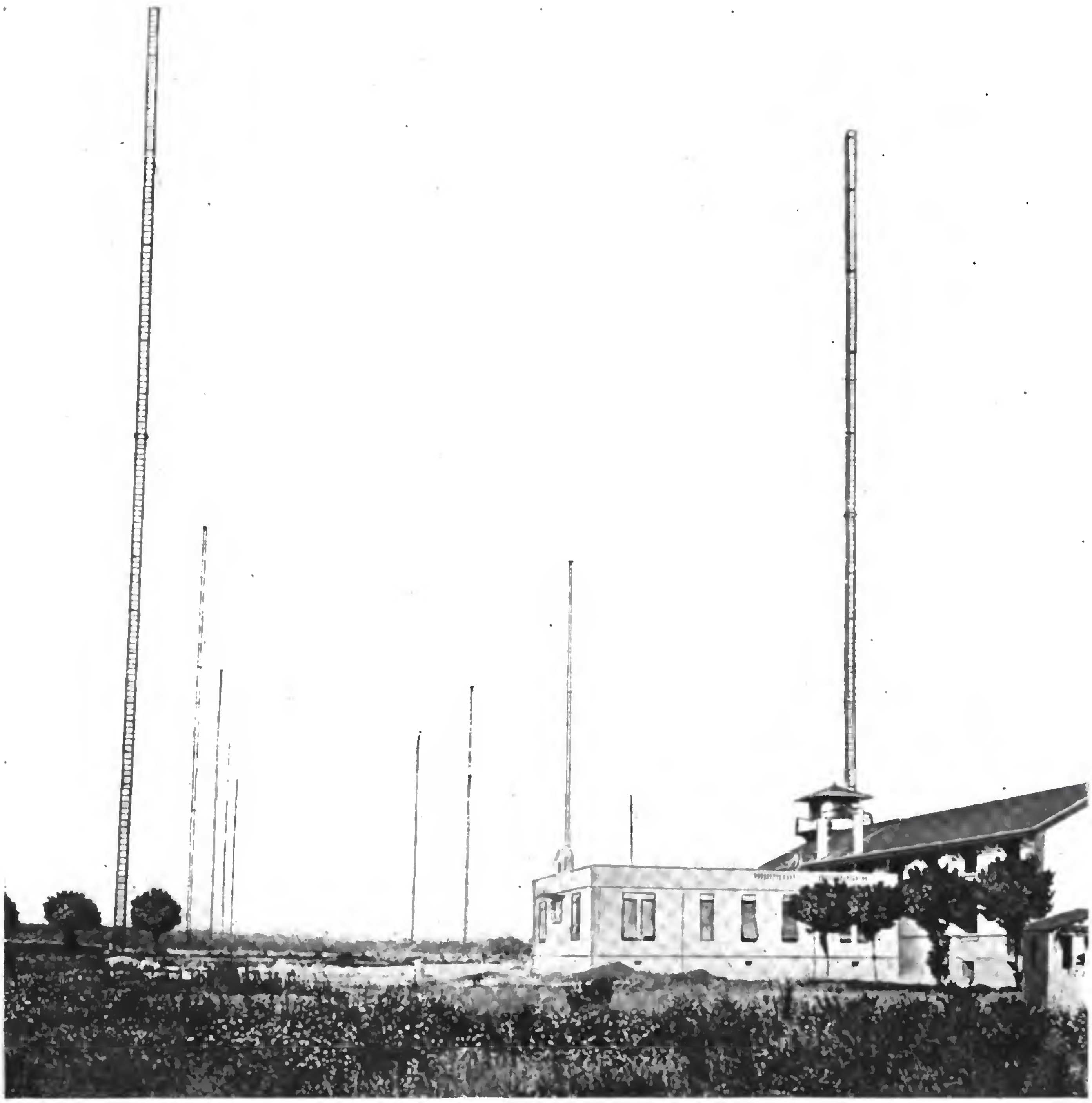
September, 1920 20 Cents

The WIRELESS AGE

Volume 7 Number 12



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Vol. 7 Contents of The Wireless Age for Sept. 1920 No. 12

Edited by J. ANDREW WHITE

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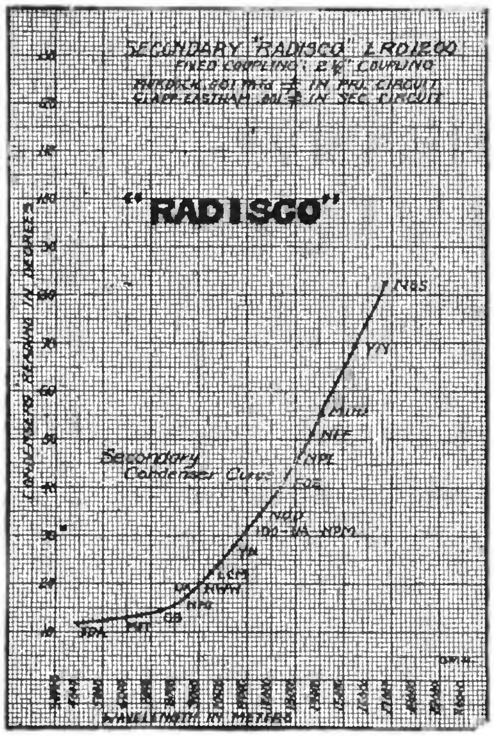

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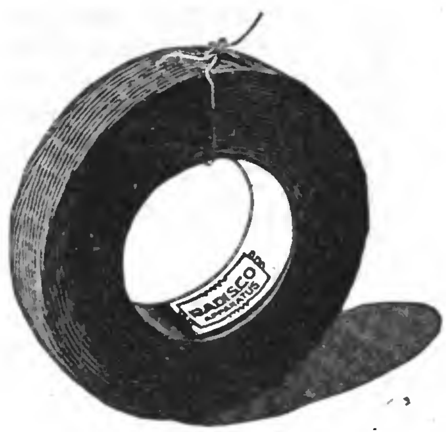

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If this page is cut out and appended to the same page cut from the editions to follow, a complete file of very interesting information will soon be available. (No. 8)

Vol. 7. No. 12. SEPTEMBER, 1920

THE WIRELESS AGE

WORLD WIDE WIRELESS

International Yacht Races Reported by Radio

IN the international yacht races radio and seaplane and dirigible were used by the Evening Post and for the first time a detailed report was given by wireless from the air.

Beyond all doubt future yacht races and such events will be viewed from above, and wireless telephone and telegraph will transmit the story to the printed page. They will be watched from the air because from above the view is comprehensive and all-embracing; they will be reported by radio because all the air is a sending medium.

In the seventeen years since the last race for the cup wireless has become a perfect working machine and the seaplane carrying wireless equipment has been perfected. Today we are able to report the yacht races from a seaplane equipped with a radio outfit direct to land, to receive the signals loudly and with the utmost certainty and to send immediately acknowledgment of receipt by radio to the seaplane.

For the 1920 series of races a staff of three men—a reporter, a photographer and a wireless operator in a large seaplane, equipped with wireless, sent the story into the offices of the Evening Post. The machine was a large converted flying boat of the Curtiss H-16 type, with two Liberty motors and a 96-foot wing spread. It was equipped with a trailing aerial 500 feet long and a transmitting set with a sending radius of more than one hundred miles. Reports were sent direct to the offices of the Evening Post, where they were transcribed by operators and set into type.

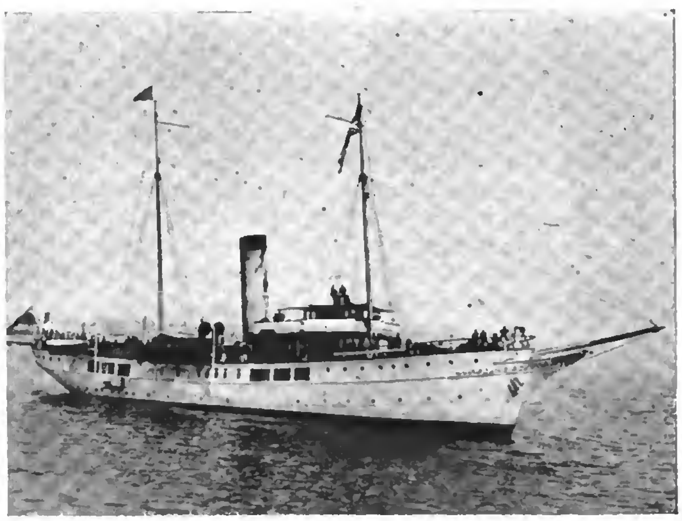
The receiving set was very sensitive, highly selective and capable of giving loud signals to facilitate copying without headsets.

The antenna used consisted of a number of parallel wires stretched above the roof of the building to a nearby building and running into the sporting editor's office. Appropriate ground connections and lightning protection switches were provided. The installation was carried out by the Radio Corporation of America. The actual receiving set and its adjuncts were specially assembled for these tests by the research department of the corporation. The receiver itself is a highly selective coupled instrument of the type used by the United States Navy. The received signal passed into a powerful multi-step amplifier using vacuum tubes for the amplification.

Those carrying on the tests were not content to use the ordinary methods of receiving wireless signals, which require the operator to wear clumsy telephone receivers strapped to his head. An additional amplifier of very special design was provided, which increased the volume of the signals in a loud speaking telephone receiver until it was very easy to read them all over a large room without wearing any telephone receiver whatever.

Some idea of the loudness of the signals can be gained from the following unusual results. Land and ship stations were easily read at a distance from the receiving set. The time signals regularly sent out from Arlington, Va., several hundred miles away, have been read three floors below the receiving set in the same building. While the signals from a distant ship station were thundering out, one of the attendants of the set remarked, "I'd rather listen to a hot battle in France than this racket."

The West Street, New York, station of the Radio Corporation of America was used for answering the airplane's messages on a special wavelength. This station is admirably suited for the purpose, being normally used in carrying messages to and from ships. The Radio Corporation made the necessary alterations and additions in the West Street station whereby the signals of that station would be readily received on the airplane but without interfering in the least with the usual harbor radio traffic.



Indicating the changed conditions in communication since the international yacht races seventeen years ago, this view of Sir Thomas Lipton's yacht Victoria, with wireless antenna strung from her masts, illustrates the modern marine practice of communicating by wireless

A loop telegraph wire was then connected between the receiving set in the Evening Post building and the West Street station, and the control key of the West Street station placed next to the receiving set. Thus the receiving operator in the newspaper building controlled the transmitter in the West Street station, although he was a considerable distance away. This novel departure neatly met the requirements and had the further advantage that it could be used for "duplex" working if desired.

The procedure in handling traffic was along the following lines: The seaplane sent its report of the yacht race to the Evening Post building. The receiving operator sent back his answer to the airplane from the West Street station, controlled over a telegraph line.

Results of Radiophone Experiments at Signal Hill Station

DISTINCT wireless telephone messages were exchanged July 24 between the Marconi Radio Station at Signal Hill, St. John's, N. F., and the steamer Victorian over a distance of 1,250 miles, according to announcement made by the manager of the station.

He said that the Victorian reported giving a wireless telephonic concert for passengers aboard the Olympic and other steamers and that thanks were returned by the same means from some of the ships.

The concert was repeated several hours later, with favorable results. The Victorian also was in constant telephonic intercourse with stations in England.

Highly successful conversations by wireless telephone took place July 25 between the station on Signal Hill, at St. John's, N. F., and the steamer Victorian, 600 miles distant and bound for Sydney with the Imperial Press Conference aboard. Keen interest was shown by the citizens of St. John's, who saw Marconi's original wireless telegraph experiments nineteen years ago, and the progress of the Victorian with daily bulletins of the telephonic concerts and other communications was eagerly followed.

The delegates were officially welcomed by wireless telephone to this side of the Atlantic when Premier Squires, in the name of Newfoundland, speaking into the transmitter, greeted Lord Burnham, Chairman of the delegation, on the Victorian.

The conversation lasted five minutes. Lord Burnham acknowledged the greetings and on behalf of his associates thanked the Premier for his welcome and complimented the Marconi Company on its great achievement.

The voice sounds from the ship came perfectly and every syllable was audible, said Mr. Squires, and he expressed the opinion that the experiments would mark an epoch in the history of wireless development by demonstrating that wireless telephony can become just as practical a medium of transatlantic and transcontinental communication as wireless telegraphy. During the afternoon many prominent men assembled on Signal Hill to witness the demonstration and took part in the conversation with those on board the ship.

When Chelmsford, England, was giving a wireless telephone demonstration to Denmark at 5 P. M. on August 2, the experimental station on Signal Hill, St. John's, N. F., picked up the sounds and heard, without interruption, the words uttered by H. J. Rounds, the manager at Chelmsford, who was talking with the operator in Denmark.

Mr. Rounds was heard to tell Denmark that Melchior would sing. Signal Hill kept in touch and heard distinctly four songs sung in Danish, as well as the conversation that followed between Denmark and Chelmsford. Chelmsford and St. John's are 2,673 miles apart.

Radio Compass Directs Airplane to Ship

GUIDED entirely by radio compass signals, a naval seaplane F-5-L left Norfolk and flew 95 miles on a "bee line" to pick up the battleship Ohio at sea, with no knowledge at the time of taking the air of the vessel's location. The seaplane then navigated its return to Norfolk entirely by radio compass.

Navy Department officials to whom the flight was reported said it was the first time radio compass apparatus had been used to direct aircraft to a ship.

Marconi on Radio-Pictures

"VERY interesting and very important," Senator Marconi described the discovery of how to transmit pictures by wireless, made by Mr. Th. Andersen, a young Danish watchmaker.

"I have not followed the experiments, but I know it can be done," said Senator Marconi. "Pictures were sent over telegraph wires several years ago, and what can be done by wire can be done by wireless. It will be of great interest to watch the progress made. The two chief uses to which the discovery can be put are the quick transmission of photographs for newspaper and police purposes."

Chicago Talks to Catalina Island, 3,000 Miles Away

WIRELESS telephone communication between Chicago and Catalina Island, thirty miles off the coast of California, was established, when William Wrigley, Jr., owner of the island, talked to his representatives in Chicago. Twenty-seven hundred miles of land lines and thirty miles of wireless were used.

The telephone was tested for the first time when conversations were held between people in Chicago and the island. Voices were as audible as those in ordinary long distance telephone calls, it was said.

"It was wonderful," said Mr. Wrigley, who talked thirty-five minutes. "The only thing to mar the conversation was Mr. Patrick asking me the score of the Cubs' ball game, and the Cubs lost."

Radiophone Messages Between England and Denmark

AN ATTEMPT was made on July 31 to send wireless telephonic messages from Chelmsford, England, to Copenhagen. The conditions for the attempt were not absolutely favorable, the air being laden with electricity, but still the attempt was a success. The first message was a greeting from Queen Alexandra to the Scandinavian people. There followed other messages and finally the opera singer, Melchior, sang the Danish, Norwegian, Swedish and British national songs, in all of which not one word was lost.

Japan Links Warships and Airplanes by Radiophone

THE Japanese navy has established a wireless telephone service between warships and airplanes on the wing. According to the naval authorities improved wireless telephone apparatus is now installed on board all the warships belonging to the first squadron and will be extended to all the other warships within the present year.

Alaska Canning Industry Uses Radio

"THE PIONEER," largest floating cannery in the world, has left Washington for Alaska for the canning season. Besides carrying canning equipment, the barge has a complete wireless outfit, and quarters for crew and cannery workers.

California Issues First Franchise for Radiophone Service

THE first franchise for wireless telephone service to be granted by any city was approved by the council of Avalon, Calif. The new system is to connect the island with all mainland long-distance exchanges.

French Lafayette Station Finished

ONE of the largest and most powerful wireless stations has just been completed near Bordeaux, France. It was begun by Americans according to American plans, and was half finished at the time of the armistice. Now it has passed into the hands of the French Government and will be used to send messages half way round the world.

The antennae are carried on eight metal towers 240 meters high and cover a space a kilometer and a half long and 400 meters across. Each tower, which is supported on three legs, weighs 550 tons, a quarter of the weight of the Eiffel Tower.

This Lafayette station, as it is called, uses an alternating current of 11,000 volts, with a frequency of fifty cycles, which can develop Hertzian waves up to 23,000 meters. The distance at which messages can be picked up is estimated at 20,000 kilometers—about half the circumference of the earth.

Radio Corporation of America Completes Organization

THE Marconi Wireless Telegraph Company of America, which operated from 243 Washington St., Jersey City, with the New Jersey Corporation as agent, filed a certificate of dissolution in the office of the Secretary of State August 2, by which it ceased to do business in New Jersey.

Former United States Attorney-General John W. Griggs was president of the concern which has been absorbed by the Radio Corporation of America.

Radio-Controlled Moving Target for U. S. Warships

THE once famous battleship Iowa, which played no small part in the destruction of Cevera's fleet at Santiago, is being prepared at the Philadelphia navy yard for a unique target experiment.

Proceeding unmanned but under her own steam and controlled by radio, probably from seaplanes, the old sea fighter will become the objective of the big guns of the Atlantic fleet superdreadnoughts in Chesapeake bay late this summer.

This will be the first time American warships have used a moving craft for a target except in actual war.

It is expected the practice will give the gunpointers of the Atlantic fleet an opportunity to test their ability under conditions as nearly like those to be expected in battle as can be obtained.

Smoke screens will be thrown around the Iowa during the runs and the course will be changed at will through the radio control system, necessitating a change in range on all the firing ships, exactly as would occur in action.

Graded System Likely to Settle Radio Operators' Difficulties

THREE independent plans for a system of graded licenses for radio operators are being worked out, it is understood. The leaders of the wireless operators, in accepting the proposal made by Admiral William S. Benson, chairman of the Shipping Board, for the extension of the life of the present agreement ninety days, have communicated with the various locals of the association. In the meantime they are endeavoring to work out a system whereby years of experience will be rewarded with better pay and the amount of work done will have some relation to the wage received.

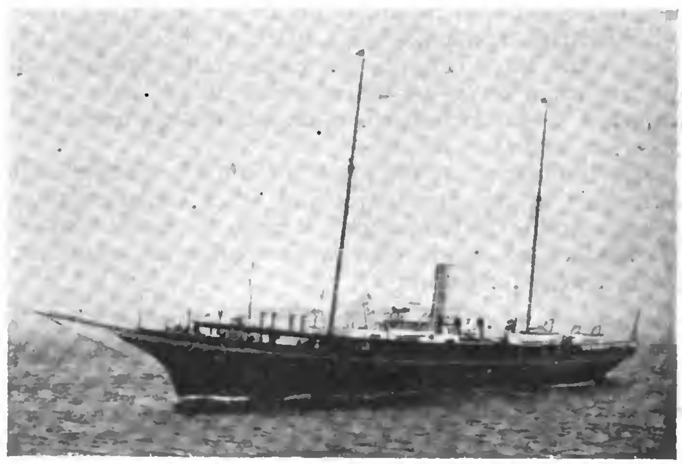
The Shipping Board has referred the matter to Eugene Chamberlain, Commissioner of Navigation. The American Steamship Owners' Association was not consulted by the Shipping Board prior to the suggestion of an extension of ninety days in the life of the agreement. It is known that the shipowners are opposed to the granting of increases in wages to the operators, although they are not unsympathetic to the desire of the wireless men to better their condition.

The radio operators are working out a plan, which will be submitted to Commissioner Chamberlain for due consideration.

It is reported that the three wireless companies, which are under contract to the shipowners and the Shipping Board for furnishing sets and operators, are laboring on a plan which they think will solve the problem now facing the shipping interests.

The Shipping Board, in conjunction with the Commissioner of Navigation, is understood to be active in regard to the scheme. It is said that the governmental board feels that the radio service should be encouraged and that there ought to be some stimulus for an operator to remain in the service after he obtains the position of a chief operator. At the present time he could not make more than $125 a month if he confined himself to radio work.

The shipowners do not feel disposed to grant the demands made by the operators recently. The wireless



The modern equipment of yachts like J. P. Morgan's Corsair, illustrated above, includes a complete wireless outfit

men wanted an eight-hour day, with provision for overtime pay, increases of $75 monthly for chief operators and $50 for assistants, assurance that the operators would not be required to perform additional services on board ships and that they would be permitted to leave the vessels when they were in port. By figuring overtime on a rather liberal scale the shipowners figured that a chief operator, who did not have to be more than twenty-one years old, might draw as much salary as a first mate on a large freighter. They were not consulted by the Shipping Board, but it is understood that they have been asked to write to Washington and inform the Commissioner of Navigation what their views of the situation are.

While it is felt that a strike among the radio men has been largely dissipated by the conference with Admiral Benson, the possibility has not been entirely removed.

At the present time there are only two classes of operators, chief and assistant. It is thought that the salaries of the operators should be increased with the performance of certain years of service. For instance, it is believed that the Commissioner of Navigation will recommend a certain percentage of increase every few years.

No statement has been made by the president of the United Radio Operators' Association since he returned from Washington, where the conference was held. It is thought that it will be several days before the system will be worked out to such a point that there can be an intelligent discussion of its merits and defects.

Wireless Signal Lamp

A WIRELESS signal lamp has been devised for various kinds of war work which enables the users to keep up communication under conditions where it would be difficult or imposisble to stretch telephone or telegraph wires. A barrage fire, for example, would be no hindrance to signaling by this new apparatus. It can be used between a ground station at the battle front and an airplane a considerable distance away, flying over enemy territory.

Maine Fisheries Company Uses Radio

A RADIO station has been established at Rockland Highlands, Maine, by the East Coast Fisheries Company. Primarily it was erected so that the company might communicate with its steam trawlers.

Wired-Wireless System Installed at Chesapeake Capes

ARRANGEMENTS are being made by the signal corps at the request of the chief of coast artillery, to install the new "wired-wireless" system of radio communication between the fortifications at Cape Henry and Cape Charles, about 28 miles apart, at the entrance to Chesapeake Bay. The system employs the principle of guiding radio waves by wires, which do not have to be insulated, and which perform their function under the water, as well as in the air.

The installation at the capes of the Chesapeake will form part of the fire-control and other communication systems at the fortifications. It is to be made because of the lack of funds for laying expensive submarine cables between the forts.

Marconi Radio Service Between Argentina and England

THE Government of Buenos Ayres made public, July 31, a decree allowing the Marconi Company to install and operate a wirelss high-power station to be used exclusively for communication between Argentina and Great Britain.

Wireless Wanderings

FLAT on his back an indolent philosopher held forth on the joys of "wireless travel," as he called it.

"We have been reading about the yacht races reported by wireless telephone. Then comes a successful experiment with transmission of pictures by wireless. Next we will have the wireless movie.

"When that time comes I shall be able to enjoy my penchant for foreign travel without the suffering of seasickness.

"I'll hire a movie aeroplane equipped with a wireless motion picture transmitter and start the flyer on his way. I'll lie here on my back and watch the panorama of the earth unfold on a screen mounted on the ceiling.

"When the aeroplane passes over a place that looks interesting I'll signal for the aviator to descend and get close-ups with the wireless movie machine, and start the wireless telephone to working so that I can hear what is going on."

Whether philosophers are optimistic depends on the philosophers. The indolent variety usually are. But even granting the optimism, the forecast is not so impossible as it may sound.

Grandparents of the present generation who might have dared to indulge in speculations on flying, wireless telephony and wireless telephotography would have been considered insane.—N. Y. Evening World.

Radio Message Explains Mysterious Blast off Jersey Coast

THE mystery of the explosion twelve miles off Avalon, N. J., July 28, was solved when Captain George Painter, of the motor schooner Mackintosh made explanation after arriving at Atlantic City from Beaufort, S. C., with a load of fish. They found that the 1,000 tons of oil discharged from the Cabrille, grounded on the Brigantine Shoals, was ruining the fishing. The engineer ignited a bundle of waste and threw it into the sea. The whole sea "caught fire" and as the flames streaked from oil pool to oil pool there were loud explosions and the Mackintosh had to escape as fast as possible.

When it became impossible to locate the tanker Kehuku it was believed that she had blown up. But this report was dissipated when a wireless announced that she had passed the Jupiter lightship off the coast of Florida.

Moonshiners Using Wireless

THE fight against the illicit still in southern West Virginia will never result in victory for state and Federal prohibition officers because of insurmountable difficulties encountered.

The layman does not realize the difficulties of enforcement officers, according to one revenue agent operating in the Charleston district. In one instance the resourcefulness of the moonshiner has surrounded his business with the protection of a wireless system. A complete wireless telegraph outfit has been installed in the mountains near the West Virginia, Kentucky and Virginia lines, through which distilling plants are notified by a code of signals from confederates when danger threatens.

Apparently meaningless wireless messages have been picked up in Charleston by William H. Moore, a wireless student, believed to have been sent by moonshiners "in distress."

The new method of protection not only has worried but has seriously handicapped raiding officers, who swoop down on a spot where a still was reported to be in operation, only to find the outfit missing.

It is said that several of these radio stations are located convenient to railroad towns and are used by confederates of moonshiners when a suspicious stranger or an officer known to the clan is seen in the town or about to leave on a mountain raid. One of these outfits is reported in the Pound section of eastern Virginia, where moonshine formerly flowed freely, but following a general raid Corburn and nearby towns are reported dry as the proverbial bone.

So far as known these are the first moonshiners in the country to adopt a wireless system in connection with their business.

Pictures Transmitted by Radio

A DANE, Th. Andersen, has made an important invention by means of which pictures and sketches can be transmitted by wireless over long distances, for instance from Europe to America.

The invention has been tested by experts who pronounced it to be of great practical value, especially for press illustrations. The apparatus is of the most simple construction and easy to work. Any wireless telegraph or telephone system can be used for transmission and the cost of working is said to be very low.

One Copenhagen newspaper has published two photographs sent by means of the new invention, one of them being a portrait of Chancellor Bauer despatched from Berlin.

The New Radio Station at Lyons

Disposition and Housing of the Installations

By Lieut. Leon Faljau

EDITORIAL

LIEUT. FALJAU'S account of the Lyons radio station in this issue invites comment regarding several points.

The arcs in use at Lyons are, in many ways, of interest to Americans. For their power they are as great an improvement over previous types of the same output as the Curtiss turbine was over the reciprocating types of engine. The French have installed the Elwell design of the Poulsen arc while the U. S. Navy so far has favored the Federal company's type. Altho the latter has an iron weight efficiency vs. power output only about 10 per cent. that of the former, a greater conversion efficiency over a wider range is claimed for it. Elwell engineers collaborated in the installation of these arcs after designing them. Whatever may prove to be their "survival value" the Lyons station is a tribute to American engineering initiative in this respect.

The generous spaces allowed for future additions are very noticeable in this station and are in line with the American tendency, as the multiplex idea is approached in large stations, to regard the station proper as a central generating station, controlled by substations.

The French have gone to some trouble to keep the mechanical and electrical features of the antenna up-to-date. Their method of securing better current distribution in the antenna and the concomitant increase in mechanical stability is worthy of study.

The double system of speed control of the 20,000 cycle generator set is ingenious. It naturally invites comparison with the Alexanderson system, which regulates even more closely.

The "blanks" of sending are those intervals during which the "choking" resistance of the antenna is in circuit. This has the advantage in some cases over the compensating wave, that the change in full sending current is more rapid—the presence of resistance assisting the changes through decreased time-constant. The compensating-wave system may require more time to achieve the required resonant rise on the sending interval, and a 200-word a minute sender may not afford the time needed. One may "chop" a wave mechanically as rapidly as desired, at some cost of broadened tuning, but one may not control its growth except by purely electrical means. It is a question for careful judgment, as to which of the two systems can be evolved so as to finally outstrip the other in sending speed. American practice of 50 to 200 words a minute for commercial service augurs well for immediate expansion of projected commercial systems of world chain stations, to challenge the ubiquitous cable.

Those who laid the ground work of radio engineering before it came to be listed in academic curricula will note the confidence with which attention is drawn in Lieut. Faljau's inventory of special features, to the original design of the antenna loading-coil. It is a hyperboloid of revolution, having the radius of top and bottom turns equal to its height. Surely the designer must have heard of the constant flux coil known a generation ago and clearly indicated in Gray's "Measurements in Electricity and Magnetism," not to mention numerous similar works.

Gray, applying Maxwell's equations, shows that a new diameter required for an additional turn to n turns on a coil, must follow such a law that the resultant field will continue to "follow" the coil profile. This means an increasing diameter. Years ago the General Electric Co. used an hyperboloid choking inductance in its lightning arrestors.

The general fact that the flux area increases as it leaves the coil, and even swings around at a critical distance from the coil-face, was shown by Gray and others to allow a maximum coupling, with a given flux in the primary, of a secondary of critical diameter, at the critical distance. The Campbell mutual inductance standard is based on this principle. Two primaries are placed at the critical distance on opposite sides of a secondary of the critical diameter. The condition of a maximum coupling causes the accidental errors due to unknown displacement of the secondary coil to be practically zero. Whatever residuals are present cancel out.

American firms long ago saw the advantages as regards improved time constant and coupling qualities in the hyperboloid, but they cut it in two on account of mechanical considerations. As the tapered or conical coil it has been tried out as early as 1906, but the production engineer will have none of it.

The Lyons station is a tribute to French thoroughness and sense of refinement and to American initiative in showing the world that the high frequency alternator was practical before the quenched spark was applied to radio.

THE Lyons radio-station situated at Villeurbanne, France, n.e. section of the larger city, back of the Rhone dikes, now affords the appearance of a large transformer substation.

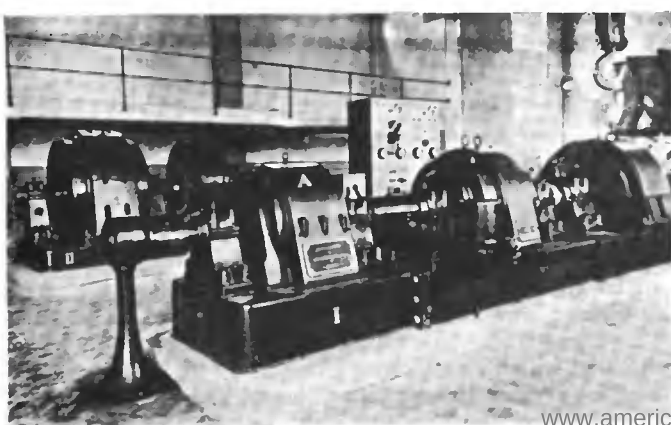
As a matter of fact the energy supplied to it by the Jonage lines, as 50-cycle three phase current, is transformed there into high frequency energy and distributed throughout the world to different correspondents by means of one or another of the four arrangements now in operation, viz:—

A spark station of 150 kw. Arcs of 200 kw. Arcs of 450 kw.

The new 150 kw. Bethenod alternator of 20,000 cycles.

The station, properly speaking, comprises the machinery hall where are assembled all the transmitter installations, an adjacent office building, where among various divisions is found the receiving and telegraphing room and an annex, situated at the north of the main hall, containing the 200 kw. arcs.

The machinery hall shows in plan, the aspect of a



vast "T" and the small sketch herewith attached shows the arrangement of the apparatus in this hall.

The rear of the hall is partitioned off, forming in this way a large section containing the apparatus constituting the damped wave set. On this side are found the Jonage supply—at 3000 volts—to the transformer group, the two groups of 450 hp. feeding the damped wave set; their excitation auxiliaries and on a platform, the switchboards. At the middle is placed the high frequency group, the dc. set which furnishes it with the necessary driving current and its own switchboards. The large

Figure 4—At the back, the spark sets and the transformers. In the foreground, the Bethenod Set. To the right, the 3-phase motor-generator set driving the H.F. set

antenna, loading-coil of which we will again speak, occupies an emplacement which is at this end, under the cupola.

We thus come in our progress, to the transverse part of the "T" where are on one side, two arcs of 450 kw., the group of 680 hp. which supplies them and various switchboards; on the other side—an emplacement still vacant which will certainly come to be occupied by new apparatus—a new alternator according to all probability.

All the accessory apparatus, pumps, compressors, rheostats, contact-makers, etc., are mounted in the basement, being controlled, for the most part, by switchboards in the hall.

The operating room is conveniently arranged in the neighboring building. Two large tables there, hold the manual or automatic sending apparatus, the tape-punching machines and the receiving systems. A desk-switchboard carries the cut-outs and the switches for the 110 volt dc. supply which works the various relays (key and turbine types) and the contactors. Finally, an indicating signal transmitter, of "marine type" connects the hall of machines, to take care of orders to start, stop, etc.

The installation thus shows in its entirety the qualities of fitness, order and thoroughness of a modern electric station, and also allows for new and necessary arrangements which will be necessary in order that the station may measure up to the progress made in the radio art.

The spark-set has been out of commission for some time already, and without doubt it will be shortly dismantled. As for the 200 kw. arcs erected rather hastily in an independent building, they are from now on almost entirely to be replaced by those of 450 kw. I will therefore intentionally pass over the description of these old-fashioned installations, in order to devote myself at some length to the new arcs and the alternator.

The 450 kw. Arcs

The arcs are two in number and can be put alternately into service during the time that the work of maintenance requires the shut-down of either one of them. They are of the Elwell type and are made up in the following manner:

At the center of a double walled bronze chamber which a current of water cools, are situated the pole pieces of an electromagnet. It is in the air-gap of these pole pieces, whose diameter is greater than 32 cm. that the arc starts between an anode of copper and a cathode formed of a carbon cylinder, 6 cm. in diameter, mounted in a revolving tube. The current which starts the arc, supplies the electromagnet, and the action of the switches allows any desired field to be obtained, by putting more or less of the field-winding turns into action. The cathode is grounded, the anode, insulated from the arc chamber by a quartz cylinder, is connected to the antenna loading inductance and the whole is shunted by a battery of condensers.

At the side of each arc is found a desk-switchboard, for the controls for the contactors of the field-switch and the water and gas cocks. That for the contactors, "shorting" the series resistance, is placed in the circuit first to provide "choking" and then to let the set function. The same 110-volt dc. current serves to work these controls and it may be broken at different places in the station when safety requires the complete cessation of transmission. No false manipulation need be feared.

The sending is effected by short circuiting an inductance of small size interposed in the antenna, and thereby producing variations of the transmission wavelengths. The longer wave is the signal wave. It is the working wave, and the shorter wave—the compensation wave—corresponds to the sending intervals.

The sending-key, which has to make or break the "short" of that inductance, is a powerful and delicate relay. It comprises a primary electric relay, worked by the sending-key in the receiving-room, this relay then acts on a double pneumatic system of small inertia, working an arm carrying contactors. The arc produced at the break between the silver contacts is extinguished by

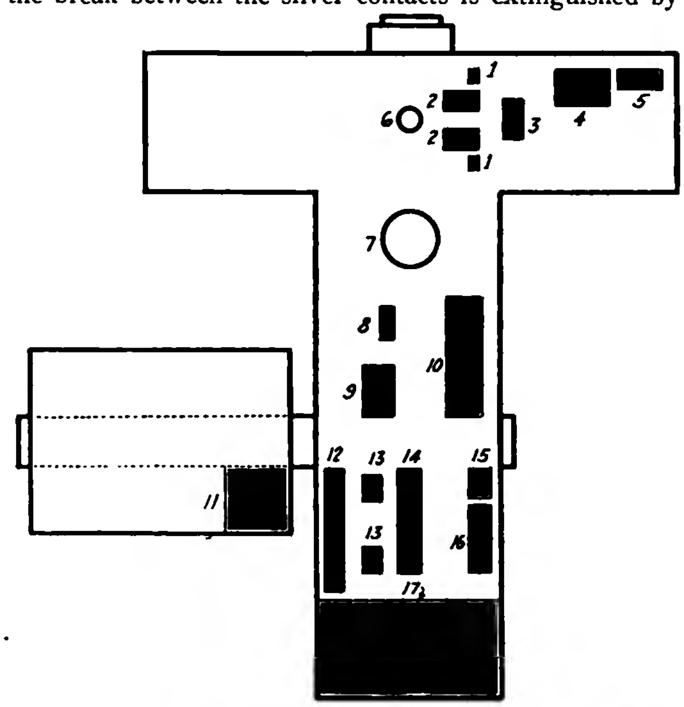


Figure 1—1—Desk switchboards for arc. 2—450 Kw. arcs. 3—Switchboard for same. 4—680 H.P. group. 5—Excitation group for same. 6—Telegraphing inductance. 7—Large antenna loading-inductance. 8—Switchboard for starting up H.F. group. 9—Group of convertors. 10—High frequency group. 11—Reception and sending room. 12—Switchboards for the damped wave set. 13—Exciter for these groups. 14, 15—Switchboard for starting up the Convertor Group 9. 16—Transformers. 17—High tension room for the damped wave set

an intense air current. These keys permit a sending speed of 2500 words per hour. The excitation group in itself comprises an independent motor of 14 hp. driving the principal exciting dynamo and the auxiliary dynamo which excites it.

This system of excitation permits perfect regulation of voltage at the arc terminals.

A desk-switchboard placed near the arcs carries all the measuring apparatus pertaining thereto, and the controls of the starters and of the field rheostats which are located in the basement. The arc current is furnished by a dynamo of 6 poles—separately excited—capable of giving 450 amperes at 1000 volts. An asynchronous motor of 680 hp. is employed to drive it.

THE BETHENOD ALTERNATOR

For some time the radio post has had the high frequency alternator constructed under the supervision of the S.F.R. and the Alsacian Society, as the result of very satisfactory trials, and it is now in regular service.

The high frequency group proper, comprises a con-

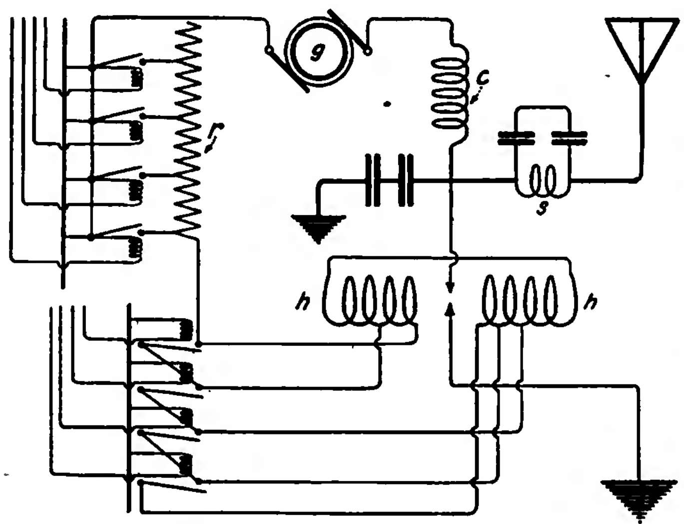


Figure 3—Scheme of arc connections

tinuous current driving motor of 450 hp. coupled to two single-phase alternators, of 1000 and 20,000 cycles respectively. The first of these two machines is intended to function during the telegraphic blanks in transmission in order to keep constant the work of the group and consequently its speed; as a matter of fact, experience has shown that it acts sufficiently like a fly wheel through the mass of its rotor, and so its windings are not connected in. It may be used, in addition, to supply a musical spark-set in case the 20,000-cycle machine migh be broken down.

This 20,000-cycle machine is a homopolar alternator with revolving inductor. The rotor is unwound, is about 1 meter in diameter and revolves at a speed of 3000 r.p.m. Excitation is furnished by a winding, normal to the axis carrying 110-volt dc. The magnetic circuit is formed through the body, the rotor and the stator. The stator carries four pairs of coils, parallel mounted, each connected into the primary of a Tesla coil; the four secondaries in series-parallel are connected into the antenna. The method of sending consists in short-circuiting every one of the four stator windings, the short-circuiting current then being about 60 amperes in each of these sections.

The great difficulties encountered in construction are caused by the necessity of maintaining the speed of the group perfectly stable, from the balancing of the machine at 3000 r.p.m., and from heat-rises which hysterisis and eddy current losses produce, and which are difficult to eliminate.

The alternator-poles have been made with their cores very finely laminated—.01 mm. The pole faces being very much reduced—4 mm—the air-gap had to be reduced in proportion. At normal speed it does not exceed 3 mm.

A pump maintains the circulation of cooling-oil through the rotor, by a hollow shaft and around the stator. Another four-cylinder pump keeps up a vacuum in the body of the machine between the stator and the rotor. Finally a system of grease lubrication under pressure supplies the bearings.

Regularity of performance is assured by two systems. One regulator, mechanically driven by the group, acts on the excitation of the driving motor, and on the other hand, the voltage at the mains of the dynamo, supplying this motor, is itself maintained constant by a second regulator, of the Thury type, acting on its excitation. This last supply dynamo with 6 poles, and separately excited, capable of giving 750 amperes at 500 volts, is driven by an asynchronous 750 hp. motor depending on the 3000-volt, 55-cycle current of the supply net-work of Jonage.

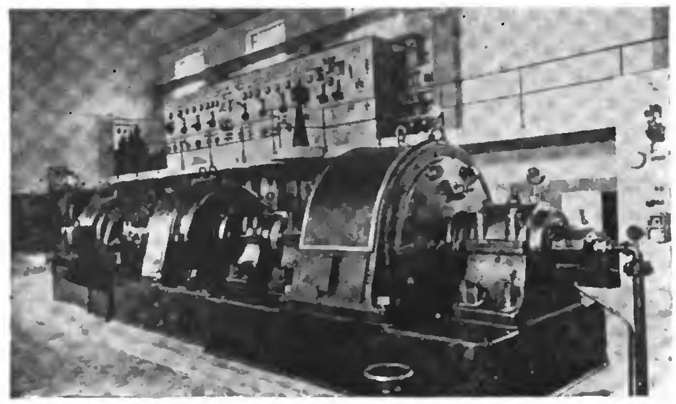


Figure 6—The Bethenod Set. From left to right, alternator giving 1000 cycles, driving motor, 20000 cycle alternator

In spite of the complexity of its mechanical elements, the group is very easily handled. It has—above all high power systems used to date—the advantage of giving a perfectly pure sustained wave. Checks by the Dufour oscillograph—recently effected—proved the form of the voltage sinusoid to be very regular. Though the machine requires careful watching it gives a steadiness of performance unknown to the arc, which requires frequent stops to change carbon, fix up the arc-chamber, etc.

THE ANTENNA

The antenna is a formidable rectangular sheet raised to a height of 180 meters above Grand-Camp. It is supported by two rows of four masts, arranged to follow the long sides of a rectangle, having nearly 1 kilometer length and 240 meters breadth, oriented practically east

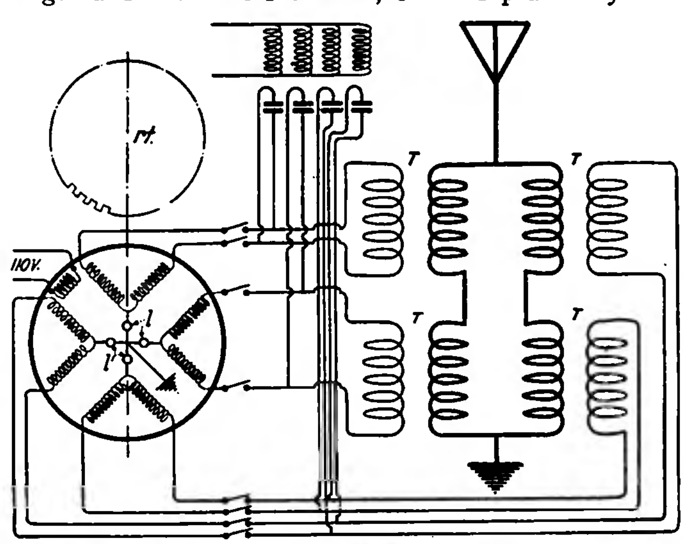


Figure 7—Scheme of alternator (20000) arrangement. rt—toothed rotor. l—lamps for grounding the mid-point of the stator windings. T—Tesla coils

to west. The two masts placed at the end of the sheet and at the entrance to the station are 200 meters high, the ten others are brought up to 180 meters.

The antenna surface is formed of twenty cables suspended parallel to one another. The respective distances between these cables increases from the ends automatically toward the station, which gives the double advantage of permitting an equal current distribution over the length thereof and of buoying up the centre of the sheet, thus diminishing the stresses in the supporting cables. On the east side all the cables fall directly toward the stations and are joined in a "crow's foot" to the cupola, which tops the hall over the large inductance.

The high powers put into action require considerably high insulation of the sheet and of all the metallic parts which hold it. The sheet is insulated from the masts by long chains of insulators. The masts themselves are insulated from the soil and rest on marble slabs and the guys which support them are sectionalized in various places by porcelain egg insulators.

In spite of these precautions continual maintenance of insulators is found to be necessary and the problem of insulation is complicated every day by the use of continually growing powers. When the 200 kw. arcs function one can still measure 100 volts between the soil and the last section of the guys below.

The antenna loading coil, studied and constructed through the efforts of the station officers, has the original form of a large hyperboloid of two meters in height. The largest section, that of the bases, is four meters in diameter. There are 28 turns of a copper band formed of thin laminations, insulated from each other, to reduce their high frequency resistance. Thanks to the carefully calculated action of this inductance the flux across any section is constant. Its rise in temperature is found to be much diminished and its efficiency considerably increased.

Such is, in a few words, the large station which connects continuously, France and America, and whose "press" is received even in the extreme Orient.

Before closing this brief description, I have to thank General Ferrie, to whom we are indebted for permission to publish these lines and for the series of photographs of his station and I ask my readers to join with me in giving homage to the commanding officer who has been capable of endowing our country with the model station which every day attracts the flattering curiosity of foreign delegations.—O. C. R.

Should all (Radio) Men be Created Equal?

By Edward T. Jones

EDITOR'S NOTE: In this article a wireless man with the broadest experience discusses a vital problem of present day commercial operating. In no sense is it propaganda for any interests, nor is it inspired by individual or associated employers. The manuscript came through the mail in the regular way and was submitted voluntarily by the author, who wishes to advance the art and asks that what he says be taken in all sincerity as the uninfluenced viewpoint of one who has made radio operating a vocation and rises to protest at the unsound conditions which have recently developed. It is published in the belief that these discussions will result "for the good of the service" and the Editor extends a wide open invitation to all interested to submit their views for publication.

RADIO OPERATORS! Radio Operators!—the constant cry of the shipping concerns.

The situation reminds one of the day the United States began to mobilize men for the great test against Germanism. Never before have we experienced such a boom in radio circles!

Three commercial radio concerns have opened service stations at fourteen points; namely, Boston, New York, Philadelphia, Baltimore, Norfolk, Savannah, New Orleans, Galveston, Seattle, Portland, San Francisco, San Pedro, Honolulu, and Cleveland to care for Shipping Board vessels under their supervision and in accordance with contracts entered into with the U. S. Shipping Board.

Transatlantic operating room of Radio Corporation of America, where expert commercial operators are employed

Competent men were needed to man these important posts and the list of old timers was practically exhausted. Then came a further drain upon the few pioneers, for the Shipping Board called for Radio Supervisors at each of the points mentioned.

Yet we hear a lot these days about wireless operating and the lack of good future.

The future depends entirely upon the individual. We who have worked our way up can look back and realize the path we have traveled. It is a straight and narrow path, and not an easy one, for its ascent meant the use of much midnight kerosene and the acquisition of tough palms. Too few endeavored to follow.

Sliding Wage Scale Best

The average pay today of a Wireless Operator is $125 per month, against the pre-war scale of $40, $50, and $75. The pay is attractive, but the question arises whether efficiency and improvement of the service as a whole will result from planting a man aboard a ship at $125 per month and holding him stationary.

Experience Counts for Naught These Days

According to the present wage scale when a young man emerges from a radio school with a license—and few are so feeble-minded that they can't pass the present Wireless Examination—the sweet graduate proudly walks over to a commercial radio company and hangs up his hat with those who have been actively engaged in wireless telegraphy five or more years.

It's all wrong. Some form of sliding scale should be adopted. I do not care to attempt fixing a maximum wage per month, but I do believe that a man without any experience in commercial wireless telegraphy should not receive more than $75 per month to begin. Let him then show his mettle, experience the hard knocks familiar to all old timers, and gradually attain the stature of a *man* and—after a certain length of faithful service—automatically have his salary raised.

There should be:

Something to look forward to.

Something to be proud of.

Something by which the shipping concern can have guaranteed Service, with a capital S.

Understand, I am not placing a limit to the salary a top-notcher should receive; I believe he should be paid in comparison to other officers of the vessel with whom he ranks. But it is worthy of emphasis that in the daily performance of their duty the other officers of the vessel constantly furnish guarantees of their ability and faithfulness, whereas the operator's primary duty is in connection with the safety of life at sea—and his test of sincerity, faithfulness, and ability, only comes at a critical moment. It is when the vessel is in distress that the wireless operator is of *prime importance*. What guarantee has the ship owner that he will perform his duties faithfully?—without experience.

Lengthy experience equips a man to handle most any situation; for that reason alone he should be paid a higher salary. There is no other vocation that classes the beginner and the expert alike, paying the same figure of compensation from assignment until death.

Second Grade Tickets

Consider the man with a second grade ticket. Does he deserve the same salary as a man holding a first grade ticket? On a one-man ship it matters not, according to the present ruling. On any ship a second grade man is not worth more than $50 per month to begin. Actually he is serving an apprenticeship with pay. In many other trades, board and lodging would be the sole return.

Operators Bettering Themselves

Maybe this is the reason why out of every ten men you will find about two who keep up with the radio game, through magazines, books, or otherwise. In fact, lately, due to the ever increasing demand, wireles operators appear as a class of world tourists only, for it is generally known that most operators make one trip per vessel. Why should they worry? All ships pay $125, and it matters not where one goes; it is easy anywhere to secure a billet.

Not until some arrangement is arrived at whereby justice shall be meted out to all, and wireles operators strive for the betterment of the art by devoting their spare time to personal improvement through study, shall we receive the recognition our skill merits.

Let me give an example of present day conditions:

An operator from a certain vessel came in one day and reported his "machine" sparking. I immediately asked whether it was the motor or the generator. After a little pause he said that it was at the *left end!*

In no uncertain tone I inquired how was I to know what was on the left end of the "machine" on his particular ship!

That is but one among numerous instances. Many men, like this one, take a student's course or learn the questions and answers to the Wireless Examination, and know there is a motor and a generator in the "machine," but fail to observe which is which.

When you mention vessel assignment to this type of youngster, he invariably wants to know first of all, where she runs, how long is the trip, if the grub is good, if there are shower baths. When you finally convince him that the vessel is OK, likely as not he says in effect: "All right bring it in. Let's take a look at it." The average may not be half this bad, but we actually have one man in this district who insists that he will not sail without a private bath.

Our concern, however, is with those who are worthy of the traditions of the sea. Which brings us back to the subject of salary. with a view toward establishing a maximum salary for old timers and men of ability in conformity to the pay of ship's officers with the same rank.

For beginners I advocate the following wage scale:

Second-class license	$50.00 per month
First-class license, first six months..	75.00 per month
First-class license, second six months.	100.00 per month
First-class license, end of 18 months.	110.00 per month
First-class license, end of 24 months.	125.00 per month

And so on, according to the salary arrived at as the maximum, with allowance for 15% increases for an extra grade license governed by the periods of actual service as provided in the table.

I expect yells of "Murder!" from those at whom this paper is directed; which matters not, since my object is placing radio telegraphing on a higher plane, and there are many in the game who are fair-minded.

A corner of the operating room of the Radio Corporation of America showing some of the control instruments

When men start in at a small wage and something is placed in front of them as a goal, better service is a certainty. Higher efficiency requires general betterment and the men will actualy strive to do well so that when their time is up another addition of winged demons will find their way into the pay envelope. The employing company will also be given a fair chance to study and judge the men in their employ and weed out the unfit. The man with the ability will gradually rise and it's a certainty that the Company will not fire him because he has arrived at a large salary. Why? Because men like him are scarce as hen's teeth. If you don't believe it, inventory yourself and see whether or not you are fit to man a good healthy shore station job with its several Morse lines and radio schedules, not overlooking the other qualities necessary for such a position. Less than one out of every 100 men aboard ship today are capable of actually manning a good live hot shore station roast. Still they wind-jam about what they can do and what they have done.

In the next few years radio is going to be changed entirely; probably to undamped apparatus. How many self-styled operators will be ready to speak with understanding about the new gear? How many will keep tab on all the radio periodicals, study, and strive to perform their duties as a man in the radio profession should? Those who will have done these things will be the ones ready and willing to give to those who have been in the game before them and who are possessed with ability, the right to a better salary.

There is a need right now of a common sense agreement. What have you to say, old timers?

Universal Honeycomb and Lattice Coils

The details of checking the classification of the formulae for lattice windings are so numerous that the third instalment of this series could not be completed for the September issue. It will appear in October.

Radio Operator's Story of the Comus-Lake Frampton Shipwreck

WITH a calm sea and a cloudless sky affording ideal conditions of navigation, the Southern Pacific steel passenger steamship Comus crashed into the steel United States Shipping Board freighter Lake Frampton at 3.15 A. M. July 12th about eight miles off Atlantic City, New Jersey.

The freighter sank in ten minutes, carrying to death an oiler and a fireman. The Comus's bow was slightly damaged but the liner sustained no other marks of the impact. Few of her sixty-four passengers, most of them women, were panicky and several aided in rescuing the remaining thirty-two officers and men on board the Lake Frampton.

The story of the shipwreck is here described by H. L. McCeney, the Radio Operator of the Lake Frampton:

I was asleep in my bunk on the morning of July 12th when a crash which occurred at 3:15 A. M. threw me out. Running to the deck I heard the alarm bells giving their signals. I tried to reach the captain to get orders as to the transmission of any possible message, but the only orders the captain issued were: "Abandon ship immediately." We were going down rapidly.

The Lake Frampton listed to port so much that it was impossible to launch the life boat on the starboard side. However, the life boat on the port side was rigged up and about fourteen of the crew got into it and the lines were cut to allow it to float away. There was no chance for me to reach the life boat so I climbed to the starboard side of the ship which was high in the air at the time, and when I thought the ship was settling, slid down t' side into the water. It was quite dark and visibility was poor. After being in the water a while I swam toward the life boat, but it kept drifting away because the crew aboard had no oar-locks with which to control the direction of the boat. As it was impossible to reach it I swam toward the Comus, which lay off about one mile distant.


H. L. McCeney, radio operator aboard S.S. Lake Frampton, as he appeared on landing after the sinking of his ship

Reaching the Comus almost exhausted, I was hauled aboard in between decks through one of the square portholes, and from there carried to the baker's sleeping room, where warm drinks and dry clothing were given me. After being aboard an hour, the first operator of the Comus, Louis J. Gallo, took me to the wireless room. I had been reported missing, though I was one of the first to be rescued, but being on the lower deck, no report had been made on my rescue.

The collision and sinking of the Lake Frampton happened so suddenly that there was no opportunity to use the wireless apparatus in securing aid. From the time of the collision to the settling of the boat, about 15 minutes elapsed. The second operator on the Comus, E. L. Chesbro, was on watch at the time when the crash came. Gallo immediately came on deck, without being properly clothed, and sent Chesbro to get orders from the captain while he took the watch in the radio room.

The captain placed Chesbro on the bridge to operate the flash light and other signals to aid in rescuing the men from the sea, and consequently he did not return to the wireless room for over a half hour, so Gallo sent a message to the steamship company reporting the collision and stating that the Comus would stand by until daylight to aid in the rescue of the Lake Frampton's crew. Other stations stopped when Gallo interrupted with "QRX" and Captain Powers of the Lake Frampton later sent: "Lake Frampton rammed and sunk at 2:20 A.M. Oiler and fireman missing." Several ships and some naval stations who were calling for particulars were also worked. After all rescue work had been attended to and a thorough search had been made for the two missing men, the Comus steered for New York.

The first operator aboard the Comus, who was aboard the Sister Ship Proteus when she was sunk in 1918 by the Tanker Cushing, south of Diamond Shoals off Cape Hatteras, said the collision was quite similar to the collision of the Cushing.

Some Electrical Guides for Wavemeter Design

By Oscar C. Roos

FELLOW I. R. E.

Synopsis of Present Instalment

General requirements of a wavemeter as compared with a receiver—wavemeters and receivers vs. "stiffness" of circuits—physical definition and examples of stiffness—effects of stiffness—general design relations in wavemeter coil and condenser—unilattice detector connection—general arrangement—anti-capacity switches—relation of wire in coil to wavelength—low coil capacity—spiral short-wave coils, sectionalized coils—use of spacers in winding—points concerning "bank winding" vs. universal winding—uses of bilattice universal winding in wavemeters—fixed multiple inductances—economy of wire in inductances—phantom antenna in wavemeters—general remarks on material to be used.

ANY receiver where the presence of the detector does not appreciably change the resonant wave length of the tuning circuit, may be considered to be a wavemeter, if it has a permanent calibration.

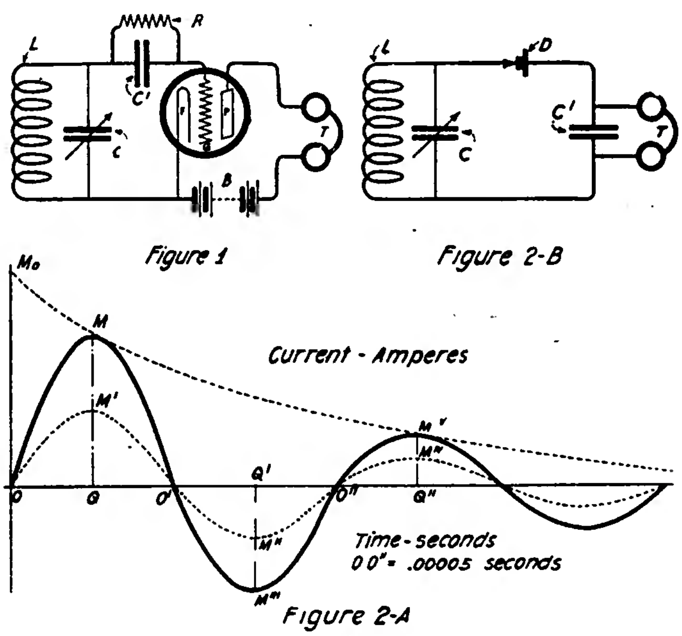
Such a wavemeter is shown in figure 1. In place of the usual crystal there is shown a thermionic relay FGP, as a resonance indicator. Its presence does not perceptibly change the resonance period of the oscillating circuit CL. This may be stated in a more technical way by saying that its reactance at radio frequencies must be between 50 and 1,000 times that of the coil L or the condenser C which has an equal reactance at resonance. For example, if L is 300 mh. and C. is .000337 mfd., at resonance the reactance of L is 9,425 ohms, which must balance 9,425 reactive ohms in the condenser in a negative or opposite phase. This occurs at 600 meters or 500,000 cycles. If the condenser C tunes down to .000085 mfd., giving about 300 meters, the effective capacity of the detector and its related series condenser C′ and grid leak R should not be greater than .000002 mfd. in order to avoid increasing the wavelength at 300 meters resonance by more than 1 part in 85.

With increasing wavelengths to be measured, this effect diminishes proportionally to the increase in wavelength, so that at 600 meters the detector has increased the wavelength by only 1 part in 170.

Reconsider the above problem from the standpoint of an inductance of 150 mh. or one-half the previous value. Our tuning condenser at any given wavelength would have twice its former capacity, and hence the relative disturbance in calibration due to the detector would be half its former value, i.e. at 600 meters it now amounts to one part in 340. To get down to 200 meters, we may have to cut down the value of L once more. This will give us, to get 600 meters, L = 37500 cm. and C = .0027 mfd. Now there are many condensers giving a capacity range of wavelength of four times the minimum. To do this, the minimum capacity must be 1/16 the maximum or .000175 mfd. In using this capacity, corresponding to 150 meters, the detector will make a difference in the wavelength of one part in 175 or about ½ per cent. Any further reduction of L to decrease this detector effect is unnecessary and is positively harmful, as it decreases the ratio of L to C, whose square root is a measure of the "stiffness" of the circuit, and this broadens the tuning.

Examples of Stiffness

Stiffness in a wavemeter circuit is measured in resistive ohms and when large, it gives to an electrical circuit a slow, very persistent oscillation, such as a stiff spring exhibits when released suddenly. Take the above circuit as an example. When tuned for 600 meters its stiffness—the square root of L_h divided by C_f—is equal to the square root of .0003 henry divided by .000,000,000,337 farad = 942 ohms approx. This is the best tuning circuit, and by contrast with it, the last circuit above considered—having L = 37500 cm. and C = .0027 mfd.—has only ⅛ of its stiffness or sharpness of tuning between 600 and 150 meters. There is an advantage in having less coil resistance in proportion to coil inductance or what is known as a better "time constant" in the .0003 henry coil. The 37500 cm. coil always shows that its tuning is broader unless very special and expensive refinements are introduced in the design of the coils to reduce their resistance to the lowest possible degree. This



Electrical effects of stiffness in radio circuits

point will be again brought up. When the 300,000 cm. coil is used, its stiffness at 600 meters is divided by 1.73, the square root of three, to get the stiffness at 200 meters. When the 150,000 cm. coil is used—the stiffness is .71 of what it was with the 300,000 cm. coil or about 680 ohms.

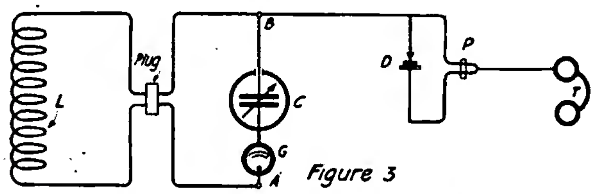
Effects of Stiffness

The user of a wavemeter naturally wants to know why so much attention is paid to "stiffness." The reason is that the property of stiffness in a measuring circuit reduces the change in resonant frequency that occurs when resistance is introduced into a theoretically free or undamped circuit. Hence, you often hear the expression "free period" of a circuit or "undamped" period or wavelength as contrasted with the "damped" or "natural" period or wavelength.

The greater the stiffness the less the effect of coil and condenser or wiring resistance on the "undamped" wavelength. Take the above 600 meter circuit L = 300,000 cm. C = .000337 mfd. It is fairly stiff, as we find that we may introduce about 150 ohms and yet only reduce the undamped frequency so that the "natural" wavelength is 608 meters instead of 600 meters. If we had L = 150,000 cm., C = .000674 mfd., and introduced the same 150 ohms the difference in wavelength would be four times what it was before—the natural wavelength or resonant wavelength—which is the same thing—would be 632 meters instead of 600.

If one introduces enough resistance—about 1,100 ohms—the first of these two circuits would cease to oscillate or "tune" at any frequency. In the case of the second circuit, 550 ohms would be enough to stop all oscillations. The experimenter should remember that inserting resistance has the same effect on wavelength that increasing inductance has, but the latter sharpens tuning while the former broadens it twice as fast. Hence the importance of low resistance to prevent great stiffness of circuit. In other words the resistance ohms must be low, the stiffness ohms must be high.

"But what is stiffness from the standpoint of something that can be physically measured or seen directly?"



Elements of typical wavemeter circuit

you may ask. Figure 2A is an attempt to answer this question.

It is intended to show that stiffness is physically an inverse measure of the first maximum current value in a damped electrical oscillation, from a discharged condenser. Figure 2A is the curve given by a Braun tube oscillograph of the current-time oscillatory discharge curve. The first maximum ordinate QM is inversely proportional to the stiffness when the resistance present has not appreciably changed the "undamped" wavelength.

The current QM is found by dividing a certain percentage of the voltage on the charged condenser by the stiffness of the circuit in ohms. If we have the discharge frequency in figure 2A of 500,000 cycles, so that the time represented by OO" is one five hundred thousandth of a second (1/500,000), with L = 300,000 cm. and C = .000337 mfd.—the current maximum, QM, will be one ampere with proper resistance in the coil and, say 1,000 volts on the charged condenser. If we halve L and double C the stiffness is doubled and the new current maximum QM' is one-half ampere. Similarly Q'M" and Q'M"' etc., are proportional to QM and QM', so that in one sense, the stiffness of two circuits of the same period may be compared at any pair of current maxima, such as $Q''M^{iv}$, $Q''M^{v}$.

In figure 2B an extreme instance of stiffness is shown schematically in an ordinary wavemeter circuit, using a crystal detector in series with a head telephone. Figure 2B is inoperative unless the path through detector D and telephone T is reduced in stiffness, by shunting the latter by the condenser C'. The stiffness of such a path may easily approach a megohm with high impedance phones of 30,000 ohms at audio frequencies in series with the very small equivalent capacity of the detector D. This detector does not pass enough current to work well, until condenser C' is shunted across the phones. It should be noted that some phones have sufficient capacity in their own windings to require across their terminals a very small condenser.

It is now evident that the most important precaution concerning wavemeter design—permanence of calibration—cannot be solved absolutely, on account of the inevitable changes in the detector. Practically any desired degree of accuracy at a given range can be obtained, as shown above, by making the circuit stiff and yet keeping the resistance down in the coil L and the reactance as high as possible in the detector.

General Design Relations in Wavemeter Coil and Condenser

It is important to have proper "overlap" from one range of wavelengths to another. With several detachable coils and a tuning condenser, it is necessary to have the first 10-20 degrees of the second range coincide with the last 10-20 degrees of the first range, and so forth in the remaining ranges.

The change of wavelength with fixed capacity and change of coil may be called l. It usually varies between 2 and 4. In a similar way the change in wavelength with fixed coil and variation of capacity may be called g. Calling the relative overlap "p" and recollecting that $g > 1$ and $h > 1$.

$$p = \frac{g-h}{g-1}$$

The above formula shows that letting the larger of two coils approach the smaller $h \doteq 1$—which means that h is greater than and approaches unity—and $p \doteq 100$ per cent.; in other words the overlap approaches unity as the coils approach each other in value. The value of g lies usually between 2 and 8. A good average overlap is given with

$g = 4$, $h = 3.4$, hence $p = 20$ per cent.

The less the overlap, in covering a given total range, the fewer coils and less wire are necessary.

It is very important to know the effective capacity of the wavemeter wiring itself. This may be as much as .000040 mmfd. in a portable wavemeter and more in others. It reduces the capacity range, g, given above, by as much as 65 per cent., with large values of g. The effective range is always less than the free range of the condenser.

Unilateral Detector Connection

The precautions regarding detector capacity illustrated in figures 1 and 2B give a sensitive detector connection, but do not give the sharpest tuning possible. The unilateral connection of the detector shown schematically with other improvements in figure 3, gives a response about one-seventh as loud as that given in figure 2B, under similar conditions, but much sharper. The energy caught in the detector is really that rectified in the radio frequency current from the fixed or high potential side B of the condenser C, through the detector D and phones T, and out into space as dielectric flux between the other side of the condenser C which is grounded to a metal shield S joined to the movable plates of C.

The phones T must not be near the shield S during calibration or use of the wavemeter. For this reason a detachable connection for the phone cords is suitable at P, in the form of plug and jack or else a clip. Both the detector D and plug P should be placed as far from S as possible. When this is done the continual change in capacity of phones due to change in position of observer is negligible. This is reduced to a minimum by above precautions and is well below the capacity allowance in the detector path, discussed under figure 1.

General Arrangement

The wavemeter should be capable of use as a transmitter or driver either by buzzer or triode (vacuum tube with three electrodes). With the latter we are not concerned here, but connecting a battery and buzzer in series to the binding posts A and B figure 3 gives a source of variable wavelengths.

The thermo-galvanometer or hot-wire instrument G should be inserted between the point A and the condenser

C. On no account should it be inserted between the point A and the coil L, as it would register the direct current in the buzzer. The advantage gained in the arrangement of figure 3 is that only oscillating current passes through G, which thus gives a relative measure of the efficiency of different buzzers, if run at a given audio and radio frequency with the same battery.

ANTI-CAPACITY SWITCHES

It is necessary to avoid ordinary cam-switches or the usual form of plugs and jacks for making connections. Both these forms of connection add appreciably to the capacity of the wiring and still further reduce the effective condenser wavelength range. At wavelengths of less than 600 meters they do not constitute the best practice. There are cam anti-capacity switches having less than .000002 mfd. capacity which are good down to 50 meters.

Where solid parts must be used as a dielectric instead of air for mechanical reasons, it is well to machine away as much of the solid as possible. This is especially true in tube and plate construction, where between 50 and 80 per cent. of the material may be removed, to reduce the dielectric loss. By doing this the capacity of a plug connector on a wavemeter detachable coil may be kept down to less than 1 mmfd.

If great refinement is required, it is better to evade the use of detachable coils and to use for all wavelengths the same set of fixed inductances arranged in different series-parallel combinations to get different ranges. A low-capacity drum-switch makes the necessary changes in the combinations and can be so designed that 80 per cent. of its volume is air dielectric. This will be taken up again under the subject of wire economy in design.

RELATION OF WIRE IN COIL TO WAVELENGTH

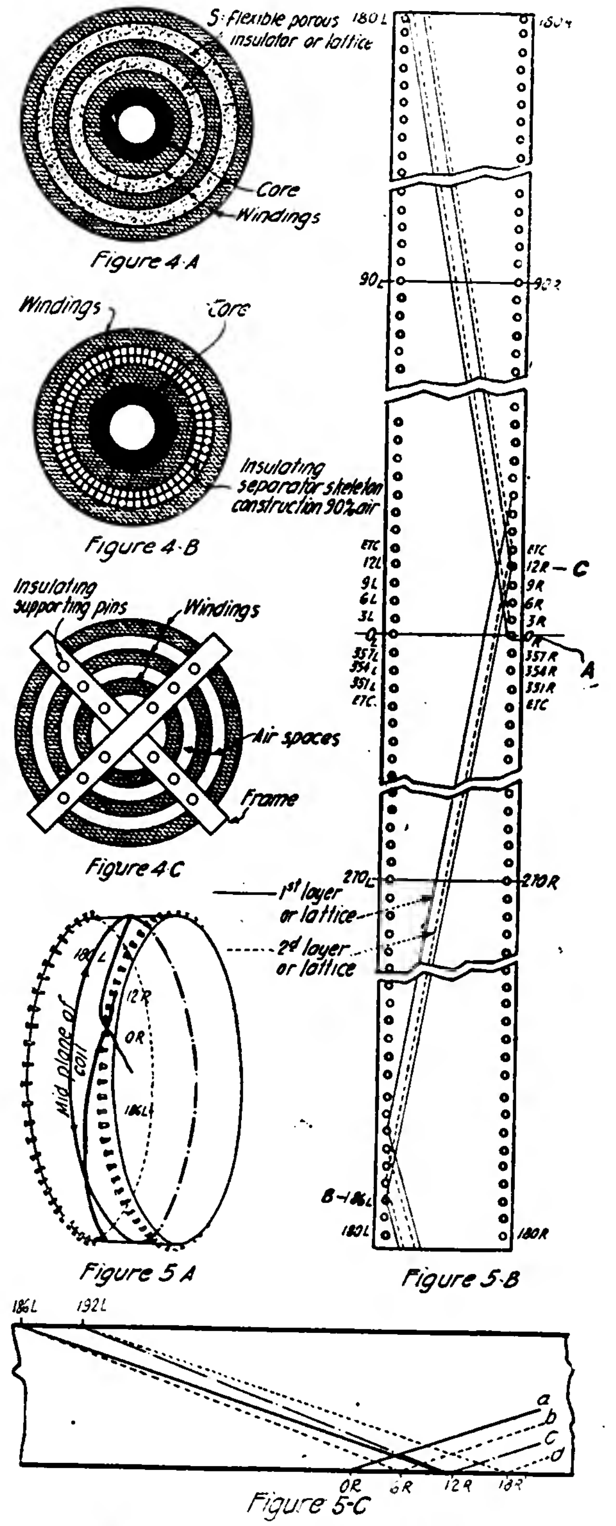
Both theory and practice warn against developing local oscillations in wavemeter coils, by tuning them to circuits oscillating near the exploring coil's fundamental frequency. Since a coil can vibrate at this frequency when unattached to any other device, its tuning value is nil at this frequency, unless for wavelength checking.

In a plain or cylindrical winding the wire length should not exceed 4 per cent. of the shortest wavelength at which the coil is used, e.g. if this be 100 meters, not more than 13 feet of wire should be used. This means a small coil if the wire is to be used efficiently, by being wound in many turns, but the coil does not pick up as much energy at a given frequency as if only one or two larger turns were used, giving smaller inductance. We find also that with the latter arrangement there is an advantage of greater sensitiveness in "picking up" an oscillating field threading the coil L, which has, usually under these conditions, also smaller distributed capacity, relative to inductance. By making these few turns of very low resistance, fairly sharp tuning can be preserved, if the coil capacity is kept low.

LOW COIL CAPACITY

We have a safe rule for maximum length of wire advisable for a given coil-inductance and wavelength. If we reduce our coil capacity factor we may safely use more wire, more turns and get greater sensitiveness in the wavemeter. There are lattice wound coils with 330 meters of wire having a fundamental of about 1,700 meters which give great satisfaction, even though their length of wire is as much as 20 per cent. of their fundamental wavelength. This is possible because their distributed capacity is only about 13 mmfd. By using the bi-lattice winding, which will be described further on, this distributed capacity may be reduced to 10 mmfd.

In short-wave coils the best form is not the universal winding, but the sectionalized spiral coil, as with a given coil sensitiveness or reception factor, the coil capacity is less. This sensitiveness or reception factor is a measure of the emf. induced in a coil of area A having an inductance L and N turns and applies to any receiving loop or coil. The wavelength received, using a loading condenser, is λ, and the coil radio-resistance or resistance at radio frequency, is R. Calling the reception factor, "F,"



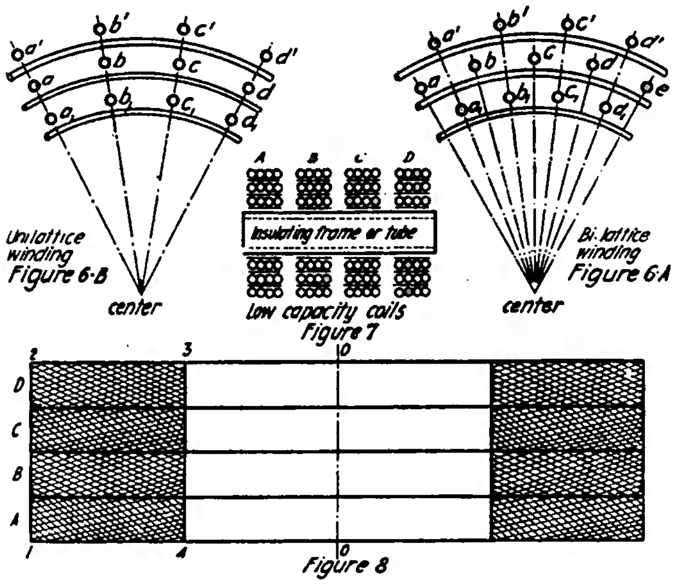
Methods of securing low coil capacitance

$$F = \frac{NAL}{R\lambda^2}$$

It is evident that for best coil efficiency, and sensitiveness, the same type of coil cannot be used in a high grade instrument for short and long wavelengths. Even the repeated use of the same windings in combinations of fixed coils for all wavelengths does not give as good a result on waves around 200 meters as the coils described below.

SPIRAL SHORT-WAVE COILS—SECTIONALIZED COILS

The best form of short wave coil is indicated in figures 4A, 4B and 4C. The common feature of construction therein is the pancake form, giving a ratio of thickness to depth of winding of not more than 1 to 4, and having the windings divided radially into three or more concentric rings separated by a porous or "latticed" dielectric. It is not generally known that a honeycomb or lattice dielectric equivalent to 50 per cent. air volume or better can be made from fine strips of flexible dielectric or from "strings" of same. Portable wavemeters for as low as 60 meters with a 4-Coil range of 60-3600 meters, were used by the Navy during the World War, having their short wave coils sectionalized as in figure 4A by coarse blotting paper S, shown by cross-hatching. The mean diameter of the coil was about 3½ inches, depth of winding 1¼



Low capacitance coils, lattice type—figures 6-A; 6-B; 8. Morecroft type, figure 7

inches, and width varied between 1/16 inch—taking one turn per layer of Navy Standard, 3-16-28 Litz—and ⅜ inch. The separations are shallower, as they occur nearer the circumference of the winding. From 3/16 inch near the center they decrease to 3/32 inch near the circumference. This tends to equalize the capacity effect of each section, as the potential drop is sharper near the center of the coil.

This sectionalizing reduces the inductance, but reduces the capacity to a greater degree, and the sharpness of tuning is improved. If two or three Litz wires are wound in parallel and there are 2n or 3n turns per layer where n = 1, 2, 3, 4, etc., we may reduce the resistance still further and thus sharpen the tuning. We should not have "n" greater than 3, giving 9 wires or 3 "turns" per layer, using the pancake coil, as we would have to enlarge the diameter of coil to keep the relative depth of winding the same. Wavemeter coils are best made of not more than 5 inch external diameter, for portable use.

When a coil is used for 200 meters wavelength or less, special care should be taken to avoid dielectric losses, and to get very low resistance. Figure 4C shows a means of accomplishing this. Here we have a coil sectionalized by air spaces, by the use of a coil frame. This method is hardly worth while for the experimenter who requires for 60 meters only about 5 turns, 3.5" mean diameter of Navy Standard Litz. He may just as well use a separator of blotting paper, using one turn per layer, but if he uses two or three Litz in parallel radially, i.e. one over the other, he will at the same time reduce the capacity between "turns" and also the resistance. The coil frame is electrically preferable, except for rough outside usage, to solid end-faces.

USE OF SPACERS IN WINDING

Detachable coils used between 200 and 600 meters give excellent results if a "spacer" or blind cord, to reduce capacity between turns, is wound simultaneously with them and removed before the wire is fixed in place with insulating adhesive. It is understood that a flexible dielectric separator is necessary between every layer. This reduces the capacity still more.

POINTS CONCERNING BANK WINDING VS. UNIVERSAL WINDING

A knowledge of bank winding is assumed and also of the universal winding known as "honeycomb," which is one kind of lattice winding. Bank winding must be done by hand and cannot conveniently go above 6 banks, using Navy Standard Litz, for engineering reasons. The coil capacity is twice as great as that of the "honeycomb" winding but is about 20 per cent. more economical of wire for a given inductance and shape of winding cross section.

The universal winding can be built up into a true pancake form, rigid and dependable. Several shallow coils "universal-wound" may be used in the frame coil, shown in figure 4C schematically. But a shallow bank-wound coil of two banks is easily wound and is electrically satisfactory for medium waves, of about 450-950 meters. At longer waves it wastes wire compared with a universal coil of same distributed capacity.

If the best result is desired, regardless of cost, the experimenter should use the universal winding, either "bi-lattice" or "honeycomb" ("uni-lattice"). If he winds his own universal coils on any of the several "jigs" shown for that purpose in current technical periodicals, he has the satisfaction of knowing that they are superior to the machine wound product in at least one important respect, from his point of view—they have at every "swing" or "cross-step" of the winding, which occurs about every 180 degrees in lattice coils, a small semicircle of projecting wire which is of great assistance for "tapping" the coil, especially when of solid wire.

USES OF BI-LATTICE UNIVERSAL WINDING IN WAVEMETERS

By a simple change in relative positions of adjacent "turns" or "circuits" in a universal wound coil, these coils have alternate lattice patterns which are "staggered" and the capacity thus reduced about 15 per cent. compared to the uni-lattice type. This effect can be obtained on a universal winding-jig used for "honeycomb" (uni-lattice) hand-wound coils, as follows: In figure 5A we have the schematic diagram of a drum intended to have a double row of radial pins 3 degrees apart at its right and left sides near the "faces." These pins are pushed upward as each layer is wound. Starting at A on the right at 0 degrees and turning the coil, the winding passes to 186 degrees on the left at B, a swing of 186 degrees coming back at 360 degrees plus 12 degrees or 372 degrees on the right at C. To follow the winding it will be convenient to adopt the following symbols.

From the right hand starting peg at 0 which we call Or, all pegs or pins, as the case may be, are called OR, 3R, 6R, etc., to show the number of degrees over which the winding has passed on that side. The symbols OL, 3L, 6L, etc., are similarly used for the left side. Let the pins, 0, 6, 12 etc. both R and L be one color and those on 3, 9, 15, etc. another color.

The lattice pattern indicated in figure 5A, is shown more in detail in figure 5B and the difference between a single wire bi-lattice and a double wire bi-lattice is indicated in figure 5C. In lattice coils it is better to call one revolution of the wire as laid down in a series of "cross-steps" a "circuit" instead of a turn.

Starting at OR in figure 5B we make a circuit plus 12 degrees at 12R. With 29 more circuits we have a "layer" before we arrive at OR again. This would be a uni-lattice coil. We make however, a 2-wire bi-lattice coil by winding simultaneously, another winding starting at 3R. Then we have a 2-wire, bi-lattice step-wound coil in contradistinction to possible spiral wound forms. (See article on Lattice Coils in General in July "WIRELESS AGE.") If the usual pitch is less than 360° (instead of 372° as above) we divide it—not 360° as above—by the advance, v, to get the "circuits" per "layer." If we had started in figure 5B at 6R instead of 3R or 9R we would have had the type of winding shown in figure 6A, which is more efficient.

The most efficient winding is obtained where the wires in figure 6A examined in sets of four, such as a^1 b a_1 a form a square. This does not give the best inductance-volume efficiency, but the tuning efficiency factor

$$\frac{1}{R}\sqrt{\frac{L}{C}} \text{ is greatest.}$$

In figure 5C we see the winding design factor come into play, turning a uni-lattice coil into a single wire-bi-lattice. The choice is made on leaving the last step (186L) before making a circuit at 12R. Passing from 12R along wire "a" gives the uni-lattice winding, but going back or "slipping" half the advance or 6° we start a bi-lattice at 6R and wind exactly as before, making a second "circuit" if we do not "slip" at 18R–"d." But we must again "slip" to 12R and we have for one more "circuit" the original lattice. So we build up two lattices with one wire. If we had "slipped" back 9° to 3R for one circuit and no degrees to 12R on the next, then 9° more to 15R, etc., we would be reproducing the 2-wire bi-lattice pattern in figure 5B with a single wire.

The staggering of the wiring to reduce mutual capacity in the bi-lattice coil is shown in figure 6A where the layer a′b′ etc., and the layer a_1b_1 etc., have the same circumferential positions at the pins, but where the layer a, b, etc., is displaced 3 degrees from both the above layers. The ordinary uni-lattice winding or honeycomb construction is shown for comparison at figure 6B.

ECONOMY OF WIRE IN INDUCTANCES

The smaller the "swing" or the angle passed over in one "cross-step" in a universal coil, the lower the inductance; the greater the copper waste per turn, but the less the capacity up to a certain limit. The ideal "swing" for wire-saving alone, would be close to 180 degrees, but not very close; as the capacity would increase too much. The mathematical solution for best pitch is impracticable and the experiment derivation of a formula is contemplated, which depends on the swing, s, and the width, w, of the winding compared to its depth, t.

FIXED MULTIPLE INDUCTANCES

To save wire, the arrangement of several low-capacity coils, as shown in figure 7 has been used in receivers and wavemeters. In most cases the various sections A, B, C and D were not all used throughout the scale; as they should be, to get the greatest economy in wire, other things being equal. With the coils in figure 7 the equivalent of 4 detachable coils can be obtained by the following combinations, secured by a properly designed drum switch.

Let "+" mean "in series with"
Let "—" mean "reversed normal series connection"
Let "×" mean "in multiple with"

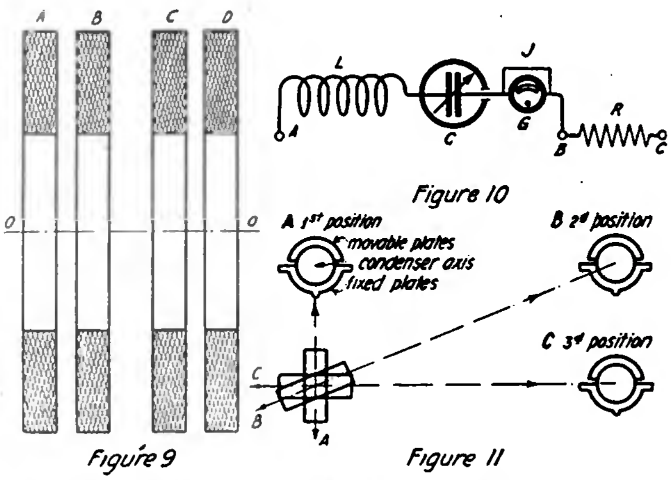
There are four ranges obtainable as follows:

Range I — A × B × − C × − D
Range II — A × B × C × D
Range III — A × B + C × D
Range IV — A + B + C + D

In Range I, A C oppose, also D and B oppose, B and C also oppose, but the system can be used even when the mutual action between B and C is but a fraction of that between A and B or the similar pair C and D.

The range in wavelength of such instruments as the above is as high as 1 to 25. This is not as good as a range of 1 to 60 obtainable in four coil instruments, of the detachable type. There is a saving of about 30 per cent. of wire over the detachable coil type of wavemeter, having approximately the same range and overlap.

It is necessary to remember that although in range I the windings have a large capacity relative to their inductance, i.e., small "stiffness," yet the coil efficiency is



Refinements in wavemeter design

good on account of the lower resistance with windings in parallel. In other words the efficiency factor $\frac{1}{R_1}\sqrt{\frac{L_1}{C_1}}$ is large where L, C and R are average inductance, capacitance and resistance per centimeter.

It is obvious that a multi-lattice coil permits the starting or stopping of a new possible winding at any point in the coil. In figure 5B, we might start several windings according to coupling requirements, at 2R, 4R, 6R, 8R or 10R at various "layers" of the coil and stop them at any others.

The fixed coil type has an overlap of 83 per cent. in some cases, whereas 17 per cent. would be sufficient, if only receiving measurements are usually to be taken. The wire expense for a given range may be thus reduced by about 80 per cent; as this expense is roughly proportional to the overlap in a given range. With four coils the range would roughly increase inversely as the cube of the overlap; i.e. if we cut the overlap from 80 per cent. to 40 per cent. by using larger coils, the range of the instrument will increase about 8 times.

When the overlap is more than 50 per cent., different degrees of tuning are practical, and when driving another circuit, the character of the waves at a given wavelength may be changed with respect to damping. Otherwise large overlap is a positive defect in its heavy waste of wire.

The best compromise between overlap, coil and condenser-range and economy of wire in a given total range has been analyzed practically, but must constitute another article. It is sufficient to show how pancake universal wound coils can be adapted to the construction indicated by figure 8.

In figure 8 four coils A, C, B and D are placed together to form a unit, whose resultant cross section of winding is a square 1, 2, 3, 4 giving the best "time constant" or greatest inductance for a given length of wire. This "Maxwell" coil is obtained when 1-4 is one-half the coil radius.

When these coils are moved apart axially, as shown in figure 9, if the spacing between them is varied, a wide range of overlap and range without disconnecting the coils may be obtained. With wider range there is, of course, less overlap. Separating the coils increases the overlap and reduces the range.

Phantom Antenna in Wavemeters

The circuits in the wavemeter should be arranged so as to permit its use as a "phantom antenna," by "shorting out" the indicating instrument G by the "jumper" J and by inserting external resistance R as shown in figure 10.

This can be easily done by a 12 point D.P.D.T. anti-capacity cam-switch, so that the first position is "receiving," second position is "dummy-antenna" and third position is "transmitting." Navy Portable Wavemeter Type 614-A was thus designed by the writer.

Exact fundamentals can be obtained with such wavemeters of coils or antennae without approximations due to "single turns" of coupling-wire or large series condensers.

General Remarks on Material to be Used

Condenser leakage paths should be at least one inch. Unemployed windings should be avoided or "shorted." Fixed coils as shown in figures 8 and 9 should if possible, be arranged with their mid-planes passing through the condenser axis. This mid-plane is the weakest part of the coil field. The greatest distance consistent with small wire-capacity and inductance should separate coils and condenser. Of the three condenser positions shown in figure 11A,B,C—the first is the worst and the second the best as far as coil-action on the condenser is concerned, but low capacity in the winding requires the use of the arrangement A in most cases. Hard rubber not exposed to the air is better than bakelite or similar compounds electrically. Its progresive surface leakage is against it, especially as it decomposes gradually under the influence of moisture and light. For general use Bakelite and Formica are satisfactory. Pyrex condenser mountings for very fine work are excellent.

The above are some of the considerations which in the main have been experimentally confirmed and form the nucleus of a systematic engineering treatment of various special wavemeter problems. From actual cases, tables have been compiled, which it is hoped to give in these columns.

Transmitter for Use on Direct Current

During 1915 and 1916 amateurs in the vicinity of New York City were familiar with the spark of two or three stations, such as "2 PM," which at that time were using what Walter S. Lemmon terms a resonant converter in a device which he has recently perfected.

The figure represents an arrangement of sending circuits of a radio transmitter in which a synchronous spark gap and an associated rotary controller are used; the rotary controller or commutator serving to make and break a direct current circuit. The source of D. C. is connected through an adjustable resistance R (whose function is to limit and control the supply energy) to an oscillatory circuit containing the commutator C, inductance I (which is the primary of the transformer) and the condenser L. It will be observed that the direct current source is so connected to the oscillatory circuit as to apply the direct current energy to two circuits, one of which contains the commutator and the other of which contains the inductance and capacity. In other words, the oscillatory circuit is, in its relation to the direct current source, made up of two parallel paths, one of which, containing the inductance and capacity, is capable of absorbing energy from the direct current source when the direct current through the commutator is interrupted; and the other of which affords a very low resistance path for the direct current when the circuit through the commutator is closed, which path also provides a short circuit for the oscillatory circuit.

With the parts thus arranged, a rotation of the commutator will periodically interrupt one parallel path causing the direct current to be shunted into the other parallel path containing the inductance and capacity, thereby storing energy in this portion of the circuit. When the commutator brush has passed over the insulation segment and comes upon the next conducting segment, the closed circuit is completed and the stored energy will discharge itself through the closed circuit, and if the circuit through the commutator remained closed, would, because of the inductance and capacity in the circuit, give rise to damped electrical oscillations. If, however, the speed of rotation and the design of the commutator is such, that the circuit is made and broken at intervals, which corresponds substantially to the natural frequency of the oscillatory circuit, then the change of circuit connections will be effected substantially without sparking and an alternating current of constant amplitude will flow into the transformer primary. Consequently, energy in the form of a constant amplitude alternating current may be taken from the circuit through the instrumentality of the transformer secondary which may be included in the ordinary spark gap circuit of a radio signaling system.

The closed resonant circuit contains a telegraph key and the secondary S, is included in the spark gap circuit which is inductively associated through the transformer with the antenna. In this case, a synchronous spark gap

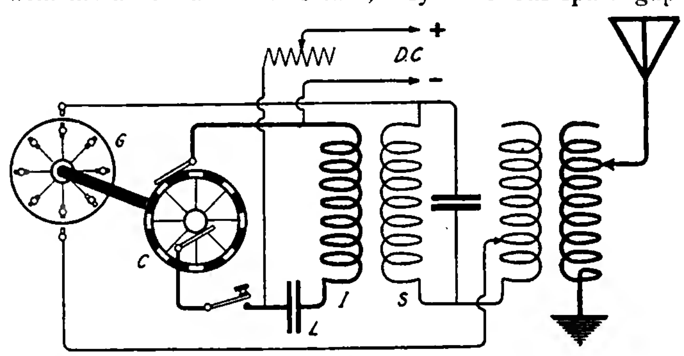


Figure 1—Diagram of connections for direct current transmitter

is used in the spark gap circuit. This apparatus may have any well known form, and should be driven in synchronism with the commutator. By way of example, a rotating disk G, is mounted on the same axle with the controller C, and carrying radially arranged spark points co-operating with two fixed spark points located at extremities of a diameter of the disk. The rotating disk G, may have the same number of spark points as the rotating controller C has pairs of segments and hence where these two devices rotate at the same speed, only alternating half waves of the alternating current are used for sparking. Both half waves of the alternating current can be utilized, thereby producing two sparks per cycle by doubling the number of spark points on the disk, G, or by rotating the disk G at double the speed of the controller C.

Modulator for High Power Work

A MEANS of controlling the great powers in accordance with vibrations of the human voice has been worked out by E. F. W. Alexanderson. In a previous article which was reviewed in this magazine, Alexanderson described a system of modulation in which a comparatively large amount of energy might be controlled by means of the feeble current set up in an ordinary telephone transmitter, wherein the amount of energy transmitted to the antenna from a local source of high frequency current was varied by means of an electron relay device controlled by the current from a telephone microphone in such a way as to vary its conductivity.

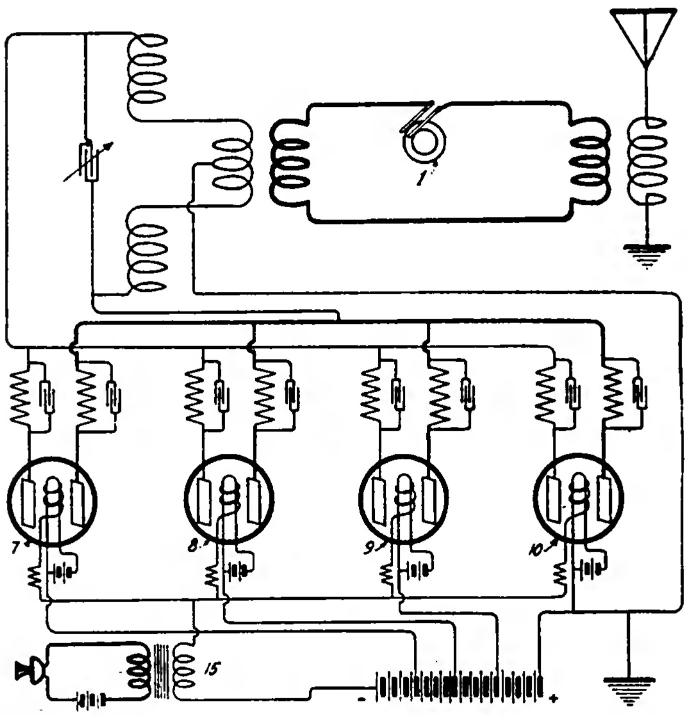


Figure 1—Circuit diagram showing hook-up

With this arrangement, in order to produce the desired variation in the antenna, the absorption of a considerable amount of the total energy of the local source in the relay circuit was unavoidable, the greater part of the energy being absorbed in the relay itself. Hence the amount of energy which might be effectively communicated to the antenna was limited by the absorptive capacity of the relay used. At the present time this capacity is limited by difficulties which appear to be inherent in the manufacture of apparatus of this type. The energy which may be controlled in such a system might be increased by connecting several relays in parallel, in which case the amount which could be controlled would vary directly as the number of relays used. By connecting the relays in parallel with resistance in series, in accordance to Alexanderson's latest invention, however, the amount of energy which can be controlled will vary substantially as the square of the number of relays used.

The drawings herewith show diagrammatically a system of connections whereby the desired result may be accomplished. A source of high frequency energy is connected through the usual transformer with the antenna. The primary of an oscillation transformer is also connected in series with the source of radio frequency energy and the primary of the transformer. The terminals of the secondary of the oscillation transformer are connected to the anodes of a series of electron tubes or relays through resistance as shown. These relays also contain filaments which are provided with a source of current for heating them. The filaments are surrounded by a grid as is usual, and the grids are all connected to one terminal of the secondary of the microphone transformer and to the other terminal is connected a battery. The filaments are connected to various points in this battery. One end of the battery is preferably grounded. The primary circuit of the microphone transformer includes a battery and the microphone. The filaments are also connected to the middle point of the secondary of the oscillation transformer 5. An adjustable condenser is preferably connected across the terminals of the secondary of the oscillation transforme, although in some cases the capacity of the relay tubes may be of sufficient order as to make this unnecessary.

With the arrangement here shown, it will be seen that the current in the antenna will vary in accordance with the current through the primary of the oscillation transformer. The amplitude of the current in the primary will in turn depend upon the current flowing in the secondary. It will be apparent that a certain portion of the energy from the source will be diverted to the secondary circuit and absorbed in the resistances and relay device therein. The system may be so designed and adjusted that the energy thus absorbed will in general bear a certain ratio to the total amount of energy derived from the source 1. Hence, by varying the amount of energy absorbed in the secondary circuit the amplitude of the antenna current will be varied in substantially the same proportion.

In a form of relay indicated in the present case, there will normally be a flow of negative electricity from the filament to the anodes but no flow of current in an opposite direction. The amplitude of the current flow through the relay may be varied by varying the potential impressed upon the grids. If a large enough negative potential is impressed thereon, the flow of current will be stopped altogether. If a positive potential is impressed upon the grids, the current flow will be increased. For convenience of description, let it be assumed that the potential of the grid is such that little or no current will flow through the relay when the high frequency potential of the secondary of the oscillation transformer is applied to the electrodes. The negative potential of the grids of the relays 8, 9 and 10, with respect to their filaments will be progressively greater. If now a current wave is produced in the microphone transformer of such a direction as to overcome the negative potential of the grids, current will begin to flow first from the relay 7 and will gradually increase to a maximum value. If the potential of the current wave is great enough, it will gradually overcome the negative potential of all of the grids and the current will begin to flow successively in relays 8, 9 and 10. When the voltage impressed upon the grids from the microphone transformer begins to decrease, the reverse action will take place, that is, current will cease to flow first in relay 10, next in relay 9 and so on, until the impressed potential falls to zero and no current will flow, as in the beginning. The relays may be so designed and the potentials applied thereto so chosen that when the current in relay 7 reduces its maximum, current will begin to flow in relay 8 and when the current in relay 8 reduces its maximum, current will begin to flow in relay 9 and so on.

Relay devices of the general type shown herein vary somewhat in their characteristics and in some cases the proportionality between the current flow and the voltage impressed upon the grid is constant only over a somewhat limited range. In such cases it may be desirable to so choose the potentials applied to the grids that before the current in one relay has reached its maximum, current will begin to build up in the next relay and so on. In this way the system may be so designed that the current flow therein will be substantially proportional to the voltage variation in the transformer 15 throughout the entire range.

When the current first begins to flow in the relay circuit the greater part of the drop in potential will occur in the relay itself and hence the relay will be called upon to absorb most of the energy of the secondary circuit. As the current increases, however, the drop through the resistances will increase and the proportionate amount of energy absorbed by the relay will decrease. The maximum energy which the relay will be required to absorb will be when the current has reached one half of its maximum value and the relay is consuming one half of the voltage. When the current reaches its maximum value in the relay the amount of energy which the relay will be required to absorb will be practically negligible, the principal drop being in the resistance.

Suppose, for example, that it is desired to control in the secondary circuit a maximum of 10 kilowatts of energy which may be represented by .5 ampere at 20,000 volts. If we do this with a single relay and secure a gradual regulation of the energy from no load to full load, the relay will be called on to consume a maximum of .25 ampere at 10,000 volts or 2.5 kilowatts. It will also be required to absorb energy during the entire period during which the change from minimum to a maximum takes place.

Suppose now it is desired to control a maximum of 160 kilowatts of energy which is represented by 8 amperes at 20,000 volts. If we use four relays as indicated in the drawing each relay will be called upon to take 2 amperes. The maximum amount of energy which any one relay will be called upon to absorb will be 1 ampere at 10,000 volts or 10 kilowatts. The change from minimum to maximum in each relay, however, will occur in one-quarter of the time required in the case where a single relay was used. Hence the average amount of energy absorbed will be only one-quater of 10 or 2.5 kilowatts. Thus it will be seen that four relays of the same capacity will be able to control 16 times as much energy as the single relay.

In the type of relay here shown there is an appreciable capacity between the anodes. This results in considerable current flowing through the relay between the anodes when the system is not being used for transmitting signals. As a result a large amount of energy is needlessly wasted in the resistances. In order to avoid this it may be desirable to shunt each of these resistances by a condenser. This will cut down the high frequency alternating current but will not interfere with the unidirectional flow of current through the relay between the cathode and anodes. It will of course be understood that the resistance may equally well be inserted in series with the cathode instead of in series with the anodes. In order to prevent the grids from consuming an unnecessary amount of current when they become highly positive, resistances may be inserted in series therewith.

Direction Finder

A NOVEL electromagnetic-wave navigational system developed by James Urskine-Murray and James Robinson, has been disclosed recently.

The direction of propagation of electromagnetic waves emitted from an external source may be determined by varying the orientation of a conductor in an oscillating field produced directly or indirectly at a receiving station by the waves. This conductor may conveniently be a closed coil in series with a condenser forming a tunable circuit and connected with a suitable receiver. Owing to the fact that the strength of the received current or signal varies more rapidly when the coil is turned in the neighborhood of the position of zero or minimum induced current, it is usual to determine the direction of the waves by varying the orientation of the coil until this condition is obtained. The orientation of the axis of the coil for minimum signal then indicates the direction of propagation of the waves.

This method has the disadvantage, firstly, that it is impossible to read the signals when on the position of minimum strength and secondly, that it is not suitable for use in aircraft or any other situations in which extraneous noises make it difficult to determine the actual minimum of the signals, since these are, in general, very weak in the neighborhood of the minimum and may appear to die away altogether at a substantial angular distance on either side of it.

Again, if an attempt is made to determine the minimum by turning the coil from side to side between the positions of equal signal strength, these are very difficult to distinguish owing to the gradual increase of strength as the coil is moved away from the minimum, rendering it impossible to make a direct comparison of two reasonably strong signals. The Murray-Robinson invention provides a means whereby the intensity of the signals at two points, one on either side of the minimum, may be directly compared by cutting out signals of intermediate intensity.

The invention provides means whereby the rotatable coil of a directive reception device and its pointer or indicator are free to move with respect to each other within determined limits, contacts being provided to constitute the limiting stops and also complete the receiving circuit.

The pointer is movable relatively to the rotatable coil over a certain angle which is determined by the positions of the stops and its position determines the limits of the angles which the rotatable coil can form with the direc-

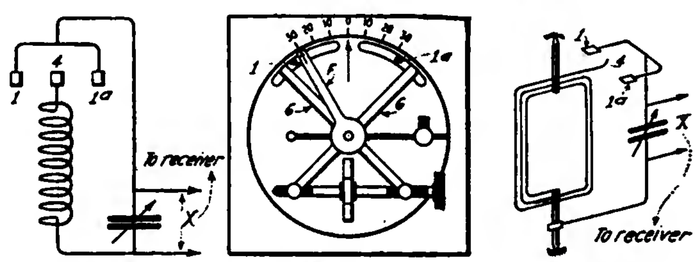


Figure 1 Figure 2 Figure 3

Circuit, plan view of indicator, and diagram of loop in position

tion line of the signal. The invention is equally applicable to a direction finding system comprising an electromagnetic coupling device, such as a radio-goniometer, in which case, the indicator stops determine the limits of the angles which the rotatable coil or condenser can form with the two fixed limits of the apparatus.

It will be seen that by this invention, signals will be audible only when the rotatable element is in contact with either of the studs or contacts and that if the pointer or indicator be moved until equal intensity of signal is observed at two stops—the minimum intensity direction line must dissect the angle contained between the two positions as the intensity of the incoming waves varies according to the distance from the source and other factors—the distance apart of the stops is preferably adjustable.

In order that the construction and action of the invention may be more clearly understood, reference is made to the accompanying drawings in which figure 1 is a diagrammatic representation of the wiring as used either directly on a loop aerial or the movable coil of a radiogoniometer. Figure 2 is a plan view of one form of indicator in accordance with this inventor, showing the mechanical details of construction. Figure 3 is a diagrammatic perspective view corresponding with figure 1.

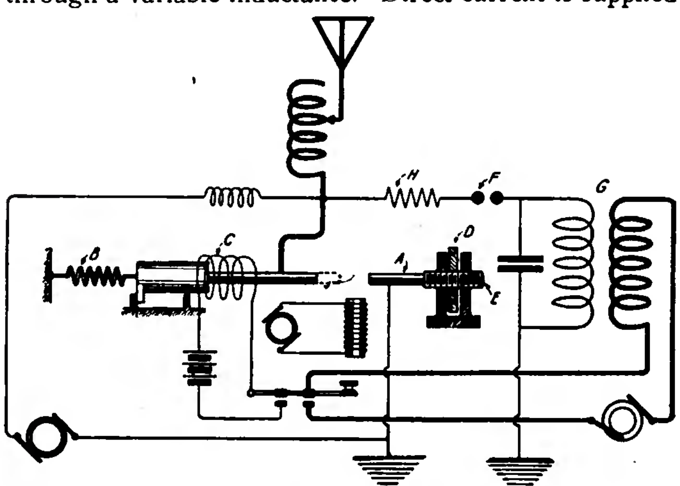
In figures 1 and 3 the two contact stops 1, 1^a, are jointly connected to one side of the tuning condenser the other side of which is connected to the aerial coil or rotatable radiogoniometer coil, the circuit being completed by contact 4 and either of contacts 1, 1^a. The receiver or amplifier is connected in any suitable method as by leads X across the condenser.

In figure 2 a rotatable disk is mounted on a base, provision being made to clamp it in any desired position by means of a clamping screw. A scale marked off in degrees is provided on the base around the disk. Two contact arms G are centrally mounted on the disk and their distance apart is adjustable by means of a left and right hand screw having a central bearing. A contact arm F rigidly connected with the rotatable aerial coil or rotatable radiogoniometer coil and forming one terminal of its winding, is rotatable about the same axis as the disk between the contact stops.

In using such an apparatus as a direction finder, the pointer—and with it the rotatable aerial or radiogoniometer coil—is rotated about the common axis of the apparatus until the pointer is midway between the contact stops. The disk is unclamped and rotated, carrying with it coil, pointer and contact, while the pointer is simultaneously oscillated between contacts 1 and 1^a until a position of the platform is found at which signals are of equal intensity with the pointer in the two limiting positions against the stops 1 and 1^a. If the pointer is then set midway between the stops it will give the direction of the electromagnetic waves producing the signals, and the actual bearing of the transmitting station can be readily ascertained.

Methods of Signaling with an Arc

CONSIDERABLE attention has been given by prominent radio engineers to the problem of controlling the arc generator with nicety at telegraphic speeds. L. F. Fuller discloses still another method of interrupting and re-establishing the arc by varying the length of the arc gap. The drawing printed herewith is a diagrammatic representation of the signaling scheme. The transmission system comprises an arc oscillation generator including the electrodes between which the arc is formed. One of the electrodes, preferably the negative electrode A is grounded and the other is connected to the antenna through a variable inductance. Direct current is supplied



Diagrammatic representation of the signaling scheme

to the arc radio generator by a D. C. generator and the choke coil is arranged in the lead which connects the generator to the negative electrode of the arc. The arc is subjected as usual to a strong transverse magnetic field produced by magnet coils located adjacent to the arc. These coils may either be separately excited or arranged in series with the generator and the negative electrode.

Signaling is accomplished by igniting the arc and subsequently extinguishing it by increasing the distance between the electrodes, the distance being preferably increased by moving one of the electrodes. In operation, the length of the arc gap is increased to such distance that the arc goes out and subsequently the length of the gap is decreased to its proper oscillating arc length and the arc is re-established by a spark or other means. These operations are performed automatically and at telegraphic speed, and signaling is accomplished with a transmission key in the usual manner.

Secured to the negative electrode and insulated therefrom is a solenoid core which is movable in a direction to increase the length of the arc gap by a spring and is movable in the opposite direction by the effect of the current flowing in the solenoid C. The solenoid is arranged in series with a battery and a signaling key, which, when depressed, closes the circuit and causes the negative electrode to be moved to shorten the arc gap to its proper oscillating arc length. An ear projection on the core of the solenoid makes contact with the stop as the core moves forward and stops the electrode so that the proper oscillating arc gap is produced. A second stop halts the electrode on its backward movement. As the electrodes wear, the length of the arc is adjusted to preserve the proper oscillating length by a nut D engaging the screw E, secured to the normally stationary electrode A, the nut being placed between two stops in such a way that the electrode is moved longitudinally by rotation of the nut.

Connected across the arc is a spark circuit containing a spark gap, the secondary of the transformer G and the capacity which shunts the secondary. A stopping resistance H is arranged between the spark gap and the antenna side of the arc to prevent direct current sufficient to maintain an arc across the gap F from following the radio frequency current across the spark gap and passing through the secondary. The primary of the transformer is in series with the alternating current generator and a switch connected to and insulated from the key. When the key is closed the electrodes are brought together and simultaneously the circuit through the primary of the transformer is closed, producing a high potential in the spark circuit and producing a spark across the spark gap which sets up radio frequency surges which ignite the arc. When the key is released, the spring B by virtue of the energy already stored up in it, increases the length of the arc up to that point where it is extinguished.

Improved Oscillator

F. K. VREELAND describes an improvement in electrical oscillators of the vacuum tube or electron relay type, whereby a greatly improved operation is secured, particularly in the matter of purity of the wave form. He has previously described a method and shown apparatus for generating sustained oscillations by utilizing either an electrostatic or an electromagnetic field excited by the oscillations to control the flow of energy in a vacuum tube or other sensitive gap in such a manner that increments of energy are supplied to the oscillating circuit in synchronism with the oscillations. One form of the invention specifically described utilizes "the effect of an electrostatic field upon the discharge of cathode particles in a vacuum tube" as a means of electrically communicating energy in a tube in such manner as to add energy to the oscillating circuit in synchronism with the oscillations.

In recent years great improvements have been made in thermionic tubes, whereby the effect of an electrostatic field set up between the cathode and a third control electrode, or grid, controls in a highly efficient manner the flow of energy between the cathode and the anode. This apparatus is so associated with an oscillating circuit that the oscillations act through the control electrode to produce the electrostatic commutating field and the variations in anode current thus produced supply high energy to the oscillating circuit.

In the vacuum tube oscillator as ordinarily employed today, a three electrode thermionic tube with its appropriate source of direct current energy is coupled to an oscillating circuit with a feed-back connection, whereby the flow of energy through the tube is controlled by the

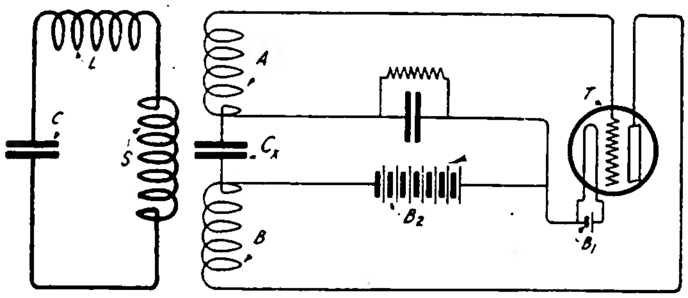


Figure 1—Showing inductive coupling of the oscillating circuit to the generator circuit

oscillations, and energy is supplied to the oscillating circuit in synchronism with the oscillations. Ordinarily the oscillating circuit is directly connected to the thermionic generator tube, the feed-back connection being associated with this circuit in any one of several ways.

The result of this arrangement is an oscillating current whose wave form is very far from sinusoidal. This is due to the fact that the wave form of the energy supplied is not itself sinusoidal, and the disposition and the proportions of the oscillating circuit are such that it is incapable of smoothing out harmonics. As a consequence, when it is desired to secure an approximately pure wave form from such a device it is usual to employ filters or other equivalent devices to sift out overtones.

Vreeland's invention provides means whereby a current wave of great purity may be secured directly without the use of filters or other extraneous apparatus.

An oscillating circuit when fed by a source of energy whose wave form is not sinusoidal will execute approximately pure sinusoidal oscillations only if its inductance and capacity reactances are large with respect to the other impedances of the system with which it is associated. The thermionic tubes ordinarily employed possess, usually, a high and sometimes a very high impedance and it is usually impracticable to construct an oscillating circuit of sufficient reactance to be a "stiff" oscillator when connected directly to such a tube. By means of the present invention it is possible to use an oscillating circuit of moderate capacity and inductance reactance which is nevertheless capable of oscillating with very pure wave form. The requisite stiffness of the oscillating system is secured by coupling the oscillating circuit to the tube and its associated circuits by a stepdown coupling whereby the effective impedances of the tube circuit, as affecting the oscillating circuit, are greatly reduced and the distortions of wave form of the energy supplied are minimized.

In the drawing, figure 1 shows the circuit arrangements of one embodiment of the invention in which the oscillating circuit is coupled to a generator circuit by an inductive coupling. Figure 2 shows an arrangement in which an electrostatic coupling is employed.

In the arrangement of figure 1, T, is a three-electrode thermionic bulb having the usual hot filament with heating battery, anode and grid or control electrode. The tube or generator circuit includes the inductance coils A

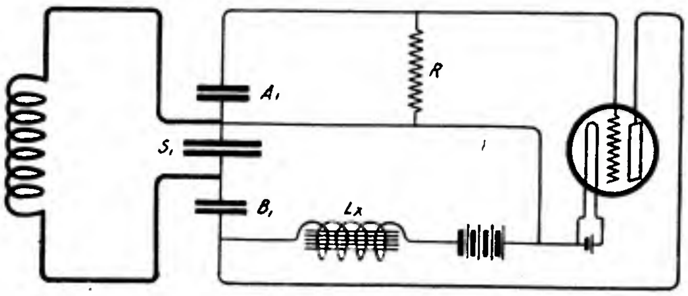


Figure 2—Showing electrostatic coupling

and B, the latter connected to the anode and the former to the grid which by their mutual inductance accomplish the usual feed-back function, the anode and grid being connected to points of opposite potential and the filament to an intermediate point. The generator circuit is completed through a stopping condenser Cx across which the anode battery B-2 is connected.

The oscillating circuit is connected to the generator circuit through inductive coupling of the coils A and B to the secondary coil S, having a relatively small number of turns, whose circuit is closed through the main capacity C and inductance L of the oscillating circuit. The coil S is preferably closely coupled to the coils A and B. By virtue of the step-down action of the transformer A, B and S, the oscillating circuit may be made a stiff oscillator with moderate values of inductance and capacity reactances while the close coupling provides an efficient energy transfer.

By a close coupling is meant a coupling whereby the coil S embraces the major portion of the field of the coils A and B, thus making the generator circuit practically aperiodic and subject to the frequency control of the oscillating circuit. The effect on the oscillating circuit, however, is equivalent to a loose coupling, inasmuch as the inductance of the coil S is small compared to the inductance L. The oscillating circuit is therefore effective in selecting oscillations of its own frequency to the practical exclusion of other frequences, notwithstanding the relatively small absolute values of its reactance while the reactances of the coils A and B may be made comparable to the tube impedances, thereby providing an efficient energy transfer. Figure 2 shows a purely electrostatic coupling. Here the generator circuit includes condensers A-1 and B-1 of reactances comparable to the tube impedance, and a third condenser S-1 of relatively small reactance which serves as a step-down electrostatic coupling between the generator circuit and the oscillating circuit including the coil.

EXPERIMENTERS' WORLD

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

A Laboratory Radiophone

By Allen H. Wood, Jr.

THE amateur of today is fortunately in an advantageous position to build and successfully operate a radiophone. Formerly, inability to buy vacuum tubes and other constructional parts proved a serious handicap to the wireless enthusiast, and rather than go to the necessary trouble of locating and building the various parts of a radiophone, he devoted his time and money to the construction of conventional spark transmitters. Many of the amateurs would gladly have devoted the time and trouble necessary to construct the apparatus, but information was lacking in regard to details. Conditions have so changed that at present, all the necessary material and information for the construction of a wireless telephone is readily obtainable.

The radiophone hook-ups offer three distinct forms of communication: voice, buzzer modulated telegraphy, and continuous wave telegraphy.

It is the aim of this article to give a detailed description of a radiophone embodying the three forms of communication mentioned above. This phone will radiate about .5 of an ampere and with the average antenna will have a speaking range of thirty to forty miles depending upon local circumstances. The telegraphic range of the same set will be much greater in the case of buzzer modulation and still greater when continuous wave radiation is employed.

The various instruments are mounted on a ¼ inch bakelite panel and enclosed in a wooden cabinet. Dimensions of panel and cabinet are omitted as they will vary with personal taste.

Some source of high-potential direct current is necessary, preferably a motor-generator, but vacuum tube-rectified alternating current or storage batteries can be used. Two Western Electric VT2 bulbs should be used if possible, but Marconi Class II tubes may be substituted.

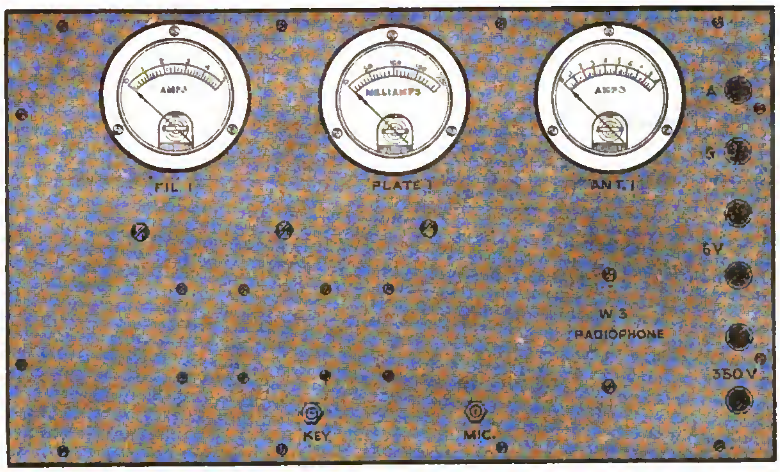


Figure 1—Front view of panel

An antenna condenser is shown in the wiring diagram, figure 3, but this is not necessary if the phone is to be used on one wavelength only. If several wave-lengths are desired, the condenser becomes a necessity. A balanced condenser of .001 mfd. capacity is a satisfactory instrument to use in this position.

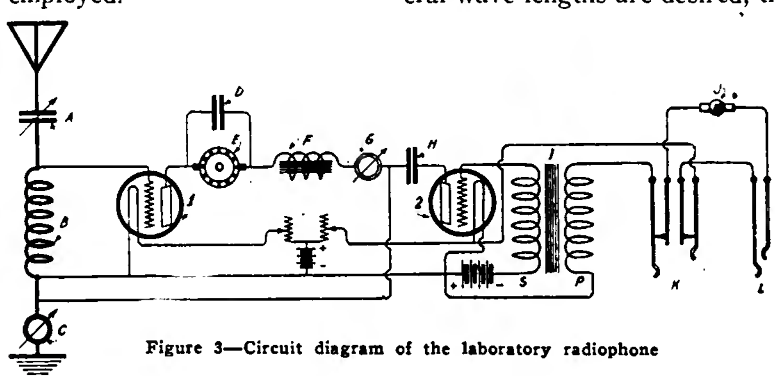


Figure 3—Circuit diagram of the laboratory radiophone

The arrangement of the apparatus can be made according to individual taste, but figure 1 indicates an arrangement which has proven very satisfactory. Whatever design or arrangement is determined upon, keep in mind that the shorter the leads, the better the results.

The antenna inductance is wound on a bakelite tube, 3 inches in diameter, 5 inches long, with ¼ inch walls. Cardboard tubing, soaked in shellac and baked may be substituted if the bakelite tubing is not available. For the average amateur antenna, twenty-eight turns of heavy Litzendraht will be sufficient inductance, to keep the phone below 350 meters. The wire should be spaced 3-16 inch from the adjacent turn. If bakelite tubing is used, a thread can be cut on the outside diameter just deep enough to support the wire. A tap is soldered onto the fourteenth turn, and a lead brought out.

Three meters are used. A hot-wire meter of 0 - 1 amp. range for the antenna current, a milliammeter of 0 - 200 milliamperes for the plate current, and an ammeter 0 - 5 amperes for the filament current. Weston meters are suggested, but any meter with correct ranges and constants may be used.

Two closed core transformers are necessary—the transformer employed in the plate circuit, and the microphone transformer. A complete description of the construction of these coils is given in figure 2.

Two jacks are introduced, one for the microphone, and the other for a key to be used with the buzzer modulation. If undamped telegraphy is also desired, a condenser of .0005 mfd. capacity should be inserted between the grid and the antenna inductance, and shunted by a key. When the key is open, the tube is paralyzed by the negative charges on the grid and will stop oscillating. As soon as the key is depressed, the negative charge is dispelled, and the tube is at liberty to function again. If this condenser and key are used, it is well to keep in mind that while using the microphone or buzzer modulation, the condenser in the grid circuit should be shunted, either by a small switch, or by screwing the key down.

A battery of about 20 volts potential is placed in series with the secondary of the microphone transformer in cut in the cabinet. This will help to disperse the heat and also give the operator access to the bulbs in case a change is necessary.

A six-volt storage battery is used to light the filaments and supply the microphone current. Filament rheostats are unnecessary, but if their use is desired, it is advisable to use 8 or 10 volts instead of six.

All connections should be made of upon. In nearly every instance where two tubes are used, one will be found to be the better oscillator.

If for some reason everything seems to be dead, check up wiring and polarities again. Another cause of failure to oscillate is due to not enough filament brilliancy. Sometimes .1 ampere difference in the filament current marks the dividing point between success and failure to oscillate.

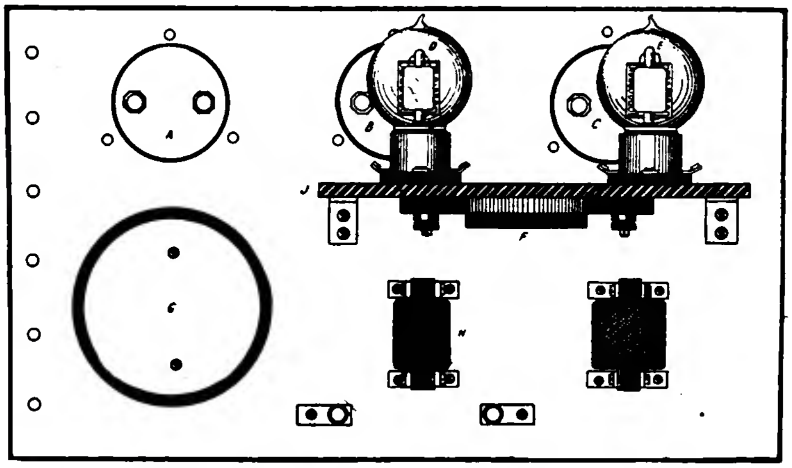


Figure 1—Rear view of panel showing location of instruments

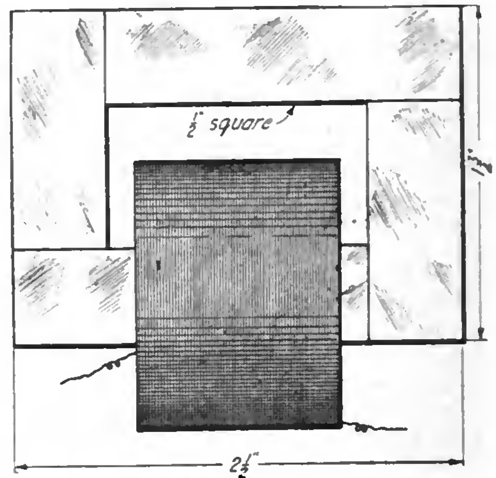


Figure 2—Dimensions and construction of coils

order to keep the curve of the modulator bulb at a proper point to prevent modulator-blocking and resultant speech distortion. The polarity of this battery is important, and extreme care should be taken that the negative side is connected to the transformer and thence to the grid of the modulator tube. Any one of the numerous block B batteries of 22.5 volts potential on the market can be used.

The condenser used in the plate circuit, indicated on the wiring diagram as H, should be constructed of mica and copper foil, mounted between two strips of bakelite. The capacity is .01 mfd. This condenser is a standard size and can be obtained from any dealer of radio supplies.

The tube sockets should be fastened to a bakelite shelf and mounted in the rear of the panel. Two holes or a small door directly over the tubes should be No. 16 bare copper wire covered with rubber or cambric tubing, and all joints should be securely soldered.

When the set is completed and ready for trial, shunt a condenser of about .001 mfd. across the antenna and ground leads. As the resistance of this condenser is low, this will serve to test the phone and will allow the operator to see whether his set is functioning properly before it is connected to the antenna.

When the bulbs are lit, the radiation meter should indicate about .8 amperes when the plate current is 100 milliamperes, and the filament meter indicates about 2.9 amperes. Plate current in excess of 100 milliamperes is apt to prove disastrous to the bulbs and consequently the current should not be allowed to go beyond that point.

Change the tubes back and forth until the best oscillator is determined

When the operator has satisfied himself that the phone is functioning correctly, the condenser is removed and antenna and ground substituted. The radiation drops to between .4 — .5 due to the increased resistance.

Good modulation is indicated by a slight falling off of the antenna current while speaking into the microphone.

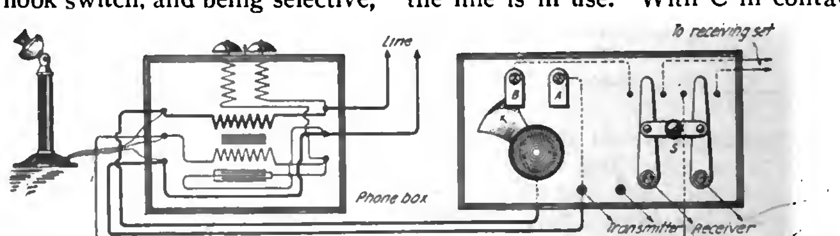
When a buzzer is used, reduce the plate voltage and filament current, as the buzzer will cause a heavier plate current to be drawn than will the microphone.

A radiophone similar to the one described above has been in use for six months and has given unfailing performance and satisfaction, and it is to be hoped that we will hear many more phones in operation when the radio season opens again next fall.

A Telephone Extension

By Eugene S. Pearl

A GREAT many amateurs, whose radio rooms are located at a distance from the Bell telephone installed in their homes, would greatly appreciate an extension telephone at their wireless table, which would enable them to answer a phone call from their radio rooms, instead of having to leave while communicating with some amateur by radio. By referring to the diagram, an arrangement is shown which will accomplish this object. The upper part shows the regular phone box with its desk telephone; the lower part shows the addition to be made. The switch "S" is an ordinary pole changing switch that is used to connect the headphones with either the detector or telephone circuit. The switch C takes the place of the telephone hook switch, and being selective,

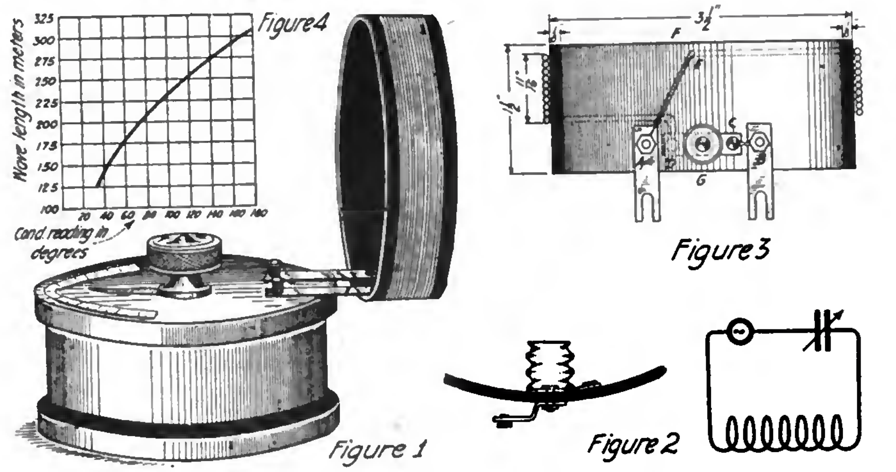


it enables the wireless operator to obtain several combinations not possible with the regular telephone.

With switch-blade C in contact with B the headphones will be in circuit, causing no indication at central, thus permitting the operator to hear when the line is in use. With C in contact with A and B there is a regular telephone circuit. With C in contact with A alone the transmitter is in circuit alone.

An Efficient Wavemeter

By E. Singer



Constructional detail and graphic chart

THE instrument herein described is a wavemeter of simple construction, consisting of an inductance in series with a capacity and an indicating device as shown in the diagram.

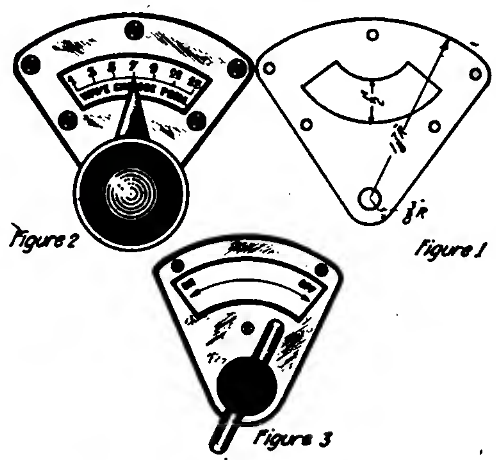
The capacity used is a Murdock 23-plate condenser. The inductance consists of 20 turns of No. 20 double silk covered wire wound on a piece of tubing whose outside diameter is 3½ inches. The length of the tubing is 1½ inches, with the winding starting at ⅛ inch from edge F. The end of the winding goes through a small hole at E and terminates on the brass strip A. The other end of the winding terminates on the outside of the tubing on the lug of the socket marked D. The dotted double line represents the two ends of the winding. The line running from E to A and from C to B are wires on the inside of the tubing.

The strips A and B are made of brass 1/16 inch thick, 1½ inches long and ½ inch wide. They are held to the tubing by 6/32 screws ¼ inch from edge G. The strips are connected to the tubing directly opposite the binding posts on the condenser, as shown in the photograph or sketch.

The indicating device consists of a receptacle for a miniature lamp with the porcelain portion removed and the socket proper mounted on the tubing as shown in figure 2. The center contact screw holds the socket to the tubing. The lamp used is a 2.5 volt Mazda lamp. The socket is mounted midway between the two strips. The wire CB connects lug C with strip B. The coil was given one coating of shellac after it had been wound.

Indicator Mounting

By D. R. Clemons



Dimensions and construction of the indicator mounting

IN the designing and construction of panel and cabinet types of radio instruments it is necessary that scales or other position indicators be used with the controls. Stamped lettering is not easily provided where the equipment is limited. Neither do scales or dials always apply to the position given them. When made to order they are too costly.

Recently a number of calibration and position indicators were desired. They were to be of uniform dimensions and design, yet having indicating lettering and directions each different from the other. By using uniform mountings and placing suitable indicators back of them, a very attractive arrangement was secured.

In the following figures the hard rubber plates were cut from discarded battery jars. After laying off the design on a piece of rubber, the opening was removed by drilling small holes within it, breaking out the piece and sandpapering the edges. Screw holes were drilled after the plate was grained by stroking it across coarse sand paper.

For each plate a piece of celluloid was cut to the same outside dimensions as the plate. With drawing instruments the scales and lettering was drawn within a space corresponding in size to the opening—heavy opaque drawing paper being used. The celluloid lies between the scale and the rubber plate all three being screwed to the panel front as shown in figures 2 and 3. The celluloid protects the lettering. It really is a small window. Such mountings function and appear well with the instrument. Three different patterns are shown in the drawings.

Second District Call Letters of Amateur Stations

(*Continued from July* WIRELESS AGE)

Letters.	Power.	Name and address.
2SA	21	J. P. Holder, 467½ Quincy St., Brooklyn.
2SC	50	Jos. J. Stantley, 1 Hampton Court Ter., Jersey City, N. J.
2SD	50	O. Dickinson, Albertson St., Hyde Park, N, Y.
2SE	500	Chas. P. Van Duzer, 34 Marion Ave., Tompkinsville, N. Y.
2SF	36	Alan S. Kollock, 9133 120th St., Richmond Hill, N. Y.
2SG	90	Fred T. May, 143 High St., Montclair, N. J.
2SH	500	H. S. Schanck, 92 Main St., Keyport, N. J.
2SI	50	E. F. Pfluger, 682 East 233d St., New York City.
2SJ	36	K. W. Schlitz, 28 Jefferson St., Brooklyn.
2SL	12	Barnet Trotsky, 308 West 147th St., New York City.
2SN	1000	N. C. Cowper, 454 Merrick Rd., Lynbrook, N. Y.
2SO	400	J. E. Johnston, 1379 Clay Ave., New York City.
2SP	600	G. Bleilevens, 318 33d St., Woodcliff on Hudson, N. J.
2SR	490	R. I. Gratzner, 802 West 181st St., New York City.
2SS	300	G. E. Burghard, 1 East 93d St., New York City.
2 SU	440	G. Fink, 315 Lenox Rd., Brooklyn.
2SV	250	J. DeJonge, 218 DeMott Ave., Clifton, N. J.
2SW	250	S. P. Suffin, 1412 Charlotte St., New York City.
2SX	50	Geo. H. Sutton, 323 Crooks Ave., Paterson, N. J.
2SY	30	H. Wm. Muller, 203 East 71st St., New York City.
2SZ	1000	J. D. MacKnight, Y. M. C. A., 1st St., Troy, N. Y.
2TA	24	F. Grunaller, 873 Broadway, Brooklyn, N. Y.
2TC	90	J. B. Milkiewitz, 876 East 179th St., New York City.
2TD	50	T. M. Dugan, 14 Elm Pl., Red Bank, N. J.
2TE	440	Victor H. Bentzig, 165 Woodmere Pl., Richmond Hill, N. Y.
2TF	1000	G. E. Franklin, 1 Cherry St., Schenectady, N. Y.
2TG	485	G. K. Thompson, 139 Maplewood Ave., Maplewood, N. J.
2TH	50	Thos. F. Hunter, 599 Monroe Ave., Elizabeth, N. J.
2TI	25	Jas. A. Francis, 133 Bank St., Newark, N. J.
2TJ	1000	J. P. Thornton, 922 Central Ave., Westfield, N. J.
2TK	1000	R. Frank, 271 Palisade Ave., Union Hill, N. J.
2TM	250	J. Mindick, 158 Columbia Ave., Newark, N. J.
2TN	12	L. P. Hanser, 1477 Bushwick Ave., Brooklyn, N. Y.
2TO	500	R. S. Otto, 730 Sherman Ave., Plainfield, N. J.
2TP	1000	H. G. Mustermann, 112 Morgan St., Union, N. J.
2TS	250	T. E. Schreyer, 72 Ridgewood Pl., Staten Island, N. Y.
2TT	12	A. Rechert, 181 Waverly Pl., New York City.
2TU	50	H. A. Kienzle, 501 East 84th St., New York City.
2TW	500	J. M. Sackheim, 516 West 174th St., New York City.
2TX	50	J. P. McClary, 88 Front St., Keyport, N. J.
2UA	800	R. W. E. Decker, 7 Odell Ave., White Plains, N. Y.
2UB	500	J. A. Bergner, 1421 East 10th St., Brooklyn, N. Y.
2UC	500	C. B. Urban, 515 St. Marks Ave., Westfield, N. J.
2UD	1000	Uda B. Ross, 586 West 187th St., New York City.
2UE	440	J. A. Erhard, 311 Maple St., West Hoboken, N. J.
2UG	1000	L. E. Bonduaux, 924 East 169th St., New York City.
2UH	18	H. L. Bock, 252 West 149th St., New York City.
2UI	100	Harold J. Illich, 715 Tilden St., Williamsbridge, N. Y. C.
2UJ	550	A. H. Knights, 862 Hewitt Pl., New York City.
2UL	50	C. L. Wood, 305 Willow Ave., Lyndhurst, N. J.

The Construction of a Portable Antenna Suitable for Use in Vacation Days

By F. C. Brockman

(FIRST PRIZE, $10.00)

THE antenna equipment described here is simple, easily erected and light enough to be carried by one person. It consists of two masts, each 21 feet high, a single wire antenna 75 feet long, a counterpoise of the same length, and four reels for the antenna, counterpoise, and guy ropes. The principal dimensions are given for those who wish to follow them. Minor dimensions are omitted as the amateur usually has a stock of odd parts which he can contrive to use.

Figure 1 shows the construction of a mast section. It is made of spruce, poplar, white pine, or some other available light wood of sufficient strength. Its length is 7 feet, which is convenient. Longer sections become cumbersome, while shorter sections require more joints, which often introduce weakness if improperly made. A 6" piece of 1⅜" O.D. by 1¼" I.D. seamless steel or brass tubing is shown at b. It is pinned to the mast by an iron or brass pin of ⅛ to ¼" diameter as at e. Provide three 5/16" holes, d, spaced 120 degrees apart and with their centers ⅜" from the open end of the tube. These holes receive the hooks on the ends of the antenna and guy ropes. A 3" piece of standard size tubing 1¼" O.D. by 1⅛" I.D. shown at a, can readily be purchased. Take a light cut off the smaller tube to make it fit into the larger one snugly. This had better be done in a lathe if one be available, otherwise it can be worked down with emery cloth. Force the tube onto the end of the section, drill diametrically and countersink for a pin, c, made of iron or brass wire about ⅛ to ¼" in diameter. Rivet the ends of the pin and file flush with the tube. Paint the section an olive drab color, leaving the inside of the large tube and the outside of the small tube clear. If they are of steel give them a thin coat of oil occasionally to prevent rust.

Make six such sections and you will have two masts each 21' high. They are all alike and therefore interchangeable, which facilitates erection. The sections are carried in one bundle. Procure a double book strap or bundle carrier having a suitcase handle and straps fitted with spring buckles. Use this in the middle of the bundle and one single book strap with spring buckle near each end. By using additional straps the four reels and the stakes may be attached to the masts and the whole outfit carried by one person.

Figure 2 shows the construction of the antenna and insulators. A harness hook or snap hook which will fit into the holes d in the tube b of figure 1 is shown at a. Six of these hooks are required, two for the antenna and four for the guys. An insulator, b, is made preferably of XX black dilecto, 3/16 by ⅜", although hard rubber will do as the strain is not very great. Links, c, are made of No. 9 iron wire bent into U-shapes with the curved part of sufficient diameter to work easily in the eye of the hook a, and with the ends flattened. Four of these links are needed. Clamp one end of an insulator between the ends of a link, with a hook in place, drill two holes and rivet together with iron, brass, or copper wire about 1/16 to ⅛" diameter as at d. Do likewise with one end of the other insulator. Rivet the other two links to the remaining ends of the insulators.

For the aerial wire secure 75' of No. 18 lamp cord, although bare stranded wire of the same size will be considerably lighter. Loop the ends through the links on the insulators as at e, figure 2; twist them back on the main wire and solder, using a rosin and alcohol flux, as acid fluxes will soon eat through the strands and cause a break. Secure a 25' piece of the same flexible wire, loop one end through one insulator link as at f, figure 2, twist back on the lead and also around the aerial wire and solder. Good soldering is essential as the energy handled is small and none must be lost in bad joints. Solder a spade terminal such as is used on automobile ignition cables to the free end of the lead for connection to the instruments. The aerial wire is now complete with its insulators, down-lead, and hooks for securing to the masts.

The counterpoise is shown in figure 4. It consists of 75' of automobile ignition cable or some other flexible stranded cable with heavy rubber insulation. Solder a spade terminal to one end and double the other end back for about one foot and tape securely so as to insulate it.

Figure 5 shows a guy rope. It is made of 30' of 3/16" braided shade cord. One end is tied to a harness hook, a, the other is looped through a 3" tent slide, c, by means of which the guy may be made taut. If tent slides cannot be obtained, a piece of hard wood 3" long, ½" by 1" in section, and fitted with two ¼" holes 2" apart may be used, or an ordinary cord tightener as used on a drop light will do very nicely. Four of these guy ropes are needed.

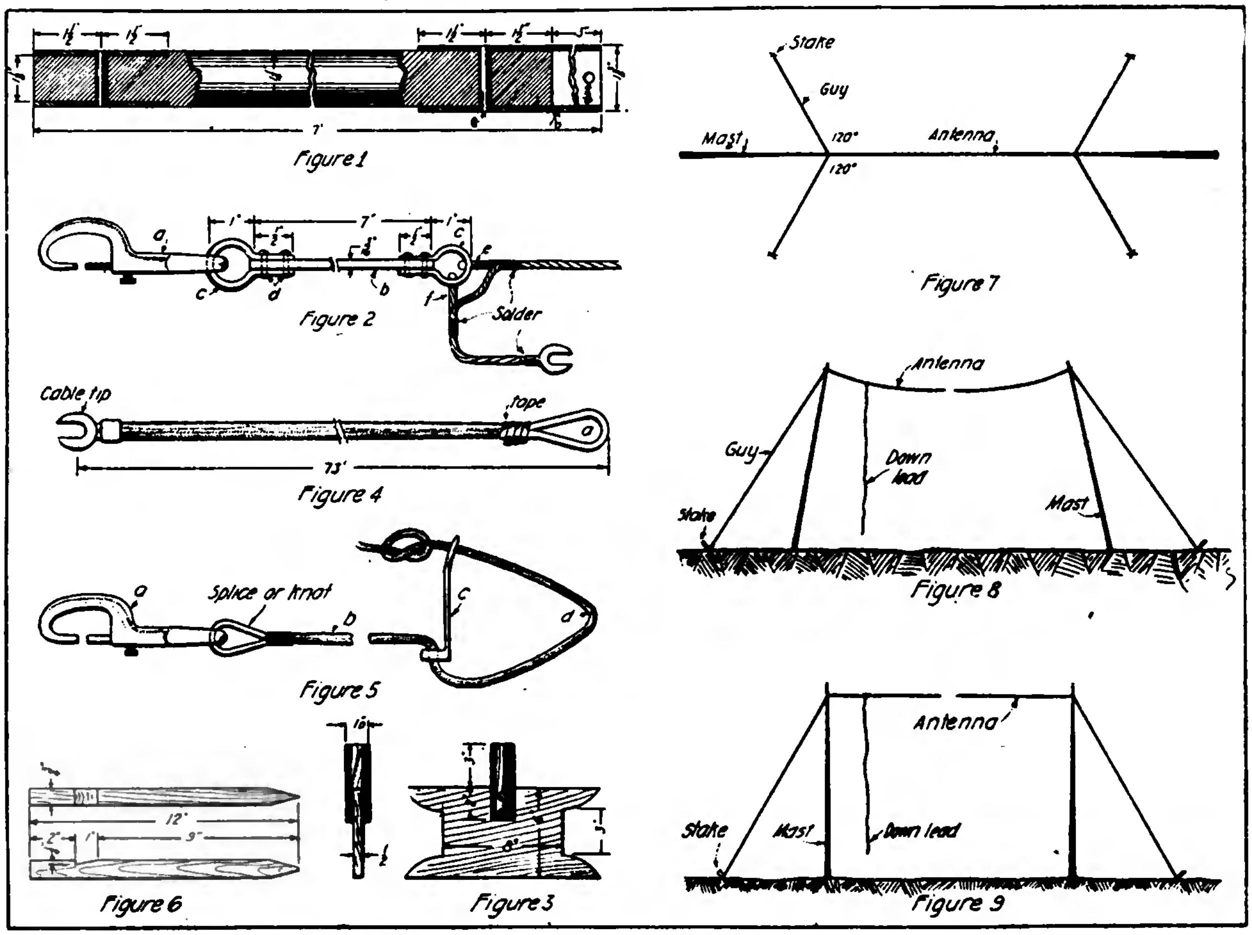
Figure 6 shows the stakes to which the guy ropes are fastened. They should be of hard wood. The loop of the rope is hooked under the notch to prevent its slipping off the end of the stake.

Figure 3 shows the reel. One carries the antenna, another the counterpoise, a third carries one pair of guy ropes, and the fourth carries the other pair of guys. The reels are made of ½" hard wood as shown in the figure.

One person can very easily erect this antenna, although two or more can, of course, do it more quickly. First choose a suitable place, reel out the antenna so that the free end points away from the station with which communication is to be carried on, and find two points about ten to fifteen feet from the ends of the antenna, and on lines which make approximately 120 degree angles with it and drive stakes leaning away from the antenna. Then lay three mast sections at each end of the antenna with their bases pointing away from it. Join them together, hook the antenna and two guys into the holes in the topmost sections and loop the other ends of the guys over the stakes. Grasp the mast a little below the middle and raise it till it stands at an angle, leaning towards the antenna. Repeat this with the other mast. Then take up on the guy ropes and adjust the position of the masts till they are vertical.

Figure 7 shows diagrammatically the parts laid on the ground. Figure 8 shows the masts leaning against the guy ropes. Figure 9 shows the antenna erected.

Set up the apparatus near the down-lead, reel out the counterpoise, laying it under the antenna. Loop the far end under the mast to keep it stretched out and running parallel to the antenna.



Views showing construction and method of erecting the portable antenna

The Construction of a Portable Antenna

By A. Hazleton Rice, Jr.
(SECOND PRIZE, $5.00)

THE camper of today takes the marks of civilization with him wherever he may go. He wants to keep in touch with the world no matter how far from its centers of civilization he may roam, and he turns to science for the gratification of this whim.

Through the development of radio telegraphy and telephony during the war, the seemingly impossible has not only been accomplished, but has become routine in operation, making it entirely feasible for the camper to include in his list of necessities a well designed radio outfit.

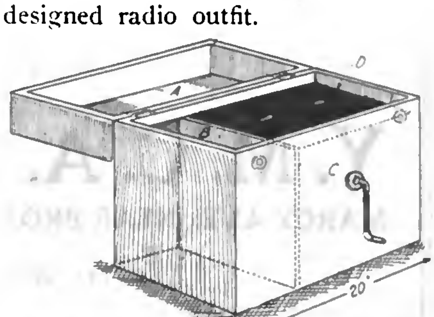


Figure 1—Exterior view of the carrying case

A radio station, to be of any value on a camping trip must be light in weight, efficient in operation, and easily moved from place to place. All of these characteristics are largely dependent upon the antenna, which must be portable, if it is to meet the requirements of the most exacting amateur. The antenna which will now be described is easily carried about, can be raised or reeled in without much difficulty, and incidentally may be so designed as to include the receiving set as well.

Supports are dispensed with, for at best they are cumbersome affairs on a canoe trip or when it becomes necessary to pack everything on one's back.

The most desirable method of suspending a portable antenna, then, is from a natural support, such as the limb of a tree, the roof of a house, or, as will probably be the case, between two trees the right distance apart.

The dimensions given, therefore, are suggestive only, as the requirements of the individual will vary greatly.

The carrying case should be built of ½" oak or birch, as shown in figure 1. The cover should be hinged at the

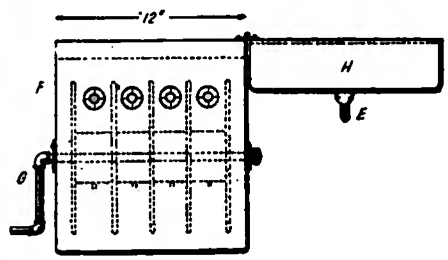


Figure 2—Interior diagram of carrying case showing drums

back and two hooks and screw eyes are used to keep it securely closed when it is being carried about. The case, when completed, should be stained some dark color; fumed oak is perhaps the best in appearance and durability.

A comfortable leather handle should be fastened securely to the cover.

Several wooden drums 3½" in diameter by 2" long and a number of flanges of ½" stock and of proper diameter should then be turned out on the lathe. The number will depend entirely upon the number of wires to be used in the aerial and the diameter of the flanges. Litz wire is the most flexible and will reduce the size of the carrying case materially; the so-called "Belden" cable and lamp cord, although flexible, are much more bulky. When the wire to be used has been decided upon, 100 feet should be purchased and reeled up roughly on a spool having a diameter of about 3½" and 2" in length. In this way an estimate of the size of the flanges required may be made.

By actual experiment, two wires have been found to be as efficient as four for receiving, and the reader is advised not to carry more than this number for his antenna, each of which should be 100 feet in length. This length will give the antenna a fundamental wave length suitable for 200 to 800 meter work.

In addition to these, a 60-foot length of wire is required as the lead-in. This length should prove ample for all practical requirements.

If a two-wire aerial is decided upon, three drums will be required for the wire alone, together with the necessary flanges to keep each in its proper place.

In addition to this a fourth drum, of the same size, is necessary upon which to wind the hoisting "rope" which, in order to persist in our policy of flexibility, may consist of a heavy linen "fish" line such as is used for big game fish. A 100-yard length is necessary and it should be cut into two 150-foot lengths and reeled onto the drum at the same time. These lengths will allow a maximum height for the antenna of 75 feet, which is more than ample; the average being about 40 feet.

After the flanges and drums have

been turned out they should be carefully drilled through their centers to fit a ½" brass pipe which is to be used as the arbor. The arbor should be sufficiently long to extend through the front and back of the carrying case and a sufficient number of threads should be turned on each end to enable the drums to be tightened so as to prevent rotation by the use of large nuts and washers. A pipe cap should be screwed on the arbor at the rear and two brass elbows and short lengths of pipe may be screwed on at the front as shown to form a very rugged handle. Brass pipe flanges of suitable size may be used as the bearings and should be screwed securely to the outside of the carrying case.

Similar flanges may also be used as guides for the wire and ropes when reeling and unreeling, but they should be carefully smoothed up on the inside with a round file and emery paper. They may then be screwed to the end of the case; the center of each being about opposite the center of its respective drum and on a level with the maximum height of the coils.

Each end of each antenna wire should be provided with a "snap" hook which makes it an easy matter to fasten them to screw eyes in the spreaders. These hooks should be tied to the wire by use of the familiar bowline knot. Screw eyes should also be fastened to each drum on the reel so that when being reeled up the wires may be merely inserted through the "portholes" from the outside and snapped onto the drums.

The lead-in wire should have a tap securely spliced and soldered at about 3 feet from the end, and securely soldered on each branch is a clamp like those used on transmitting helices.

Each spreader, when extended, allows for a span of 3 feet between wires, and should be of sufficient diameter to withstand the strain. One inch square, straight grained material is suggested. Each half of each spreader is 18½" long, and the two halves should be hinged. When extended, two pieces of strap iron may be bolted opposite the hinges to main-

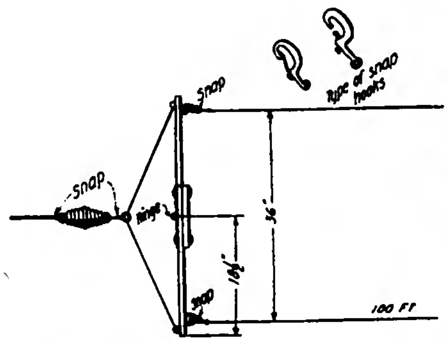


Figure 3—Antenna construction and rigging

tain rigidity. In folding the spreaders, however, it should only be necessary to remove one bolt. A screw eye should be fastened to each end of the spreaders, both front and back.

With the addition of short lengths of line fastened at each end of the spreaders and two electrose ball insulators the antenna is now complete and ready for erection.

This is easily accomplished. A desirable spot is chosen; preferably a place having but a few trees with branches well above the ground. Ropes and wires are then unreeled and unfastened. Each rope is fastened to an insulator which, when used as a weight, can be slung a considerable height. There is usually a good tree climber in the party, in which case the problem is much more easily solved. After the ropes have been thrown over their respective supports the spreaders are fastened to the insulators; the antenna wires bared at one end; the lead-in wires clamped on; the antenna wires snapped into the screw eyes on the spreaders and we hoist away. Reference to the drawings will undoubtedly make it all clear.

A word on "grounds" may not be amiss, for portable aerials and portable grounds usually go hand in hand, and the one is as essential as the other.

Don't drive a short iron pipe into the ground and expect results. You won't get them.

If the experimenter is on a canoe trip, his one best bet for a ground will be in the water; a roll of chicken wire has been known to give excellent results when placed under water. Two additional lengths of wire may also be laid upon the ground directly underneath the antenna wires, thus acting as a counterpoise, and will give good results. By the addition of two more drums to the reel, these wires may be carried without inconvenience.

As shown in the drawing, the receiving set may be conveniently mounted on bakelite or hard rubber and fastened to the inside of the cover of the carrying case.

The ability to literally take your radio friends into the woods with you will more than repay you for time and labor expended in the construction of this little outfit.

Portable Mast

By C. R. Leutz

(THIRD PRIZE, $3.00)

THE following described portable mast was designed for Boy Scout use and was very successful in practice, although it required four men to erect it. However, a mast fifty-five feet high could not be expected to be raised quickly without four men.

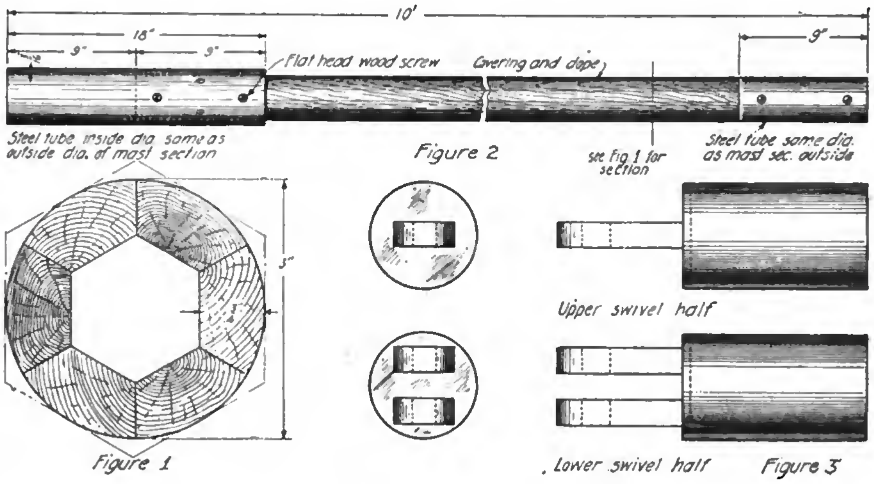
It was decided that one large mast would be a better proposition than two small masts both from the point of bulk and from the standpoint of operation in service and the weight to erect. The type thought of was a built up hollow mast. A model mast was constructed and found very satisfactory and a large type was then planned in accordance with the model.

The height decided upon was fifty-five feet. An umbrella antenna at this height was suitable for 200-meter transmission and reception and also suitable to string a large antenna to some high surrounding point for long distance long wave reception. Out of the fifty-five feet, this mast was divided into five sections, four ten-foot and one fifteen foot.

In the selection of the wood a strong light wood is most desirable, say clear spruce, poplar, basswood or whitewood. Figure 1 shows the cross section of one mast section, the lower fifteen-foot piece. This is built up of six pieces of wood that have previously been cut and planed in accordance with a template laid out on paper. The most successful manner to build these strips would be on a buss-planer if available, otherwise careful hand planing will have to be done.

Four or five octagonal shaped pieces the size of the inside diameter of the mast are cut to allow the six pieces to be assembled without falling apart. Gluing is done immediately with the best grade of flake fish glue. This glue is bought in sheets and should be cracked up and boiled in water to a consistency where it drops slowly on the end of a stick after dipping. After setting twenty-four hours the portion shown in dotted lines should be turned off in a lathe or planed off by hand, to approximate a circle. The pole may then be varnished or, first, preferably, covered with a layer of airplane linen and varnished at the same time. Valspar varnish will be found entirely satisfactory.

Figure 2 shows the middle section (one of four) fully assembled. Notice that on one end, the wood has been turned down 3/16" and 9" back and a piece of steel tube driven on and held with countersunk wood screws. At the other end, a larger piece of steel tube is slipped over the outside of the mast section and held there with wood screws. Nine inches protrude beyond the end of the section to receive the opposite end of the following section. Considerable trouble in making each section somewhat smaller than the next higher section will be experienced, but it is worth while if one has the time.



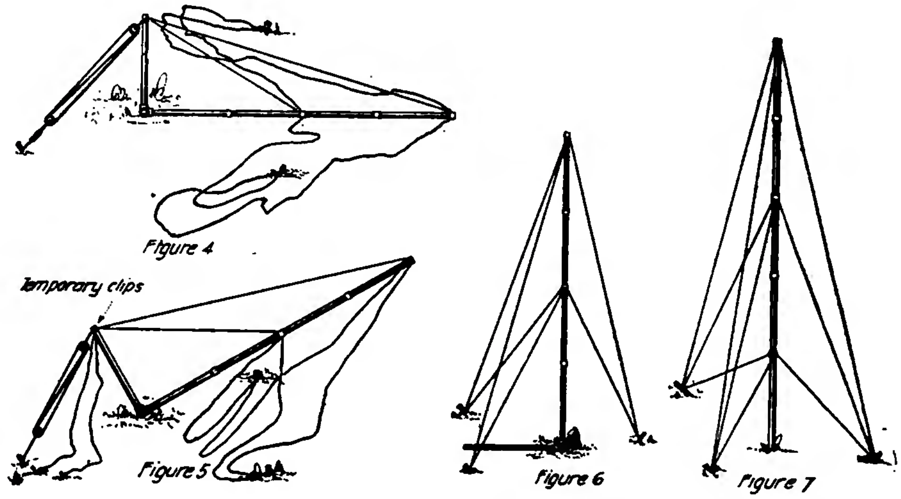
Construction and dimensions of the hollow wooden mast

Tube fittings are not made for the joint between the last ten-foot length and the first fifteen-foot section, as a swivel joint is placed there in accordance with the sketch, figure 3. This consists of two iron castings to fit over the end of the first fifteen-foot section and the joining ten-foot section. The purpose of this section is obvious when studying the sketches.

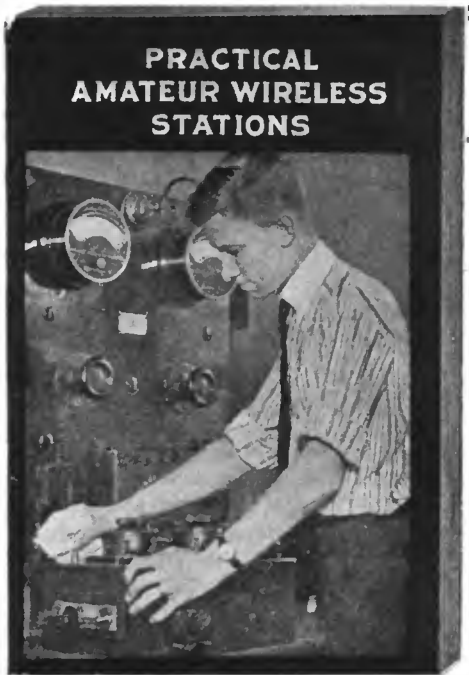
Now, having the mast sections, tube fittings and swivel joint all complete, there remains the guy wires and other accessories to lay out. At the top of the mast, twenty feet down and just above the swivel, an iron band should be placed around the mast and fastened to prevent slipping. Holes should be provided to fasten guy wires, which are, of course, the antenna wires as well. The guy wire lengths can be calculated and cut exactly to the required size. They should not reach to the ground, as there is an insulator and piece of rope at the end of each guy, as shown in the sketch. Four iron stakes with loose rings should be made, three for guys and one for the erection operation.

The four ten-foot sections are first placed in each other at the joints and laid out along a smooth stretch of land. The top and middle guy on one corner of the triangle is fastened at the temporary clips that hold the fifteen-foot section at right angles to the four ten-foot sections. A pulley is fastened on the top of the fifteen-foot section and this is used as a gin pole. The other sets of guys (two) are run out along the side of the pole to the stakes, their position being measured. The rope running to the pulley is then taken to another iron stake and the mast is ready for the first hoisting operation.

One man holds the left side guys and one man holds the right side guys while two men pull on the pulley running to the gin pole. The mast may buckle slightly but can be raised without difficulty. After the gin pole is pulled to within twenty degrees or so of the ground, the pole can be pushed to the ground. While one man is at one of the three sets of guys feeding out as required, a fourth man, or two, if available, should lift the fifteen-foot section up from the ground to a vertical position. There are three guys at the swivel joint, and once the mast is raised above the forty-five degree position considerable assistance can be given by pulling on the guys.



Method of erecting the antenna mast



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Prize Contest Announcement

The subject for the new prize contest of our year-round series is:

"CRYSTAL DETECTOR SETS FOR USE WITH INDOOR AND OUTDOOR ANTENNAE"

Closing date, October 1, 1920.

Contestants are requested to submit articles at the earliest practicable date.

Prize Winning Articles Will Appear in the December Issue.

During the winter months thousands of new amateurs will be setting up small sets and listening-in while many who have been among us for years will once more bring their old reliable crystal detector into use. We should like to hear something new in crystal detector design and hook-up. Here is an opportunity for you to help out the newcomer as well as the oldtimer.

PRIZE CONTEST CONDITIONS—Manuscripts on the subject announced above are judged by the Editors of THE WIRELESS AGE from the viewpoint of the ingeniousness of the idea presented, its practicability and general utility, originality, and clearness in the description. Literary ability is not needed, but neatness in manuscript and drawing is taken into account. Finished drawings are not required, sketches will do. The contest is open to everybody. The closing date is given in the above announcement. THE WIRELESS AGE will award the following prizes: First Prize, $10.00; Second Prize, $5.00; Third Prize, $3.00, *in addition to the regular space rates paid for technical articles.*

All manuscripts should be addressed to the Contest Editor of THE WIRELESS AGE

The guys are all the right length, and fastened to the insulators. The slack taken up by the ropes running from the other side of the insulator to the iron stakes make the mast vertical. This may seem like a difficult proposition, but if the mast is constructed properly, the total weight is only about forty pounds from the swivel joint up and can easily be lifted as described and in a surprisingly short time.

During experiments, four men raised a mast of this type completely in twelve minutes, and started to receive signals and then dismantled the mast and was under way in seven minutes.

Three upper sections were strapped together for one man, and one ten-foot mast and the lower mast strapped together for the second man. The third man carried the iron stakes, pulleys and rope and storage battery and the last man carried the apparatus. Surprising results were had when the mast was erected on top of high hills clear of surrounding countries.

The Monthly Service Bulletin of the

National Amateur Wireless Association

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

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Chicago Amateurs' Annual Report

CHICAGO now has 262 amateur radio stations, according to the annual report made to Washington by Charles C. Kolster, United States radio inspector for the Chicago district, and for the first time in the history of the local radio station the number of commercial radio operators seeking jobs exceeds the vacancies.

Until a month ago commercial operators were in demand, the vacancies outnumbering the applicants by fifteen. However, during the past month, twenty-eight applicants successfully passed the government examination, a number of whom have since been placed in positions.

Since October 1, 1919, when the government ban on amateur radio stations effective during the war was raised, 872 stations have been opened in the Chicago district, which takes in Illinois and eleven neighboring states.

While Chicago, St. Louis and Kansas City, all in this district, are well represented among the amateurs, the smaller cities and rural districts have their share of radio fans. Boys from all parts of the state and even from neighboring states come into Chicago to take the examination, not waiting for the time when examinations will be given near their homes.

There is no enthusiast like the radio fan. Their cheapest equipment costs about $250, and in some cases their plants represent an investment of several thousand dollars. Right now there would be double the number of amateurs in the district if the apparatus were obtainable. Manufacturers report that they are as far as eight months behind in filling orders.

In order to pass the examination as amateurs, applicants must have a thorough knowledge of their equipment, know the regulations pertaining to national and international radio traffic, and be able to receive at least twenty words a minute in the code test.

Out of 533 taking the examination as commercial operators, since Oct. 1, 1919, only 228 were successful. The majority of the amateur stations can transmit messages only a few hundred miles. However, several in the district are known to have sent messages as far as Washington and intercepted messages at greater distances.

Honeycomb Inductance Coil Mounting

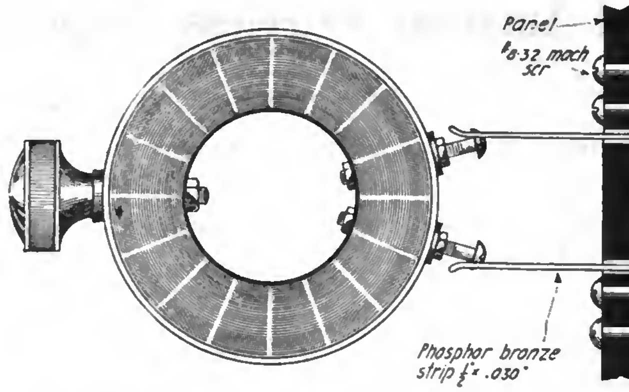
By Clyde J. Fitch

IN a recent issue of The Wireless Age I described the construction and mounting of honeycomb inductance coils. Since then I contrived the mounting shown in the accompanying drawing, which is so simple and easy to construct, that it should be preferred by experimenters. I have used this mounting and it works satisfactorily.

After the coil is wound and removed from the arbor, the holes for the brass machine screws are made by forcing round pointed wooden pegs, slightly larger than the machine screws, through the winding. The winding is then given a thick coat of orange shellac and baked till it is thoroughly dry. It will be thoroughly dry when all the odor has disappeared. The wooden pegs can now be removed and the machine screws inserted, using a fiber washer on each side of the winding. The two ends of the winding are each connected to a machine screw. The coil can now be inserted in the clips as shown in the drawing, the head of the machine screws snapping into the holes in the clips. This allows the coil to swing sideways, which will vary the coupling between two or more coils mounted side by side.

The hard rubber knob may or may

not be used depending upon the fancy of the builder. It will help to overcome the capacity effect due to the nearness of the operator's hand when the regenerative circuit is used, which is not exactly a disadvantage, as tuning is accomplished with the variable condensers alone.



Construction of the honeycomb inductance coil mounting

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed. Positively no Questions Answered by Mail.

G. H. C., Wisconsin:

The only improvement we can suggest is to get a vacuum tube and use standard diagrams with regenerative connection. Your apparatus appears to be O. K. but it is not sensitive enough to receive long distance stations, or weak signals which amounts to the same thing.

* * *

C. M. G., Missouri:

1. In order to give you the exact size of the condenser for a one half kilowatt set it is necessary to know the frequency of the supply line, the secondary voltage of the transformer and the number of studs and speed of the rotary gap.

2. QSA means: Are my signals strong? Your signals are strong. QRM means: Are you being interfered with? I am being interfered with.

3. If you have a license for the station and one for yourself your brother can transmit under your supervision.

* * *

C. K., Ohio:

The size of the Audio-choke coil you speak of depends upon the impedance of the tube it is used with and too many factors must be known in order to properly design one. Would suggest that you use a secondary unit from a one or two-inch spark coil with an iron core, made of a bundle of iron wires, in the center. Simply try various coils until loudest signals are heard.

* * *

W. T., Tennessee:

1. The best answer we could give you would only be theoretical and until we find out what electricity is, it is almost useless to explain, in the true sense of the word, just how the current does flow from the plate to the filament.

2. The multi-layer winding gives greater inductance in a smaller space and less capacity for the same amount of wire than the single layer coil type.

3. The connecting of rectifiers in series is something that would have to be tested. While the idea is not new we can not say at the present writing just what the action would be. Why not try it and if successful write an article regarding your results?

4. Fahnestock Binding Posts may be ordered from the Fahnestock Electric Company, Meadow, N. Y. Hunterpoint 877.

5. In regards to bare tinned copper wire, would suggest that you get in touch with wire manufacturers listed in the advertising section of the "Wireless Age."

Operating Suggestions for the Radio Amateur

By Leigh M. Townley

I'M an amateur myself and this idea of eliminating jamming hits me just right. Previous to the war we had a system in our town which gave real operators a chance to work, new "birds" a chance to listen-in on the good stuff and lots of chance for them to CQ around and test. It is my belief that if this system were improved upon and enlarged to take in more than one town, it might be worked with success for the benefit of all amateurs and the improvement of working conditions in the air.

From 1915 to and through 1917 we had an epidemic of radio bugs. The big idea of everyone seemed to be that if your set was powerful enough to jam through the others you could work, otherwise you were out of luck. It was this condition of affairs that gave rise to our scheme.

All the amateurs, or at least as many as could, got together to discuss this problem. We had no radio club and no one seemed to be anxious to start one because of the great range of ages, nationality, religion, station in the social life of the town, yes and even the difference of sex of the amateurs. However after several meetings we devised this system.

Because there were so many of us in such a small space, promiscuous "flat chewing" must be done away with. Testing was limited to the last ten minutes in each half hour and the station's call must be signed. If important work was being carried on, testing must be postponed till the next test period. Four fellows, owners of 1 k.w. sets. were appointed to act in a sort of advisory capacity as control stations. They were numbered 1, 2, 3, 4 and took their seniority in order of their number so that if more than one happened to be on at once, it would be understood who was on command of the air. They had absolute QRT privileges over the stations in that vicinity and could pipe anyone down at will and could also give anyone "clear air" at will. Believe me, when one of these amateurs heard a QRT fired at him from one of those stations he never let a peep out again until told that he could by proper authority.

In this manner, if anyone has business to clear he would call the control station on at the time and request clear air. The control station would clear the air by a CQ—QRT and then tell him to go ahead. If, in the estimation of the controlling four stations, one station was requesting clear air more than was his right he was told to lay off for a while. This eliminated useless calling because the controlling stations kept a log of all the stations on at the time and should anyone start calling a station which was not on, the control would tell him so and tell him to QRT 'til that station reported on.

We found this system worked O. K. chiefly, because, if there were any offenders they were immediately discovered and a mad gang of radio operators is not pleasant to settle with. Then again it made the beginners come on when no business was being handled and no one cared if they CQ'd their set apart. This little idea seemed to improve the operating, because everyone wanted to handle real business, but no one wanted to ask for clear air and then fall all over themselves with the whole gang listening in.

While this scheme worked beautifully in a small city and the surrounding country it might not prove so successful on a large scale but it is my conviction that if all the radio clubs and associations of the country were to adopt this scheme, jamming and all its attendant evils would be materially reduced. At any rate a beginning has to be made and practical experience with the scheme here outlined will no doubt establish its value.

Book Reviews

The Year Book of Wireless Telegraphy and Telephony, 1920. Cloth binding, 1148 pages. Illustrated. Wireless Press. Price, $3.75, postpaid.

The eighth successive year of publication is marked by the issuance of the current edition of this standard reference work. The volume appears considerably enlarged in scope and with many novel features.

The section devoted to the Record of Development chronicles the many epochal events in radio during 1919 and completes the record from the year 1827 to the beginning of the present year. The very comprehensive section containing the National and International Wireless Laws and Regulations stands unrivalled and unique in its complete form, incorporating the full text of the International Radio-telegraphic Convention and the Safety of Life at Sea Convention, as well as the laws and regulations of all the countries of the world. In this section alone are 400 pages of information obtainable in no other single volume. Noteworthy among the additions to this section are small maps which show the position of the wireless stations in each country.

The Directory of the World's Wireless Stations occupies 386 pages and lists land stations and ship stations, giving call letters, range, wave-lengths, nature and hours of service, owner and message tariffs. The key list to the call prefixes of all nations are also included, together with valuable data on meteorology. Time and weather signals are dealt with internationally, complete information on all countries and a full interpretation of the symbols being included.

A new feature, and a specially valuable one, is a series of special articles reviewing the development of radio in the principal countries during the past year. Each resumé is written by an authority in the countries represented, which include France, Germany, Great Britain, Holland, Italy, Japan, Norway and the United States. The thought of eminent scientists is also expressed in general articles devoted to: The Progress of Wireless Telephony; Valve Amplifiers for Shipboard Use; Wireless Telephony and Its Application to Aircraft; Direction Finding; The Berne Bureau; and Radiotelephony and Aviation.

A patent section records the issues of the past year and segregates those relating to vacuum tubes. The useful data section has been exhaustively revised, giving tables and general information along with the terminology of radio and foreign equivalents.

Complete information about all the principal commercial radio companies is again included, along with biographical notes of the world's leading authorities on wireless. The literature of the art is catalogued in another section, inclusive of books and periodicals and the most important articles which appeared last year, according to the subject discussed. An amateur section and a code signal section concludes the volume.

Obtainable through the Book Department, The Wireless Age.

Radio Engineering Principles. By Henri Lauer and Harry L. Brown. Cloth binding, 295 pages. Illustrated. McGraw-Hill. Price, $3.50 net.

The purpose of this book is to record and explain the extensive developments in radio made during the war. It is devoted principally to study of the characteristics and use of the vacuum tube, but deals with the essentials of the older apparatus in which important principles are embodied. The use of mathematics is kept to the minimum and appears only when essential to clarify the theory. The volume, in fact, concerns itself only with instructing the reader in radio communication principles and the general means of utilizing these in practical work.

Obtainable through the Book Department, The Wireless Age.

Practical Amateur Wireless Stations. Compiled by the Editor of The Wireless Age. Paper, 136 pages. Illustrated. Wireless Press. Price 75 cents net.

This volume is announced as an experience book, containing the best suggestions of thirty-three experimenters on building, installing and operating experimental stations for radio communication. In a foreword its purpose is explained as that of presenting in convenient form the experience of practical workers in the art. The methods described as those which the authors have worked out and tried out themselves, and the same is true whether the chapter deals with a single piece of apparatus or a complete station. The selected chapters made their first appearance in THE WIRELESS AGE in the form of magazine articles, giving the volume the peculiar merit of standing as a record of results and final conclusions, presented without the restriction of viewpoint by prejudice or preference that obtains in the writings of a single author.

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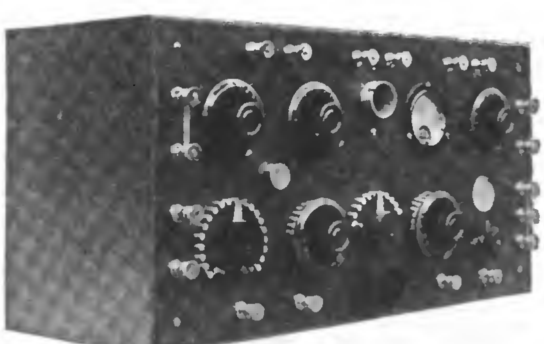

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Marconi on the Future of Wireless

GUGLIELMO MARCONI, in a signed article in the Nuvo Giornale of Florence on the predicted revolution in wireless communication, says:

"Eventually science will find a way of directing electrical energy without wires in an absolutely straight line. The result will be less expenditure of energy for short distances and hence less expense for messages. Once directive control has been established we shall undoubtedly be able by means of powerful machines to girdle the whole world with waves of electric energy without wires."

Marconi describes a radio telegraphic receiver no bigger than a gramophone by means of which, without any other communication with the atmosphere, he receives all day in his study every scrap of wireless news sent to the European press. He says that very soon with an instrument of this kind "bankers, politicians and business men in general will be able from minute to minute to keep themselves in contact with both hemispheres." He continues:

"Very soon, too, that miserable ticking machine on which all newspaper offices depend will yield place to this mighty invention, which is suitable for news sending, news receiving and simultaneous communication with any number of receiving stations.

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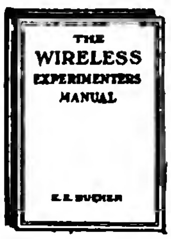

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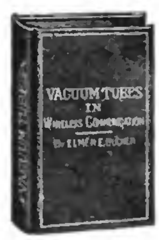

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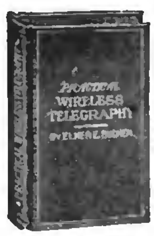

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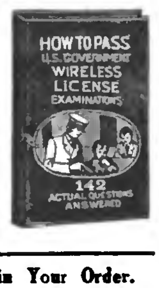

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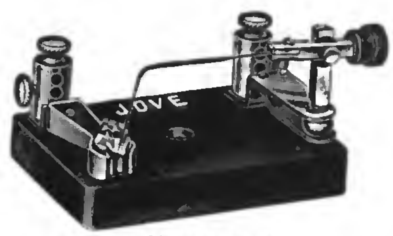

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