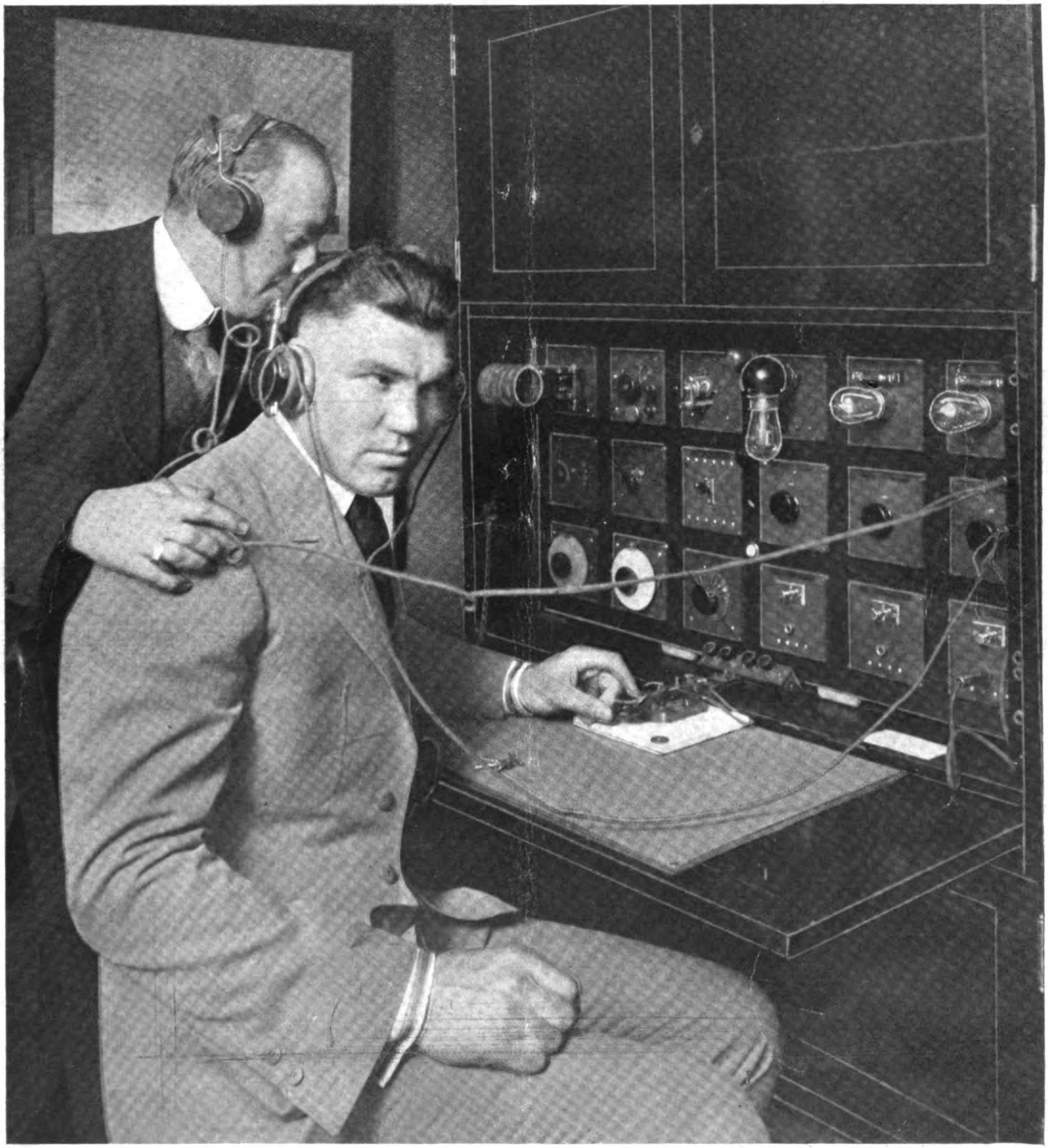
July, 1921

25 Cents

The WIRELESS AGE

Volume 8

Number 10



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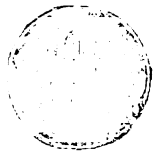

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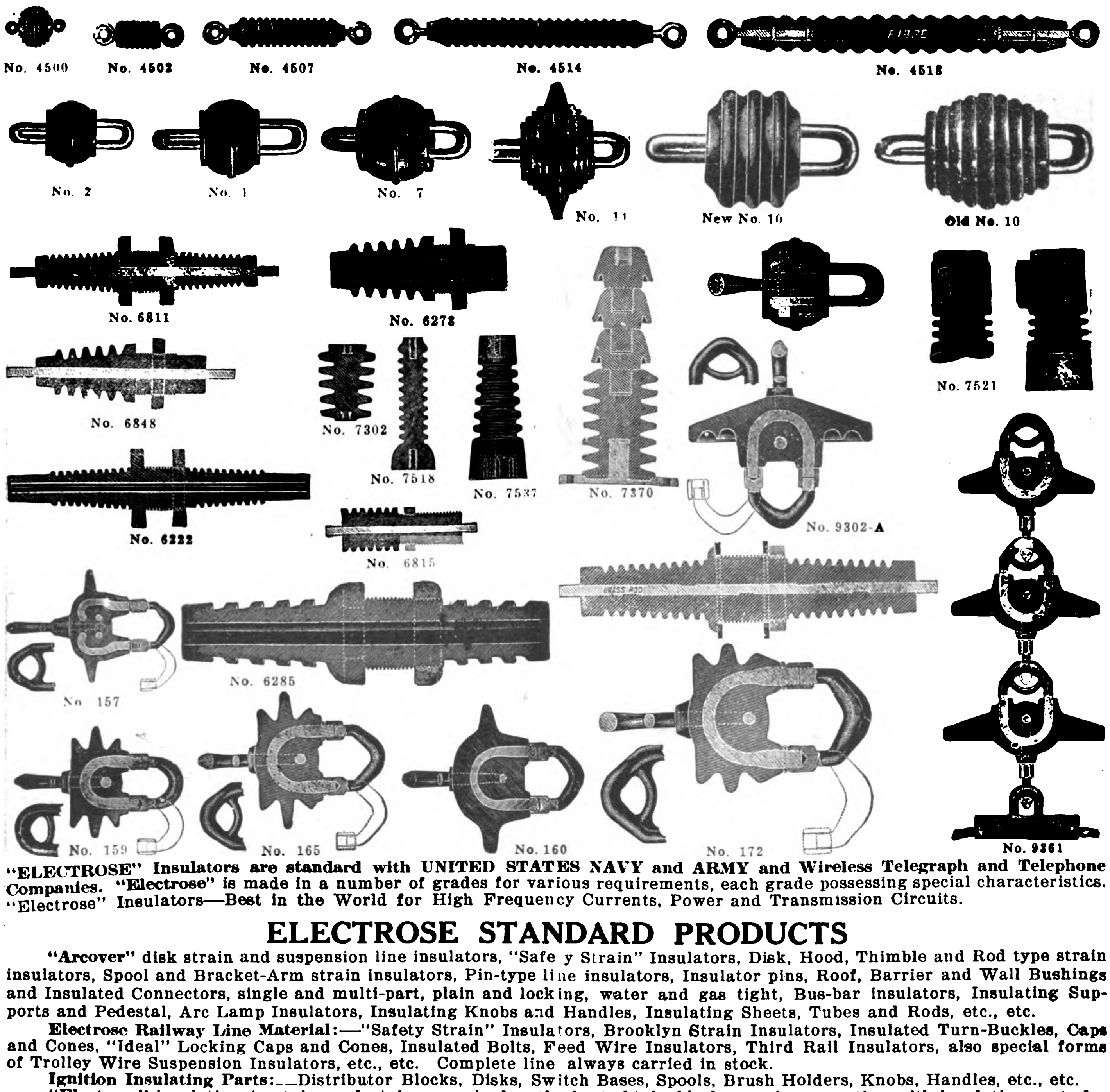

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Vol. 8 Contents of **The Wireless Age** for July 1921 No. 10

Edited by J. ANDREW WHITE

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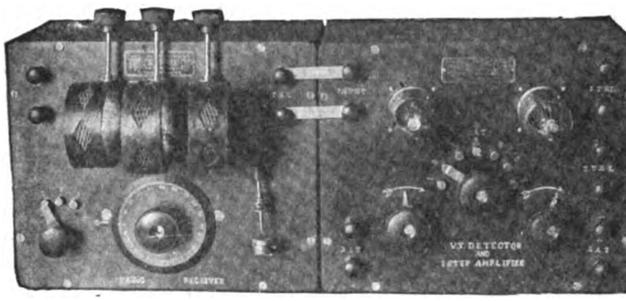

The combination shown here is the ABC Receiving UNIT and the ABC Combined VT Detector and One-Step Amplifier UNIT. This set is highly recommended for receiving all classes of signals on all known wave lengths. A One or Two-Step Amplifier or the ABC Clarion may be added at any time. Price of the Receiving Cabinet complete, $24.50. Price of the Combined VT Detector and One-Step, $37.50 (without tubes and batteries). This entire outfit, including aerial, phones, tubes and batteries may be secured for about $84.00, a price never previously approached for guaranteed, high quality radio apparatus.

For those who want it, there is also provided the *ABC* Completion Package to go with this Unit. The Completion Package contains phones, aerial, insulators, ground clamp; in fact, all the equipment needed to set a complete working station in two hours. This package is an unusually good buy at $7.50.

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For amateurs who prefer to build their own sets, we offer *ABC* Standardized Unassembled Parts, identical with parts used in the *UNIT* system. The complete *ABC* line including the *UNITS* is described and illustrated in our new 2 color catalogue. Gladly mailed for 10 cents in stamps or coin. Request Catalogue CW7.

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Vol. 8. No. 10 JULY, 1921

THE WIRELESS AGE

WORLD WIDE WIRELESS

International Communications Committee at Paris

TECHNICAL problems involved in the world's use of wireless communication which were left unsolved by the International Communications Conference upon adjournment of the experts last October are expected to be adjusted at a conference of the commission for that purpose in Paris.

Gen. George O. Squier, chief signal officer of the United States army, and representatives of the navy, who will include Rear Admiral William H. Bullard, will represent the United States. All of the allied and associate powers will be represented at the conference.

This committee, one of the many created by the conference to investigate certain phases of the radio and cable problem, has been investigating highly technical matters pertaining to international radio communication. The meeting in Paris is to allow the members to report the results of their experiments. Paris was chosen because the chairman of the committee chanced to be a Frenchman. The first session of the committee will be held on June 20.

A meeting of the full Communications Conference, now sitting in Washington, is unlikely to take place for several months. While all the committees except the Radio Committee about to meet in Paris have submitted reports on the subjects assigned to them and these reports have been forwarded to all concerned for examination and study, it is not likely that the various powers will be prepared to renew discussions for some time.

The whole matter of the disposition of the former German cables is also held in abeyance pending a decision on the status of the Island of Yap.

Radio Service Not Affected by Aurora Borealis

WHILE telegraph and telephone systems generally were put out of business by the strange electrical disturbances occurring on May 14 and 15, wireless service was not interrupted. Mr. E. J. Nally, president of the Radio Corporation of America, states that it may be interesting to know that these disturbances did not in any way affect radio communication proper.

The engineers of the Radio Corporation of America were well pleased with the behavior of radio during the powerful magnetic disturbances which accompanied the Aurora Borealis and which were followed by the breaking out of a large cluster of spots on the sun. They reported no noticeable change in the transmission and reception of the powerful radio waves which are constantly being exchanged between the United States and Europe and Asia.

In this connection it is interesting to note that our experience of the last few days is parallel to that of the French radio service, for we were informed that the Bordeaux radio station seemed relatively immune from the dangerous ground currents which have so seriously affected wire communication.

It has been known for some time that disturbances similar to those produced by the aurora borealis would not affect radio, and we were glad to have the opportunity to confirm this theory. Indeed, we have graphic record of this fact, for our high-speed records of radio signals taken throughout the presence of the disturbances show not the slightest trace of the aurora borealis.

Rear Admiral W. H. G. Bullard, chief of the Communications Division of the Navy, also stated that the

Photo by International

Opening the new radio station to be used for broadcasting market and weather reports. Left to right: J. C. Edgerton, Secretary Wallace, Postmaster Hays,, Charles E. Marvine, Dr. S. W. Stratton, W. A. Wheeler.

Aurora Borealis did not interfere in any manner with the operation of naval wireless communications ashore or afloat.

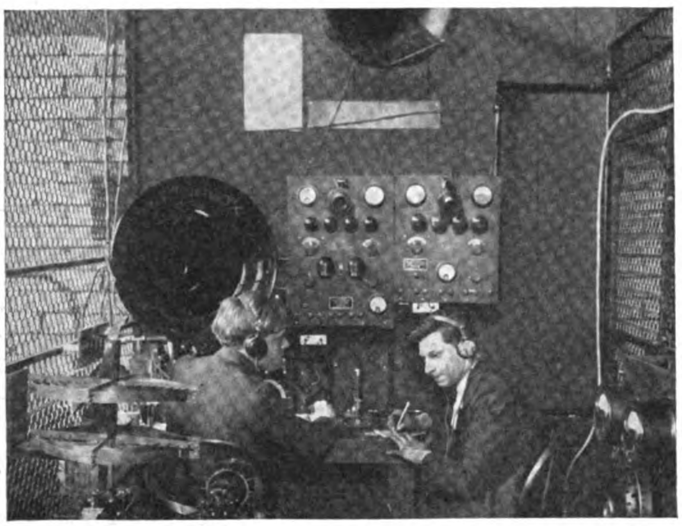
Just why cables and land wires should have been interfered with and radio communication not bothered Admiral Bullard does not seek to explain. He frankly admits that he has not yet been able to solve the mystery, but considers it important that on two notable occasions now when there have been sun spots accompanied by auroral displays radio communication instead of being interrupted has been seemingly improved during the period the sun spot aurora was active.

Veteran radio operators in Alaska have stated that on nights when there is no auroral display whatever in Alaska there has been difficulty experienced in radio operation. There have been nights in Alaska when, try as hard as they can, the radio operators have been absolutely unable to jam through their radio messages. These nights are known to these operators as "black nights." Those black nights have never occurred when there was an auroral display.

Berlin Radio Press Rate Increased

AN increase in the rate charged for press matter sent by wireless from Berlin to New York from 1 mark 80 pfennings, or 2.88 cents a word, to 5 marks 20 pfennings, or slightly more than 8 cents a word, has just been announced. American newspaper correspondents were informed that operation costs had risen and that the Government could no longer afford to continue the old rate. It was declared that the Government had been losing on every wireless message sent to the American newspapers. The new rate equals the rate charged for wireless matter from New York to Berlin.

There is little doubt that the increased rate will bring about a reduction in the vast amount of press matter which has been sent out by American correspondents here. Hitherto the rate has been so low that much material of a secondary news value, such as interviews with prominent Germans setting forth the German point of view, have been wirelessed to the United States.



Chicago high school students relaying dance music by radio. The operators are Jack Callahan and Harold Bernstein

Market News by Radiophone

AGRICULTURAL market reports by radiophone is the latest innovation announced by the Bureau of Markets, United States Department of Agriculture. Daily radio market reports are now being dispatched from Omaha, St. Louis, Washington, and Bellefonte, Pa., and received by wireless operators in 22 Central and Eastern States, who immediately relay the news to farmers, shipping associations, distributors of farm products, and others. Although in existence but a short time the department is receiving many gratifying reports regarding the usefulness of this service, and marketing organizations everywhere are not only watching the work with keen interest, but are arranging as rapidly as possible to utilize the service.

Radio Station for Switzerland

THE Swiss Federal Government has authorized Marconi's Wireless Telegraph Company to construct a wireless telegraph station to be located near Berne about 1,500 feet above sea level. The station will employ a Marconi valve continuous wave transmitter of 25 kilowatt capacity. The aerial will be supported on two towers each 300 feet high. Up-to-date apparatus for high speed automatic working will be employed.

The new station which will afford special facilities for press traffic, besides conducting a commercial telegraphic service, will be ready for the use of journalists attending the second session of the Assembly of the League of Nations in September next. It will be recalled that in November last the Marconi engineers erected at Geneva, in the record time of nine days, a temporary station which materially assisted the international journalists attending the first Assembly of the League.

Radio Aids the Distressed

W. B. MIDGETT, a coast guard at Maneto, S. C., gives thanks for his life to the wireless, aided by the airplane.

Midgett was overcome by gasolene fumes at Maneto. The one physician in the vicinity was away and a wireless message for medical assistance was broadcasted. The call was picked up by the Hampton Roads naval operating base, and Lieut. C. L. Haynes, naval surgeon, responded in an airplane.

Haynes covered the 150 miles in less than two hours. Midgett will recover.

Quick work on the part of a wireless operator saved the life of Carl Peterson, a seaman of the Steamer Sherman, anchored off the Statue of Liberty, N. Y. Harbor. The operator picked up the Sherman's call for a doctor and relayed it to police headquarters, and Inspector Halleck went out to the Sherman on the police boat John F. Hylan after calling an ambulance from the Broad Street Hospital.

Peterson, a mechanic on the Sherman, was hoisting a heavy casting on board ship when it fell and crushed his left leg, severing an artery. Inspector Halleck and others made a tourniquet, with which they stopped the flow of blood and hastened to Pier A with the injured man. There he was taken to Broad Street Hospital, where it was stated it would not be necessary to amputate Peterson's leg. The injured man's home is at 327 Forty-third Street, Brooklyn.

Captain G. T. Pickford, of the British steamship Kenbane Head, died of peritonitis, at the Riverside Hospital, recently.

Captain Pickford was a distinguished service man of the British navy and was taken seriously ill while the vessel was enroute to Newport News from New Orleans. He remained in delirium and was kept alive until the vessel docked through wireless communication with two other vessels that had doctors on board them. Through the doctors' advice medical attention was rendered the captain by the members of the crew.

Peru Clarifies Radio Situation

PERU has assured the United States Government that American cable and radio interests in Peru will not be endangered by the concession made to the British Marconi company, to operate telegraphs, radio and posts, in Peru.

The Peruvian assurances were made in response to an inquiry from the State Department made through the American Embassy at Lima. The Peruvian reply is understood to close the question, although the State Department is watching the communications situation in Peru and all other South American countries to guard against the United States being placed at a disadvantage in this field.

State Department officials emphatically denied reports that protest had been made against the Marconi concession. Despatches from South America when the Marconi concession was granted, indicated that a monopoly had been given, but the Peruvian Government, it is said, dissipated this view.

French Inventors Adapt Baudot Apparatus to Radio

BEFORE the French Academy of Science an invention was described by Professor Lippmann by which in recent trials over 7,000 words were sent and correctly received by one set of wireless transmission and reception instruments.

The new invention is the work of two electrical experts, MM. Abrahams and Planiol, who have succeeded in adapting for use by wireless the Baudot system, which is used over wire. By this system several messages can be sent at the same time over the same wire.

The instruments used in the wireless trials were practically the same as those used for ordinary telegraph purposes. The dispatch was from a Baudot apparatus and was received by a Baudot automatic printing apparatus, the only difference being in the fact that Hertzian waves were used instead of telegraph or cable. The messages were typed out separately by the receiving instrument in the ordinary way.

Instead of each message having to be sent separately, a whole series can be sent at the same time by the new method, with an immense saving in the time of transmission by operators.

The committee of experts who saw the trials declared themselves completely satisfied, and orders have been given to install the instruments to relieve the land wire congestion.

Lafayette Station Has Restricted Range

THE Radio Review notes a report in Radioelectricite that the preliminary tests and working of the Lafayette Radio Station indicate that while its power is ample for communication with the United States, it is still insufficient for continuous traffic with South America or with the East; *i.e.*, over ranges of 6,250 miles or more. The signals at these distances are seriously interfered with by atmospherics. For example at Hanoi the signals from Croix d'Hins can be heard strongly between 21:00 and 05:00 G.M.T., but at other times they fade. Similarly at Shanghai the signals are unreadable between 17:00 and 19:00, although they are strong at 21:00 G.M.T., and throughout the morning. This is apparently one of the reasons underlying the project for the large Paris Radio Center upon which work has now been commenced.

Radio Heroes Honored

ABOUT two score wireless operators from various ships now in port stood reverently uncovered for five minutes in Battery Park on Decoration Day while a wreath was hung on the monument erected to wireless operators who gave their lives by sticking to their posts until their ships sank. Among the names inscribed on the monument is that of Jack Phillips, who went down on the Titanic.

The wreath was hung by E. E. Pillsbury and W. S. Fitzpatrick, of the Radio Corporation of America.

Intercity Co. Withdraws Action for Injunction

APPLICATION of the Inter-City Radio Company of New York for an injunction to restrain Herbert Hoover, as Secretary of Commerce, and the Department of Commerce from interfering with its business was withdrawn when it came up for hearing before Judge L. Hand in the Federal District Court.

Attorneys for the petitioner announced that a satisfactory adjustment had been made with the Department of Commerce, permitting the radio company to operate its wireless business in New York, Cleveland, Detroit and Chicago.

Application for an injunction was made by the radio company when Secretary Hoover threatened to revoke its license and directed discontinuance of its high-powered plant on the ground that it interfered with Government wireless stations and the operation of battleships at sea.

Patent on Armstrong Circuit Upheld

A FAR-REACHING decision affecting wireless apparatus throughout the world has just been handed down by Justice Mayer, in the U. S. Federal Court, in favor of Edwin H. Armstrong and the Westinghouse Electric and Manufacturing Company. The decision confirms the patent rights of the "Armstrong regenerative circuit." It is probably the first time that such a patent has been confirmed in the courts.

The action in which the decision was rendered was contested by the DeForest Wireless Telegraph Company and the American Telephone and Telegraph Company. These concerns urged prior invention, and also that Armstrong's invention was of a limited character. Judge Mayer held that Armstrong was the first inventor and that the invention was of a broad character, covering any regenerative arrangement.

Executives of the Radio Corporation of America assembled at a dinner tendered David Sarnoff in honor of his appointment as General Manager of the Company

Belgium to Build Radio Station

BELGIUM is to begin the building of a wireless station, having eight steel antenna towers, each 850 feet high. The station will cover 250 acres of ground and will simultaneously maintain twenty-four-hour service with North America, twelve-hour service with Argentina, and eight-hour service with the Congo.

Radio Inventors Relief Bill

THE House Committee on military affairs has a report on the bill introduced in the House for the relief of inventors of improvements in radio communication. The bill seeks to obtain from the Government more than $13,000,000 for use of inventions commandeered during the war period.

The claims are recognized as being valid but in the adjustment the aggregate amount is reduced to about $3,500,000. It is the purpose of the bill to settle these claims without resort to the Court of Claims.

July 2nd Fight Described by Radiophone

The Great International Sporting Event Will Be Voice-Broadcasted from the Ringside By Radiophone Under the Direction of the National Amateur Wireless Association on the Largest Scale Ever Attempted

BROADCASTING by wireless a voice description of the Dempsey-Carpentier championship contest is not only a novelty for the annals of sport, but a new development in the field of applied science. The arrangements already made for the radiophone transmission on July 2nd called for new and unusual departures in communication engineering. Never before has anyone undertaken the colossal task of simultaneously making available a voice description of each incident in a fight to hundreds of thousands of people. Transmission of the voice by wireless on a large scale is new to the world, and the event has no little historical significance. The plans for its introduction have been carefully made so as to insure a complete success. Due to the fact that French and American causes are to be aided through the exhibitions in various cities, it has been possible to secure apparatus and services that would otherwise be available only at prohibitive cost.

The transmitter to be used in this unusual voice broadcasting is the most powerful wireless telephone set of commercial type ever built. It is being donated by the Radio Corporation of America for the purpose. The set has been assembled at the Schenectady laboratories of the General Electric Company, and when completed, will be brought down the Hudson River to the Lackawanna Terminal at Hoboken, N. J., where it will be installed. The 400-foot tower at the Lackawanna Terminal will be used. An antenna of six wires, on 30-foot spreaders, will be swung between the 400-foot tower and the clock tower of the terminal building. The antenna will be 680 feet long, and the natural period 850 meters.

The voice transmission will be on 1600 meters. On this wavelength the antenna current will be between 20 and 25 amperes, representing approximately 3½ K.W., and the daylight range of the station will undoubtedly be in excess of 200 miles overland, representing 125,000 square miles.

The radio station at Hoboken will be connected by direct wire to the ringside at Jersey City, and as the fight progresses, each blow struck and each incident, round by round, will be described by voice, and the spoken words will go hurtling through the air to be instantaneously received in the theatres, halls and auditoriums scattered over cities within an area of more than 125,000 square miles.

Through the courtesy of Tex Rickard, promoter of the big fight, voice-broadcasting of the event is to be the means of materially aiding the work of the American Committee for Devastated France and also the Navy Club of the United States. These organizations will share equally in the contributions secured by large gatherings in theatres, halls and other places. The amateur radio operators of the country are to be the connecting link between the voice in the air and these audiences. The entire broadcasting arrangements, both transmitting and receiving, are under the direction of the National Amateur Wireless Association, but there are no restrictions. Any amateur who is skilled in reception is eligible, whether or not he is a member of any organization.

Representatives of the American Committee for Devastated France and the Navy Club are engaging halls and theatres for July 2. All financial arrangements are entirely within the hands of these two organizations, and all admission charges are fixed by them. All arrangements of that kind are being rapidly completed.

As theatres, halls and auditoriums are secured in the sixty-one cities, assignments of skilled amateur wireless operators will be made.

The assignment of amateur radio operators who desire to participate in this greatest of all sporting events and this unprecedented undertaking of voice broadcasting, and who are willing to voluntarily assist in this most worthy cause, will be made in accordance with their qualifications, which, necessarily, must be of the highest type.

In participating in this great event, unparalleled in the annals of sport or the history of radio communication, the amateur will be identified with an undertaking which has for its object the rehabilitation of the devastated regions of France, and to provide for the comfort and happiness of the men of our navy when off duty—objects which most certainly should appeal to the patriotism of every amateur.

At a joint meeting of executives of the American Committee for Devastated France and the Navy Club a resolution was passed suggesting that recognition of the services of the amateurs be issued in permanent form. This resolution has been embodied in a certificate which will be presented to each amateur participating in the radiophone broadcasting.

In effect, it officially testifies to the expert assistance rendered voluntarily by its holder, and his essential participation in the reception of broadcasted radiophone reports employed in this manner for the first time in history, making possible the successful accomplishment of the following objects:

> Promotion of amity between the nations represented in the greatest international sporting event on record.
>
> The scientific triumph of simultaneous transmission of the human voice without the aid of wires to audiences in many cities.
>
> The contribution of financial and material aid in the task of rehabilitating the war-torn and devastated regions of France.
>
> Aiding establishment and maintenance of a home, hotel and club for enlisted men of the United States Navy and Marine Corps.

It will bear the signatures of Tex Rickard, Georges Carpentier, Jack Dempsey, Miss Anne Morgan and Franklin D. Roosevelt.

In small cities, towns, villages, hamlets or private homes amateur operators can actively participate in the furtherance of this unprecedented undertaking in the way of inviting small gatherings of their friends to listen to the voice description of the big fight. This only applies, of course, in locations where halls are not secured by the American Committee for Devastated France and the Navy Club and the arrangements handled by these organizations.

In the case of these small gatherings it is suggested that amateurs can take up a voluntary contribution, and any amount made up in this way will be acceptable, and will be appreciated. Money collected in this way should be sent to the office of the National Amateur Wireless Association, 326 Broadway, New York. Full acknowledgment of all such contributions, with the name and address of the amateur in charge of such local arrangements, will appear in the columns of THE WIRELESS AGE.

All money received in this way will be immediately turned over to the Committee for Devastated France and the Navy Club, who will acknowledge its receipt through these columns.

Some Operating Characteristics of Electron Tubes

By W. C. White, E. E.
Research Laboratory, General Electric Company

THE three-element tube is becoming a fairly common tool to the physicist, electrical engineer and experimenter, and the literature on the subject has grown rapidly, so that at the present time it is really voluminous.

Its theory of operation is quite widely known and is found in most modern textbooks on physics and radio communication. Radio literature is usually generously sprinkled with vacuum-tube circuit diagrams.

It is not the purpose of this paper to take up any of the fundamental theories of operation of the tube or its circuits, but to furnish information and give help to those who professionally, or for pleasure, experiment with these devices.

It is also not the intention to attempt to cover the field of tube operation, but merely to call attention to certain phases of the subject not widely known or appreciated.

Although in the past it has usually been the custom to operate the tungsten filaments of vacuum tubes at an approximately constant current by means of an ammeter, operation at constant voltage is to be recommended as giving a much longer life to the filament in about the ratio of three to one.

In operating tungsten filaments in vacuum tubes, observance of the three following rules will greatly increase the useful life of the tubes:

(1) The most favorable adjustment of the set, of which the tube is a part, is the one which gives the desired result with the *lowest value of plate current.*

(2) The filament *current* or *temperature* should *not be materially raised* to give a *slightly increased output,* or signal, which is not vitally necessary.

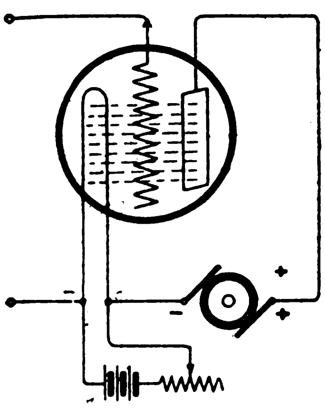


Figure 1

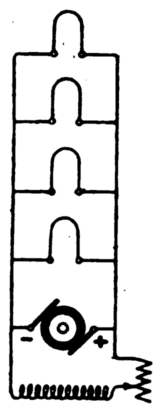


Figure 2

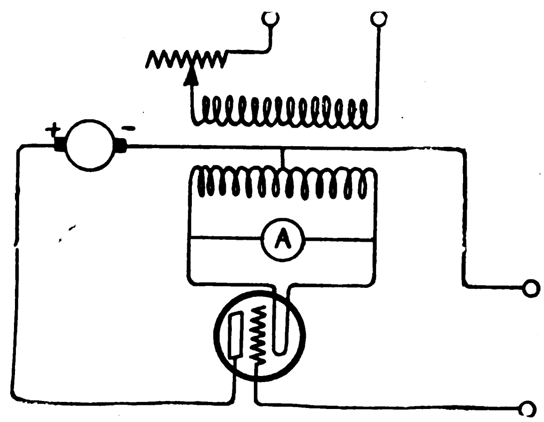


Figure 3

Diagrams of circuits when filaments are heated by low-voltage direct current or alternating current

It is a rather usual occurrence to those working with vacuum tubes in an experimental way to encounter unlooked-for difficulties and obtain unexpected results.

A number of these more unusual effects will be discussed; first those of a general nature, next those occurring when the tube is used as an oscillator, and finally a few when the tube is used for other purposes.

A tungsten filament type of tube is assumed in the paragraphs to follow, and most of the discussion relates to power tubes.

Certain properties of a tungsten filament as an electron emitting source will first be mentioned, for although these are simple and probably well known, they will bear repetition because of their importance in obtaining satisfactory results with such a type of tube.

The electron emission and life of a filament are quite sensitive to changes of filament current. A 1 per cent. change in filament current causes about 25 per cent. change in life and approximately a 10 per cent. change in total electron emission. An increasing filament current decreases the life and increases the emission.

Owing to the fact that, like most other metals, tungsten has a positive temperature coefficient of resistance, a certain percentage change of current gives a correspondingly greater change of voltage. Numerically, this amounts to a 1¾ per cent. change of voltage for a 1 per cent. change of current. Therefore life and electron emission from a tungsten filament are more subject to filament current change than voltage change of the filament.

(3) *Do not,* for any length of time, *exceed the maximum filament rating,* and in all cases *reduce* the filament temperature to as *low* a value as is consistent with satisfactory operation of the apparatus.

Most tubes are designed for operation in one or two designated positions; that is, vertically, or horizontally, with a certain side, or end, up. It is advisable to observe this feature, because a hot tungsten filament has a tendency to very slowly sag, and if this is not prevented, or compensated, by operation in a certain designated position, there is liable to be changes in the electrical constants of the tube, caused by changes in the distance between the electrodes.

If for some reason the vacuum in a tube becomes faulty, it is usually noted by the characteristic glow due to ionization of the gases present. If gases evolved from the metal parts or glass, due usually to the heat from an overload, are the cause of this glow, it will be blue in color; whereas, if it is due to leakage of air, it will appear purple or pink.

Occasionally a tube will be met with which, when the filament is energized, shows a sort of yellowish-white smoke in the interior near the filament or it fails to come up to normal brilliancy at rated amperes and a dark-blue powder forms on the plate and grid. Both these effects are due to considerable amounts of leakage of air, but formed under different conditions.

The smoke or powder formed is an oxide of tungsten which exists in several forms and varied in color from a very light yellow to a very dark blue, depending upon the conditions at the time of its formation.

One limit to the possible output of a tube an an oscillator is the amount of energy that can be dissipated safely in the form of heat. If it is attempted to dissipate too much energy, the glass and electrodes will be liable to evolve gas which reduces the vacuum. If the tube is enclosed in a small unventilated space, normal operation may overheat the glass of the bulb and cause it to evolve gas. This is most likely to occur where a number of tubes are operated in parallel, thus causing a considerable energy dissipation in a small area.

When the filament of a power tube is operated from a direct current source through a regulating resistance, the plate current causes an inequality in the filament current. This action is represented in figure 1.

The electron emission occurs along the length of the filament and therefore one end of the filament will carry more total current than the other end; this causes one end of the filament to be the hotter, which for the same

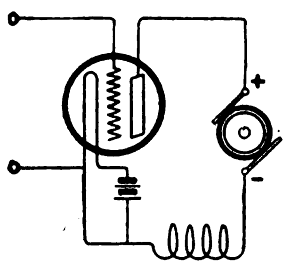


Figure 4A

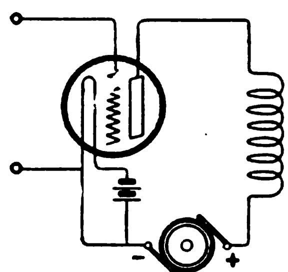


Figure 4-B

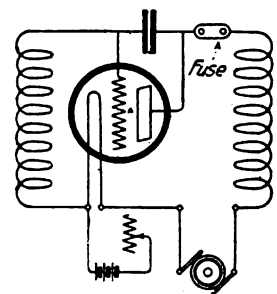


Figure 5-A

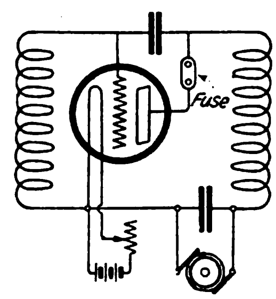


Figure 5-B

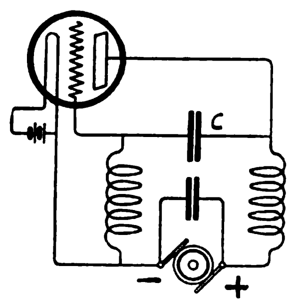


Figure 6-A

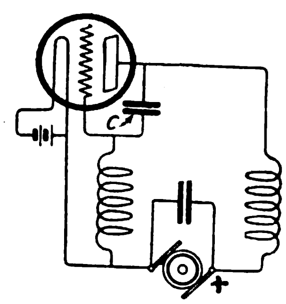


Figure 6-B

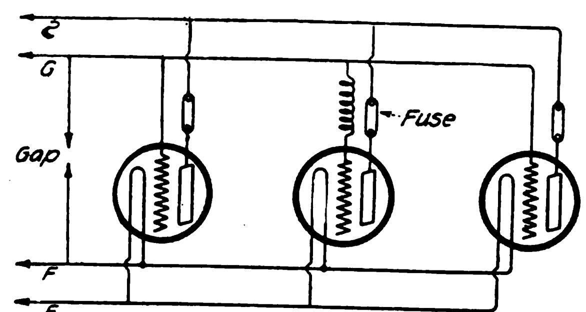


Figure 7

Diagrams of circuits for oscillating tubes

amount of emission will shorten the life. The relative resistance values of the regulating rheostat and the filament, and also the location of the point of connection between the filament and plate circuits, determines the amount and direction of this effect. As shown in figure 1, the plate current causes the filament temperature to decrease at the positive filament terminal. This is the safest and best mode of connection.

If, however, the filament is operated from a few cells of storage battery, or directly from a low-voltage direct-current generator, so that the resistance in series with the filament is small, it is immaterial whether the return from the plate circuit is made to the positive or negative terminal of the filament; the heating current in the negative side of the filament is increased by the same amount. A considerable resistance in series with the filament is essential to any alteration in the distribution of the flow of plate current through the filament circuit as a safety precaution. As the plate current is usually in the neighborhood of 2 per cent. to 7 per cent. of the filament current, and as a 3 per cent. increase of filament current halves the life of a tungsten filament, the importance of this effect is evident.

If a low-voltage direct-current generator is used for filament lighting, it is usually connected in circuit as shown in figure 2, the filaments being directly connected to the armature leads, the adjustment of filament temperature being made by a rheostat in the field circuit of the generator. With such an arrangement difficulty may be experienced with the generator not building up if the filaments are left in circuit. This is owing to the fact that the cold resistance of a tungsten filament is very low, only one-thirteenth to one-sixteenth of its normal operating resistance. Therefore, if a small low-voltage direct-current generator is used at full load to supply tungsten filaments, the cold resistance of the filaments may be so low that it acts as practically a short circuit on the armature and prevents the generator from building up.

On power tubes it is preferable to use alternating current for filament excitation. The chief reason for using A.C. is that it obviates the unbalanced condition of a D.C. filament current, as described in a previous paragraph. It is also more practical to generate and distribute the low-voltage high-current energy for filament operation by means of A.C.

In using A.C. for filament excitation the filament terminals should be connected directly to the transformer low-voltage terminals, the regulating resistance being placed on the power side. Also the return of the grid and plate circuit should be made to a center tap of the coil supplying the filament. This mode of connection assures minimum disturbance in the plate and grid circuits from the frequency of the filament source. Both these points are shown in figure 3.

Some points in connection with the use of tubes as oscillators will next be taken up.

In the various diagrams of connections which are shown in this paper, each one is simplified so as to more clearly show the point under discussion. For this reason many diagrams for clearness or simplicity omit features which in another paragraph are shown to be advisable.

In all tube oscillator circuits there is an inductance in the plate circuit across which the high-frequency voltage is set up. Care should be taken that this inductance is not placed between the filament energy source and the plate energy source, as shown in figure 4A. Both of these sources have, usually, a large capacity or a certain resistance to ground, so that a circulating current will flow through the coil and through each source to ground. For the type of circuit shown, the correct arrangement is shown in figure 4B. The importance of having the circuit correct in this respect becomes greater the larger the power and the higher the voltage used.

In arranging an oscillating circuit to deliver high-frequency energy, it is important to reduce to a minimum the losses in the high-frequency circuits. Not only should the wires used be of low resistance and the condensers have low losses, but it is best to trace through the circuits carrying high-frequency currents, to be sure that the resistance is a minimum.

Three common errors in this respect are shown in figure 5A, which represents a capacity coupled oscillator circuit. In this diagram the high-frequency current of the oscillating circuit must pass through a resistance path comprising the filament in parallel with its resistance and battery source. Also it must pass through a fuse in the plate circuit and through the plate voltage source. In figure 5B the same circuit is shown with these three errors corrected; the first, by changing the wiring so that the return of the grid and plate circuits is brought back to the same filament terminal; the second, by change of the fuse position, and the third, by shunting the plate circuit generator with a by-pass condenser.

For miscellaneous laboratory work the capacity coupled type of circuit is a very convenient one to set up and operate, usually giving little trouble. However, if the circuit happens to be set up in a certain peculiar way, very puzzling results and failure to operate may sometimes occur, particularly if a tube of low impedance is used, or several tubes are in parallel.

This arrangement is shown in figure 6A. If, as shown in this diagram, the leads from the coupling condenser C are connected to the plate and grid coil terminals rather than to the corresponding tube terminals, as shown in figure 6B, very high-frequency oscillations may occur, a second capacity coupled circuit being formed, the capacity between the electrodes acting as the coupling condenser and the leads between the grid and plate coils and the corresponding tube terminals acting as the grid and plate inductances. This condition is accentuated by having these leads long and the leads to the coupling capacity short.

This unexpected production of ultra high-frequency oscillations is often a very troublesome problem in high-power tube apparatus when a considerable number of tubes are operated in parallel. The low impedance of the tubes in parallel accentuates the effect. One expedient which often aids in overcoming this difficulty is the insertion of a very small inductance (a few microhenries) in one or more of the grid leads close to a tube grid terminal.

This coil is shown in figure 7. This figure also shows fuses in the plate circuit of each individual tube, a very desirable feature on high-power high-voltage tubes. This fuse should blow at two to four times the rated plate current of the tube.

This figure 7 also shows another desirable feature for high-voltage, power-tube circuits. In experimental work with oscillating circuits unusual conditions may occur which will cause transient voltages to be set up between the grid and the filament, which will reach peak values many times higher than that set up in normal operation. It is impractical to design and construct a tube and its base to stand up under this very abnormal voltage, which only occasionally occurs, due to incorrect adjustment.

A safety spark gap should therefore be provided between the grid and filament terminals at or near the tube socket or mounting. This gap should be adjusted to between one-thirty-second and one-quarter inch, depending upon the plate voltage employed and the number and type of tubes used. This precaution should be taken on any tube or group of tubes delivering over 50 watts of alternating current energy or operating at a plate potential above 2000 volts.

In one of the simplest and most frequently used forms of capacity-coupled circuit there is a precaution that should be observed.

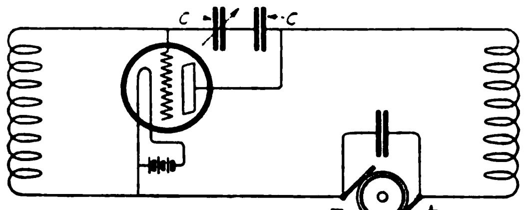


Figure 8

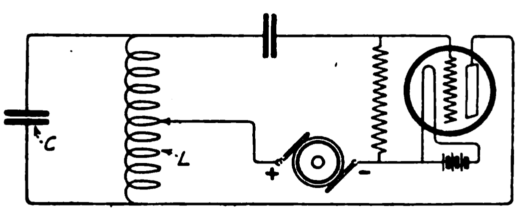


Figure 9
Improved circuits for oscillating tubes

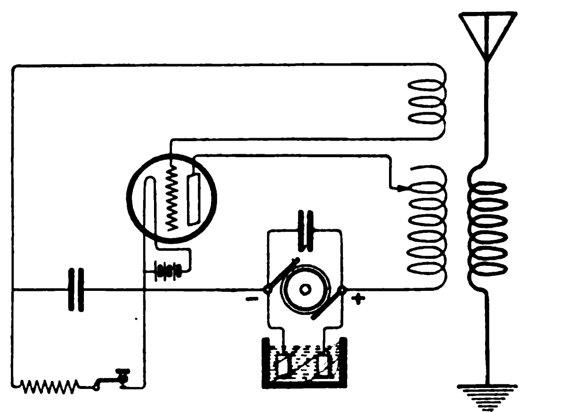


Figure 10
Circuit having generator protective device

This is illustrated in figure 8. It will be noted that the coupling capacity C has one of its terminals connected through the grid coil to the negative terminal of the high-voltage plate source, while the other side of this capacity is connected through the plate coil to the positive terminal of the high-voltage source. Very often this capacity C is a variable air or oil dielectric condenser, and its breakdown, due to high-frequency and high voltage, will therefore short-circuit the generator. The resultant arcing inside the condenser may also burn the plates badly.

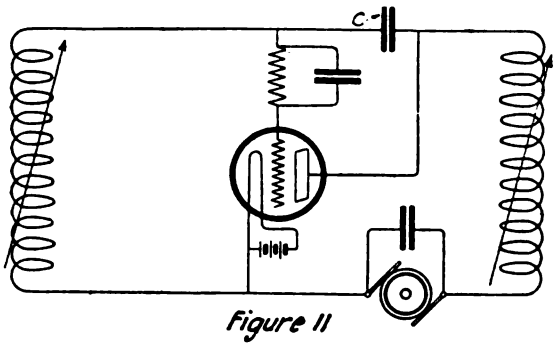
This possibility may be prevented by the use of a second capacity C_1, which should be large in capacity in comparison with C. The condenser C_1, if it is at least one hundred times the value of C, need not be a low loss condenser. It is necessary, of course, that the condenser C_1 safely stand the voltage of the D.C. source.

In a typical form of oscillating circuit, as shown in figure 9, the frequency of oscillations is principally determined by the value of the capacity C and inductance L.

As far as the natural frequency of oscillation is concerned, it will remain constant as long as the product of L and C is constant. However, it will be found that the type of circuit shown in figure 9 will only oscillate at a given frequency in a satisfactory manner when the capacity C is under a certain limiting value. This is explained by the fact that certain values of high-frequency voltage are necessary on the grid and plate. If the capacity C is very large, the tube will not supply sufficient energy to pass enough current through C to set up across it the necessary grid and plate high-frequency voltage. The lower the value of resistance and the lower the losses in the oscillating circuit, the larger the value of C that may be used and still maintain oscillations.

For the type of circuit shown in figure 9, the limiting value of C, for the usual types of small tubes running at reasonable values of plate voltage, is in the neighborhood of a maximum of .001 microfarad for a frequency of one million cycles (300 meter wave-length). This is necessarily a very approximate figure because of the many factors which are involved, but it at least gives the experimenter an idea of what not to use.

In the use of high-voltage direct-current generators operated singly or in series, it has been found that when they are employed for supplying energy for tube-plate circuits, a considerable strain is imposed on the insulation of the armatures. This is particularly accentuated when the tubes are used for radio telegraphy and telephony where the load fluctuates rapidly, or is switched



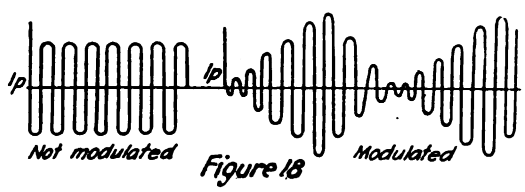


Figure 11—Circuit for reducing frequency variation

off and on suddenly. For the usual type of circuits, one of which is shown in figure 10, the negative side of the generator is practically at ground potential.

The strain which is imposed on the machines is in the form of a voltage surge which momentarily raises the generator voltage several fold. One terminal being grounded, the strain occurs on the insulation between the frame or armature core and an armature conductor which at the instant is near the positive terminal or brush.

A condenser shunted across the generator terminals, described in a previous paragraph, also acts as a sufficient protection against these voltage strains in the case of very small machines. In the case of generators, singly or in series, for voltages above 500 and power outputs above 50 watts, some sort of protective device to safely limit and discharge this voltage should be used. For this service aluminum cell lightning arresters are very suitable. They should be connected across the generator terminals. In figure 10 one protective cell is shown in circuit.

These cells consist of a pair of oxidized aluminum plates immersed in an electrolyte. Many different electrolytes are used to meet special requirements, but for experimental purposes covering a short period of time a saturated solution of borax is satisfactory. These cells are connected in series, and when the oxide film is properly formed, one cell should be used for each 300 volts of rated generator voltage. These cells involve the same general principles as the familiar type of electrolytic rectifier.

These cells, owing to the thin oxide film acting as a dielectric, have considerable electrostatic capacity between electrodes, which is an added advantage in their use as protective devices on generators supplying oscillating vacuum tubes.

In certain experiments it is often desired to keep the frequency variation of a tube acting as a high-frequency oscillator as small as possible. This is particularly desirable in the calibration of wavemeters and in measurement work. The variation of frequency due to voltage variations of the power sources can be greatly minimized by using a very high value of grid leak resistance as shown in figure 11. This applies to practically all types of oscillating circuits.

It is often desired to obtain high-voltage high-frequency energy to test dielectrics and measure dielectric losses. Figure 12 shows a type of circuit very suitable for using an oscillating tube for this purpose. The frequency of oscillation is largely determined by the period of the simple series circuit comprising L_1, L_2, L_3, L_4 and C. The condenser C_1 is merely for safety, as explained in a previous paragraph, and is large in comparison with C. Maximum output is obtained by variation of L_1 and L_2. The

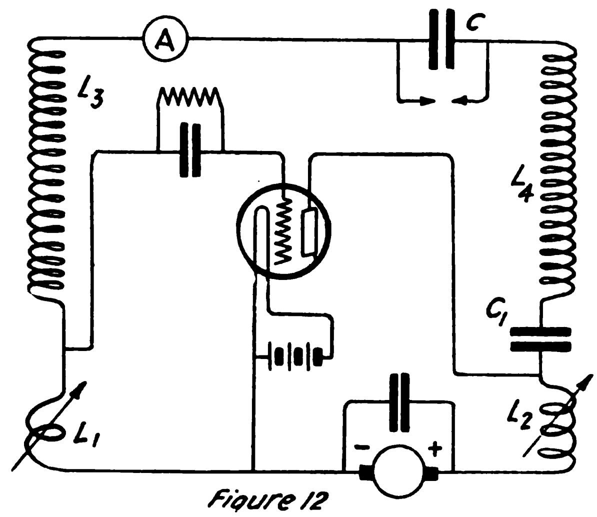


Figure 12—Circuit for measuring dielectric losses.

voltage obtained may be computed by measuring the frequency with a wavemeter and reading the current at A, passing through the condenser C of known capacity value. A spark gap across C may also be used to check the value of voltage obtained.

For high voltages the capacity C should be small and the inductance in circuit large. It is also important to have the losses low in the inductances and capacity.

In most power tubes the higher the plate voltage that can be used, the greater the output. Tubes may fail to stand up under an increased voltage for many reasons, but there is one factor in connection with this limitation that is usually overlooked. This factor is electrolysis of the glass. In most of the types of small-power tubes all the lead-in wires are usually carried through a common stem and seal. When this is the case, the plate voltage that may be used is limited by electrolytic action in the glass of this seal between the plate and grid leads. Hot glass is an electrolytic conductor; that is, the metallic elements in the glass appear at the negative pole. This electrolysis in the course of time, if continued, will ruin the seal, making it leak air, and sometimes even crack it. An early indication of this electrolysis which appears long before leakage occurs is a blackening of the grid leads in the glass of the seal near the vacuum end. This action takes place at the grid lead, because this is usually the most negative one when the tube is oscillating.

Therefore, if tubes of this type are operated considerably above their rated plate voltage, the life is liable to be terminated by leakage of air into the bulb through the seal, rather than filament burnout.

In the various circuits described, the source of D.C.

potential for the plate has been shown in series with the plate inductance. The shunt feed method of connection is just as satisfactory, but is sometimes not quite so convenient for the experimenter with limited apparatus.

Also the various circuit diagrams in this paper have for the most part shown, for the sake of simplicity, a battery as a filament source and a D.C. generator as a plate source. The filament battery may, of course, be replaced by a generator or transformer and the plate generator by a battery or a rectifier system for producing D.C. from A.C. at commercial frequencies.

There are a few points of interest that arise when a tube is used as an amplifier for alternating currents of appreciable energy (several watts at least), and when it is used as a voice current amplifier and modulator in radio-telephony.

A very common form of graphical plot employed to show one of the electrical characteristics of a three-element tube is given in figure 13B. The curve A-B illustrates the well-known relation between grid voltage and plate current. This curve assumes a constant plate voltage. However, in many amplifying circuits a resistance, as in figure 13A, is included in the plate circuit.

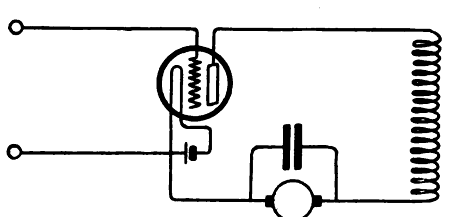


Figure 13-A

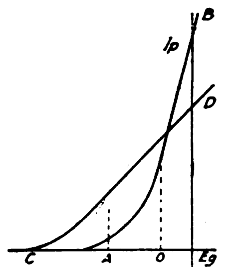


Figure 13-B

Figures 13-A and 13-B—Amplifying circuit and characteristics

When an alternating E.M.F. is connected between filament and grid, a corresponding variation in plate current occurs. Therefore an alternating voltage is set up across the resistance in the plate circuit and the voltage of the plate is no longer constant, being higher than normal voltage while the resistance is discharging and lower when it is charging. For this reason the grid voltage and plate current will not follow the curve A-B. They will, however, follow a curve of the type C-D, because at the low-plate current the plate voltage is higher than normal and therefore a higher negative voltage is required to bring the plate current to zero, while at the higher plate-current end the actual plate voltage is lower and so the plate current is lower.

In most amplifying circuits it is usually desired to keep the grid negative during practically the entire cycle of operation, and therefore the grid is made normally negative by a so-called biasing potential. It is also usually desirable to make this normal negative potential of a value equal to half the grid voltage required to bring the plate current to zero. This value of normal negative grid voltage should be computed from the curve C-D rather than the static curve A-B. In other words, the best value of negative biasing grid voltage should reduce the plate current to much less than half the value obtained at zero volts on the grid. A negative voltage that reduces it to about one-quarter value is approximately the best.

The foregoing, of course, does not apply to receiving amplifiers or cases where the amount of plate-current fluctuation is small.

The most usual method of modulation employed for vacuum-tube radio-telephone transmitters is shown in figure 14. In this arrangement the output of the oscillator tube is varied above and below its normal amount by variations in plate voltage set up by the amplified microphone voltages. Therefore the peak of plate current in the modulated oscillator tube is considerably higher than in a straight oscillator circuit. More electron emission is therefore required for the modulator tube than for a simple oscillator tube. Very often poor articulation in a radio-telephone transmitter is due to insufficient electron emission in the oscillator tube.

In a radio-telephone transmitter correct wave-lengths and normal antenna current are not, as in telegraphy, indications that the set is functioning properly. Neither of these factors give any information as to the degree of modulation. The amount of modulation is most satisfactorily obtained by means of an oscillograph, but this is seldom available for use when and where desired.

A simple device to indicate modulation is a miniature tungsten filament lamp in the plate circuit of the modulator tube. This should be chosen of such a rating or so shunted that normally it burns at a dull red. When the microphone is spoken into, it should flash up and the degree of this brightening soon becomes a very good indication as to whether the modulation is normal or not. This arrangement is shown in figure 15.

There are so many things that may prevent a radio-telephone transmitter from properly functioning while

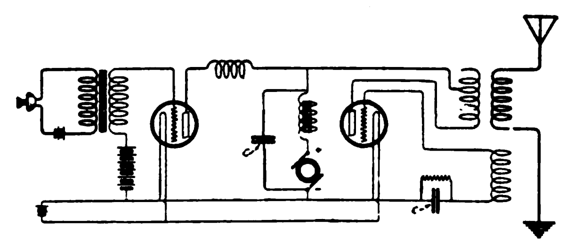


Figure 14

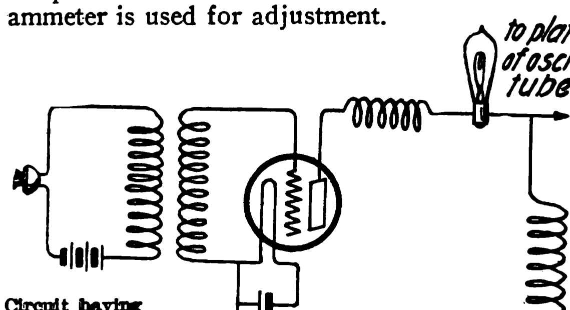
Figure 14—Modulating circuit for a radiophone transmitter

showing full radiation current, that an indicator, as described above, is very useful.

OPERATING CHARACTERISTICS

It is very desirable to operate the tungsten filaments of transmitting tubes at constant voltage rather than constant current. The filament life at constant voltage is approximaely three times the life at constant current.

The emission during life at constant voltage drops slightly, but this can be easily taken care of in design if it is desired to maintain absolutely full output to the end of life. The filament current at constant voltage decreases five to ten per cent. during life. For this reason it is not possible to obtain full life from a filament when an ammeter is used for adjustment.



Circuit having tungsten filament lamp to indicate degree of modulation

Figure 15

The variation of life and electron emission with filament voltage is shown in figure 16. These curves show the poor economy in forcing a tube, because it will be seen that to double the emission reduces the life to one-quarter. Conversely it shows the advantage of operating a tube conservatively, for by reducing the electron emission to one-half, which allows half rated output, the life is quadrupled. This is even more forcibly shown in figure 17, which shows the variation of high frequency output current (radiation current), for a 5-watt tube in a typical oscillating circuit, plotted against filament amperes. At low filament temperatures the output is entirely limited by the electron emission whereas beyond a certain point increased emission does not appreciably increase the output, which becomes limited by other factors in the tube. A life curve with filament current is plotted on the same sheet and shows that, in order to gain an increase of 5 per cent. above rated output by filament temperature increase alone, the life is decreased to approximately 40 per cent. of the normal.

In making filament adjustments the three following points should be kept in mind:

(1) Do not materially raise the filament current to get a small increase of output. The curves of figure 17 show the poor economy of this. Considering operation over a period of one year it would be more economical to operate conservatively two tubes in parallel and get even a greater output than from the one running with an excess filament temperature.

(2) For long tube life the best circuit adjustment is the one showing the lowest value of plate current. It is for this purpose that an ammeter in the plate circuit was suggested in a previous paragraph. It is well worth while to experiment with various circuit adjustments in order to get a satisfactory output with a minimum input current. Expressed in another way this simply means getting as high an oscillator efficiency as possible. If a milliammeter is not available for use in the place circuit, a miniature incandescent lamp may be employed during adjustment and the lowest current judged roughly by the filament brilliancy.

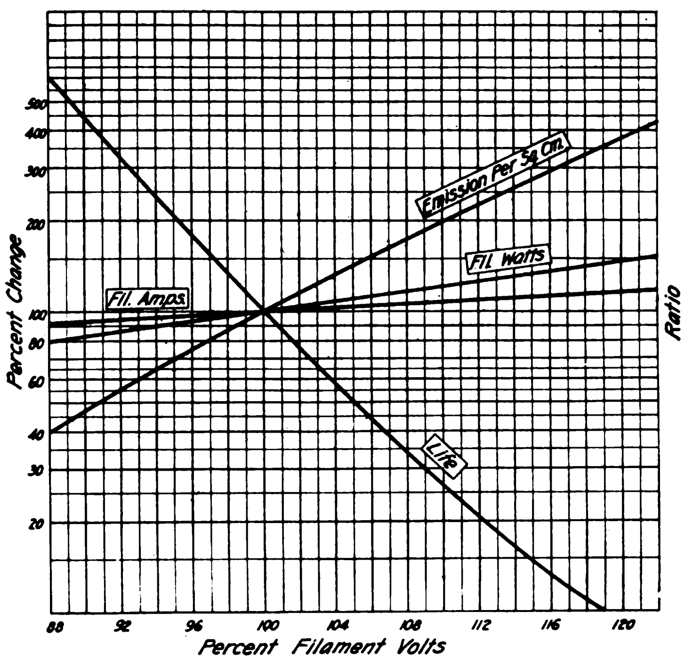


Figure 16—Graph showing variation of life and electron emission with filament voltage

(3) The maximum rated filament voltage of the tube should not be exceeded for any length of time. In all cases the filament should be maintained at as low a temperature as possible, consistent with satisfactory results. As noted in a previous paragraph the filament current at constant filament voltage decreases during life, therefore, adjustment by current is sure to result in abnormal temperature of the filament as its life progresses. All tubes are given a certain rated filament current plus or minus an allowance at a rated voltage. This, as above stated, can apply only to a tube when it is new as the filament resistance increases during life. This rating denotes or should denote the filament voltage at which the tube will give rated output at rated plate voltage throughout its average life under specified conditions. Therefore, it is a distinct advantage if the user can obtain the result he desires by operating the filament at a voltage under normal. Operation at 95 per cent. normal filament voltage should double the life of the tube. Under many conditions this is possible. Under some abnormal conditions the filament must be operated at an over-voltage. Under the latter condition the user must expect and accept a shorter tube life.

This question of rating is a difficult one, but not entirely unlike the rating of other electrical apparatus. Consider the case of a direct current motor rated 1 H.P. at 110 volts. This rating is fixed by a commonly accepted set of standardization rules which govern permissible temperature rises and other factors. Both the manufacturer and the user know that probably 2 H.P. is obtainable from the motor, but both also know that if this overload is persisted in, disastrous results are sure to follow sooner

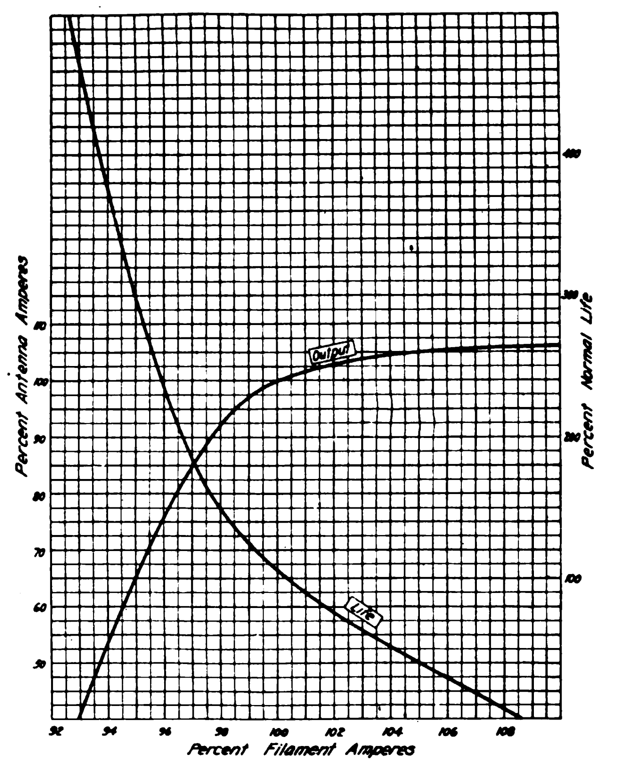


Figure 17—Radiation current for a 5-watt tube in an oscillating circuit plotted against filament amperes

or later and the useful life of the motor greatly shortened. Also both know that the motor will operate at an over-voltage, say 150 volts, but they also both know that this lowers the factor of safety of the commutator and that a flashover or bad sparking is almost sure to result. Eventually vacuum tube ratings will also be fixed values, but this standardization must await a wider understanding of the technical features involved before it reaches the same status as in the case of highly standardized forms of electrical machinery.

In the case of the larger sizes of power tubes a fixed filament rating is maintained principally to insure uniformity and establish a definite tube rating. In all cases the filament should be operated at as low a temperature as possible.

It should be remembered that the variations of life, electron emission and other factors do not bear the same proportionality to filament current as to filament voltage. This is due to the temperature coefficient of resistance of the filament resulting in an increase of resistance with an increase of current. Owing to this factor a 5 per cent. change of filament voltage causes about a 3 per cent. change in filament current in the useful range of filament temperatures.

In experimenting with different circuits and circuit adjustments it is advisable to first operate at one-half or one-third normal voltage. In case of abnormal adjustment or faulty connections the tube itself then has a much larger factor of safety against destruction.

This same precaution should also be observed when the set has not been operated for some time. Then in case some part of the circuit has, through accident, been changed, no harm will come to the tubes and the voltage may be turned off and the circuit corrected.

Most well made tubes will stand a great overload on the plate for a few seconds, but a continuation of an abnormally high plate temperature is sure to deteriorate the vacuum.

Most transmitting tubes have a definite plate voltage rating. As in the case of a filament voltage rating this voltage should be the value which will give rated output throughout the average life of the tube. It is to the interest of the manufacturer to make this voltage as high as possible as it allows a higher power rating of the tube, but in all cases some factor limits this voltage. These factors are usually electrolysis of the glass of the seal, dielectric strength in the base or stem, overheating of the metal parts or glass due to the increased energy to the plate, or puncturing of the glass.

On the small types of tubes in which all the leads are brought through a common stem, electrolysis in the seal of this steam is the factor usually limiting the plate voltage. At plate voltages above rated value electrolysis causes air leakage through the seal and thus unduly shortens the life of the tube. Even at rated voltage a slight, but harmless amount of electrolysis takes places which can be detected by a blackening of the grid leads in the glass of the seal. This blackening is due to electrolytic deposition on the grid leads which is the negative electrode for the electrolysis.

At higher plate voltages where this electrolysis is more severe the glass of the seal in the vicinity of the grid lead changes to a dark brown color.

In a radio telephone transmitting circuit of the usual type a modulator tube is employed and a buzzer is often substituted for the microphone when it is desired to send out interrupted continuous waves. This imposes very severe voltage strains on the oscillator tube and if an over-voltage is also applied to its plate the voltage between grid and filament may be excessive. The protective gaps described in a previous paragraph are a safeguard against breakdown due to this voltage.

Unless the constants of the oscillating circuit are changed the plate current will go up when the plate voltage is increased causing the energy loss to the plate to be rapidly increased. This, of course, is liable to cause deterioration of the vacuum.

Puncturing of the glass occasionally is met with and is caused by the heat of electron bombardment or dielectric losses softening the glass or it may be caused by excessive voltage when the glass is a dielectric.

In most types of tubes, if puncturing does occur, it will take place through the stem between the leads inside the stem and the sleeve on the outside which either supports the grid or plate structure. Such puncturing is much more liable to occur when the glass is very much heated due to overload. It is most effectively provided against by the protective spark gap previously mentioned which should be set as close as possible and still permit normal operation. Puncturing of the bulb itself is rare at plate voltages under 5000.

Some of the principal precautions to be observed in the use of power tubes have been explained. The experimenter with the larger sizes of tubes will find many interesting conditions and discover many new phenomena. However, he must be careful and use good judgment or an undue destruction of tubes and apparatus is almost sure to result.

A New Inter-Tube Audio-Frequency Amplifying Transformer

IT is a well-known fact that the impedance of a tone frequency amplifying transformer for maximum amplification must at least be equal to the output impedance of the preceding tube in a cascade amplifying set. There is an allowable variation for the impedance of the transformer when loaded on the secondary by an amplifying tube, but nevertheless, the maximum signal is obtained from a transformer especially designed to fit the output impedance of the tubes with which it is used.

An audio frequency transformer has been developed by the Radio Corporation which has been specially designed for use with the Radiotron U. V.-201 amplifier tubes, and in which the transformer losses have been reduced to a minimum.

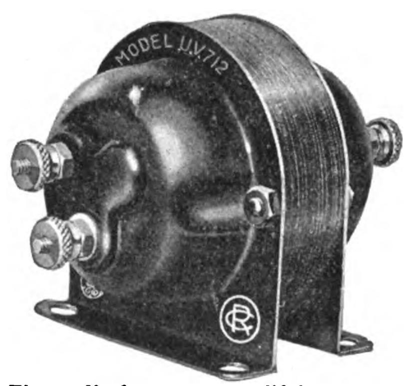
The new transformer of shell type design is shown in the accompanying illustration. Its characteristics are:

Ratio of secondary to primary turns, 9/1; the useful frequency range, 60 to 3000 cycles; the allowable current on each winding, 10 milliamperes; the test voltage between windings and between core and windings, 300 volts at 60 cycles; the terminal voltage limit of secondary winding is 300 volts; the D. C. resistance of windings: primary 430 ohms, secondary 5100 ohms; impedance at 1000 cycles (one milliampere):

	(approximate)
Primary with secondary open	19,000 ohms
Primary with secondary shorted	650 "
Secondary with primary open	1,400,000 "
Secondary with primary closed	43,000 "

Overall length 3⅞", height 2¾", base 2 x 2¾". Core 75 soft iron laminations.

In general, a tone-frequency amplifier transformer should occupy the same position in the output circuit of a vacuum tube as the receiving telephone. The terminals P and F of this transformer should be connected to the binding posts which ordinarily are connected to the telephone receiver. The secondary terminals should connect to the grid and filament of the following tube. Such a circuit using two stages of tone frequency amplification is shown in figure 1. This circuit makes use of a Radiotron U. V. 200 as a detector and the amplifying qualities of Radiotron U.V. 201.



The audio-frequency amplifying transformer completely assembled

In many radio receiver circuits, it is of great advantage to connect a variable condenser from the plate of the detector tube to the negative side of filament, as shown by the dotted line at C1. It is also frequently advisable to ground the point shown by the dotted lines at G in order to obtain complete stability and eliminate inductive noises, although it is possible that noisy operation may be caused by rundown batteries, loose connections and faulty adjustment of the amplifier.

If the Radiotron amplifier U. V. 201 is used in the circuit of figure 1, a plate potential of from 40 to 100 volts may be used, the resultant amplification increasing with the voltage. Forty volts, however, is sufficient for ordinary purposes. When using 100 volts on Radiotrons U. V. 201, the plate current is approximately 5 milliamperes, and if this voltage is used, the polarity of connection to the telephone receivers should be such as to increase the magnetization of the permanent magnets rather than to decrease it. Using Radiotron U. V. 200, as a detector, the plate voltage should be adjusted to some value between 18 and 22½ volts.

It is highly essential to connect the transformer terminals as marked and as shown in figure 1. Transformer terminal marked "G" must always be connected to the grid of the next tube.

In all radio amplifier circuits using this transformer, the insulation of all apparatus connected to the secondary must be as perfect as possible. Leakage from the grid to the filament of amplifier tubes, through the socket, mounting, panel, wiring, or otherwise, will decrease the amplification. The lead from terminal "G" should be kept reasonably short, but in cascade amplifier sets adjacent transformers should not be mounted too close; a separation of at least 3 or 4 inches should be allowed.

R1, R2, R3 are the filament control rheostats PR535, and R4 is a special "A" battery potentiometer.

The circuit diagram here given has the secondary F terminal connected to the filament rheostat on the side away from the filament. This puts a bias negative potential on the grid of the amplifier tube which will have a value of approximately one volt providing a 6-volt battery is used and the filament current is adjusted to the normal value of one ampere. Separate biasing batteries may be used if it is desired to get the absolute maximum of amplification. One or two dry cells may be connected in series with the grid circuit. These cells should be connected near to the low potential terminal of the secondary; that is, next to one leg of the filament. The positive terminal of the battery should connect to one leg of the filament and the negative terminal to the tuner secondary.

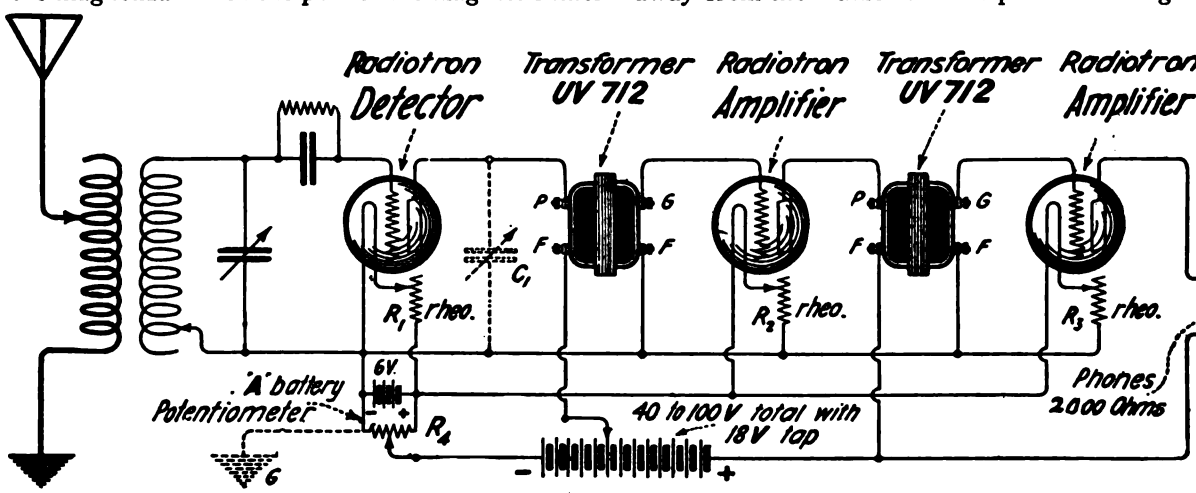


Figure 1—Hook-up of two audio-frequency transformers in a circuit using two stages of amplification

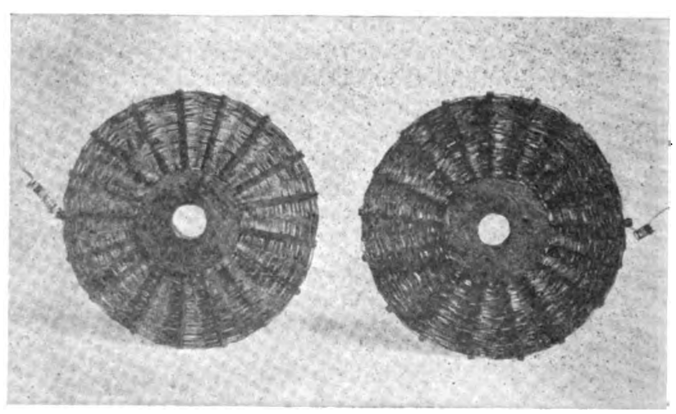
Stagger-Wound Inductances for Radio Work

By D. R. Clemons

The choice of inductancess for radio circuits is governed by the value of the unit, the space available, and the coil design. Flat spiral inductances are highly efficient and desirable in radio circuits, but they are not always conveniently mounted in a fixed position, or for variation of magnetic coupling with a second coil. Inductances of this form are desirable for wave-meters, receptors, and low power transmitting circuits.

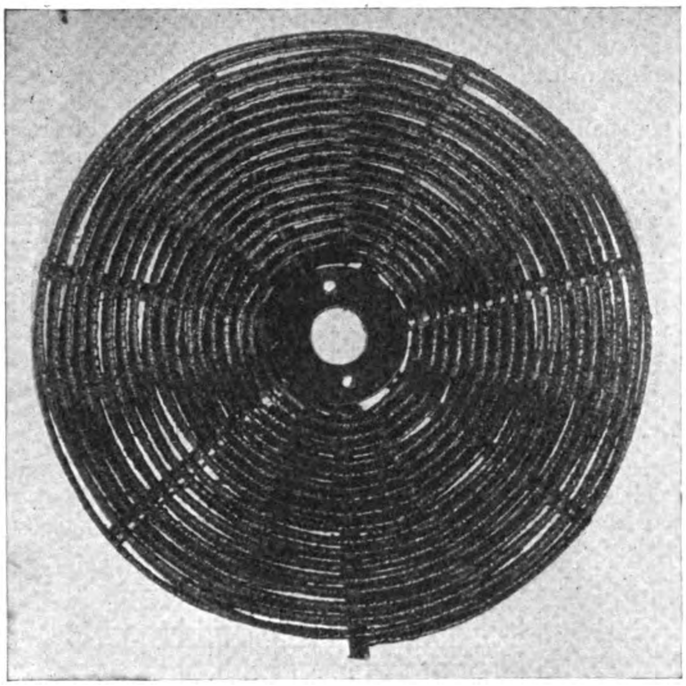
Three typical stagger-wound inductances, selected for use in wave-meters or short wave receptors, and also a primary and secondary system for long wave tuners up to 20,000 meters, will be described. In addition a description is given of an inductance that is eminently suitable for low power tube and spark transmitters.

In constructing inductances of this type the wire is stagger-wound through a number of wooden pegs set radially into holes drilled into a cylindrical wooden core. This core provides a suitable base for mounting the coil upon a panel; or it may be drilled and carried upon two brass rods so that it may be moved to or away from a second coil. An odd number of pegs must be used; i.e., 5, 7, 11, etc. The number will depend upon wire size and the depth of windings. If the pegs are few, the winding will not be uniform as the depth increases. For coils employing relatively coarse wire, the rigidity of the wire holds the winding symmetrical through a few pegs, but if



Coils suitable for receivers and wavemeters using 1 millihenry inductance

the wire is finer than No. 22 gauge the number of pegs should be substantially increased. This principle is illustrated where seven pegs are used for coarse wire and seventeen for finer gauge material. Some flat spirals are varnished and the pegs are drawn out or entirely removed as the winding proceeds. The coil then stands without



Sideview of stagger-wound coil

the pegs in position. This latter practice is not recommended where high temperatures or inclement weather may be encountered. The pegs are of dry wood and cannot impair the efficiency by remaining in position.

For winding inductances with relatively fine wire, a wooden frame is first constructed and arranged so that it may be turned by hand. The wire is fed alternately through the pegs; passing to the right and left of the pegs as the framework revolves. The wire will lay uniformly in position if the tension is not great. However, if the tension is heavy—that is, if the wire is wound in

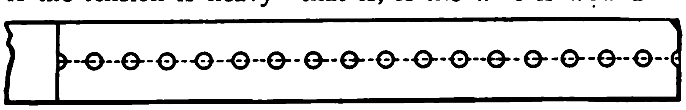


Figure 1

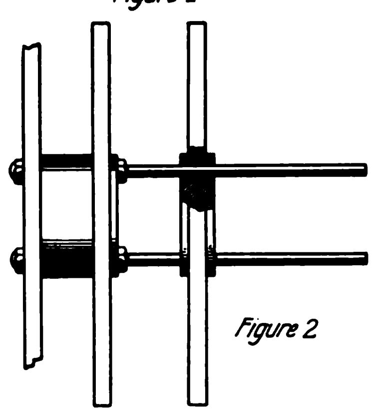
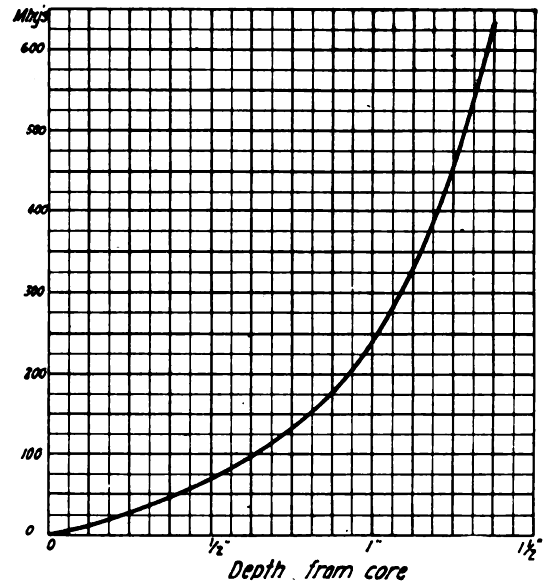


Figure 2

Figure 1—Strip for accurately locating pegholes about cores
Figure 2—Suitable mounting for movable and stationary coil

tightly and even forced inward occasionally—more wire may be placed within a given depth. This latter practise results in a coil that is not so uniformly symmetrical, but the inductance within it may be more than twice as great as a loosely wound coil. It is true that its capacity will increase somewhat, but this increased capacity scarcely differs from a coil loosely wound. A comparison of two coils wound loosely and crowded is shown in the first illustration. It should be borne in mind that energy losses due to the capacity of the coil itself are negligible unless it should cause the coil's fundamental to occur within a band of wave-lengths to which the system may be tuned. Where an inductance is provided with numerous lengthy taps, the loss due to this addition may be much greater than losses in the coil itself.

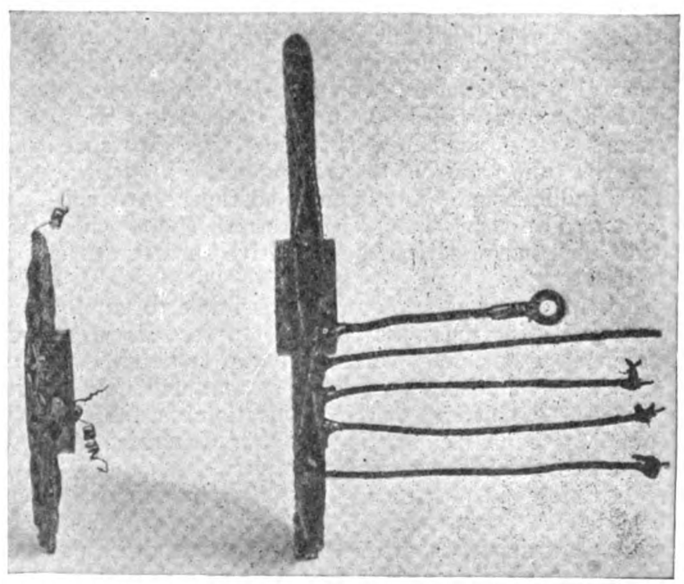
Graphic curves show the inductance increase with the



Staggered coil No. 1—Diam. Core, 1¾ inches; Pegs, 17 matches; Wire, No. 2 S. Silk

depth of winding. Should any intermediate values be required, a tap or lead may be attached for that value. In solenoids, multi-layer coils or spirals, slight variation from given curves must be expected. This is due to the impracticability of reproducing a coil accurately. Curves given are the averages taken from several similar coils symmetrically wound.

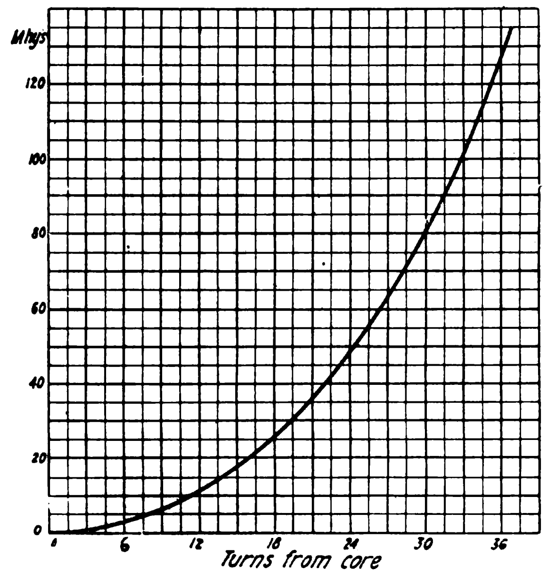
A type of coil suitable for receivers and wave-meters requiring about 1 millihenry for inductance is shown in



End views showing tap leads

figure 1. The curve given is for the coil at A, in which the winding is symmetrically wound by the method previously mentioned. The inductance is 480 millihenries. The coil to the right is similar except that the winding is forced to gain increased inductance. Its value is 1,200 millihenries. Both coils were constructed as follows:

The core is a section of magnet-spool centers 1¾ inches in diameter, cut squarely to a length of ⅝ inch. A strip of paper ⅝ inch wide is placed about the cylinder and the circumference marked where the strip overlaps. A line along the center is marked into seventeen points of equal spacing; or a point for each desired peg, as shown by figure 1. These points are then struck through into the wood by wrapping the strip about the core and using a prick punch. These points are then drilled with 3/32 inch holes and free ends of match stems driven in tightly. The framework is then complete. Several ounces of No. 26 s. silk wire is then stagger-wound through the framework by first attaching it to the base of one peg with several inches of wire protruding for leads. The framework is then turned slowly as the wire is fed alternately



Staggered Coil—Diam. Core, 1¾ inches; Pegs, 7, skivers; Wire No. 18, Annunciator

to the right and left of the pegs until a desired value, diameter, or depth is reached. If intermediate taps are required they may be soldered into a bared section of the wire and the joint covered with tape. On finishing the spiral all protruding stems or pegs are cut away and the coil is varnished.

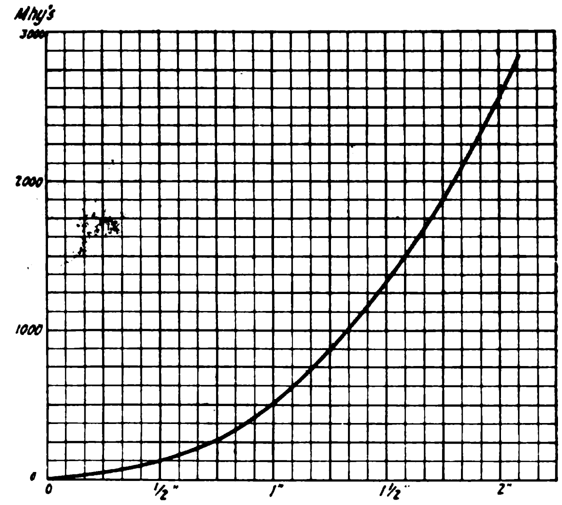
Coils in the illustrations at figure 1 are 4½ inches in diameter, while a side view shows the core length of ⅝ inch. The inductance of coil A is 480 millihenries, which, with a capacity of .0005 mfd., tunes from 95 to 920 meters. Its fundamental is 74 meters. Two such coils in series tune from 270 to 2,150 meters, giving a value of 2,705 millihenries. The distributed capacity of coil A is 7.5 micro-mfds.; coil B 12.5 micro-mfds.; and where two coils are used in series, their relative surface capacity is 16 micro-mfds.

For long wave receptors it is desirable to employ two small coils for magnetic coupling to secondary. Large loading systems must be used in the respective circuits. A primary and secondary load system will now be described. Illustrations of this application in a tuner will be found in the November issue of the WIRELESS AGE on "The Universal Wavelength Receiver."

A rolling pin measuring 2½ inches in diameter is cut into nine sections, each ¾ inch long. A ¾ inch strip of paper is wrapped about one disc or core and the point of overlap marked. This strip is then sub-divided into eleven equal spaces similar to figure 1. By binding it about each core-disc the points are indicated in the wood with a prick punch and each drilled with a 3/16 inch hole. Eleven wooden pegs, called "skivers," are set into the holes of each core. Skivers are used in butchershops for pinning meat rolls and they are very cheap. After nine of these forms are constructed, the wire may be wound in position by the usual process. No. 24 gauge s. cotton should be wound to a depth of 2¾ inches on each coil. Projecting pegs are then cut off with a hacksaw and the coils are varnished. All nine coils are fastened together by passing two threaded brass rods through corresponding holes through the cores. All coils must be connected so that all fields interlink or add; i.e., the general direction in which the windings progress must be continuous throughout. A curve is shown for this type.

Eight coil frames are similarly constructed for the secondary system. This latter is wound with No. 26 s. cotton wire. They also are mounted upon brass tie-rods. Such units for long waves are very effective and economically constructed. They are easily separated or dead-ended and tapped for any inductance value required.

A very efficient and practical coil for spark or tube



Staggered Coil—Diam. Core, 2½ inches; Pegs 11, skivers; Wire No. 24 S. Cotton

transmitters is illustrated and an accurate curve provided. This variety is constructed like the inductances used in the "Buzzer Transmitter" recently described in the WIRELESS AGE. A core is cut from a spool center measuring 1¾ inches in diameter. Seven 3/16 inch holes are located and drilled by again using the paper strip described. Wooden skivers are then firmly glued into position and the framework wound with No. 18 cotton covered annunciator wire. Such wire is excellent for very high frequency circuits. Leads may be secured by soldering a short lead into a short space bared of insulation. The joint is covered with tape and the winding completed. On the last turn a hole is drilled in one peg, through which the finishing turn passes to provide an extended lead. Pegs are then cut, and the unit varnished.

Illustrations show this last unit. The diameter is 7½ inches and ⅝ inch core length; although this core may project outward somewhat in case the coil is to be held away from the point of attachment. The inductance is 127 millihenries; capacity 4.2 micro-mfds. Where several coils are to form a large unit as described for the long wave tuner, radial pegs may be set into a solid core not cut into separate sections. It is advisable to construct each unit separately for convenient handling.

For a variable coupling between two staggered spirals, holes may be drilled in such a way that one coil may be moved along two small rods passing through them as shown in figure 2.

Varnishing all coils with liquid bakelite or shellac after winding not only excludes moisture, but also strengthens the work mechanically. One light application should be followed with a heavier covering.

In conclusion it should be said that any losses or capacitive changes due to varnish is negligible. For inductances of less than 5 millihenries, there is no change recorded in the measuring instruments. For very large inductances in the order of 40 millihenries the capacitive change due to two heavy applications of varnish is so very low that it may be considered negligible.

Radio Telegraph and Telephone Transmitter and Receiver

A SYSTEM of radio telegraphy and telephony in which a message can be telegraphed simultaneously with a radio telephone conversation has been described by A. H. Taylor, who says the circuit has many new and novel features, among which are the following:

1. Telegraph signals and telephone conversation may be transmitted in such a way that the telephone conversation cannot be received continuously in logical sequence.

2. The transmitter will operate on a single antenna and will radiate a telephone conversation on either a carrier wave or a signal carrier wave on intermittent blocks of speech and will simultaneously transmit telegraph signals on the signal carrier wave.

3. The receiving circuit will work in conjunction with the transmitter, comprising a single antenna system with a plurality of co-operative oscillating circuits adapted to respond to the carrier and signal carrier wave and piece together or combine the blocks of telephone conversation and simultaneously receive the telegraph signals.

In other systems for the simultaneous transmission of radio telegraph signals it has been customary to employ two distinct oscillating circuits energized by separate transmitters. It has also been proposed to utilize a commutating circuit in a multiplex system for transmitting a plurality of radio telegraph signals having different frequencies. Another system is that by which radio telephone or telegraph signals may be transmitted in a semi-secret way by employing a rotating contact breaker in the antenna circuit. Another suggestion is that telegraph and telephone signals may be transmitted simultaneously on a single wave length.

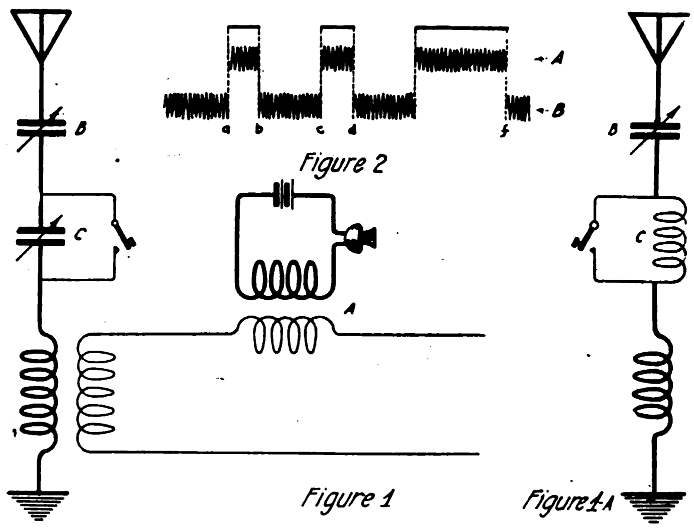
In the system for the simultaneous transmission of radio telegraph and telephone signals, described here, secret communication has been successfully established by radio telephone, simultaneously with the transmission of telegraph signals between the Bureau of Standards, Washington, and the Naval Air Station, Anacostia, D. C. The telegraph signals could not be heard in the telephone receiving circuits and the telephone conversation did not interfere with telegraph reception. It was also impossible to receive intelligently the telephone conversation with standard receiving apparatus.

Figure 1 indicates an antenna, and series variable condensers, and the antenna inductance connected to ground. The inductance may be energized by a source of sustained oscillations, by means of the coupling coil or any form of connection may be employed to suitably excite the antenna system. The sustained oscillations are modulated in accordance with voice frequencies by a suitably arranged circuit at A. The series variable condenser C in the antenna circuit is shunted by a key. The condenser may be substituted by a suitable inductance C, as shown in figure 1A.

Figure 2 shows the fundamental action of the simultaneous radio telegraph and telephone system. The waves are represented for telegraphing the letter "U" on the signal carrier wave A, while blocks of speech are telephoned intermittently on the carrier wave B, and signal carrier wave A.

When the key of the transmitter of figure 1 is in the normal open position the carrier wave B is radiated on a certain wave length, for example 500 meters. If the letter "U" is to be telegraphed while the carrier wave is continuously modulated by speech, the key is depressed for the periods ab, cd, and ef. Upon pressing the key at point a the radiated wave is shifted to another wave length, say, for example, 600 meters, and transmits "dot" ab as a telegraph signal. Upon releasing key the wave is automatically shifted back to 500 meters as at point b.

This action is repeated for each key depression as shown and blocks of telephone speech are radiated. By shunting the condenser C the wave length of the antenna system is increased and the result obtained as above described. If, however, the inductance coil C in figure 1a is substituted for the variable condenser, and the key depressed, the signal carrier wave will be shifted to a lower wave length and in this event the carrier wave will be, for example, 600 meters and the signal carrier wave 500 meters.



Antenna circuit and fundamental action of the system

The circuit diagram of the receiving system employed is shown in figure 3. The antenna is connected in a closed oscillatory circuit comprising primary inductances 15, 17 and 18, and variable condensers 16 and 19 with a ground connection 6 located between inductances 17 and 18. The telegraph receiving apparatus is inductively coupled to the primary 15 of the antenna circuit. The secondary winding 20 is shunted by variable condenser 21, and connected at one end with the grid of a vacuum tube 23. The plate is connected through variable condensers 28, 29 and 30, with one end of the secondary inductance 20. Variable condenser 28 shunts the primary of the radio frequency transformer 31, one end of the primary being connected through test telephone receivers 32, and the high voltage battery to the midpoint, between variable condensers 29 and 30, and the opposite end of secondary inductance 20. The grid leak is shunted between the grid and the high voltage battery and filament battery. The test telephone receivers 32 are placed in the plate circuit of tube 23 in order to determine the oscillating condition of the vacuum tube circuit.

Oscillating circuit 35 is inductively coupled with the circuit of tube 23 by means of transformer 31 and is regeneratively constructed by means of the usual coupling coil 36. Amplifiers 37 and 38 are inductively coupled with the regenerative circuit and containing telephone receivers 39 adapted to respond to the telegraph signals.

The method employed for receiving the intermittent blocks or telephone conversation and combining them to produce complete understandable conversation will now be considered. Secondaries 40 and 41 are inductively associated with primary windings 17 and 18, respectively. The secondary coils 40 and 41 shunted by variable condensers 51 and 52 are connected respectively to vacuum tube circuits 42 and 43, having their output terminals connected to the primary windings 44 and 45, of the audio frequency transformer 46. The secondary winding 47 of the audio frequency transformer is connected to the input terminals of a multi-stage thermionic amplifier represented at 48 and 49. The output of this multi-stage amplifier is connected to telephone receivers 50, which respond only to the received telephone conversation.

In the operation of the receiving apparatus primaries 15 and 17 and condenser 16 are adjusted in resonance with the signal carrier wave and primary inductance 18 with condenser 19 are tuned to respond to the carrier wave. The telegraph receiver is adjusted by first setting vacuum tube 23 into oscillation, until the oscillating condition is detected by means of test telephone receivers 32 inserted in series with the plate circuit. The resulting impulses in vacuum tube 23 will be of 10,000 to 30,000 oscillations per second and therefore constitute a wave of from 30,000 to 10,000 meters in length. The plate circuit of V. T. 23 is tuned to this wave by means of variable condenser 28 in shunt with the primary inductance of radio frequency transformer 31 permitting that wave to be transferred by virtue of the coupling between the primary inductance and the secondary winding of the transformer 31, to the oscillating tube 35 whose oscillations are combined with the oscillations transferred from tube 23 in such a way as to produce an audible signal, which in turn is amplified by the circuits 37 and 38 to actuate telephone receivers 39 to reproduce only the telegraph signals. This action has the effect of double heterodyne, for the signal oscillations in the antenna circuit are superimposed upon tube circuit 23 which is in itself generating local oscillations, thus producing a beat effect in the primary winding of the transformer 31, which in turn interacts with the local oscillations produced in the oscillating circuit 35, thereby producing a second beat of audible frequency. This audible beat telegraphic signal is amplified by circuits 37 and 38 and operates telephone receivers 39. This method of telegraph reception prevents the telegraph signals from affecting the circuits in which the telephone conversation is pieced together.

In the operation of the telephone receiving apparatus the blocks of telephone speech are received and made intelligible by adjusting the couplings in the two oscillatory circuits 42 and 43 and tuning them to the two intermittent wave lengths of the signal carrier wave and the carrier wave. The blocks of speech received on the two wave lengths are combined in the output circuits of the two vacuum tube systems by means of differential audio frequency transformer 46, and amplified in circuits 48 and 49 by thermionic amplifiers and made audible in telephone receivers 50. By suitable adjustment of tuning and coupling the two parts of the speech in primary windings 44 and 45 of the differential audio frequency transformer 46 are combined in a common secondary winding 47.

In the practical operation of this simultaneous telegraph and secret telephone system, the apparatus is adjusted as follows: When the transmitting station starts with simultaneous test signals on both telegraph and telephone, tube 23 is turned on. The primary windings 15 and 17, together with condenser 16, are adjusted to the signal carrier wave. The secondary 20 of the telegraph receiver is adjusted to resonance with the antenna circuit with the tube 23 oscillating and the coupling between coils 15 and 20 very loose, as determined by test telephone receivers 32 in the plate circuit of the tube 23. The tube 35 is now turned on and allowed to oscillate. Amplifiers 37 and 38 are next turned on. The windings of the radio frequency transformer are next turned by varying the shunted condensers, and the telegraph signals obtained in the telephone receivers 39 by means of the double heterodyne effect as previously described.

The telephone receiving apparatus is adjusted by first turning on the tube 42 and amplifiers 48 and 49, and the fragmentary speech superimposed on the signal carrier wave tuned in by means of secondary 40, with condenser 51 using as loose a coupling as is consistent with satisfactory audibility. Tube 42 is then turned off and the vacuum tube 43 turned on, and the component part of the telephone speech superimposed on the carrier wave tuned in to approximately the same audibility as the first component of the telephone speech by adjustment of antenna circuit 18 and 19 with secondary 41 and condenser 52. Tube 42 should again be turned on and slight adjustment of coupling of the secondary 40 made to correct any difference which may exist between the audibilities of the two blocks of speech. The thermionic amplifiers 48 and 49 are manipulated as usual to produce maximum audibility of speech in telephone receivers 50. By accurate adjustment of the two circuits the telephone conversation will be immune from interference by the telegraph signals recorded in the telephone receivers 39.

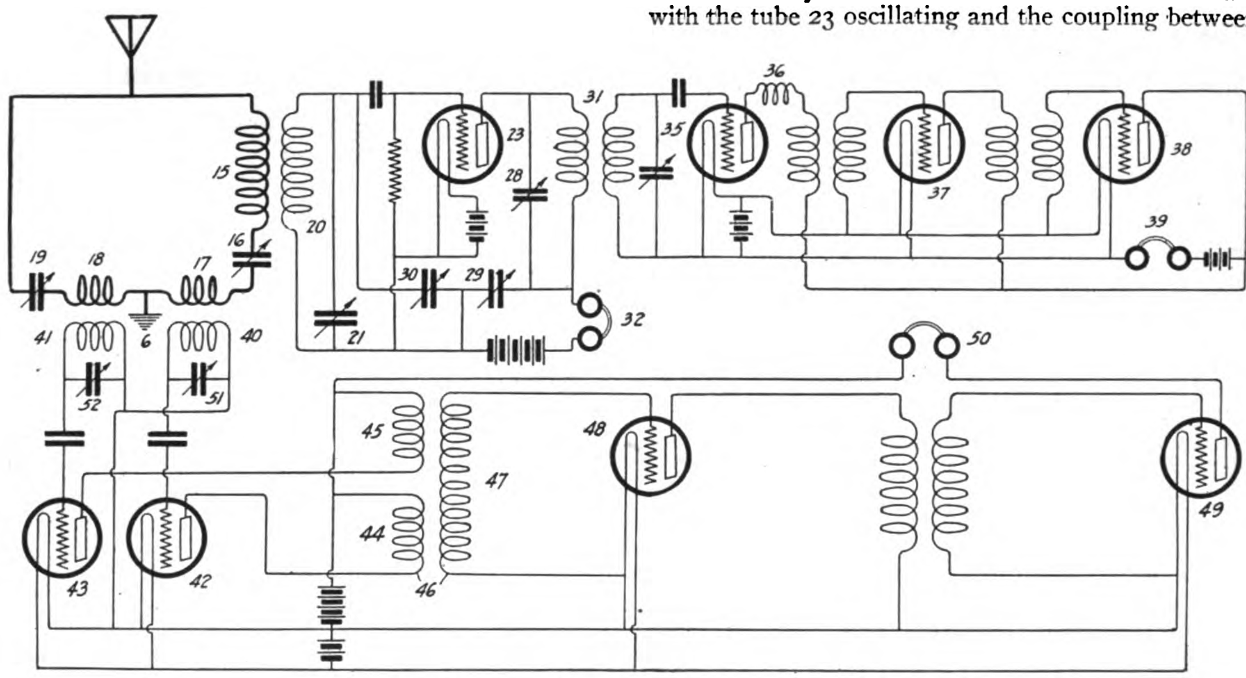


Figure 3—Circuit diagram of the receiving system

A Novel Receiving Circuit Employing Two Vacuum Tubes

E. W. B. GILL of Oxford, England, describes a receiving circuit in which the received signals act upon the grid of a vacuum tube, the anode of which is connected directly to the grid of the second tube while the variations in the current in the anode circuit of this second tube act upon a telephone receiver.

The voltage of the first grid is adjusted so that the current in the anode circuit of the second tube may decrease as the voltage of the first grid increases, and increases as the voltage of the first grid decreases, or in other words the anode current of the second vacuum tube is varied, inversely with the potential of the grid of the first vacuum tube through a portion of a cycle. The voltage of the first grid may also be adjusted with respect to the signal strength, so that the variations of the current of the anode of the second vacuum tube occur between the same limiting values of maximum and minimum for all signals above a predetermined signal strength.

In figure 1, F, f, are the filaments, G, g, the grids, and A, a, the anodes of two vacuum tubes, the filaments being connected in parallel to the battery B, through a resistance R. The anode A, and the grid g, are connected together, but otherwise they are insulated. The voltage of the grid G, can be adjusted by means of the potentiometer P, a small battery C being inserted between the potentiometer and the grid and having its negative side connected to the latter. D is a turned oscillatory circuit loosely coupled to an aerial E. The anode a is connected through a telephone T, and a battery V, to the filament circuit. The vacuum tube should be fairly hard.

Such an arrangement gives a characteristic of the form shown in figure 2, the abscissae being volts between the filament F and grid G, and the ordinates being the values of the current in the circuit of the anode a. It will be seen that as the grid G has its potential increased (positively) with regard to the filament F, the anode current of the second vacuum tube is approximately constant from K to L; from L to M it decreases and then becomes approximately constant again from M onward. From L to M the combination has a negative resistance; *i.e.*, increase of applied volts results in a diminution of the current; and the arrangement has two rectifying points L and M.

The curves in figure 3 show the effect of varying the filament currents, keeping the plate voltage fixed, while those in figure 4 give the result of keeping the filament current constant and varying the plate voltage. In both these figures the abscissae are grid volts and the ordinates anode currents in microamperes. In figure 3 the difference in potential between the anode a and the filament f is constant and equal to 40 volts, while the filament current in amperes is shown by figures to the right of each curve, the filament current in the two tubes being approximately equal. Similar results can be obtained by varying the filament current of the first tube only, keeping the second constant, the filament current of the first being the determining factor. In figure 4 the heating current is .53 amperes for all three curves, while the anode volts are shown by the figures to the right of each curve.

Figure 4 shows that there is only one result obtained from increasing the plate voltage of the second tube, and that is to increase the current drop; the place on the potentiometer where the drop begins and the ends being about the same for all plate volts; increase in plate volts therefore increases the steepness of the curve.

Figure 3, on the other hand, shows the variation of the filament current has no appreciable effect on the steepness but determines the extent of the drop. Hence by suitably adjusting the plate volts and the filament current any desired curve in reason can be obtained. For instance, a small steep drop can be obtained by using a large plate voltage and a low filament current. Signals will be heard in the telephone when the potentiometer is adjusted to give either L or M of figure 2. The signals at L are always better than those at M, this being due to the fact that at M, damping is produced by the current flowing into the first grid.

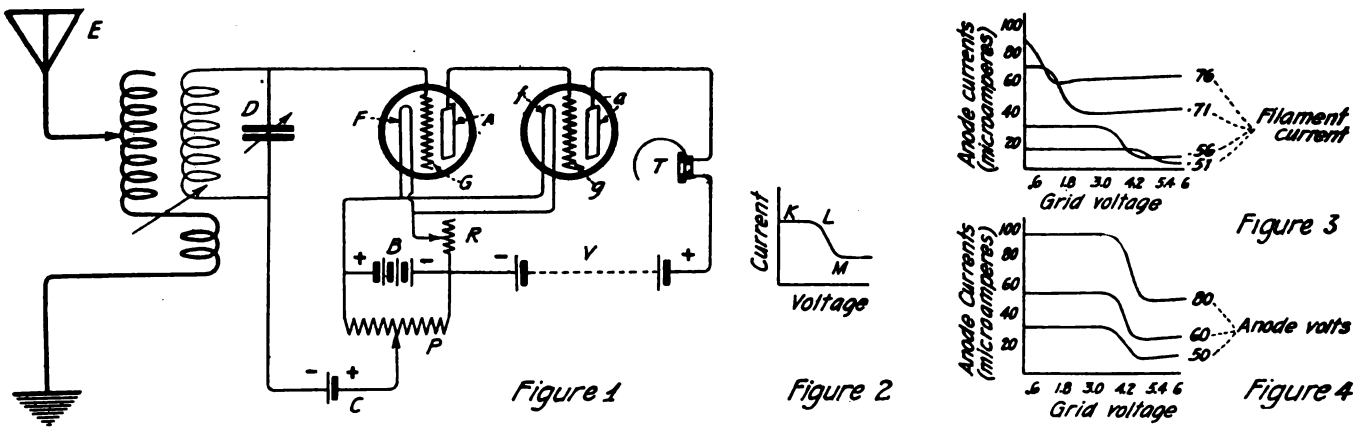
There are two main uses to which this circuit can be put for reception:

(1) Limitation.

(2) Discrimination between different types of signals.

With regard to (1), the maximum rectification depends on the drop from L to M; if therefore this drop is made small, which can be done as explained above, all signals over a certain strength will give sounds of equal strength in the telephone.

With regard to (2) between the two rectifying points L and M, signals go to a minimum, and it has been found experimentally that the position of this minimum differs for different types of sending gear. Thus the minimum for a Telefunken is not the same as for a British navy spark, and it is possible, if their strengths are about the same, to hear the Telefunken only on one adjustment, and the navy only on another adjustment. Disturbances due to certain types of "atmospherics" can also be reduced relatively to the signals it is required to receive.



Circuit diagram and characteristic curves of operation under varying filament currents

Selective Receiver for C.W. Reception

A CIRCUIT developed by E. F. W. Alexanderson, which has the advantage of being very sensitive, and capable of amplifying signals considerably while at the same time proving very selective, is described in this article.

The continuous wave receiver employs a system for the local generation of high frequency oscillation which is adjusted so as to be normally inoperative. It is also arranged so that when signals of a desired frequency are received the local means for producing high frequency oscillations will be set into operation to produce oscillations of the same frequency as the signaling oscillations, the production of these oscillations continuing as long as signals are being received. If the high frequency oscillations thus produced are rectified or detected, a continuous current will be produced, the duration of which will correspond to the length of the dots and dashes of the telegraphic signals received. Such a current will not produce any indication in the ordinary telephone receivers, which are customarily used for reception. Therefore, additional means are provided for producing an indication of the signals which are received.

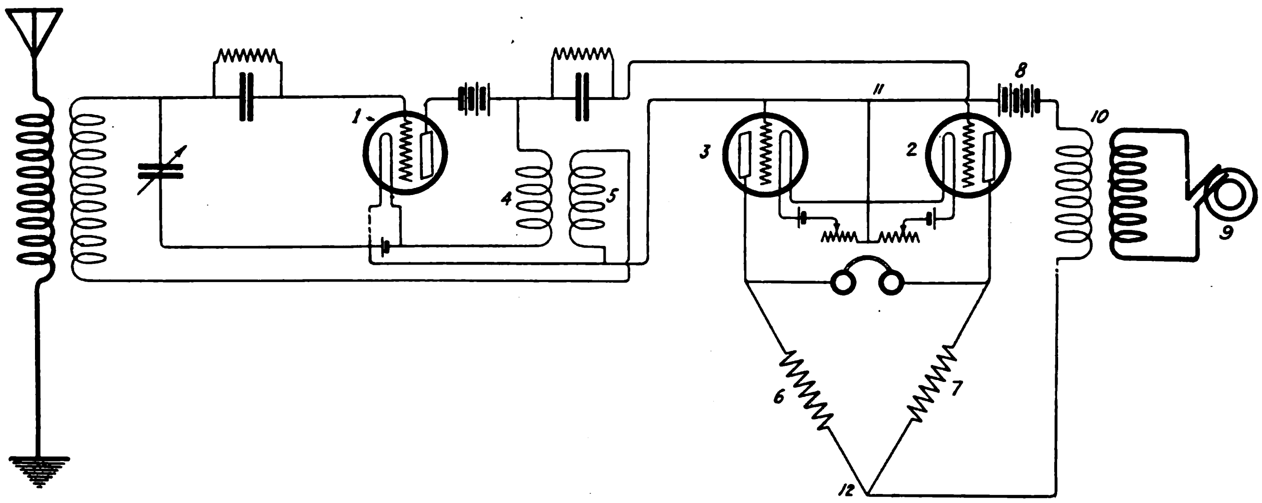


Figure 1—Circuit diagram of the C.W. selective receiving system

As shown in figure 1, the receiving system comprises a vacuum tube 1 containing a grid circuit for the purpose of tuning to the frequency of the signals which are to be received. Inductance 4 and 5 are so coupled together that the system is normally on the verge of oscillating. The operation of such a system for the production of high frequency oscillations depends upon the transfer of enough energy from the plate circuit to the grid circuit to make up for the losses in the grid circuit. If the coupling is so arranged that the amount of energy which normally would be transferred is too small to produce oscillations, a slight increase in the energy in the grid circuit will cause the device to act to produce high frequency oscillations. The small amount of energy required is supplied by means of signaling oscillations received upon the antenna and impressed by means of the primary coil upon the secondary coil in the grid circuit. Since the energy supplied to the grid circuit must have a proper phase relation to the current in the plate circuit in order to cause the device to act as an oscillator, it is apparent that if the received signals are of different frequency from the frequency for which the oscillating system is tuned, this phase relation will not be suitable for the production of high frequency oscillations. Therefore, the system will not be caused to produce oscillations by signaling currents of other than the desired frequency and will be highly selective for currents of the one particular frequency for which it is tuned. The high frequency oscillations produced by the local oscillator will be of much greater magnitude than the oscillations received upon the antenna, because of the amplifying properties of the vacuum tube.

In order to produce an audible indication by means of the high frequency oscillations produced in such a manner, the potential changes set up between the cathode and anode of the vacuum tube 1 are applied to the grid circuit of another vacuum tube 2, the plate circuit of which is included in one arm of a wheatstone bridge, the other arms of which are made up of a third vacuum tube 3, and resistances 6 and 7. The grid circuit of the detector 2 includes the grid condenser and grid leak and by means of this arrangement the resistance between the cathode and anode of the detector 2 will be varied in accordance with the signals received. In other words, the current flowing through the detector 2 from the direct current source 8 will vary at a periodicity corresponding to the length of the individual dots and dashes making up the signals which are received. These current changes will, of course, produce no audible indication in the telephone receivers which are connected between two terminals of the bridge. The bridge is normally so balanced that no current whatever will flow through the receivers. When the signals are received the resistance of the detector 2 which forms one arm of the bridge is varied and current will be caused to flow through the telephone receivers. In order that an audible indication may be given in the receiver, a source of current of audible frequency 9 is provided which is impressed by means of the transformer 10 between the two terminals 11 and 12 of the bridge. When the bridge is unbalanced, current of this audible frequency will flow through the telephone receivers and give the desired indication of the signals which are being received.

EXPERIMENTERS' WORLD

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

An Ideal Cage Antenna and Counterpoise Ground

By George W. Grauel

FIRST PRIZE $10.00

THE cage aerial with counterpoise ground, has not as yet gained much popularity in the amateur station. However, commercial corporations and some of the leading amateurs are acknowledging the remarkable results obtained by the use of this aerial and a good counterpoise. The cage type lead-in which leads from the flat top aerial to the instruments is now becoming recognized as the best type of lead-in. It takes time to start the ball rolling, and I believe eventually the cage aerial as well as lead-in will be employed by the best working stations. Too many amateurs prefer the easily constructed and quickly operated flat top aerial for quick results. How can they get the best results?

The facts concerning the cage antenna, as to its electrical efficiency and mechanical features, should be carefully surveyed when building an aerial for the best results.

As to its mechanical construction the cage occupies less space, which is often an important factor to the amateur. It requires less gaging and will certainly withstand windstorms, ice and sleet that the flat top could not endure.

Electrically the cage type provides a high center of capacity, also the lead-in which is a vertical cage permits a high capacity that improves the radiating properties considerably. The center of capacity should be as high as possible from the earth's surface, therefore the aerial should be raised as high as possible. The oscillating period of an antenna should be less than the normal working wave length. An aerial need not be long to get a 200 meter wave with the most power. The radiating properties of an antenna depends upon its radiating resistance. In the cage aerial and lead-in an equal current distribution is obtained through the entire system, which reduces the resistance and consequently the radiating properties are increased.

As to the construction a cage 3 feet in diameter and 60 feet long with six wires seems to be of sufficient size for 200 meter work. Strong and light material is to be used for the ring separators. Five rings are used in the aerial and three in the lead-in, making eight rings in all. Brass or copper tubing ⅜ inch to ½ inch in diameter is strong enough, and its weight is much less than the solid rod. Aluminum is still lighter, but it is very difficult to solder or weld. Strong galvanized iron wire, or copper wire, is less expensive and will serve the purpose, the disadvantage being the weight. Good strong rings may be had by using the rims of old auto tires. If rods or wires are used they must be bent into shape. In order that the rings may be of uniform size and shape, six nails may be driven into the floor in a circular shape with a diameter of three feet. Then the material is tightened and bent around the nails to form a circle with one foot overlapping for connection. Smaller wire is then wrapped over the joint and soldered to make it solid. Copper wire No. 12 is a good size for the aerial. Stranded phosphorous bronze wire will give better results, but it is more expensive. The aerial wires are cut a little longer than 60 feet, three of the wires are a few inches longer than the remaining three. The longer wires are for the bottom side of the cage. These being longer wires with more

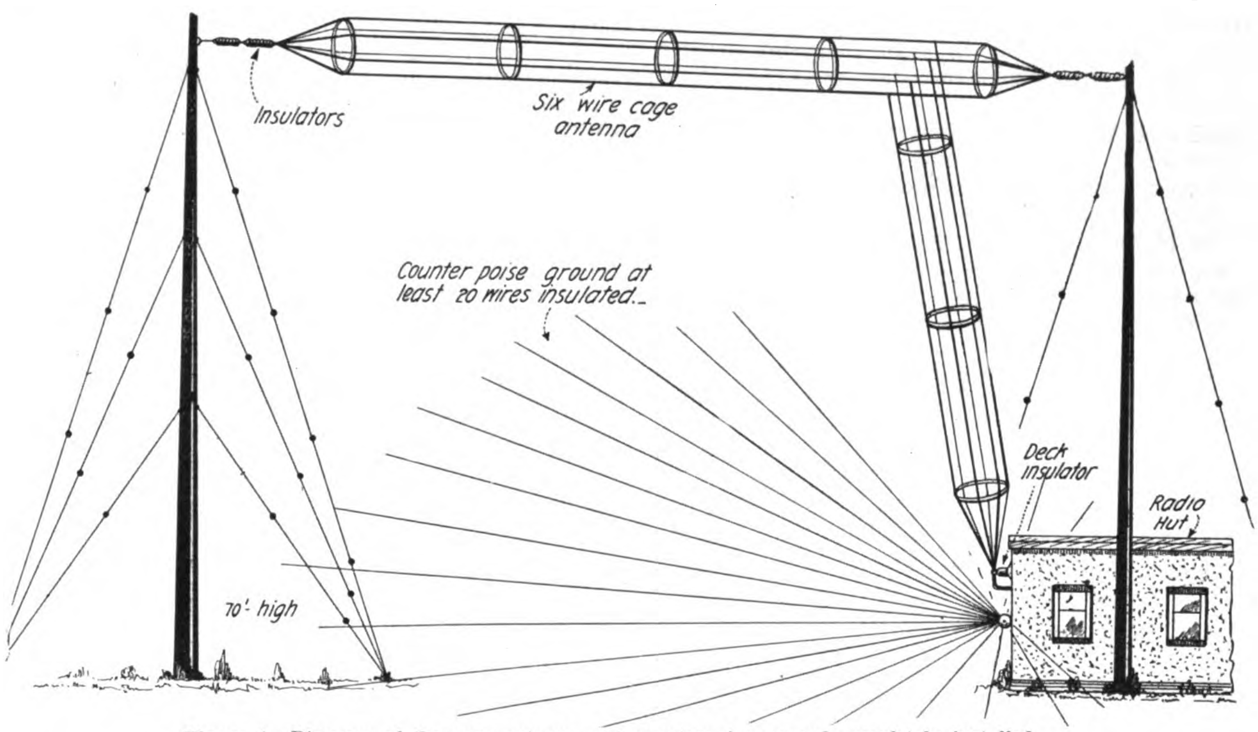


Figure 1—Diagram of the cage antenna and counterpoise ground completely installed

weight will tend to keep the aerial well balanced. Connecting the aerial wires to the rings is the next step. The wires at the crossing position of the rings must be reinforced with separate wires which are wrapped about the ring and aerial wire (see figure 3), and soldered.

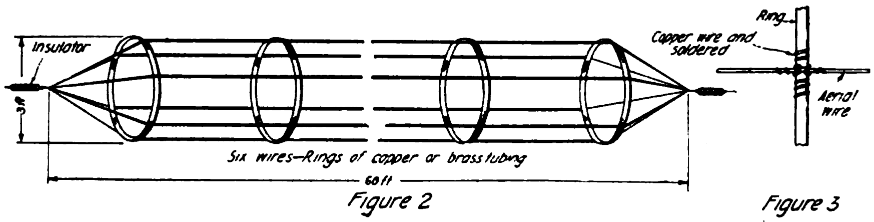
Some stations cannot get distance because they have a poor lead-in. A good aerial without a good lead-in is a serious error. The lead-in should be a vertical cage of six wires spaced by three-foot ring separators. This lead-in furnishes surface and has the form for a good radiating conductor. In figure 1 the wires of the lead-in are bunched at the entrance to the building, then taken to the instruments. Long electrose insulators are used at the ends of the cage. The guy wires are broken up every 20 feet with strain balls. All connections must be securely soldered throughout the antenna system.

An ideal counterpoise ground system consists of at least 20 strands of No. 12 to 16 copper wire radiating in all directions, the largest number of wires being placed under the antenna post. The wires radiate like the spokes in a wagon wheel as illustrated in figure 1. The length of the wires vary from 70 to 100 feet, and they should be suspended in the air 8 or 9 feet from the ground. They are insulated at the ends for best results. If conditions permit the counterpoise should be insulated from the ground. If, however, the counterpoise cannot be insulated from the ground it can be buried a few inches in the ground. Very few amateurs regard the importance of having a good counterpoise ground. There is an idea among some experimenters that a four-wire aerial must have a four-wire counterpoise, in which the wires are parallel to and directly under the aerial wires. This idea of counterpoise is good, but more wires are better.

The lead to the counterpoise must have a wide surface to permit all the energy to get into the counterpoise. A one and one-half inch copper ribbon offers enough surface for safely carrying the current from the oscillation transformer. All connections in the counterpoise must be securely soldered.

A break-in system in which an anchor gap is inserted in the counterpoise lead near the counterpoise connection, is becoming popular. The electrodes of the gap are spaced close. No change-over switch is needed; when receiving the amplifiers are turned on and when sending the key is used without touching any of the switches.

I have not had the opportunity to test the resistance and inductance of this system. An antenna and counterpoise as here-in described when properly tuned will increase the average flat top antenna current from 20 to 25 per cent. And as to distance, it is beyond me to state the records that will be made in the next year with good apparatus properly tuned.



Figures 2 and 3—Construction plan of the antenna and method of fastening wires

A Practical Cage Antenna

By Geo. J. Smith

SECOND PRIZE $5.00

AFTER having done considerable experimenting to increase the results obtained from a 10-watt C.W. transmitting set, I decided to erect a cage antenna. My theory was that since electrical waves are radiated in a horizontal plane, it is evident that the two exterior wires of a flat top antenna would radiate the most energy, and the interior wires, due to confliction with the others, would radiate very little. However, if all the wires were placed on the outside, as in the case of a cage antenna, better results could be expected.

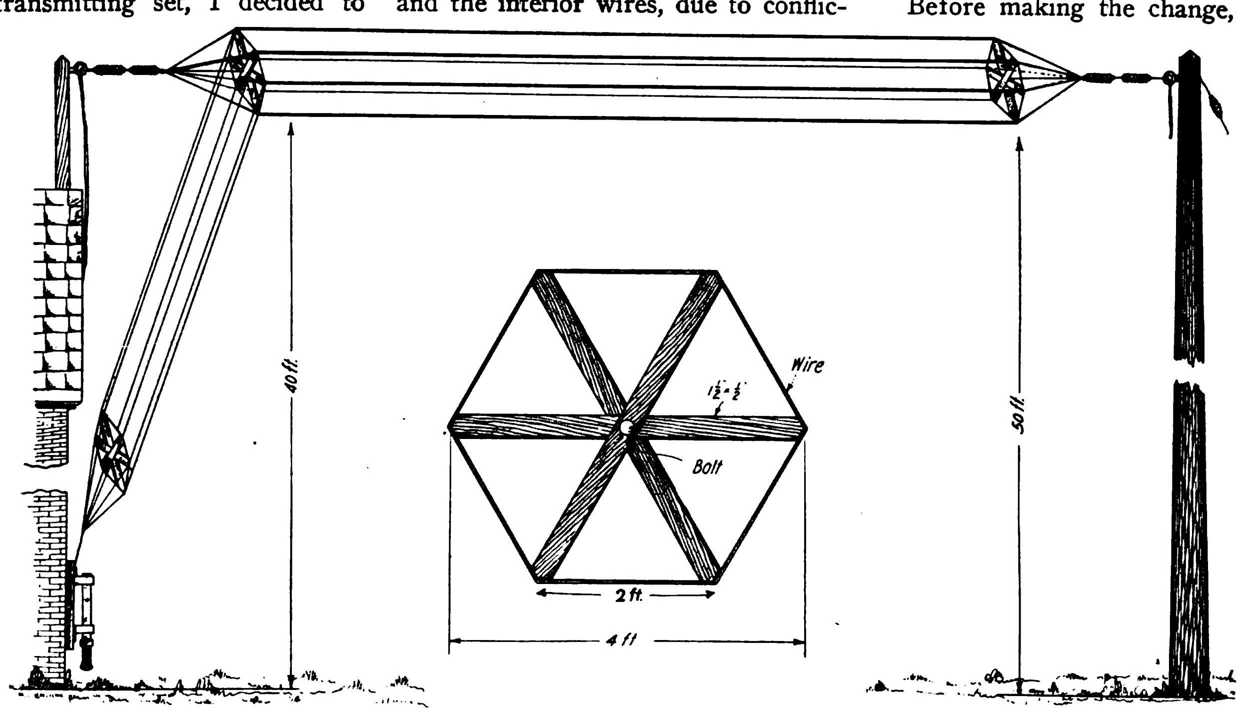


Figure 1—Construction diagram with dimensions and view of installation of the cage antenna

Before making the change, I used an inverted L antenna of three wires, seventy-five feet long, fifty feet high at one end and forty feet high at the lead-in end. Also, I might add, that at all times I use a counterpoise ground, due to the sandy condition of the soil, which makes it difficult to secure an efficient ground connection. With the inverted "L" I secured three-quarters of an ampere radiation. When I changed to a cage antenna I secured a full ampere. Moreover, signal strength was greatly increased. It is to be remembered that radio waves traveling in a horizontal plane render an antenna of this sort more efficient for reception.

The present aerial, with the same height and length as the former flat-top antenna, consists of a cage of six wires separated by a spreader four feet in diameter. At each end the spreaders were constructed of three pieces of white-wood, one-half by one and one-half by four feet, fastened in the middle by a bolt. The ends of the sticks were then spaced evenly apart, being spread out in spider formation and held secure by a wire around the edge, the whole making a very light sturdy spreader. Bridles, approximately 4 feet long, were attached to the end of each stick and also at the center to keep the spreader from buckling. The wires were then attached and the insulators inserted betwen the bridles and the pulley rope. At the lead-in each wire was continued in cage formation and held by a spreader 2 feet in diameter to the lightning switch.

Considering the superior results obtained from an antenna of this type, it seems that other amateurs would do well to examine their antenna system and compare notes.

Cage Aerials and Counterpoise Grounds

By Geo. F. Patrick

THIRD PRIZE $3.00

THE amateur station owner will do well to give the subject of aerials and ground connections his best thought and study, for herein lies the reason for a large percentage of the poor transmitting stations scattered about the country. As pointed out in the contest announcement many amateur station owners spend considerable time and money building or buying and putting together an excellent transmitter and then connect it to an antenna and ground system which is the acme of badness. Of what use is it to pump energy into an antenna system of such a high resistance that it cannot oscillate, the energy is expended in overcoming this resistance and but little is left for effective radiation. The fact that the radiation meter reads high does not prove anything. It is freely admitted that it is possible to force a large current into a poor oscillator, but unless the true ohmic resistance of the system, and the resistance due to absorption by objects in the immediate vicinity be low, there is only a small percentage radiated in the form of electromagnetic waves. Otherwise the bulk of the energy is expended locally. The total resistance of the antenna and ground system is composed of three factors, namely: the ohmic resistance of the conductors, including splices, ground connections switch or clip connections; the resistance due to absorption by surrounding objects, such as stays, trees, chimneys, etc., and the radiation resistance. To keep the first factor low the leads to the antenna and ground should be of large surface area; all joints and splices should be well soldered; all switch contacts and clip contacts on the inductances made firmly, and the connection to ground well soldered. The second factor is dependent on surrounding conditions and generally but little can be done to improve matters. It is possible though and desirable, to break up all mast stays and guy wires into short lengths by inserting insulators. For the amateur station the radiation resistance will depend almost entirely upon the effective height of the center of capacity of the antenna. For this reason the antenna should be raised as high as possible. A few feet more or less in the height of this center of capacity makes a big difference in the effective range of the station.

The shape or form of the aerial makes little difference, provided the center of capacity be gotten as high as possible, but the cage antenna is the best type for securing large capacity on short wave lengths. At the average amateur station, however, the capacity and inductance of the antenna are unimportant except as they relate to putting the antenna in resonance with the transmitting system.

The ground system is of greatest importance. The real ground is the permanently wet strata below the earth's surface, though where dependence is placed upon water pipes it is hard to tell how many miles these pipes run before the real ground is reached. The lead from the transmitting apparatus to the ground should be as short and direct as possible and for this reason dependence should not be placed on water pipes. This is one reason why so many stations are over the prescribed wave length, although they have built antenna to measurements which should give a length within the range allowed.

Where it is not possible to get a short ground connection of very low resistance, a counterpoise is to be preferred. The installation must be very carefully made, however, or poor results will follow. All wires composing the counterpoise should be at equal heights above the earth and very carefully insulated from their supports. This insulation should also be uniform at all supports, and connection to the counterpoise should be made as near as possible at the exact center. To go into the reasons for these precautions would entail a lengthy discussion. It will be sufficient to say that unless the counterpoise can be made with infinite resistance to ground, and connection be made at the center of capacity of the system, it is better to depend upon a plate of large area or a system of pipes buried or driven into permanently moist earth. If you are in doubt about ground connection and can obtain a ground connection which you are positive is good, run a lead from this good ground to the one which you suspect, and if a spark is obtained between the two when transmitting, it shows that your suspicions are correct and your ground can be improved on. When attempting to make improvements the radiation meter cannot be relied upon too much to indicate what is being accomplished, the best test is to ascertain how some distant station receives your signals. A very small increase in the radiation meter reading may give a signal of many times the intensity at the receiving station.

Newark Club Holds Dance

THE Newark Wireless Club is holding meetings every Wednesday night at 8 P. M. Recently the club staged, at the Rivoli Dance Palace, the first radio dance to be held in the city. Various CW stations along the Atlantic seaboard contributed with music. A radiophone and several measuring instruments are nearing completion and will soon be ready for use by the club members. The club desires to secure as members, amateurs and operators living in the suburbs of Newark. Meetings are now attended by amateurs from Newark, Belleville, Jersey City, Arlington and Elizabeth. Persons interested are cordially invited to pay the club a visit any Wednesday night at 284 Market Street, Newark, N. J.

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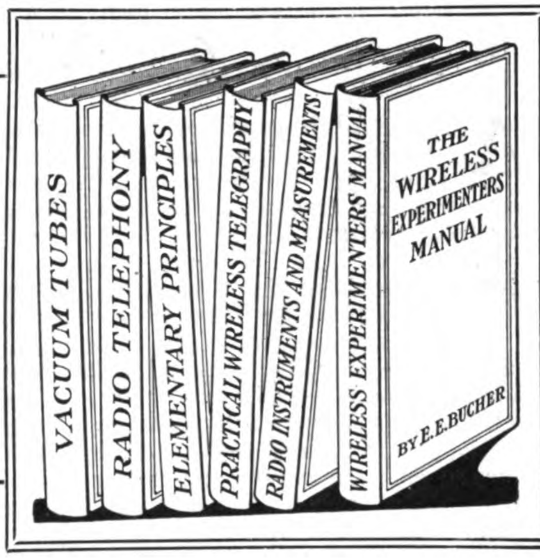

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C. W. Below 200 Meters

A 100-WATT continuous wave transmitter (two 50-watt Radiotrons, type UV-203), employing alternating current on the plates, has been used at 2ZL station, Valley Stream, L. I., since February of this year, and it has proven a very satisfactory transmitter for relay work.

The plate current of this set was 300 milliamperes at 1,500 volts on each side of the split secondary transformer; the filament current, 130 watts, a total of 580 watts total for both tubes. The antenna current on 350 meters was 3½ amperes.

In working the regular traffic schedules it was found possible to work tion and stations 8ZG at Salem, Ohio, and 8ZV at Canton, Ohio, over a period of several months. Mr. Manning, at 8ZG, reported that the signals from the A.C. set were always of good audibility, and entirely sufficient for regular relay work, and that the signals were preferable to those from the D.C. set previously used at 2ZL because of their steadiness and greater ease in locating and handling in reception. He further stated that the signals of the A.C. set were being copied regularly at Salem without having a detector tube oscillate, or in other words, without heterodyning. Practically the same report was received The grid condenser is a small mica-condenser of .0005 mfd. Mica-dielectric condensers of .002 mfd. capacity were used for the self-rectifying feature of the plate circuit. Condensers of higher or lower capacity can be used in this part of the circuit, providing the dielectric is of sufficient strength to withstand the potential employed in the plate circuit. The tuning inductance used was one of 20 turns approximately 5 inches in diameter. In connection with the system at 2ZL this arrangement gave the set a transmitting wavelength of 350 meters. A short wave condenser of the same capacity as the antenna system

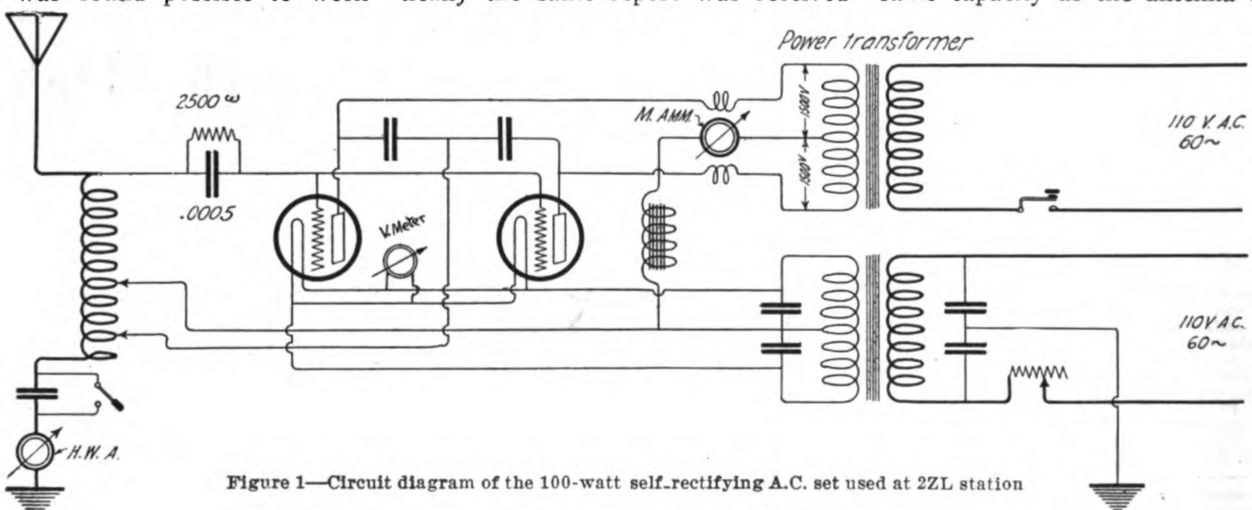


Figure 1—Circuit diagram of the 100-watt self-rectifying A.C. set used at 2ZL station

Boston, Salem and Canton, Ohio, without trouble. Mr. S. B. Young, Dorchester, Mass., 1AE, reported that the signals of 2ZL were steady and the audibility sufficient at all times for regular relay work. The signals of the A.C. set were found to be more easily controlled than the signals of the D.C. set previously used at 2ZL and there was less trouble in picking them up than in the case of D.C. signals. It might be well to mention here that a regular schedule was maintained between 2ZL and 1AE stations for a period of three months while the 100 watt A.C. set was in use at 2ZL. Even when difficulty was experienced in the reception of the signals from 1AE at 2ZL station, the signals from the latter station were read without trouble at 1AE. While the distance between the two points is about 200 miles, the territory has always been known as being difficult for amateur short wave spark transmission. Swinging and fading of signals between the two points are usually very pronounced. It will be noted, however, that it was specifically reported that the signals of 2ZL station were generally steady at Boston and that no difficulty was experienced in their reception.

In addition to Boston, regular schedules were maintained between 2ZL station and stations 8ZG … from Mr. Ley, 8ZV at Canton, Ohio.

The circuit employed in the case of the 100-watt A.C. transmitter at 2ZL station was selected after long experiment as being one which was entirely practical and which can be depended upon to work under practically any conditions. The set employs a high voltage transformer of approximately 3,000 volts, with a neutral center tap for the filament return, which gives a working plate voltage of approximately 1,500 volts on each side. The object of this split secondary transformer is, of course, to utilize both sides of the alternating current employed. The arrangement of condensers in the plate circuit completes the self-rectifying feature of the set.

The filaments are lighted by means of a split winding on the transformer. In line with the more recent practice in tube transmission, constant voltage is maintained on the filaments of the tubes rather than constant current. An A.C. voltmeter is connected to the terminals of the tube and the voltage kept constant at the proper rating for the tubes employed by means of a regulating rheostat in the primary of the filament line transformer.

The value of the grid leak resistance used in shunt to the grid condenser is approximately 2,500 ohms.

was used for reducing the wave to approximately 200 meters.

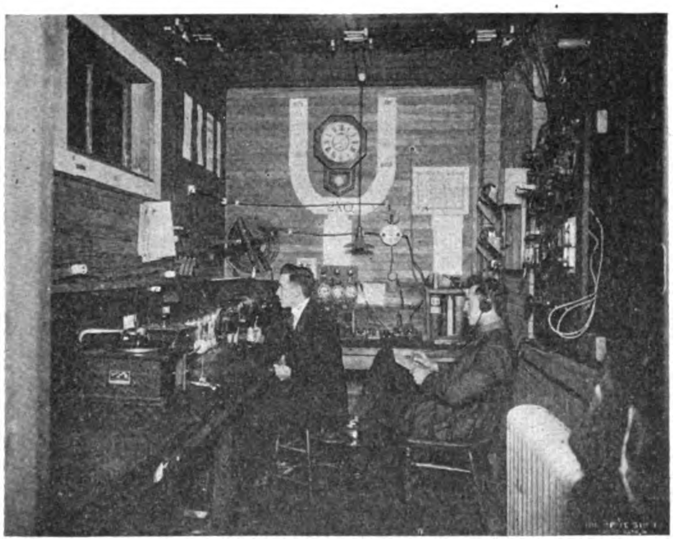
Some experiments were made to determine the practicability of employing wavelengths below 200 meters in connection with tube work. A separate antenna, considerably smaller than the main antenna regularly used, was used for this short wave work. This smaller antenna was about 60 feet long overall and consisted of 4 wires. It was found entirely possible to work on this antenna using wavelengths between 140 and 200 meters. Considerable work was done on 175 meters, the antenna current on this wavelength being 2 amperes. 100 miles in daylight was worked on this wavelength without trouble with this amount of current in the antenna. The antenna current on 150 meters was in the neighborhood of 1½ amperes, but as practically no amateur stations were equipped with receiving apparatus which would accommodate a wavelength of 150 meters, it was found impossible to make any experiments on this wavelength to determine the daylight range of the set under these conditions. When the transmitter was adjusted to a wavelength of 175 meters it was found, in at least three instances, that the receiving operators had to adjust their secondary circuit variometers at zero in order to hear the signals. When the wave was further reduced it was found impossible to "raise" any of the listening stations. After communication had been carried on for some time on 175 meters, considerable comment was made by other amateur stations on the desirability of working on that wavelength in that there was no interference and very little trouble from atmospheric disturbances on nights when static was giving considerable trouble on wavelengths above 200 meters. A great deal has been heard from various points to the effect that it was difficult or impossible to secure any antenna current on a wavelength of 200 meters to enable the transmitting station to work any respectable distance. It would seem that this condition is due entirely to the fact that many amateurs attempt to adjust C.W. outfits to a 200-meter wave on an antenna with a fundamental wavelength of 200 meters. This arrangement, of course, prevents sufficient coupling in the tuning arrangement to allow free oscillation of the set.

It is now possible to work on 175 meters with tube transmitters, without trouble, providing the antenna system is of the proper size for that wavelength. In addition to the advantages of having practically no interference on this wavelength and the absence of static, there is a very satisfactory feeling when working on this low wavelength of being entirely within the law in the matter of wavelength, leaving the operator of such a transmitter entirely free to make a selection of any wavelength he desires. The idea that tubes will not operate and generate power on 200 meters has evidently arisen through lack of experience. Tubes will oscillate on short wavelengths just as well as on long wavelengths. At 2ZL station a 50-watt pliotron, type UV-203, was made to oscillate and generate power in a small dummy antenna circuit with a period of only five meters.

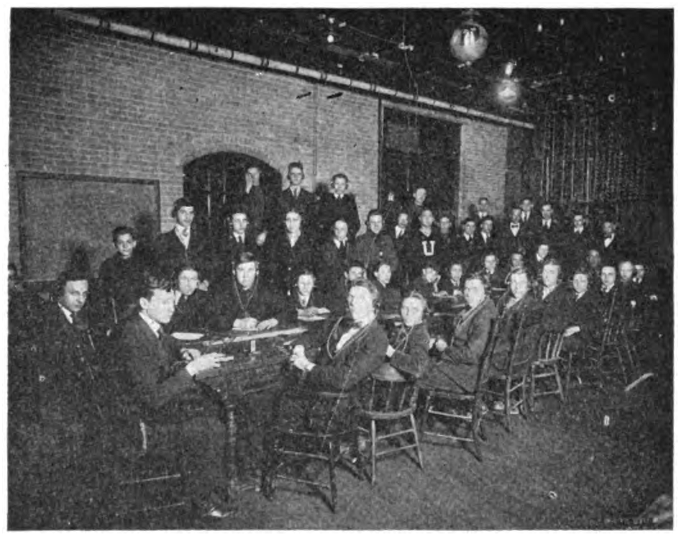
A complete diagram of the set used at 2ZL which generated 2 amperes of current in a 175-meter wavelength antenna system, is shown in figure 1.

Eight-Hour Radiophone Transmission by Union College

WHAT is believed to be a record for continuous transmitting by an amateur radio station equipped with vacuum tubes, was the recent feat performed by the Union College Radio Club, of Schenectady, N. Y. For eight hours, from 10 o'clock at night until 6 o'clock the following morning, the Union station was in steady use. Dance music supplied by Dabney's syncopated orchestra from Ziegfeld's Follies was sent from the Junior Prom held in the college gymnasium. From a large receiving horn placed over the orchestra, a wire carried the music to the radio plant, where it was sent out to the 2,000 or more amateurs within a radius of 1,200 miles. There was not a hitch and several cards have already been received from distant cities, congratulating the club on its remarkable accomplishment.



Union College radio station (2XQ) uses six U.V. 203 Radiotrons in the transmitter



The free code class at Union College has an average weekly attendance of 50 students

The Union station is equipped with the most modern of apparatus, including six of the new type 50-watt UV-203 Radiotrons. For several months the college has been giving weekly concerts on Thursday nights, sending on a 350-meter wavelength.

For the last few weeks, sermons, prepared by Dr. C. A. Richmond, president of Union College, have been sent out at eight o'clock Sunday nights. These are preceded by a hymn played on the phonograph and followed by another, and at the end the doxology is sung—a real church service (without the collection) heard at home by radio operators in no less than 24 states of the Union, in four provinces of Canada and by ships 700 miles from New York at sea. This is attested by the hundreds of letters and cards received by the radio club from amateurs telling of having listened in and complimenting the club on the clear tone in which the music and sermons are received.

Some of the letters received in reference to these concerts are interesting. One from Beloit, Wis., from Glen Franz, said:

"Heard you fine, tonight. Using only one tube. Keep up the good work."

Another from a little town in North Carolina, signed by Taylor M. Simpson, reported that the concert was very loud in that place. C. W. Carter of Schwinigan Falls, Quebec, said:

"I've just been listening to your radio concert, and it was very good, indeed. Wish you could give one every night."

A little rivalry is evident from another communication sent by R. J. McKnight, of Springfield, Ohio. He said he heard the concert and that it came in a good deal louder than either "NSF" or "KDKA." The former is a government station at Washington and the other is a station in Pittsburg.

A correspondent from Fort Wayne,

(*Continued on page* 33)

Frieda Hempel's Radio Concert

FRIEDA HEMPEL, the world-famous soprano, while in Denver, Colorado, recently, sang several arias from well-known operas and several popular songs into the transmitter of a radiophone installation at the home of Mr. H. H. Buckwalter, 713 Lincoln street, that city (experimental station 9XAG).

Mr. and Mrs. H. H. Buckwater listening in at the concert

Frieda Hempel singing into the transmitter at 9XAG

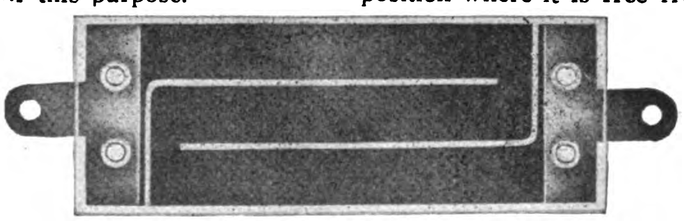
The radio song recital was very successful and the golden notes of this noted songbird of the land of opera were heard by hundreds of listeners in radio stations throughout the Rocky Mountain and Plains states. It is estimated that at least 1,000 radio stations were in the range of the transmitter and that approximately 5,000 persons listened to the voice of the famous soprano.

Mr. Buckwalter is the dean of the radio amateurs of the Denver section and is a sort of a godfather to the young Marconis of the section. His station is well known for its regular concerts, which are always of excellent quality. It will be seen by the illustration that the voice or music is first picked up by a large horn. It is then carried through a local transmitting circuit, containing several amplifiers, before going into the radio set for transmission. This arrangement makes it possible to handle very extensive programmes, including singers and instrumental music.

A Constant Resistance Unit

IN the accompanying illustration is shown a new type of resistance unit in which the resistance value is absolutely constant, a characteristic which has been lacking in most other units designed for this purpose.

As normally supplied the sheet of mica on which the deposit is made is protected by means of a second sheet. This protection is ample when the unit is mounted in back of a panel or in a position where it is free from normal injury. When the unit is exposed a brass protecting case is supplied. The use of this unit is also possible for high frequency resistance measurements. The construction is such that the unit is non-inductive and the thin layer of metal being exposed edge to edge the capacity effect is negligible.



The new resistance unit which can be made for practically any desired rating between 1 and 1,000,000 ohms

The construction of the unit is rather unique, it is composed of a strip of clear mica, on which there has been deposited, by chemical action, a film of pure platinum, or alloy of platinum and gold. This film of metal is the resistor metal. By varying the length of the deposit the resistance is varied, assuming that the width and depth of the strip remain constant, or, conversely, the length may remain constant and the width and depth be varied.

A variation of all three factors simultaneously results in the production of units of practically any resistance and a combination of the units in parallel permits the use of any desired current carrying capacity.

Considerable success has been obtained in the use of this resistance as a voltmeter multiplier. The unit may safely be operated to temperature as high as 300 degrees Fahrenheit. Similar units, with a slightly heavier coat of metal, have been used for years as heating units in electric flat irons, curling irons, etc. These resistance units are made for practically any desired rating between 1 and 1,000,000 ohms.

Distance Records

WHEN signals from a radio station are heard at unusual distances it is proof that the station is an efficient radiator of energy. The location, apparatus, construction and operation of an efficient station is, therefore, of great interest to all amateurs and THE WIRELESS AGE wants this information.

You are therefore requested to send us a monthly list of distant amateur stations heard, which will be published regularly. Report only stations located 200 miles or more distant from your station. Arrange the calls by districts (each district a paragraph), and the calls in alphabetical order.

In a second group arrange the stations you hear regularly by district, including only two or three stations, to determine consistency of performance.

State whether the stations heard use a spark or C.W. transmitter. THE WIRELESS AGE will follow the records closely and whenever possible will secure and print for your benefit and the benefit of amateurs in general detailed descriptions in illustrated articles on the stations consistently heard over long distances.

If a station is an efficient radiator of energy, it should be given proper credit in the history of amateur progress, and at the same time you will be given credit for efficiency in receiving in having heard it, as your name, address and call letters will be published with all lists submitted by you.—THE EDITOR.

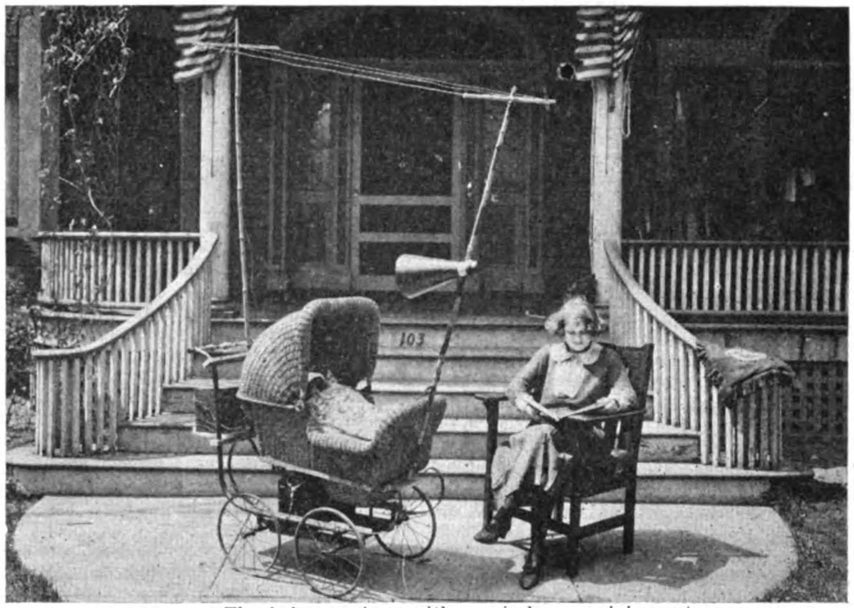
A Wireless Baby Carriage

IT is becoming a truly wireless age when radiophone music shares the interest and favor of baby with the milk bottle. There is, as yet, no specific record that baby has cried for the music from the air, but the fact that it has proved to be a great pacifier of the younger generation will undoubtedly be of interest to numerous mothers and nursemaids.

The wireless baby carriage has just recently arrived and was exhibited at Schenectady, N. Y. It was wheeled through the principal street of the city and through the parks, with lullabys pealing forth from the radio receiving horn attached to the carriage just as plainly as though coming from a phonograph a few feet away.

The music is sent from the Union College radio station at Schenectady, and can be picked up in Chicago, in fact, in any city within a radious of 1,200 miles, just as easily as by the baby carriage in that city.

The wireless baby carriage, devised by the college boys, has an antenna of three wires, stretched across the top two pieces of a bamboo fishing pole. Underneath the carriage body is the storage battery and hidden under the canopy in such a way that it in no way interferes with the baby, is the amplifier, which multiplies or adds to the volume of the music as it is sent to the horn—an ordinary megaphone secured by wires to the front antenna pole. The tuning box is attached to the rods leading to the carriage handle.



The baby carriage with a wireless receiving set

After thoroughly testing the carriage in the electrical laboratory at the college, the tour of the city was started early one evening. The music was turned on as the boys with the carriage left the college grounds, and it is doubtful if a circus parade ever created more attention and curiosity than this musical baby carriage as it pushed through the city's streets. It was afterward stopped and demonstrated in the city's principal park, to the great interest of a large number of papas, mammas and nursemaids.

Eight-Hour Radiophone Transmission

(*Continued from page* 31)

Ind., reported hearing the radio phone concert very distinctly and a similar report was received frmo Keyser, West Va. Another report received from Francis Duffey, of Cabery, Ill., said:

"Very loud here; heard your concert last night. I could heard you all the time about ten feet from 'phones and at times thirty feet from 'phones."

Another message from Ontario congratulated the club, saying:

"Your concert was heard here frightfully loud. This 'phone is the finest I have heard to date. It beats '2QR' and 'NSF.'"

An interesting message came from the steamship Peeksville, 700 miles out of Ambrose Channel. It follows:

"Thanks for your concerts. I never knew that 'Annie Laurie' could sound so well."

From the S. S. Ann Arbor, on Lake Michigan:

"When these old salts start shaking their shoulders and doing the shimmy, I'll say they enjoy your music."

THE Department of Commerce announces that beginning June 1, 1921, Arlington (NAA) will transmit the usual weather forecasts, warnings and general information on 2,650 meters, instead of on the wave length of 2,500 meters heretofore used.

The Bite of The Bug

THE wireless bug of which you've read has bitten me, that's clear. No serum treatment yet devised can help me now, I fear. At first I had a simple set, loose coupler and receivers, detector of galena stone, take note you unbelievers. It worked and each and every night, (the effect of the bug increasing), I'd try to understand the code. My efforts were unceasing.

Now and then I'd catch an "o," and "is" I got with ease. The signals weren't so very good, just loud enough to tease. In order to increase them, I got a two-stage set. The code and music now are great, it beats a "Vic" you bet.

Oh! when I think of all the time I've spent in crystal gazing, in search of useful spots thereon, in truth it is amazing; and some day in the years to come, when I have learned the code and when I get my license, I'll write another ode, and tell you all about the joys, as would old Epictitus, of how it feels to have a case of genuine "wireless-itis."

—BY PETER DEETS.

AN amateur operator in Chicago reported the following: "Mike Costello did not get his booze on time last Thursday night. If this happens again payment will be stopped." The prohibition enforcement officers are trying to locate the origin of the message.

PLANS for the free training of amateur radio operators throughout the United States, whose services would be called upon should the nation need them in an emergency, are being completed by the War Department.

The proposed plans provide for the recognition of amateur organizations within each army corps area. The headquarters of the various army corps area have already been fixed upon.

The District of Columbia will come under the jurisdiction of the Third Corps area, which is at Fort Howard, near Baltimore. Other headquarters of the various corps will be at Boston, New York city, Fort McPherson, Georgia; Fort Benjamin Harrison, Indiana; Fort Sheridan, Illinois; Fort Crook, Nebraska; Fort Sam Houston, Texas, and San Francisco, Cal.

At each of these headquarters there is to be established a transmitting radio station with a range sufficiently great to cover the entire corps area, and also a receiving set. Courses of instruction will be prepared and sent out by radio and by mail, and questions will be received and answered.

The amateur personnel will be formally inducted into the signal reserve corps and called to active service where practicable for approximately two weeks' camp during the summer.

The MONTHLY SERVICE BULLETIN *of the*

NATIONAL AMATEUR WIRELESS ASSOCIATION

Guglielmo Marconi *President* — J. Andrew White *Acting President* — H. L. Welker *Secretary*

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HEADQUARTERS: 326 BROADWAY, NEW YORK

THE first five months of 1921 have been rather unusual for radio amateur work. During the first two months of the year, usually the best for radio work, there were many nights of "dead air" and bad static. This followed in a general way the weather conditions, which, as is well known, were unusual, in that the past winter was one of the mildest experienced in this part of the country for a long time. Now, at the beginning of summer, the weather has been cool, the temperature having been below normal for several weeks, especially at night. As a result, amateur radio operators are enjoying some good radio conditions. On June 1, 2 and 3, for instance, amateur work between the First, Second, Third and Eighth districts was in full swing, and after one of these nights of good air and good work it was very easy to imagine that it was January instead of June. The prophecy of a cool summer may not be of great interest to seashore resort proprietors, but it certainly interests the radio amateurs.

THE unusual activity of the aurora borealis on the nights of May 13, 14, 15 and 16, which caused a general paralysis of wire and cable communication throughout the United States, caused very little disturbance to amateur radio communication. It was noticeable, however, that when the display was most prominent, the air was "dead," insofar as long-distance work was concerned. At the same time there was comparatively little or no static, and local, or daylight range work was not affected. To the experienced operator, however, there was the "feel" of an intangible "something" in the air, a sort of "dome of silence," which while not exactly definable, made itself felt by its effects.

During the week preceding the display of the aurora, the atmospheric disturbances had been quite strong, but gradually subsided toward the end of the week, when the first manifestations of activity by the "northern lights" occurred. On Friday, the 13th, the first display occurred, which was noted by many amateurs who took a look around outdoors after shutting up shop for the night. On Saturday night, the 14th, the display was quite brilliant, and conditions were about the same as on the preceding night. Wire communication between New York and many other cities was paralyzed, and as a result of this condition considerable press matter for the Sunday editions of papers in other cities was handled by amateurs for the Associated Press and relayed to various points. The request for this unusual voluntary service on the part of the amateur operators originated in the offices of several newspapers in cities outside of New York, when their editors found that wire communication could not be relied upon and that the papers would be short of their regular amount of news matter the following morning under the existing conditions. Unfortunately these requests for assistance were not made until after midnight, which allowed very little time for making connections and handling this unusual volume of traffic before the time of going to press arrived. Even under this handicap the amateurs responded in fine shape and successfully handled a large amount of news matter for the Sunday editions of the papers whose editors were alive to the possibilities of this second line of communication.

On the night of the 16th, Sunday, the aurora borealis was still very much in evidence, although not nearly so brilliant as on the previous night. There was some indication of activity on the night of the 17th, but only occasionally, and as the night progressed conditions slowly returned to normal and a large number of amateur radio operators, who had been up all night for the two preceding nights, just to see what would happen, finally went to bed.

THE City Council, of Salem, Massachusetts, recently passed an ordinance at the request of City Electrician Ashby, governing installation of wireless apparatus "connected with or intended to be connected with a current of electricity." The ordinance provides that a residence permit must be secured from the City Electrician, who will, before such permit is granted, see that the equipment is installed in conformity with the National Electrical Code.

It is claimed by the Essex County Radio Association of which F. Clifford Estey is president, that the enforcement of the ordinance will make it almost impossible for amateurs to operate transmitting apparatus in the City of Salem. It is further contended that the ordinance was adopted without a hearing having been granted the amateurs on the subject and a protest has been made to F. W. Broadhead, President of the City Council, but the latter has backed up the action of the Council to the extent that there are forty amateur wireless installations in the City of Salem which do not conform to the rules and regulations of the National Code.

The Boston Executive Radio Council, at a recent meeting, went on record to the effect that the new Salem ordinance is unnecessary, in view of the fact that existing federal laws and the insurance regulations are sufficiently specific to handle any such situation if properly enforced. It is stated that further action is to be taken in an endeavor to have the present ordinance annulled.

It is understood that the action of the Salem City Council was based upon complaints of disturbances on the regular house lighting lines of the city, due to lack of protective devices and other precautions. It is, in fact, another instance of the trouble which has been frequently reported from various parts of the country. The same trouble was experienced in Omaha, Nebraska, and Denver, Colorado, recently, but in both these cities engineers of the power and lighting companies met representatives of amateur organizations and after considerable discussion means were successfully adopted for obviating the disturbances on the lighting circuits.

It is claimed by the Essex County Radio Association that the City Electrician has in the past, frequently been invited to attend the meetings of the Association with the idea of formulating a plan for obviating the trouble which has resulted in the adoption of the new ordinance by the City Council, but the Association claims that no effort was made by the local authorities in the way of co-operation.

A NEW system of radio licenses for commercial operators becomes effective on July 1st of this year. The new regulations were adopted after several conferences between various radio companies, steamship owners and Commissioner Chamberlain of the Navigation Department of Commerce. Under the new regulations licenses issued by the Department of Commerce after July 1st will be graded more to the length of service of the applicant. They will start with third grade, second class licenses, progressing through the various grades up to a commercial first grade license. It will be possible to obtain a first grade license only after extensive experience. The speed for code transmission and reception has been increased to 25 words per minute, Continental Morse, instead of 20.

THE Kitsap County Radio Association has been formed at Bremerton, Wash., with an initial membership of 24 boys and men, all of whom were enthusiastic over the proposed activity.

George Dewey, of Bremerton, was elected president and Travers Campbell, secretary-treasurer.

Meetings are held at 8 P. M. Thursday evenings, and the monthly dues are fifty cents. No entrance fee is charged.

Two licensed commercial operators of long experience, H. S. Pyle, and H. R. Andrews, serve as an advisory board, and present papers dealing with the practical operation and construction of various pieces of apparatus from time to time. They are also at the service of the club in the capacity of consulting engineers.

All correspondence should be addressed to the Secretary, Travers Campbell, 1534 Elizabeth Avenue, Bremerton, Wash.

D. B. McGOWN, Assistant Radio Inspector at San Francisco, in a recent letter to the "Pacific Radio News," brings up several points of information and interest in connection with amateur operation of C.W. transmitting stations, as follows:

No authority for wavelengths in excess of 200 meters may be granted for radio telephone sets, and these sets require licenses just the same as radio telegraph stations. It has been observed that, in a number of cases, amateurs who are assigned regular official call letters, do not use them. Instead, they use the last two

Superlatives

No wonder you, Mr. Radio Man, are confused by the extraordinary descriptives such as best, most efficient and all the others you know so well. Do you ever stop to think that any one who can pay for an advertisement can make these claims? Fraternize with the old-time radio men and find out their opinion of Clapp-Eastham apparatus, of Clapp-Eastham service which goes with every sale and their reputation for fair dealing.

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Z. R. F. D. A. Receiving Set.
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Type Z. R. F. D. A. Regenerative receiving set is designed exclusively for those who require the very utmost in long distance short wave reception. It comprises two of our Z. R. V. Variometers, one Z. R. C. Variocoupler with switch, one of our famous balanced condensers and a detector and two stage amplifier.

All are mounted on a highly finished formica panel in heavy oak case with hinged cover.

Price complete except bulbs, batteries and telephones	$140.00
Same set without amplifiers, Type Z. R. F. D.	85.00
Same set without detector, amplifier, variable condenser or cabinet, Type Z. R. F.	38.00
Detector panel only, Type Z. R. D.	12.00
One stage amplifier panel, Z. R. A.	18.00
Variometer, Type Z. R. V. With dial and knob	6.50
Variocoupler Type Z. R. C., with dial and knob	7.50
Variocoupler, Type Z. R. C. with dial and knob switch and points	9.00
Balanced Variable Condenser, Type F800 with dial and knob	7.00
Two stage amplifier, Type O. Z. in cabinet	40.00

Amplifying coil, semi-mounted, Type Q. O.	$4.00
Unmounted Filament Rheostat, Type Z. R. R.	1.20
Knob and dial, 3 inch, heavy brass, black finish, composition knob	.75
Graphite Potentiometer, 5000 ohms	3.00

The Hytone Panel Transmitter

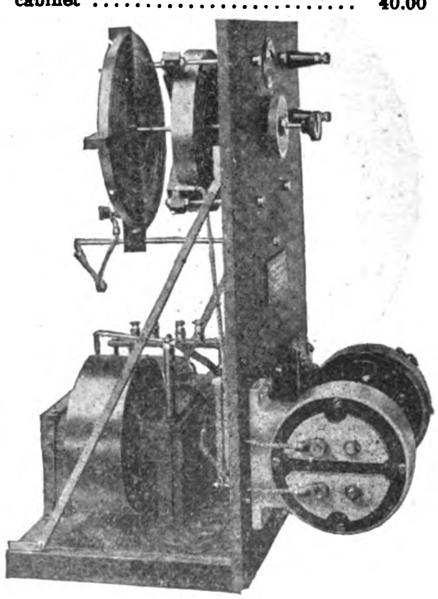
All the advantages of 500 cycle transmitters are combined in this set without the use of cumbersome and expensive motor generator sets as it operates directly on 60 cycle current. It produces a clear high pitched note which is variable at will. This set is highly efficient, with low decrement and gives sharp tuning and minimum of interference with maximum radius of communication. The set includes the following instruments all mounted on a formica panel ½ inch thick: Transformer, special low voltage type, Hytone rotary spark gap entirely enclosed in aluminum housing, Variable speed motor direct connected through flexible coupling, Mica condenser, Oscillation transformer, Thermo couple ammeter, main line switch and key.

Complete ½ K W Transmitting set as above	$250.00
Similar Transmitter 1 K W capacity	$500.00

These sets are also supplied in ratings of 2-3-5 and 10 K. W. Prices on application.

We also supply the following transmitting apparatus as shown in our complete catalogue:

Transformers, Type Z. R. L. 400 watts, especially for rotary spark gaps	$15.00
Transformers, Type L 500 watts, mounted $28.00, unmounted	22.00
Transformers, Type L 1000 watts, mounted $40.00, unmounted	34.00
Cambridge Rotary Spark Gap for use up to 1 K W including variable speed motor	50.00
Improved antenna switch	12.50
Boston Key on engraved Formica base, 10 amperes $7.50, 20 amperes	8.00
Oscillation Transformers, Type Z651	16.00



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HEADQUARTERS FOR RADIOTRON TUBES — All Types in Stock letters of the call (or three letters, as the case may be), and omit entirely to use the numeral part of the call. This constitutes, in effect, the signing of false call letters, as no call letters, or signals, can be used by any station except the calls assigned by the Department of Commerce which is given on the station license. This does not, of course, mean that "personal" signs may not be used, when there are several operators in a station, but if these latter are used, the full and complete official call must also be used at the same time, so that no doubt as to the identity of the station may exist to anyone who may happen to hear it working.

A number of experimenters and amateurs seem to be of the erroneous opinion that the use of a tube telephone, or continuous wave transmitter, permits them to use a longer wavelength than 200 meters. This is absolutely and entirely contrary to law, and anyone who so operates is liable to prosecution under the Radio Laws, unless specific authority to use a longer wave length has been granted under a special or experimental station license, in the usual manner. It might be added that the desire to operate a telephone on these longer waves does not constitute any reason for the issuance of a special or experimental license.

In all cases licenses for both station and operator are required where the operation of a radio telephone transmitter is desired. These licenses and the examination for them are all exactly the same as for a telegraph equipment. This requires that the operator be able to copy at least ten words per minute in the Continental Morse Code and to answer a number of reasonable questions concerning the operation and adjustment of his apparatus and the Laws and Regulations governing radio communication.

Contrary to popular impression, a telephone or vacuum tube transmitter will operate on 200 meters as well as on any longer wavelengths. Mr. McGown states that he has experimented with vacuum tubes and has found no trouble in getting down to 200 meters and even lower. He used two 5-watt tubes on various wavelengths. On 375 meters he obtained about 1.2 amperes and with the same apparatus returned to 200 meters the radiation dropped to about 1.1 amperes. At 180 meters, which was the lowest wavelength he attempted, the antenna current was just a little over 1 ampere. The natural period of the antenna used was 140 meters, and on the lower wavelength only an extremely small inductance in the antenna circuit was used, which was not sufficient for maximum coupling. If the antenna had been a little smaller, the radiation would not have decreased noticeably on the lower wavelength. Other experiments have indicated the same results. He has found that a vacuum tube will oscillate and generate current efficiently on 90 meters, the antenna current being about .6 of an ampere in the case of a single 5-watt tube. In this case the antenna had a natural period of but 40 meters, which indicates that the great trouble with most amateur radio telephone installations is that they are unable to get reasonable coupling on 200 meters. It is believed that if the amateurs who claim that they are unable to get proper antenna current on 200 meters will cut the antennae in half that they will have no trouble in working satisfactorily on 200 meters.

Prize Contest Announcement

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

The Construction of a Chopper for Interrupted C. W. Transmission

Closing date, August 1, 1921

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

Prize Winning Articles Will Appear in the October Issue.

Here's one for the C. W. enthusiast. Many amateurs already using vacuum tube transmitters feel that there is a big need for an efficient interrupter so that local amateur stations not equipped for C. W. reception may be worked. Prize article should include clear photograph or sketches as well as constructional details.

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, it's practicability and general utility, originality and clearness in description. Literary ability is not needed, but neatness in manuscript and drawing is taken into account. Finished drawings are not required, sketches will do. 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

RADIO Station 2QR, owned and operated by Hugh and Harold Robinson, at 13 Walnut Street, Keyport, N. J., has again been heard in Aberdeen, Scotland, and also by a Ship's Operator in port at Tela, Honduras. The following letter from James Miller of Aberdeen, Scotland, tells of again hearing 2QR, the fourth time that this station has been reported from Scotland:

April 5, 1921.

Dear Mr. Robinson:

I have just received your letter and owing to my removing from Mile-End Avenue, it was delayed. The other letter you sent in January came when I was ill. I sent a letter in reply to that one which you don't seem to have received. I got you several times in January and at the beginning of February, but I had to take my set down and I haven't done anything more at

it since, as I am taking the chance to improve it. I'll be ready in about a month to check you up again. I expect I'll hear you much better now and I hope to check you up without any mistakes. I heard you every time I listened in for you before I took down my set. The only thing was that my tuning was not very selective and other stations jammed me, however, I am improving that and I hope to hear you clearer. You are quite as good on the 275 meter wave as you were on the 600 wave. I'll send the details of your transmissions in a short time, as I haven't my notes here just now; also details of my set and photographs. I have only used three valves during the whole time and my aerial is 80 feet long double, 40 feet high, but I'll send you the whole details next mail, and also when I'll be ready to start again. I hope to use a loud speaker and let a company hear you. I don't know if I'll manage but I'll try and if I succeed then that will knock the experts freak theory on the head. I am using an entirely new type of valve, an idea of my own, and I suppose that is the reason for the remarkable results. I would like to say that your transmissions are really remarkably good. Your modulations are extremely clear, the carrier wave is really the weakest in comparison to the speech that I have heard. You really get remarkable results. I am writing this on the train, so I hope you will be able to make it out, but I want it to catch this mail so as to let you have it as soon as possible.

Hoping to hear from you soon, and also hope to hear you speaking. I remain, Yours sincerely,

James Miller.

Please note change of address: Care of Mrs. Barnett, 48 Albury Road, Aberdeen. Scotland.

Further details from the ship's operator, who heard 2QR's radiophone while in port at Tela, Honduras, are now on the way, and he has advised that both voice and music were received very clearly.

According to Mr. Robinson, these distances are records which have never before been equalled by any radiophone of the small size and power used by 2QR, and many of the distances exceed those made by even the most powerful radiophone outfits in the United States.

Mr. Robinson's radiophone uses only four 5-watt transmitting tubes, which are the smallest made. Power is taken from an ordinary light socket and is using less current than that required for an ordinary electric lamp. The whole outfit weighs less than seventy-five pounds and takes up a space approximately the size of that required for an ordinary typewriter.

Mr. Robinson further states that these recent letters practically remove all doubt as to the genuineness of 2QR being heard in Scotland, and the letters from other stations at various distances over 1,200 to 2,900 miles give further evidence to the fact that Mr. Robinson's radiophone is actually reaching remarkable and hitherto considered impossible distances, considering the smallness of his outfit. Mr. Robinson is carrying on his experiments with the expectation that 2QR will eventually be heard in every state in the Union.

The monthly meeting of the Radio Society of South Africa was held at the University, Cape Town, on the evening of March 24, there being a fair attendance. After the usual business had been concluded, L. Buckley Bridge read a very interesting paper upon the construction of a receiving set, having a range of 150-800 meters, and using crystal detection. The speaker dealt completely with each component, and furnished constructional details for the benefit of those interested. Various diagrams were given.

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Telephony is being seriously taken up by the more advanced members, and the results are good. Fifty-watt transmitting valves, with grid control, associated with the auto-transformer type of transmitter, seems to be the most favored scheme at present, but choke control, with loose coupling, is likely to prove a serious competitor shortly.

Meetings of the Society are held on the last Friday of each month. Persons desiring information should communicate with the Provincial Hon. Secretary, A. T. Stacey, P. O. Box 2055, Cape Town, South Africa.

THE Southern Ontario Radio Association of Detroit, Michigan, has set a good example for a great many other radio clubs by purchasing a wavemeter and a decremeter. There is a strong movement under way in Detroit at the present time, to check up the wavelength of all amateur stations in order to bring about a more general observance of the 200 meter feature of the law and the wavemeter and decremeter recently purchased by this club, is undoubtedly a good step in the right direction to accomplishing the desired result.

THE fourth of a series of direction finding stations to be erected by the Naval Service of Canada was officially opened recently at St. John, New Brunswick. Three other stations located at Chebucto Head, Canso, and Cape Race, are already in operation. The new station is located at 45.15.05 north and 66.0.50 west and will give a continuous service to the ships coming into the Port of St. John.

A system of directional finding stations, similar to those on the Atlantic Coast, will in all probability be established on the British Columbia, Canada, Pacific Coast, in the near future.

THE Vermilion County Radio Club holds meetings regularly at the Y. M. C. A., Danville, Ill. Joseph Fairhall, Jr., is president of the club, whose membership numbers twenty. Professor Smith, of the Danville high school, is an enthusiastic member. Mr. Anderson, of Westville, who was in the navy during the world war, as a wireless operator, and who is vice-president and traffic manager of the new organization, will instruct the members in the receiving and sending of code messages.

THE Department of Commerce announces the repeal of Paragraph 86, Page 58 of the current radio regulations, effective July 1.

Under this section of the radio regulations the operation of a radio station has been permitted prior to the actual issuance of a license providing the proper application had been filed with the Department of Commerce and call letters assigned. The repeal of this section requires that a license must be actually secured before any radio station, commercial or amateur, can be legally operated.

THE Fordham Radio Club was organized recently for the purpose of establishing the "CW" transmitter in every amateur's

sending set. That the progress in this direction has been great, is evidenced by the fact that at every meeting new members are enrolled in the "CW" chapter, and the point is being reached where a spark transmitter in the vicinity is becoming a rarity, partly because of its unpopularity, but chiefly because the members recognize the extremely high relative efficiency of the continuous wave transmitter.

Those in and around the Second District, who are hearing 2XK, 2BNL, 2ACT, 2QK, and others, regularly, do not have to be apprised of the good work already done by means of C.W.

Meetings are temporarily being held at the home of L. M. Cockaday, 2XK, 2674 Bailey Avenue, Bronx, New York, every Monday night at 8 P. M. The club extends a cordial invitation to all interested in radio, to attend the meetings at the above address. Communications are invited, and should be addressed to Richard Leitner, 1113 Forest Avenue, or to the Secretary, William Weller, 2156 Webster Avenue, Bronx.

THE Appleton, Wisc., Y. Radio Club has been reorganized this year. The regular weekly meetings are held at the Y. M. C. A. building each Wednesday night. Iner Erickson, who has a large station at Racine, Wisc., is the original organizer, and the present instructor.

At the first regular meeting, Antone Rank (9ALT) was elected president; Robert Thompson (9AUF), vice-president; John Harriman, secretary, and Harry Leith, treasurer.

THE Troy YMCA Radio Club has just closed a most successful season. Organized in 1914, and originally known as the Amateur Marconi Radio Association, the club has progressed steadily until at the present time, it is the strongest and most active of its kind in northern New York. Due to its efforts, better co-operation among the Capitol District amateurs has resulted than ever before.

Meetings were held throughout the year on alternate Monday nights, the social side being kept in mind as well as the technical, thereby always keeping up interest, and eliminating a weak point found in many clubs. Speakers from out of town, the General Electric Co. in Schenectady, and from the Rensselaer Polytechnic Institute faculty gave interesting lectures, and these talks were always popular with the members.

The Radio Club gave its first annual ball in February, which proved to be a great success. Those present enjoyed the novelty of dancing to music transmitted by radiophone from Schenectady, 15 miles away, and many for the first time listened to the Arlington time signals, which were audible throughout the six-story building of the YMCA, so great was the amplification.

From an operating standpoint, the club's station, call 2SZ, was highly successful. Over 30 states and Canada were worked, and with but 750 watts input and a short antenna surrounded by tall office buildings, 2SZ was reported heard in every district but the 6th and 7th. Actual communication was carried on at a distance of 1,300 miles with a station in Kansas, and during the winter months, a large volume of traffic was relayed to all parts of the country. The Radio Club was represented by two delegates at the Second District Radio Convention.

Meetings are suspended during the summer since most of the members, who are college students, return home. The club will reopen in September, but correspondence will be answered if addressed to E. M. Williams, YMCA Radio Club, Troy, N. Y.

The Australians

THE conditions which the amateur has to contend with in Australia are little known to the American amateur, according to Clement E. Ames, Secretary of the Wireless Institute of Australia, who expresses the opinion that even the English amateur, with his license fee of 10 s. 6d. and his 10-watt power limit, has much to thank the stars for, when he compares his conditions with those of the Australian experimenter. In Australia the license fee is £2 per annum, and the amateur is not allowed any transmission whatever.

The amount of commercial traffic to be heard is very small, and it is almost useless for the Australian amateur to work a receiving station unless he can afford to use a vacuum tube, which is a very expensive matter in that country. Nearly all amateurs are compelled to construct their own equipment, and in consequence there are only about 400 licensed experimental stations in the whole of Australia.

The Wireless Institute, which represents the majority of these experimenters, is now undertaking to convince the authorities that the license fee should be cut in half and that amateurs be again given the privilege of transmitting, even if only with low power.

Queries Answered

ANSWERS will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no questions answered by mail.

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

Q. 1. Is it advisable to install a counterpoise instead of a regular ground when my station is located at the seashore, about 400 yards from the ocean? The ground is sandy and water can be reached by digging about five feet.

Ans. 1. It is not necessary to install a counterpoise when water can be reached so readily. Advise you to drive a 10 ft. length of 3/4 inch water pipe into the ground, leaving it about 1 foot above the surface, or bury as much mesh wire as possible in the moist sand.

* * *

L. C. H., Atlantic City, N. J.

Q. 1. I have two tubes which I would like to wind as a loose coupler, not to exceed 600 meters, with an aerial of 110 ft.

Secondary 7 1/4 inches long; outside diameter 3 3/8 inches. Primary 5 1/2 inches long; outside diameter 3 3/4 inches; wall 1/8 inch. Kindly advise me where to tap for 200, 300, 350 and 600 meters.

Ans. 1. It is impossible to give an accurate estimate without knowing the exact wave length of the antenna. Space prevents including the formulae for such computation, but they can be found in the chapter on radio design in "Wireless Experimenter's Manual," by E. E. Bucher.

* * *

P. G., Jersey City, N. J.

Q. 1. What is the wave length of a transmitting set, the aerial being about 75 feet high, 40 feet long, and four wires of No. 12 copper wire. The set consisting of a 1 inch spark coil operated by a transformer, 110 volts-60 cycles A. C.?

Ans. 1. Approximate wave length 150 meters.

Q. 2. What are the dimensions of a spark coil, using the same aerial, that will send about 175 meters?

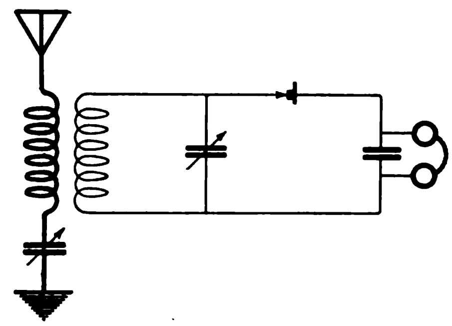
Ans. 2. The spark coil has nothing to do with the wave length.

* * *

A. H., Hammond, Ind.

Q. 1. I wish you would put in the WIRELESS AGE question corner a hookup for three honey combs, a mineral detector, a fixed condenser and a variable condenser.

Ans. 1. In using honeycomb coils with a crystal detector only two coils are necessary, one for the primary, the other for the secondary. Such a diagram is shown below.



The third coil is used only in connection with vacuum tube detectors.

* * *

H. D., Fayetteville, N. C.

Q. 1. What kind of license, if any, does the Government require the operator to hold who works for individual companies or corporations handling messages for their own use between inland states, or in other words, between cities in different states?

Ans. 1. Commercial 1st grade.

* * *

F. M. E., Oak Park, Ill.

Q. 1. Kindly advise what value of inductivity may be expected in glass photograph plates used as condenser dielectric?

Ans. 1. Depends upon thickness of plate.

Q. 2. Will the capacity of a bank of condenser plates placed against each other be greater than the capacity of a single plate multiplied by the number of plates in the bank? If so, is there any correction factor that will give the true capacity value?

Ans. 2. No greater.

Q. 3. A certain standard table, on transformer design, allows .0125 watts dissipation per cubic inch of iron core at a flux density of 60,000 lines per square inch. In designing a small transformer I am compelled to use .0025 watts instead of .0125 to make room for winding; and assuming the hysterisis loss is 35.55 per cent of the total transformer loss at 60,000 flux density. Please advise whether or not there would be any detrimental effect in using a core larger than called for, as set forth in the above figures?

Ans. 3. No, it probably would not be any disadvantage.

* * *

H. J. P., West Bend, Wis.

Q. 1. Is there trans-atlantic wireless telephone transmission?

Ans. 1. There is no regular schedule of trans-atlantic wireless telephony.

Q. 2. If so when was the first accomplished?

Ans. 2. Trans-atlantic wireless telephony was accomplished between Arlington, Va., and Lyons, France, in 1917.

Q. 3. When between Washington and Paris?

Ans. 3. The above is the answer to this part of the question also.

Q. 4. What was the largest distance covered by wireless telephone transmission?

Ans. 4. Approximately 3,500 miles, though the Telefunken Co. claims to have carried on conversation between Sayville, L. I., and Nauen, Germany, in 1917.

* * *

E. H. McE., Roosevelt, Okla.

Q. 1. Could a 6-volt automobile generator be re-wound to give 300 or 500 volts for C.W.?

Q. 2. Could you tell me the size of wire and how to connect field and armature if question one is practical?

Ans. 1 and 2. It could be done if the generator armature and field were of large enough size, but would not be practicable.

Q. 3. Would the Alexanderson tuned antenna system be practical for amateur C.W.?

Ans. 3. It would be practical and very useful, but considerable care must be exercised in making very careful adjustments of the individual antennae.

* * *

H. I. M., Hendersonville, N. C.

Q. 1. In reference to your answer to R. L. B., Wadesboro, N. C., in the May, 1921, issue, I have been repeatedly told that in order to hear the wireless phones from any distance to speak of it is necessary to have the receiving set regenerating as much as possible, while at the same time "oscillating" of the bulb must be avoided.

Ans. 1. The trouble seems to be that you make a distinction between regeneration and oscillation of the valve. In order to have regeneration it is absolutely necessary for the bulb to be oscillating. The reason for the greatest strength of signals being received when the tube is operating just below the regeneration point, is that the tube is then amplifying, but when the regeneration point is reached the tube has reached the saturation point and then proceeds to oscillate thereby distorting the spark signals and also the telephone speech.

As regards the reception of phone conversation. A crystal detector with two stages of amplification will work just as well as a vacuum tube detector and one-step of amplification and, of course, there is no chance for any oscillating being done by the crystal.

* * *

F. L. H., Brandford, Conn.

Q. 1. Which would be the most satisfactory for extreme long distance on 200 meters, a modulated C.W. using two 50-watt tubes, or a 600 cycle spark outfit?

Ans. 1. The most satisfactory outfit would be a set employing modulated C.W. with two 50-watt tubes.

Q. 2. Kindly publish what you consider as the most practical diagram of a modulated C.W. apparatus, using two 50-watt tubes. I do not want to experiment, but want an outfit with which I can sit down at and do good consistent work on 200 meters.

Ans. 2. See diagram on page 30.

Q. 3. Some years ago, when I first entered the wireless field, there was a very high pitched spark in use at the Metropolitan Tower in New York City. Can you tell me what frequency they were using and whether it was a spark with rotary gap or quenched gap? I would like to duplicate that note with my outfit, for outside of old N. Y. at 42 Broadway with which I often worked while an operator on various East coasters and South American ships, it was the most pleasing spark I ever heard to copy from.

Ans. 3. I am unable to locate anybody who has detailed information on this station although several persons have a hazy recollection of it.

Q. 4. On short waves of amateur length would a 600 to 700 cycle spark give best results on a quenched or rotary gap if the latter was synchronous?

Ans. 4. A synchronous rotary.

Q. 5. Where can I purchase a three-quarter kw. 500-700 cycle motor generator, and where can I get one of the old "coffin" type open core transformers made for the U. W. T., of one kw. capacity.

Ans. 5. Refer you to the radio division U. S. Shipping Board, for the motor generator. As to the "coffin" I would refer you to the "for sale" columns of the various amateur magazines. You may find one advertised for sale from time to time.

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D-L-150,	660-2200	90c
D-L-200,	930-2850	95c
D-L-250,	1300-4000	$1.00
D-L-300,	1550-4800	1.05
D-L-400,	2050-6300	1.13
D-L-500,	3000-8500	1.20
D-L-600,	4000-12000	1.33
D-L-750,	5000-15000	1.40
D-L-1000,	6200-19000	1.50
D-L-1250,	7000-21000	1.63
D-L-1500,	1200-25000	1.80

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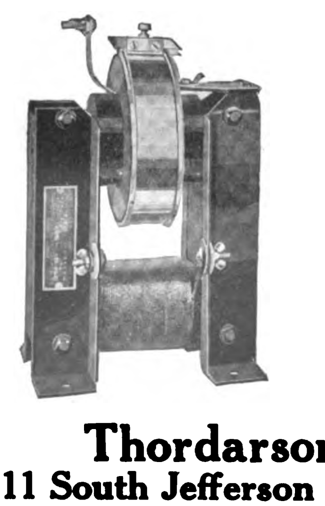
Type "RS"

TRANSFORMER



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SELENIUM DETECTORS—This cell is a light sensitive crystal radio detector and in addition can be applied to any purpose the ordinary selenium cells are used. They are entirely different from any other cell produced and will do many things impossible with other types. Pure platinum electrodes, ¼ square inch active surface sealed moisture proof. Current swing at 45 volts from dark to full sunlight is over 20 milli-amperes. I believe they are the most sensitive and quickest cell made. Unmounted $2.50 each, postpaid. Mount them to suit yourself on your own panel. Unlimited field for experiments. Russell Hart, Los Angeles, Calif. Route No. 8, Box No. 49.

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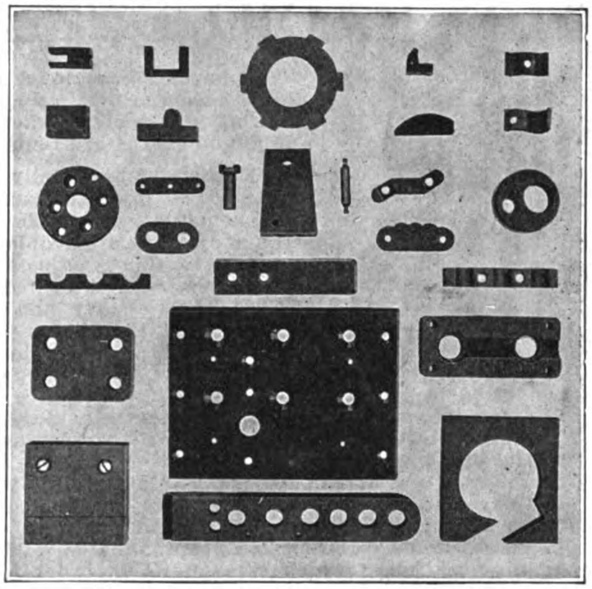

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Use a Tuska C. W. Inductance in your new tube set. Send your dealer's name and 5 cents for our illustrated C. W. Booklet.

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The vario-coupler that's "accurate to the .002 part of an inch"! Moulded base, Formica tube, Brass for all metal parts. *Price $7.50 postpaid.*

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No. 68, 3¾" 1.00
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CP-4 Brass, dozen 35c
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Radisco No. 1 .... $7.00
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All orders for apparatus not listed as postpaid must be accompanied by postage charges.

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1921 MODEL 3000 OHMS

FORMERLY $12.50 Now $8.00

Specifications: 3000 ohms resistance (each receiver 1500 ohms); cast aluminum backs, genuine Bakelite ear caps; reinforced cords with strain loops and posts; braid-covered military type head band; finest workmanship throughout. Rugged and sturdy but exquisitely sensitive. A triumph in radio-phone building. Price complete, prepaid, anywhere, only $8. At this price, Red-Heads are unquestionably the best wireless phone values in the world!
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Remler Radio Mfg. Company
E. T. Cunningham, Sales Mgr.
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MESCO RADIO BUZZER

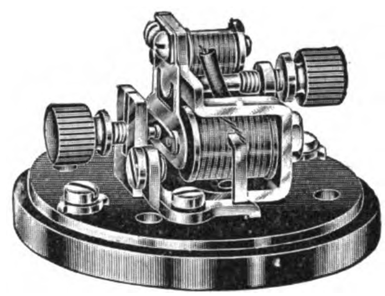

Illustration Shows Buzzer With Metal Cap Off

This buzzer maintains a constant note and is recommended as an exciter for checking wavemeters where pure note and ample energy are required.

It consists of practically a closed circuit field of low reluctance, having a steel armature to which is riveted a strap supporting a movable contact. The armature tension is adjustable by means of a screw with a milled head large enough to be easily and permanently adjusted with the fingers. The stationary contact is adjusted by means of a similar screw. The magnet coils are connected in series with a total D. C. resistance of 3.9 ohms. Shunted across these coils is a resistance having a D. C. value of 3 ohms. This shunt eliminates all sparking such as occurs at the break on ordinary radio buzzers and the energy saved thereby is transferred into any oscillating circuit connected to it, the result being that this buzzer as constructed radiates five times more energy than any other existing type. All connecting wires liable to be broken are eliminated. Contacts are of genuine platinum, which is essential in order to maintain a constant note. The parts are mounted on a Condensite base to insure constancy in operation.

This buzzer is also made to operate on a 6-volt direct current, a feature making it valuable for communication and other purposes where a 6-volt current is available. It has also been approved by the U. S. Government.

Diameter 2 in., height 1¼ in. The cap is attached to the base by a bayonet joint.

List No.		Price
55	Mesco Radio Buzzer operating on 1.5V	$2.50

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You should have it even if only superficially interested. Around about you every day you read of some marvelous occurrence in which wireless played a distinguished part. It may not be entirely clear to you. The Manual will explain it. To the student of Wireless Telegraphy, the Manual contains much that is indispensable to a proper understanding of the art.

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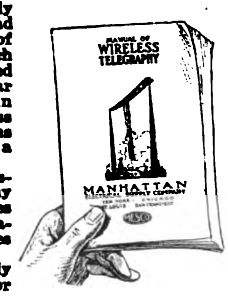
The book is printed on highly finished paper with a two-color cover and measures 9 x 5¾ inches.



Containing as it does a fund of valuable information not generally contained in a catalogue, it approaches nearer a text book in the fascinating field of wireless telegraphy. No expense has been spared to make it accurate and reliable.

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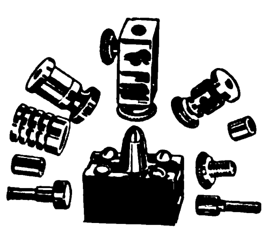

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GENUINE HARD RUBBER KNOBS, POLISHED NICKEL INSERTS

Style No.	*Diameter*	*Thickness*	*Inserts*	*Each*	*Dozen*
946	1 "	¼"	6 or 8 x 32	$0.35	Less 10%
947	1¼"	¼"	"	0.40	"
948	1½"	¼"	"	0.45	"
503	1½"	½"	"	0.45	"
504	1¾"	½"	"	0.50	"
505	2"	¾"	"	0.55	"
946A	1 "	¼"	reamed 3/16"	0.40	"
947A	1¼"	¼"	or ¼" diam.	0.45	"
948A	1½"	¼"	"	0.50	"
503A	1½"	½"	"	0.50	"
504A	1¾"	½"	"	0.55	"
505A	2 "	¾"	"	0.60	"

Rotary Double Pole Double Throw Switch, knurled hard rubber knob nickeled spring levers, eight polished nickel contact points, two stop posts, nuts, washers, all complete, special $1.10 postpaid.

Let us quote prices on all kinds and quantities of small parts and complete instruments. The highest quality in materials and workmanship is our watchword.

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We are even more proud of the efficient manner in which the CR-5 Receiver performs at any wave-length within these limits.
Included in its ranges are amateur, commercial and Navy wave-lengths, special land stations, ship CW stations, Navy low-wave arcs, all phone work and "Time."
It is a complete receiver—the only additional equipment needed are phones, batteries, and a detector tube.
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Grebe Radio Apparatus is Licensed under the original Armstrong and Marconi patents.

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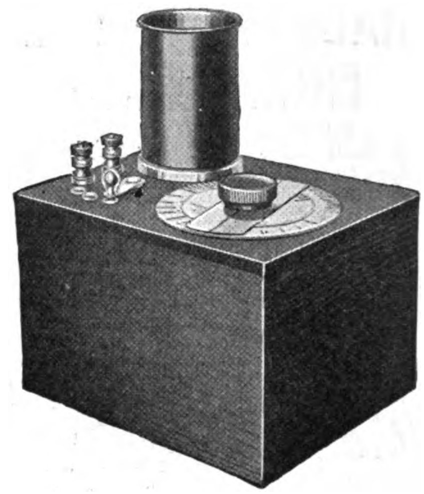

The Doolittle Decremeter can be used for determining the wave lengths of the stations which you receive as well as the wave length and decrement of your own transmitter. A good wave meter is an investment. Ask your dealer to show you the Doolittle Decremeter and send for descriptive literature.

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SIX Stages of audio frequency amplification!

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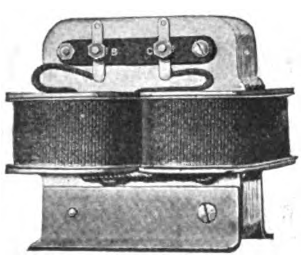
USED BY ALL LEADING MANUFACTURERS AND EXPERIMENTERS

The Ideal Radiophone Filter Combination

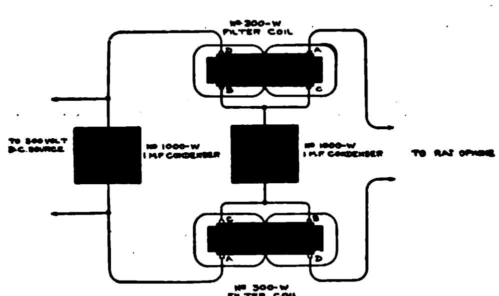
Two No. 300-W 800 M. A. Filter Coils
Two No. 1000-W 1-M.F. Condensers



No. 300-W
800 M. A. Filter Coil

The Federal Filter Coil is of High Impedance Value for A.C. and a negligible resistance to D.C.
Highly recommended for use with both transformer and generator Plate Voltage supply.

Price, each $7.50



FEDERAL FILTER CIRCUIT

No. 1000-W
1-M.F. Condenser

Federal No. 1000-W Condenser is of the Mansbridge self healing type, designed to stand 1000 volts (D.C.).

Price, each $2.00

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COMPLETE SETS OR UNASSEMBLED PARTS

We can supply all necessary parts for those who build their own apparatus, or complete, ready-to-operate sets. Our complete stocks offer you a wide choice of dependable apparatus at reasonable prices.

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Copper aerial wire, No. 14.....50c lb.
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(100 amps., 600 volts)
¼ HP A.C. Motor............$17.50

Reasonable prices, good apparatus, and courteous attention has earned for us the confidence of our radio friends.. You, too, will find this store a pleasant place to visit.

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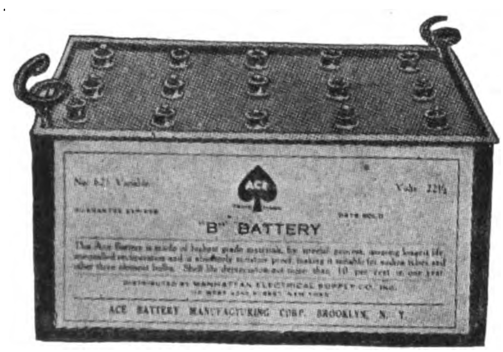
VARIABLE—ACE "B" BATTERIES—PLAIN



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Write for Catalog No. 15

Cat. No.		Size	Voltage.	Hrs. Ser.	Taps	Lbs.	Price
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623	Variable	2½ x 2 x 3⅝	22½	400	5	1	1.75
625	Plain	3 x 4 x 6⅝	22½	1400		5	2.50
625	Variable	3 x 4 x 6⅝	22½	1400	5	6	3.00
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ACE "B" BATTERIES are made according to government specifications, and are especially adapted for Plate Circuit, Detector and Amplifying Tubes.

Guaranteed not to Depreciate more than 10% in one year when not in use. Absolutely Moisture proof.

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ACE BATTERY MFG. CORP.

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