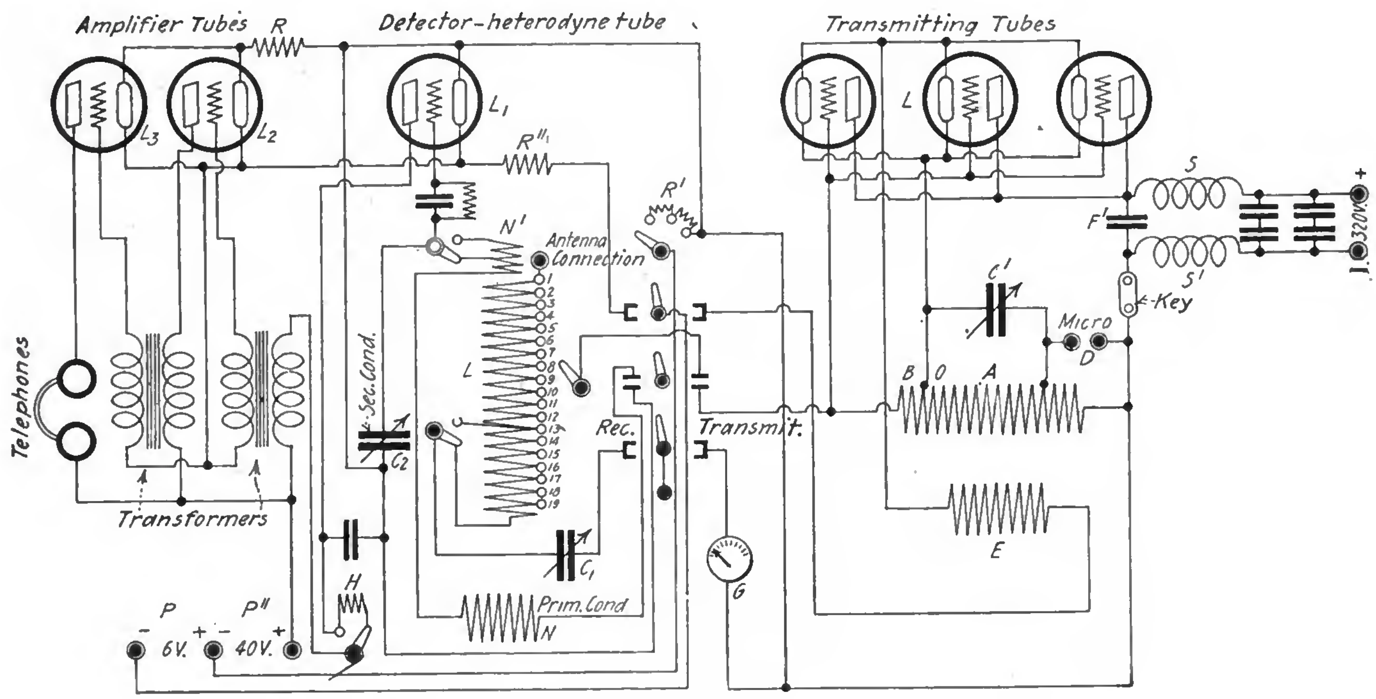
Receiving practice with an American made SCR 54 Receiver and a French Amplifier Type 3 ter secondary coil with five taps connected to the contacts of corresponding dial switches. The terminals of the primary circuit were connected to the ground and antenna respectively. Across the terminals of the secondary 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.

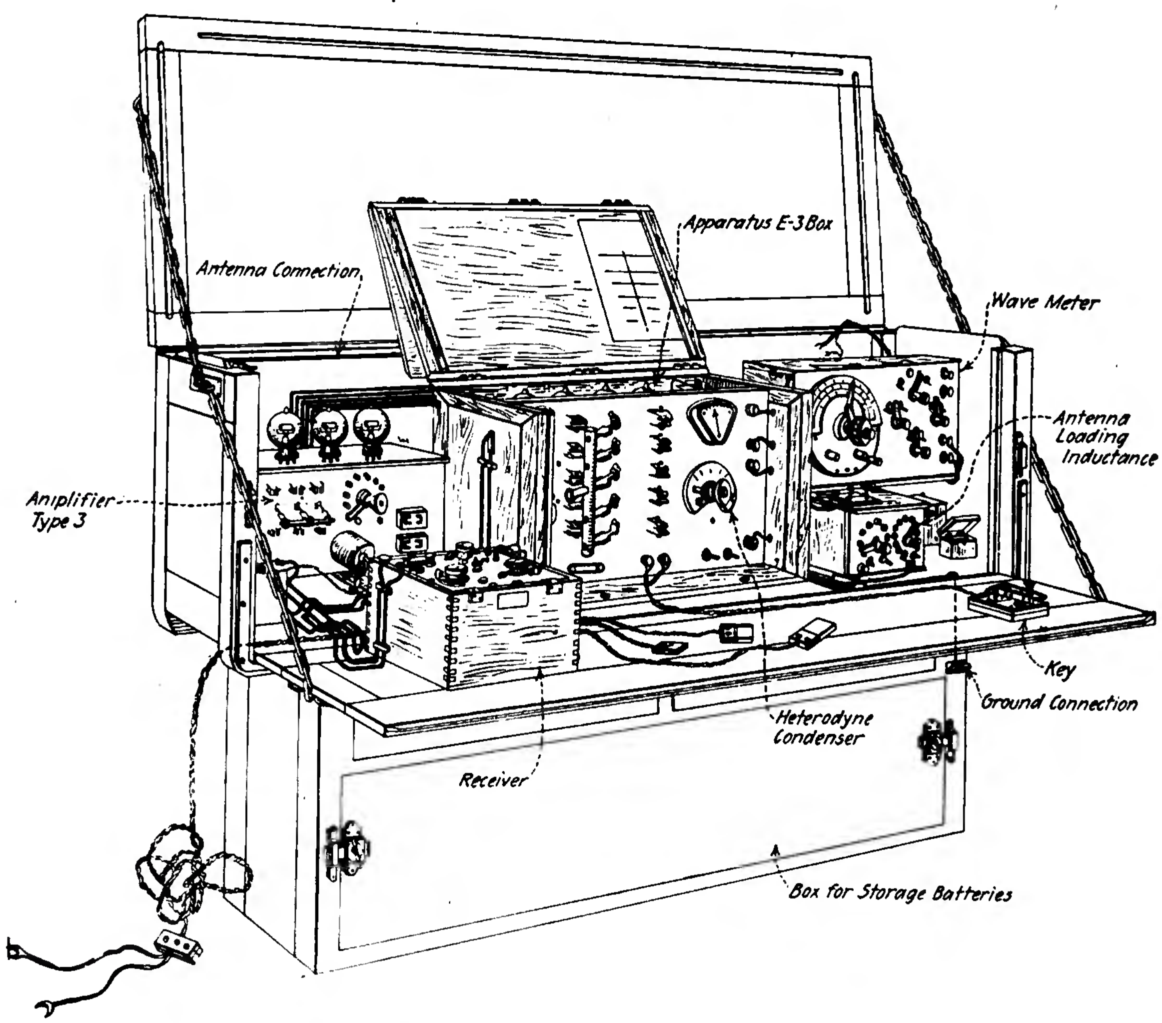
For receiving radio signals, damped or undamped, the E-10 bis set was provided with three vacuum tubes, as above described. When undamped signals were to be received one of the tubes acted as a detector and heterodyne, while the remaining two tubes amplified the detected low frequency signal impulses. 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.



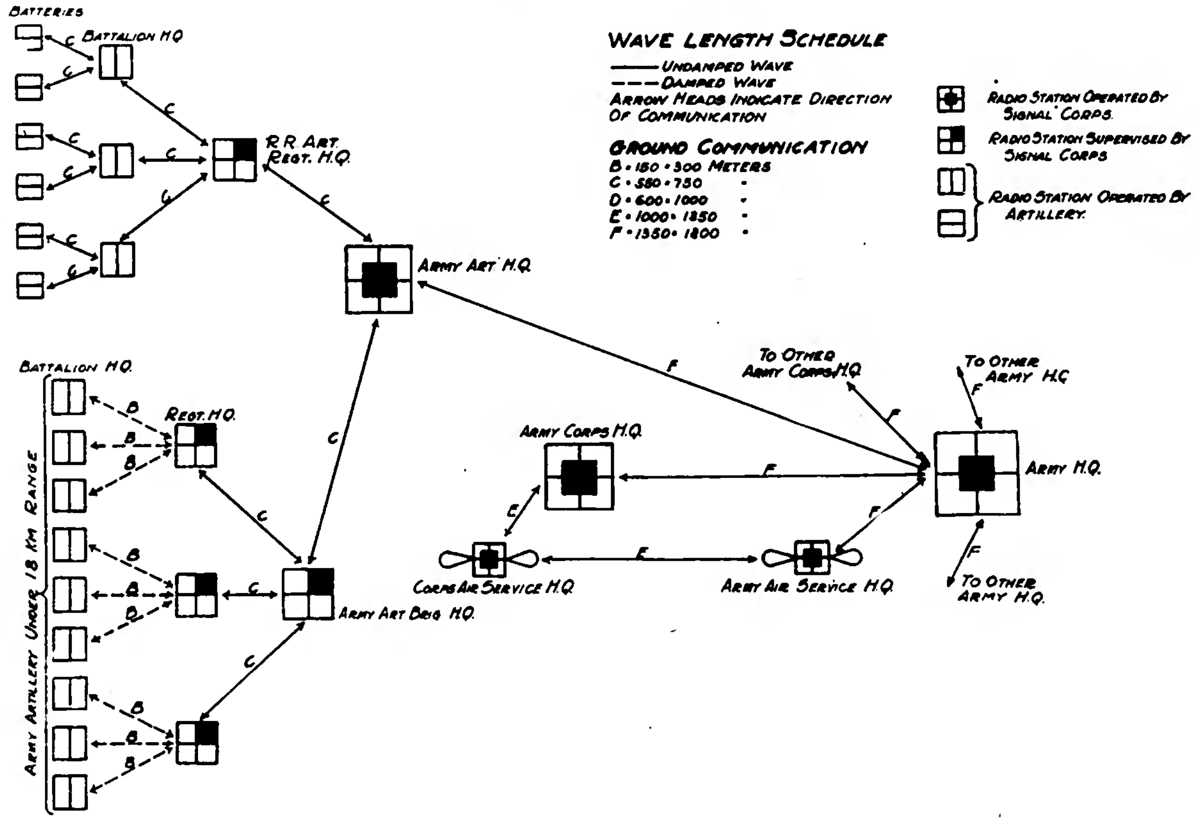
Sketch showing method of mounting the various component parts of Radio Sets Types E-3, E-3 bis and E-3 ter

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.

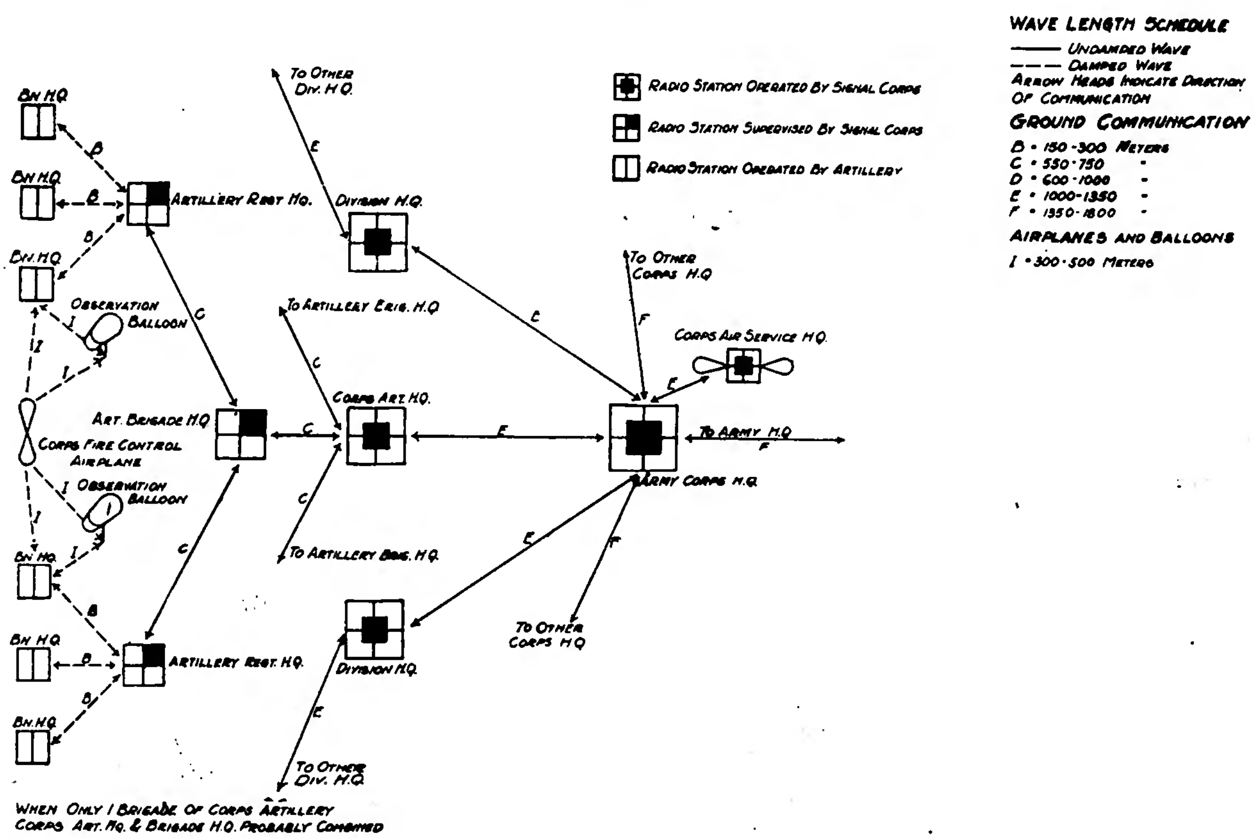
Shortly before the signing of the armistice a new set was developed by the French known as radio set type E-13. This set was found to be very efficient in operation and was extremely compact, as compared to the bulky E-3 bis or E-3 Ter sets. The wave-length range was from 1,200-2,800 meters. It was planned 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.

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 of the antenna loading inductance A and a coil B in the plate circuit wound on the same ebonite tube. The

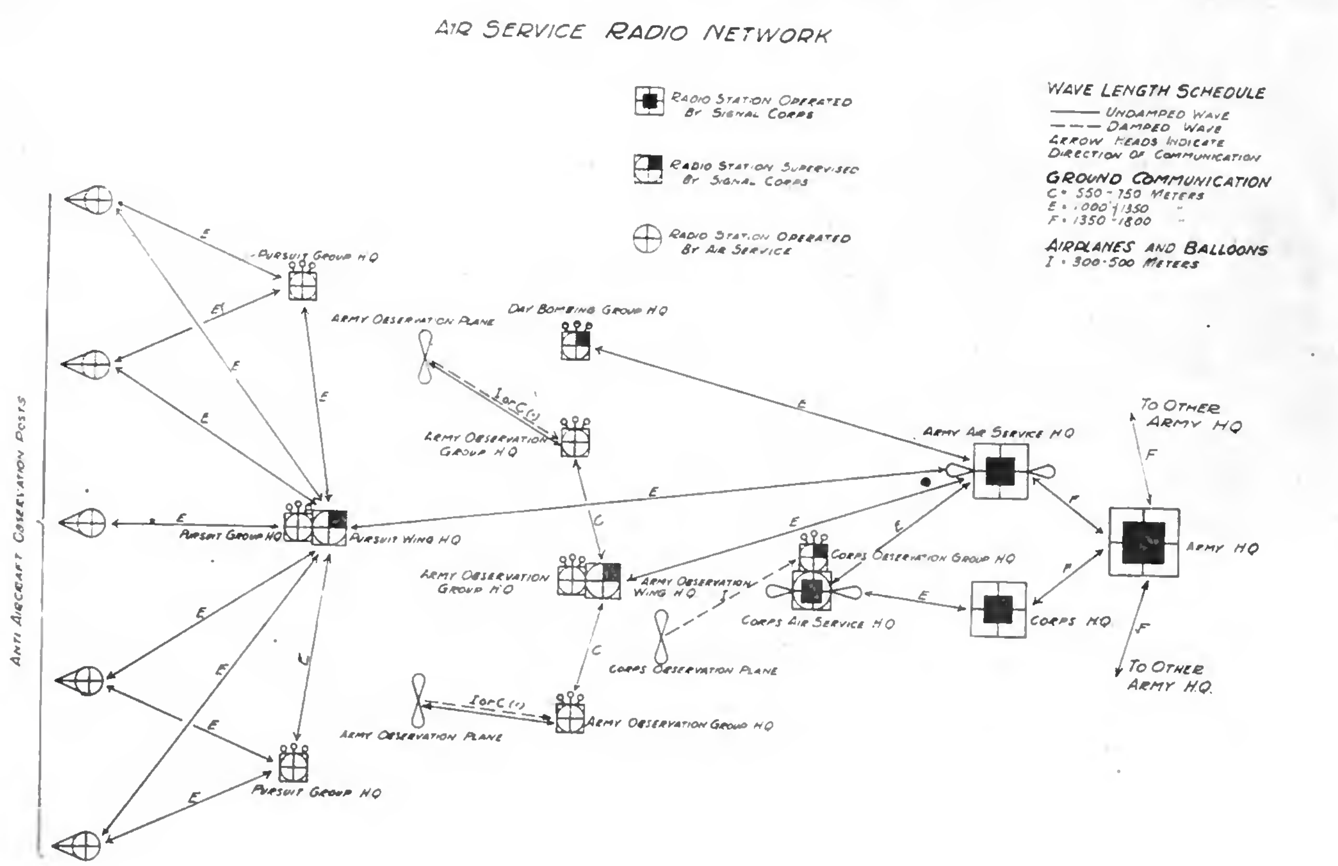
ARMY RADIO NETWORK



ARMY CORPS RADIO NETWORK



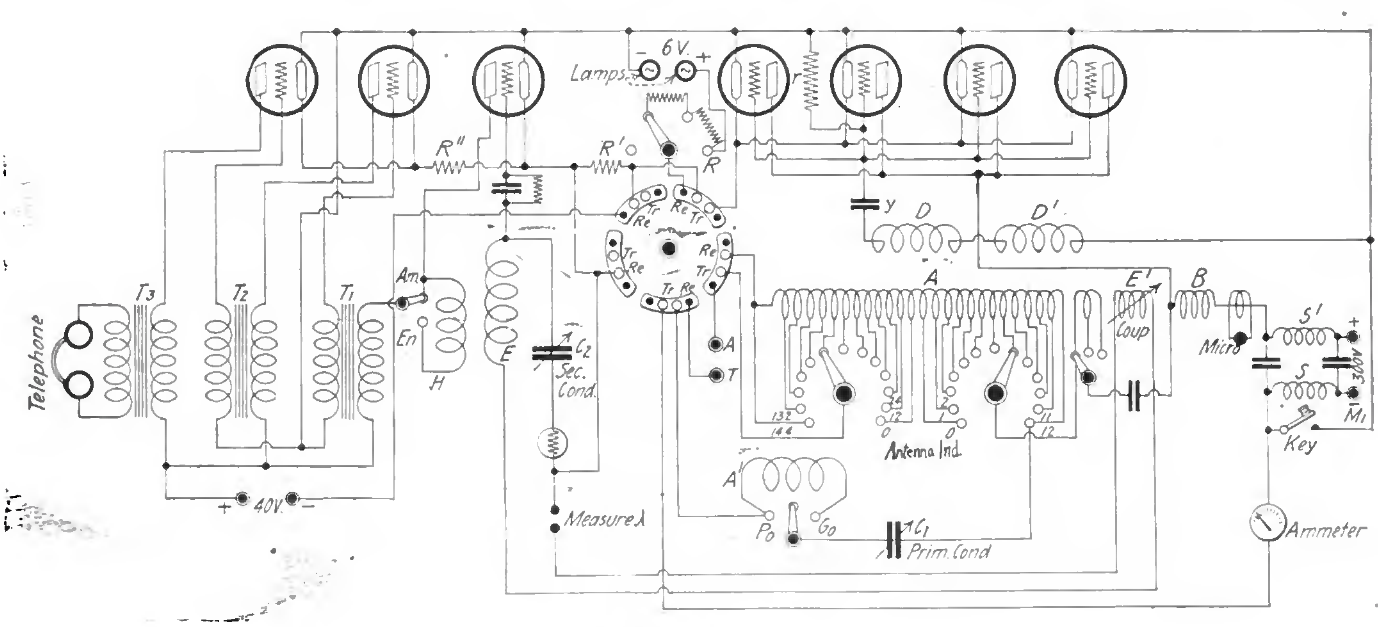
two grid coils D′ and D are in series and link with the coils A and B respectively. The coil D′ is placed within



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

The coils S, S¹ and the condenser M¹ 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.

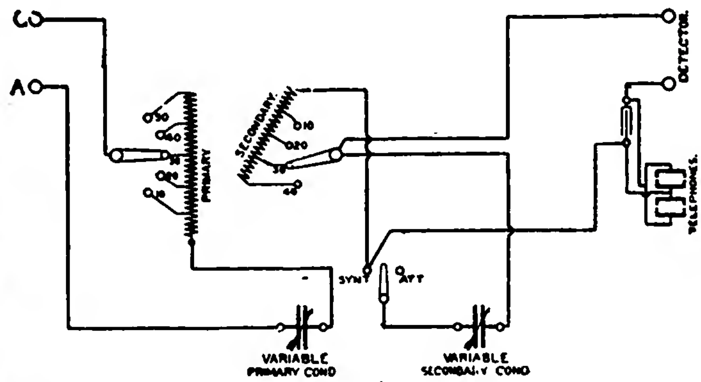
A key in the plate circuit is used for telegraph signals and an auxiliary coil wound around the coil B and in series with a microphone permits the set to be used for radio-telephony, in which case the key is short circuited. For reception three standard French vacuum tubes are used for receiving either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



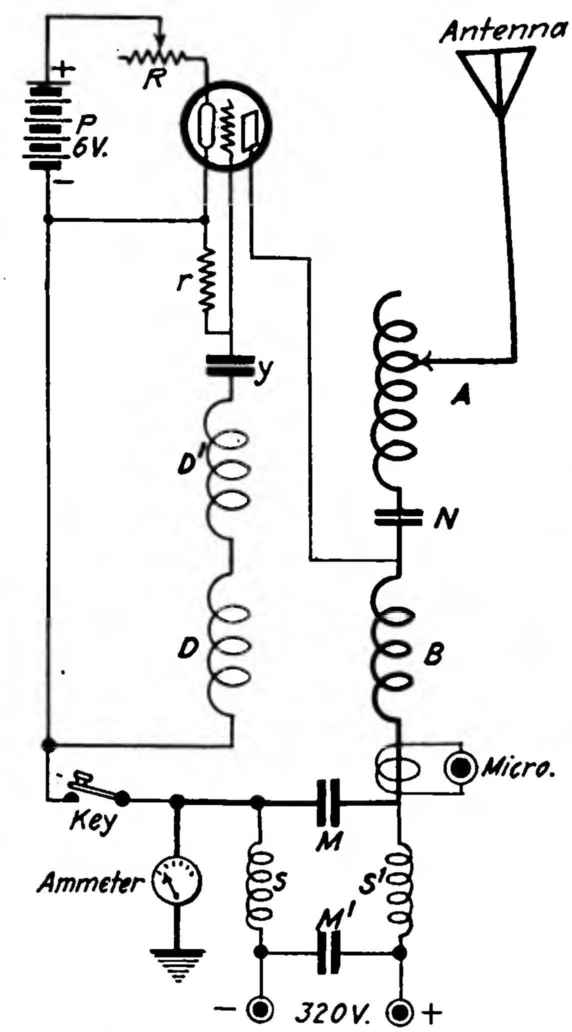
Circuit diagram of Radio Set Type E-13

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 A¹ in series with the inductance A. The coil A¹ 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.



Circuit diagram of Receiver Type A-1

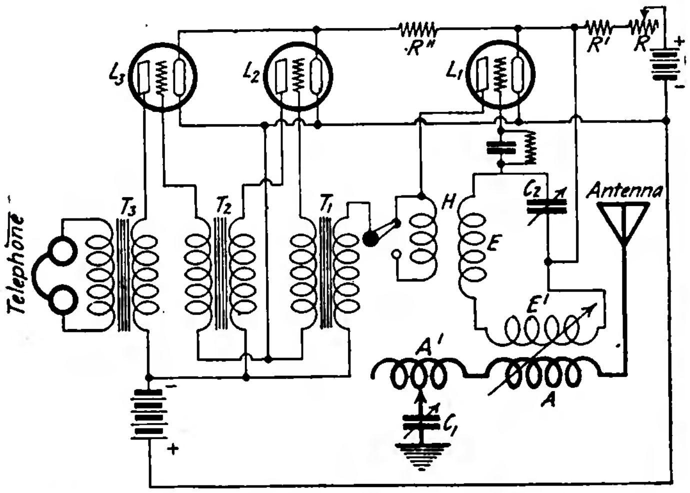


Simplified diagram of Radio Set Type E-13 transmitting tube circuit

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 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

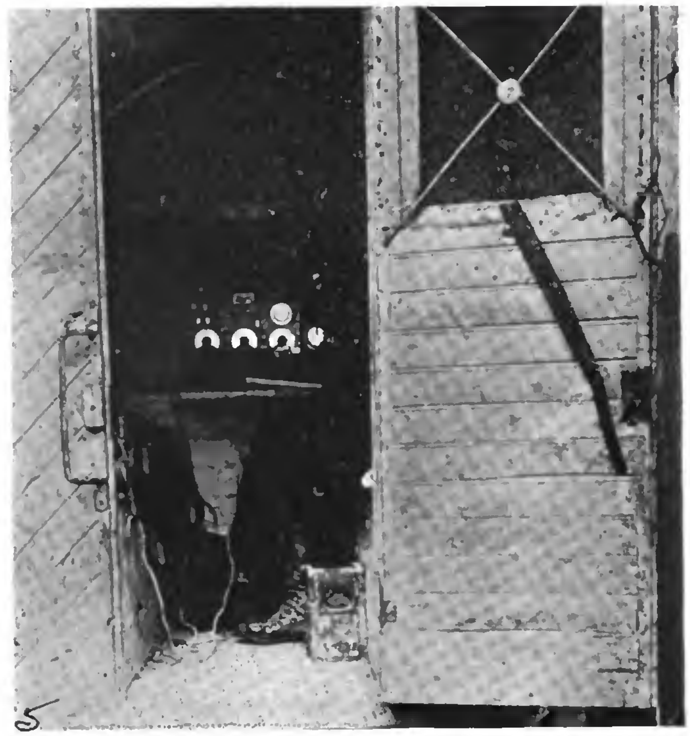
A Ford Radio Tractor, Divisional Headquarters Radio slang phrase "I'll tell the World" would have had a real meaning in that case.

This article outlines in a technical way the offensive or communication radio service in our army. It does



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

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.



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.

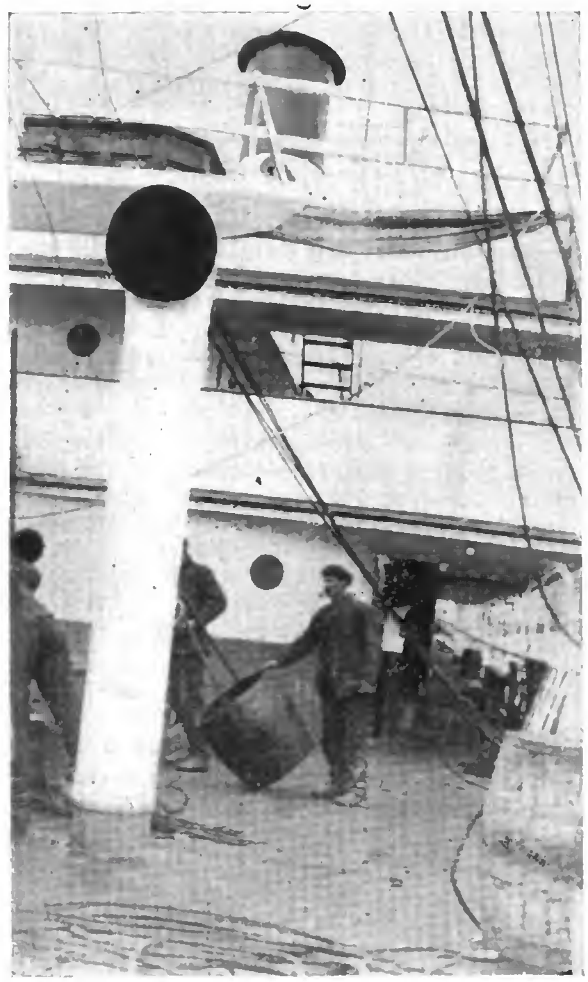
As soon as dinner was served, we noticed that there were others missing; all told, seven waiters and the buffet man had been left behind. All evening the half-deaf steward tried to accommodate the patrons, each of whom had a method all his own for mixing drinks, with a result that proved a lasting entertainment.

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.

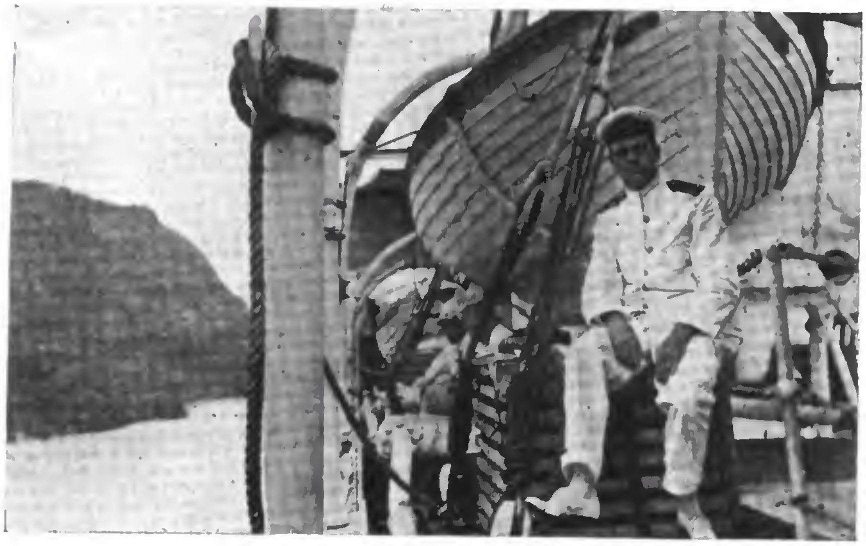
From the start they conducted themselves in non-orthodox invalid style. They managed to secure introductions to every member of the fair sex on our passenger list, alternating dances in the dining room with tete-a-tete on deck or rendering select ballads on the mandolin.

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 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.



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

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.

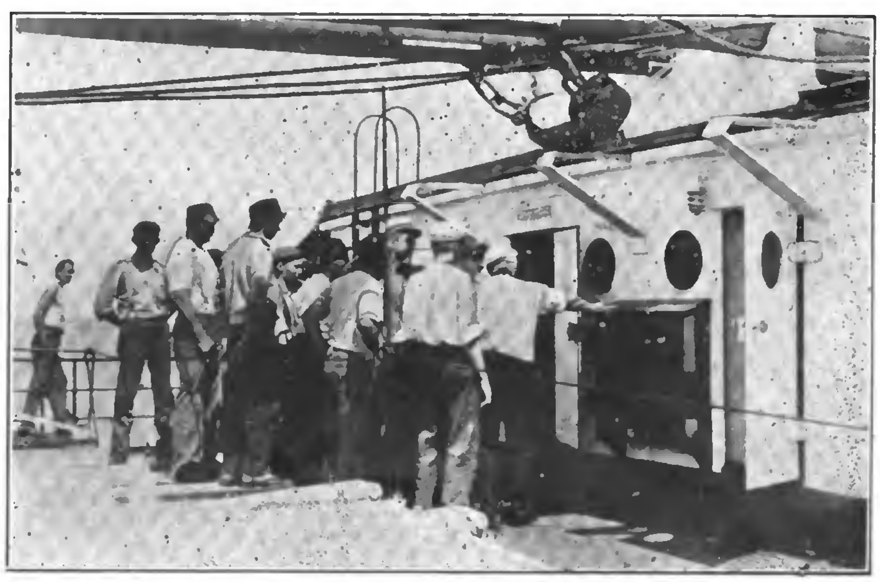
"Oh, we do," asserted Skeet. "So does uncle. He sleeps soundly, too, and our window is not very far from the ground."

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.

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

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



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-

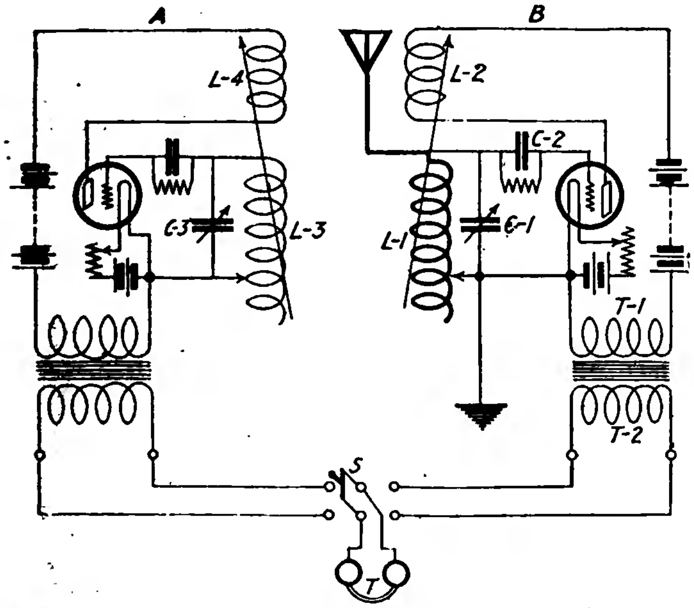


Figure 1—Circuit diagram of the "stand-by" and "tuned" continuous-wave receiver

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

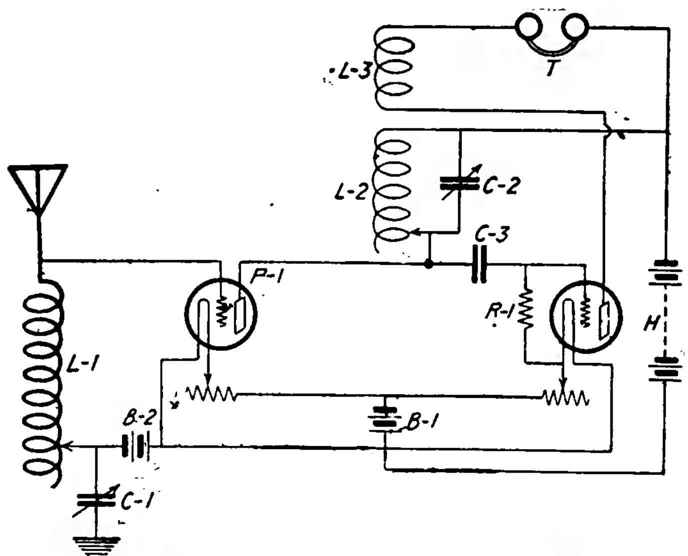


Figure 2—Diagram of connections of the general receiving circuit for damped or undamped waves

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

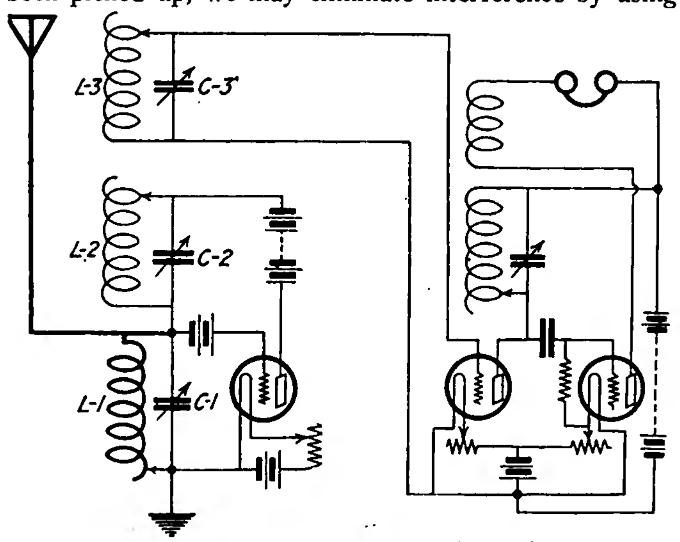


Figure 3—Circuit of a highly selective receiver

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

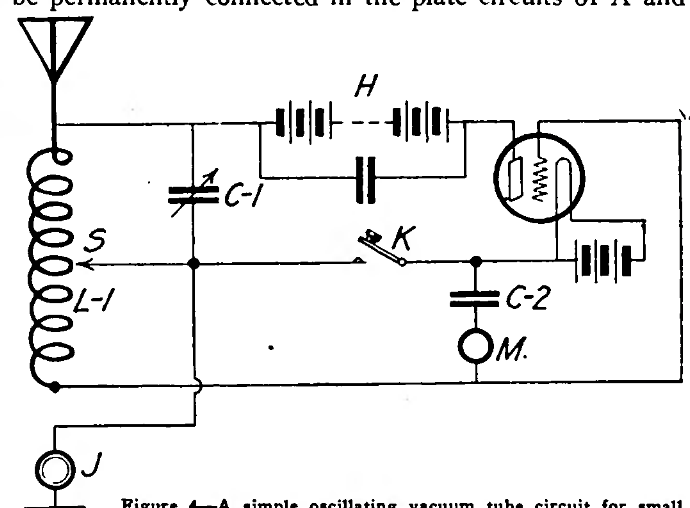


Figure 4—A simple oscillating vacuum tube circuit for small power continuous wave transmission

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.

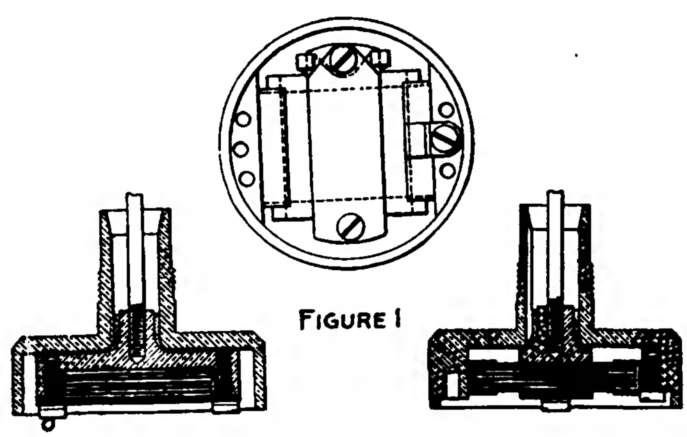


FIGURE 1

FIGURE 2 FIGURE 3

Detailed construction of the mica condenser

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.

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 former. 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 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.

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

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 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.

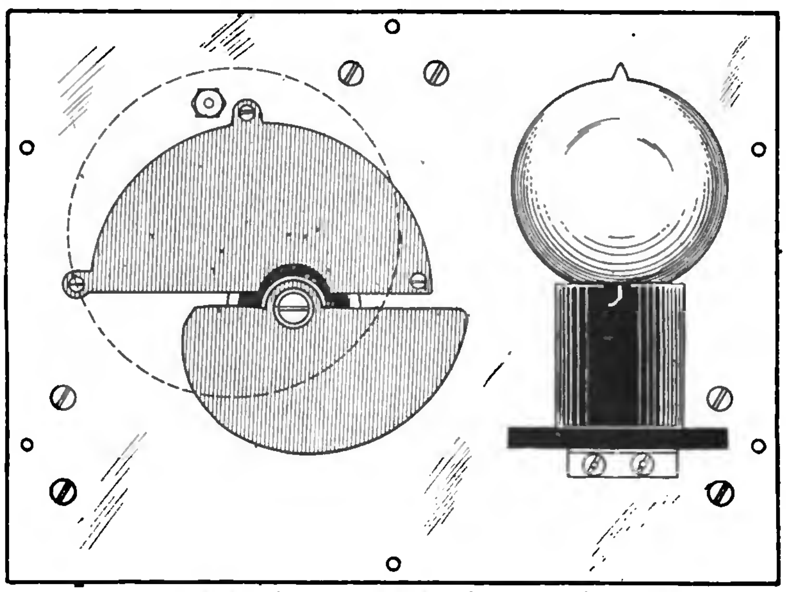


Figure 1—Showing variable condenser and the standard four-prong bulb

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 trans- 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 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 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-

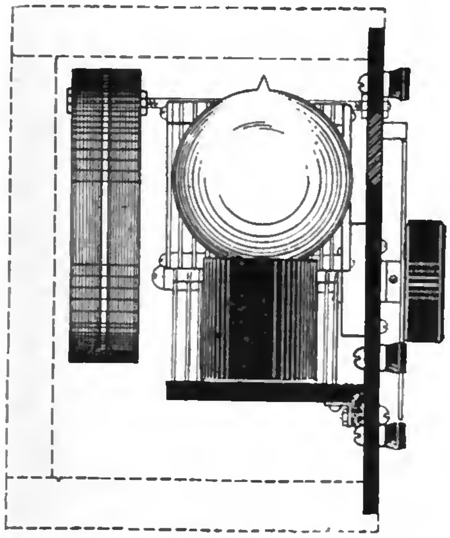


Figure 2—Side view of panel with instruments in place

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-

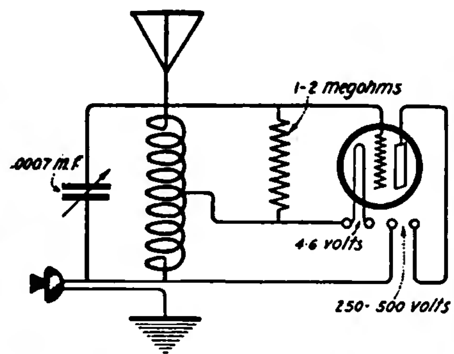


Figure 3—Circuit diagram used

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

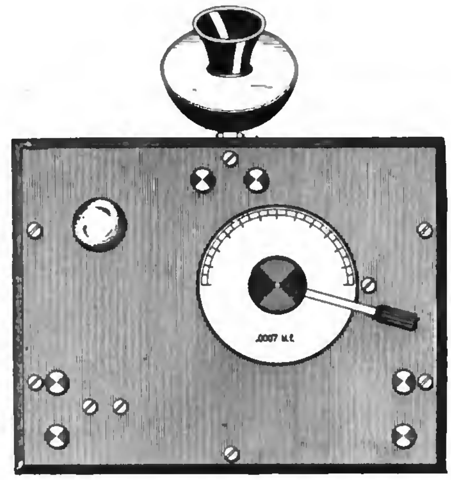


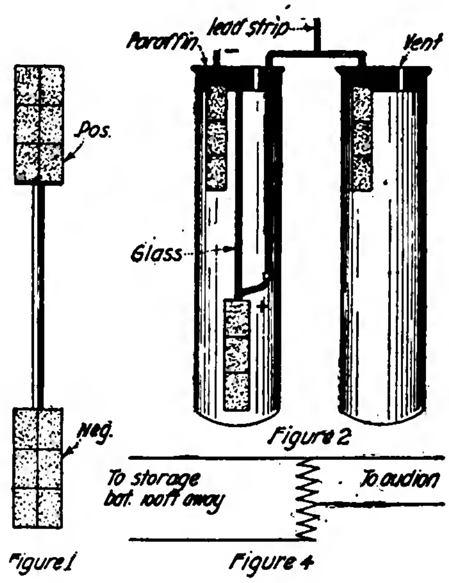
Figure 4—Radiophone containing the oscillatory and power bulb with microphone on top

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



Detailed construction of the "B" battery

made to suit the size of the test tube used.

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,

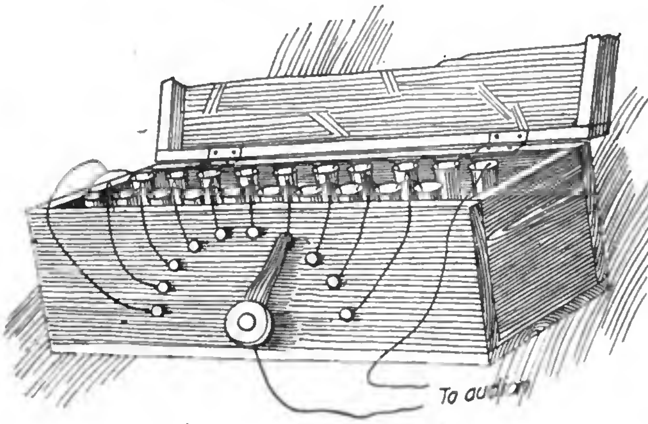


Figure 3—Voltage regulating switch

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.

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.

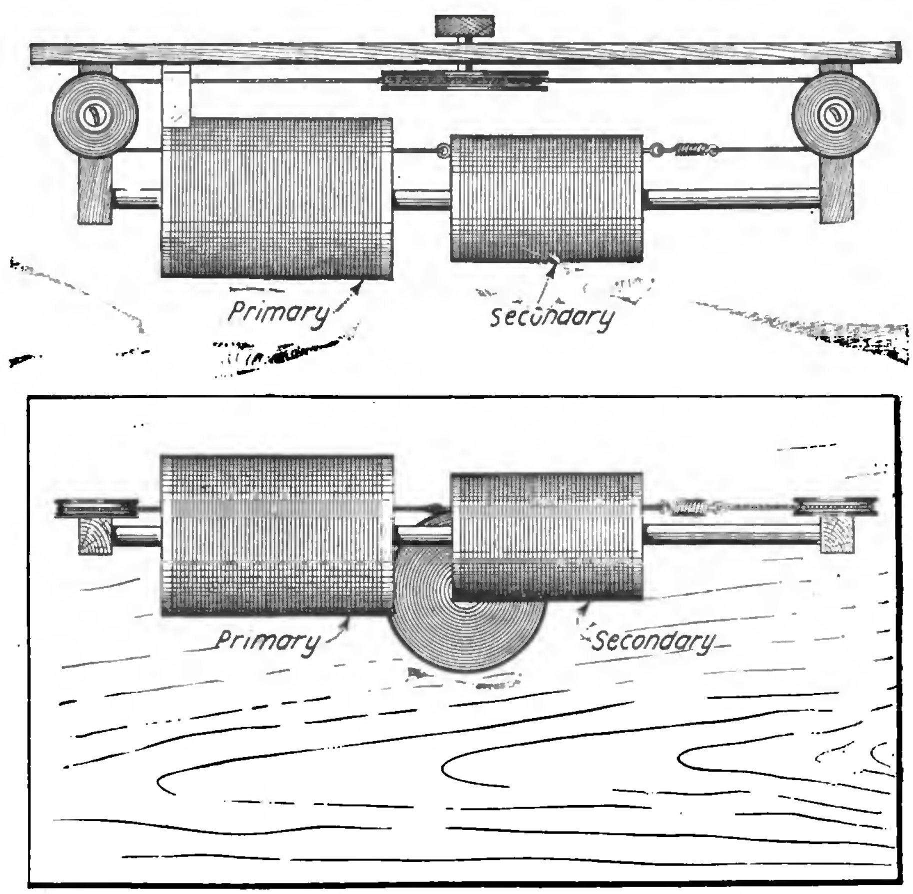


Figure 1—Standard form of coupler and method of mounting

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

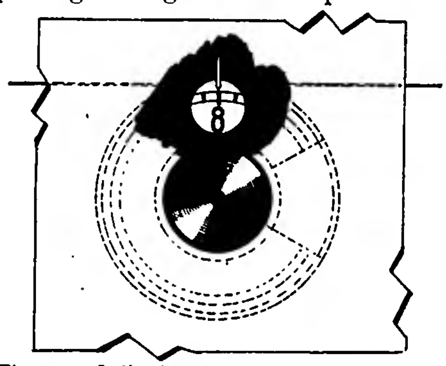


Figure 2—Indicating scale of the secondary coil

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

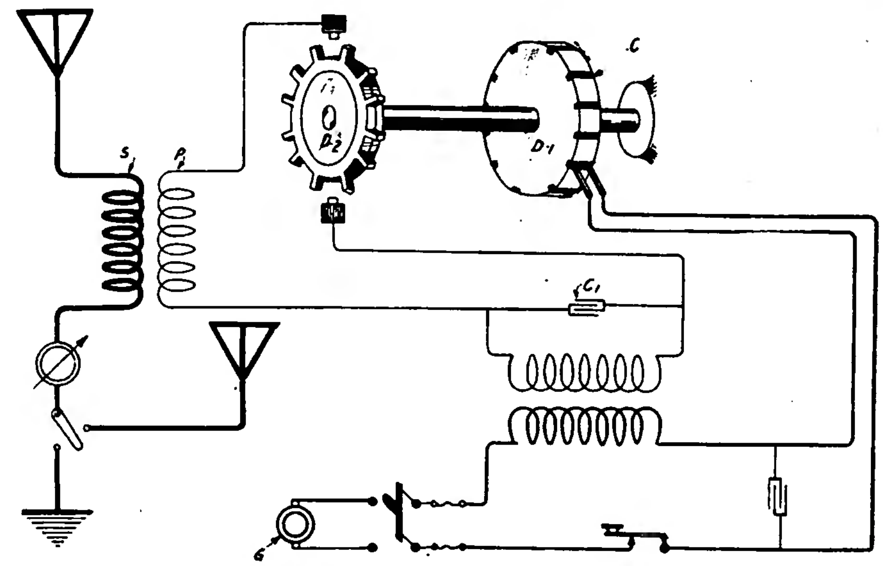
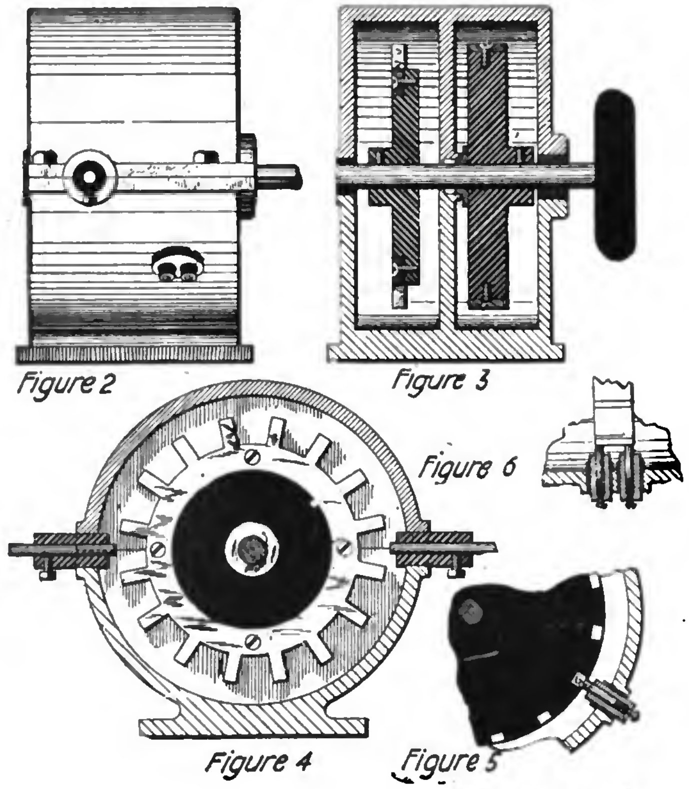


Figure 1—Circuit diagram and connections for the rotary interrupter

obtained from the primary interruptions.



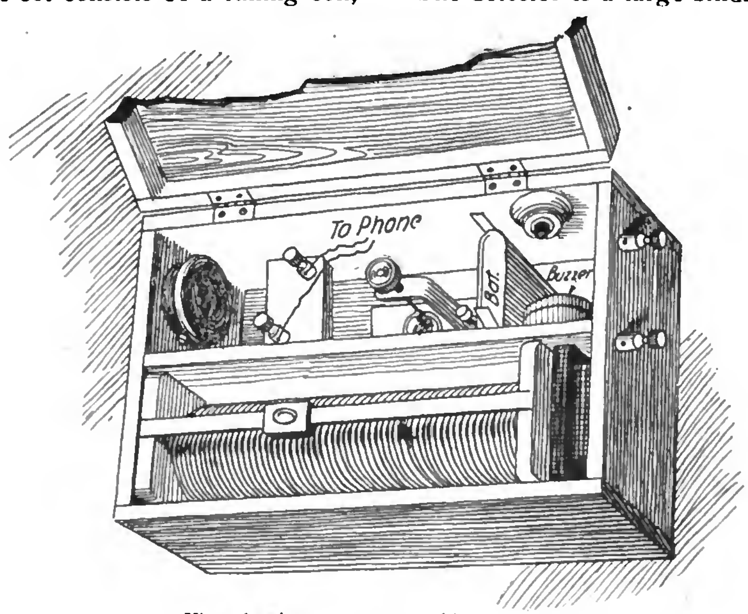
Detailed construction of the direct current transmitting apparatus

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

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.

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.



View showing arrangement of instruments

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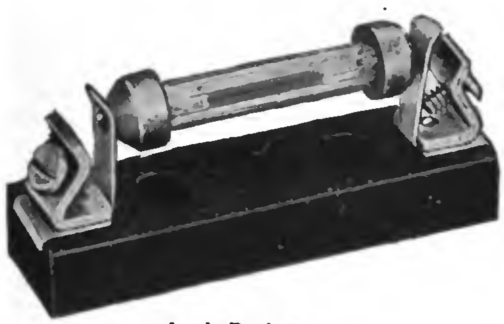

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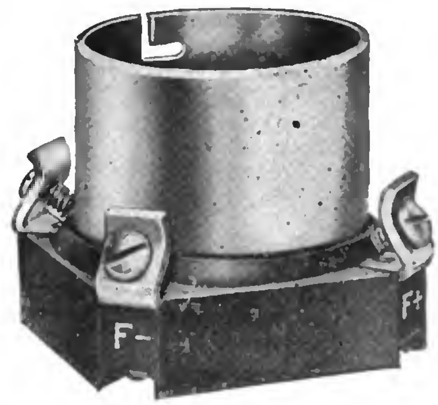

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WRITE FOR PRICES

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 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 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.

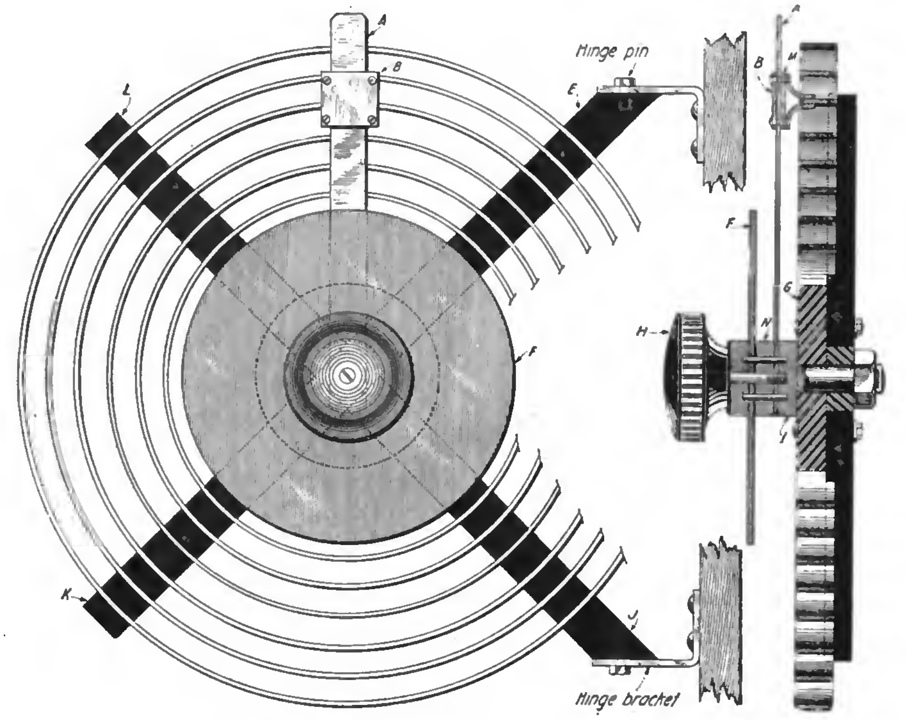
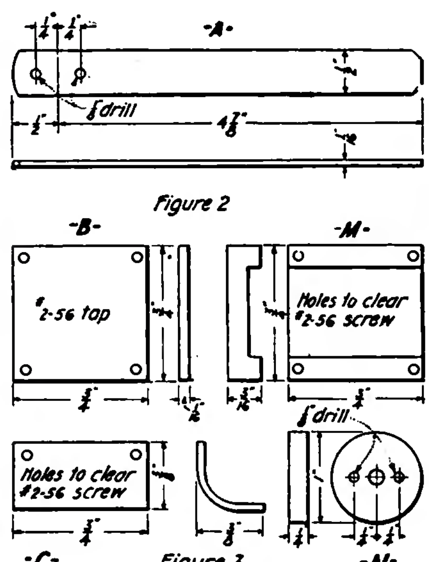


Figure 1—Assembly of the secondary of the oscillation transformer



Details of figure 1

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

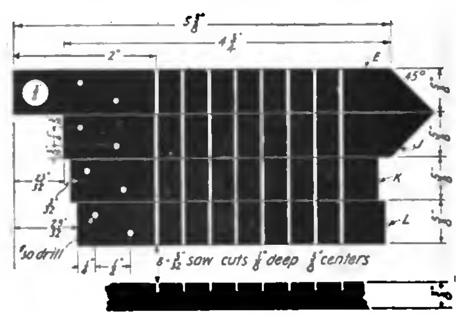


Figure 4—Dimensions of the spokes

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

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

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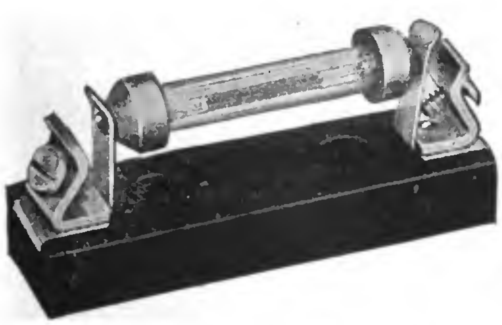
Tubes in either class may be used for detection or amplification, but those of Class I are best as detectors, and Class II tubes are superior as amplifiers.

Standardized Socket $1.50 additional



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The Marconi Resistance, connected in the circuit between the grid and the filament of the Marconi V. T., is made in the following standard sizes:

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Resistances of any special fractional values up to 6 megohms can be supplied.

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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 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.

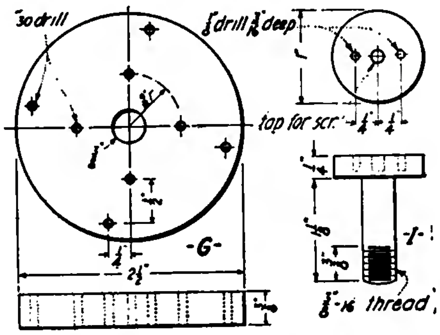


Figure 6 Figure 5

Constructional plan of shaft and bearings

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

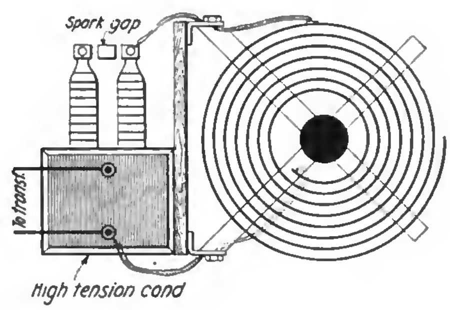


Figure 7—Arrangement of the closed circuit units

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."

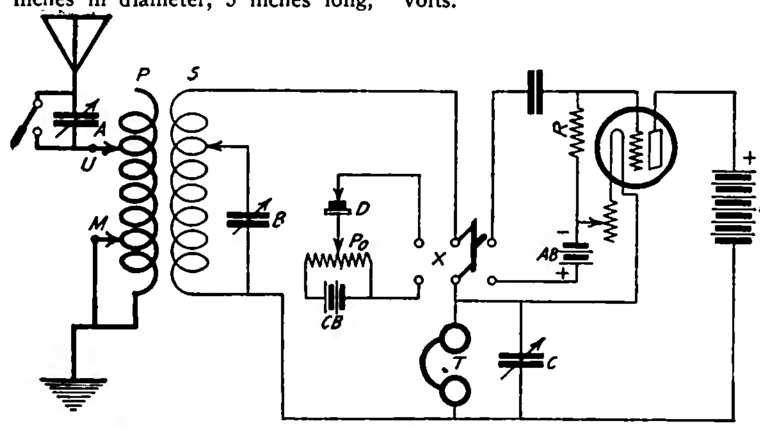
We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject by November 15:

"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,



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

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.

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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Captain D. W. Todd, *U. S. N., Director Naval Communications*
Rear-Admiral W. H. G. Bullard, *U. S. N.*
Prof. Alfred N. Goldsmith, *College of the City of New York*
Major William H. Elliott, *American Guard*
E. E. Bucher, *Instructing Engineer*
Prof. Samuel Sheldon, *Brooklyn Polytechnic Institute*
Colonel Samuel Reber, *Signal Corps, U. S. Army*
Prof. Charles R. Cross, *Massachusetts Institute of Technology*
William H. Kirwin, *Chief of Relay Communications*

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 De-

cember. 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.

* * *

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.

* * *

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

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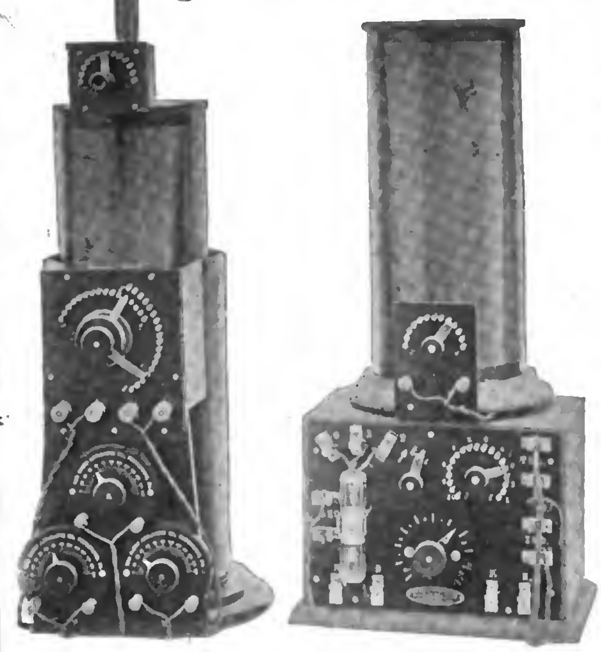
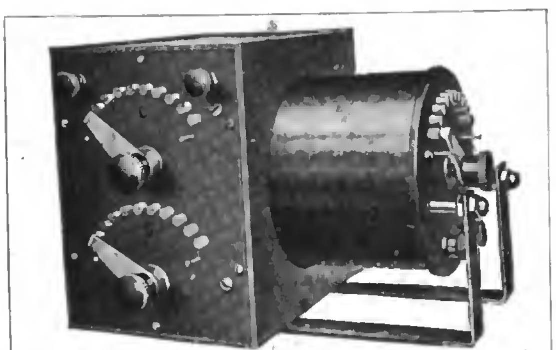
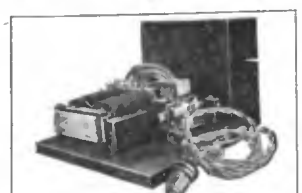


Type 93 Undamped Wave Set



Type-Y673-Coupler



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