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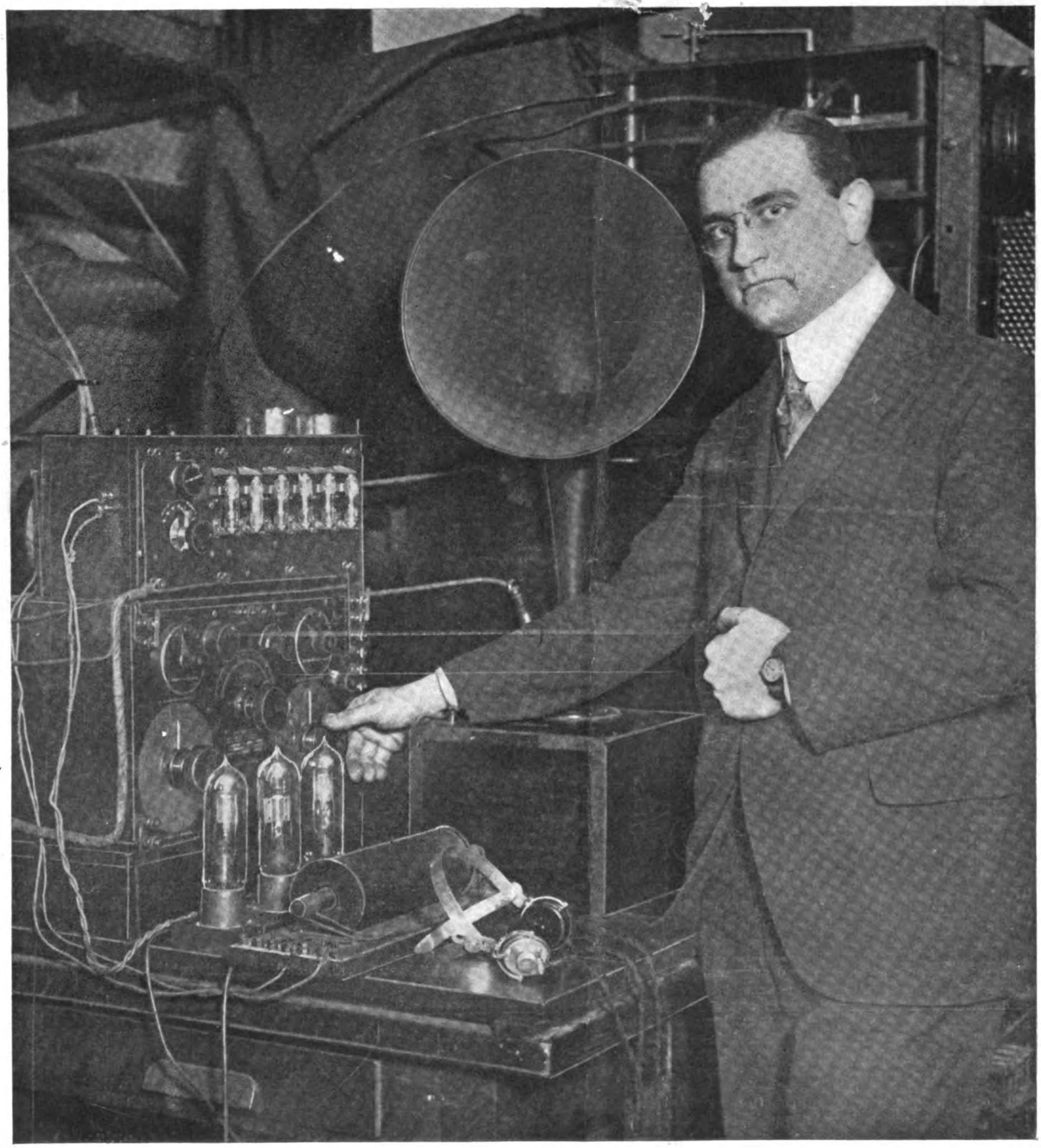
The WIRELESS AGE

Volume 8

Number 7



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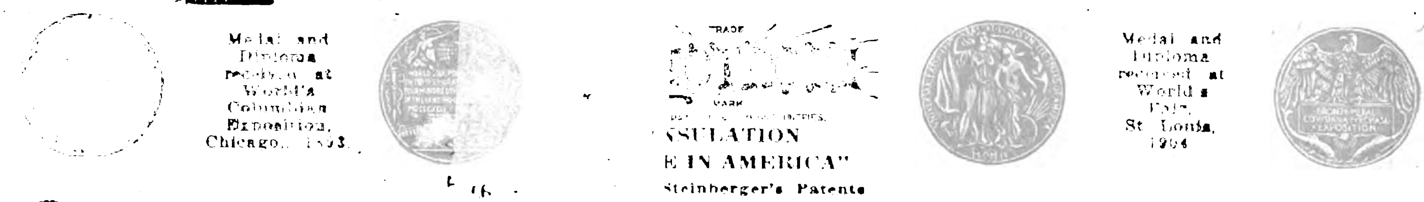

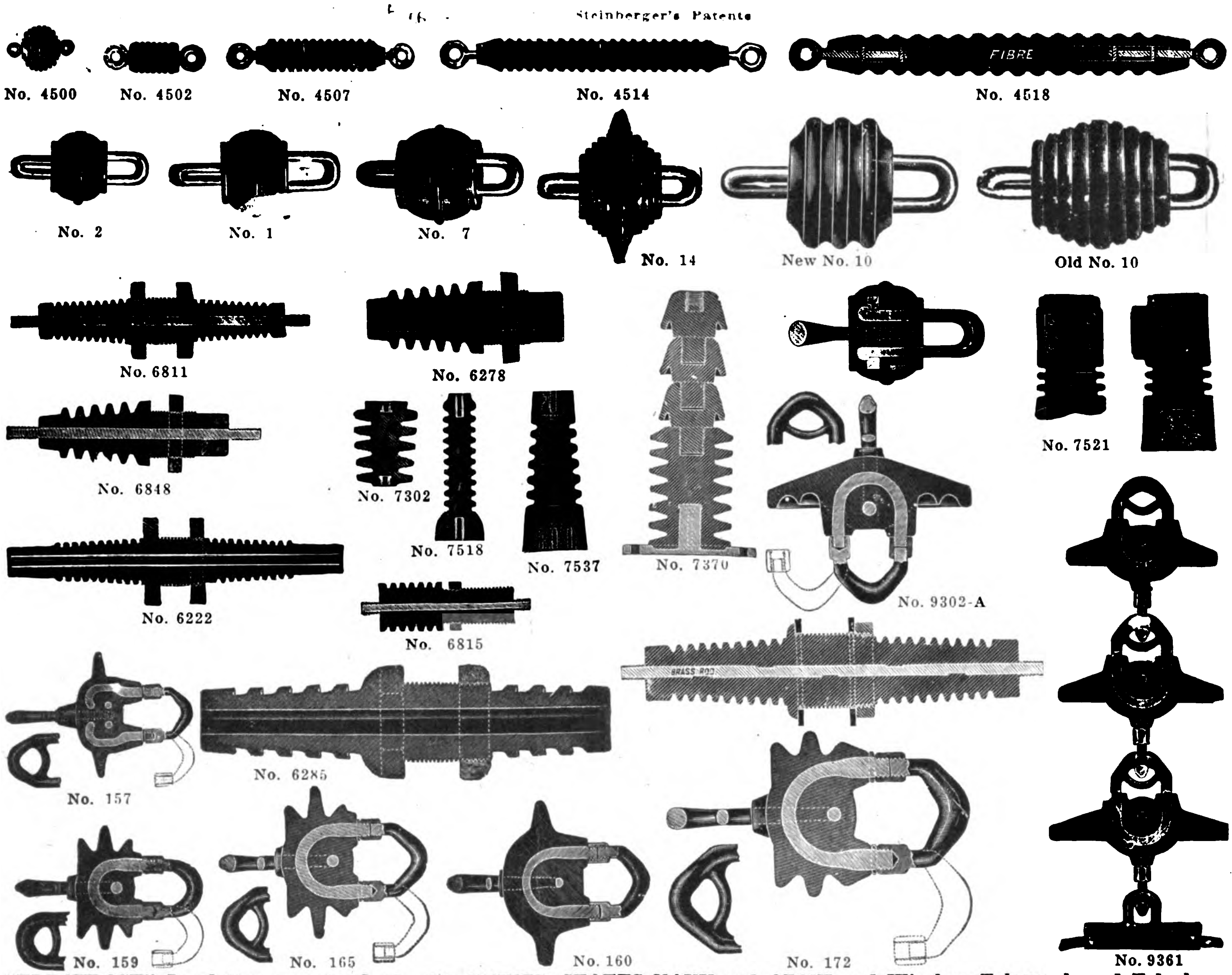

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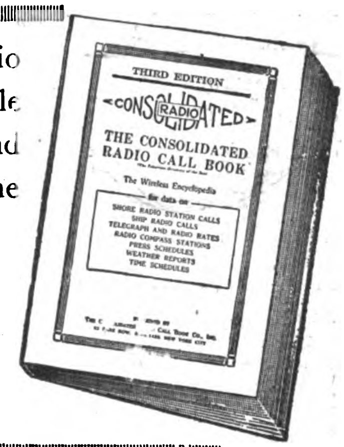

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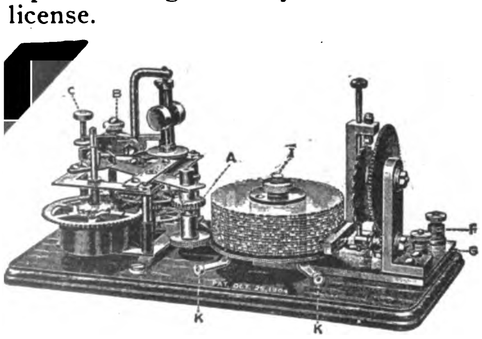

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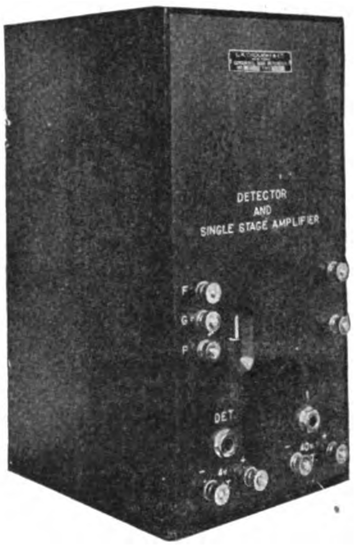

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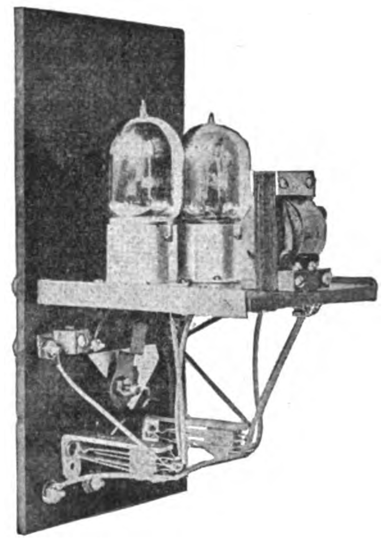

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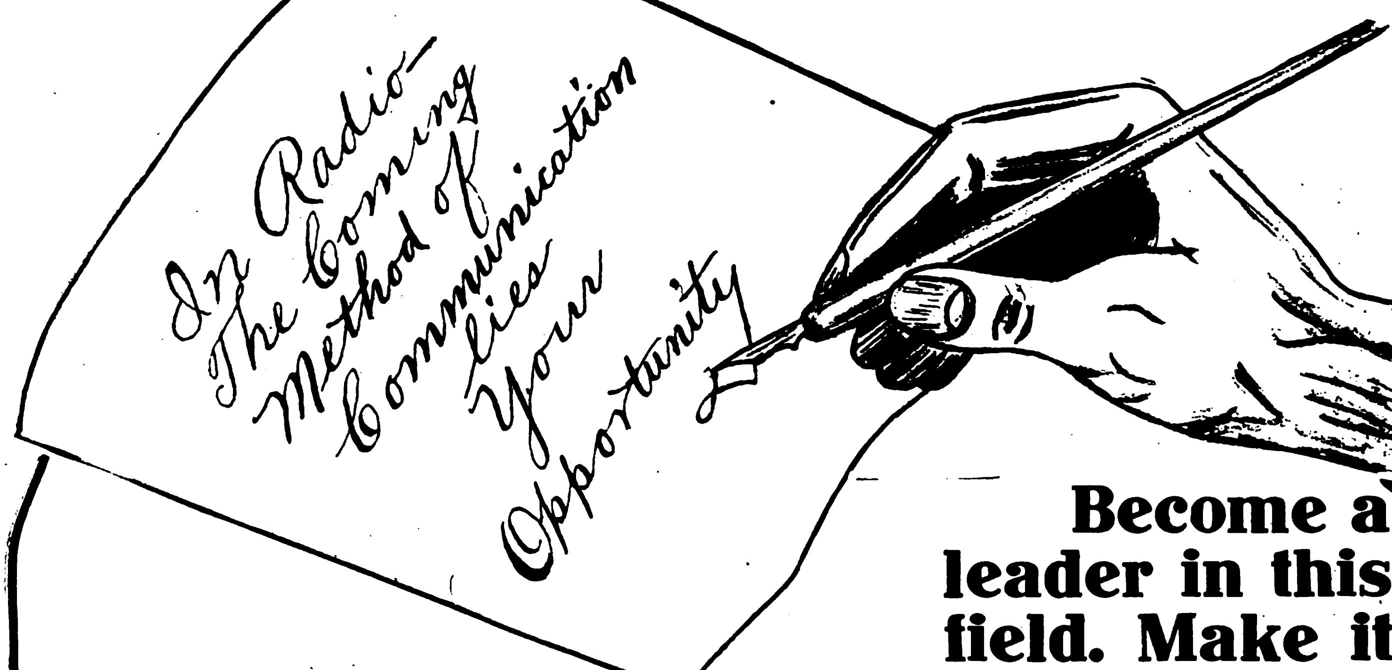

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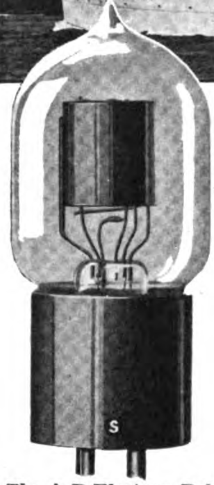

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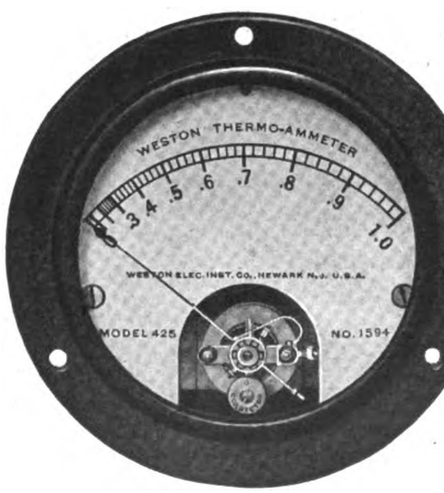

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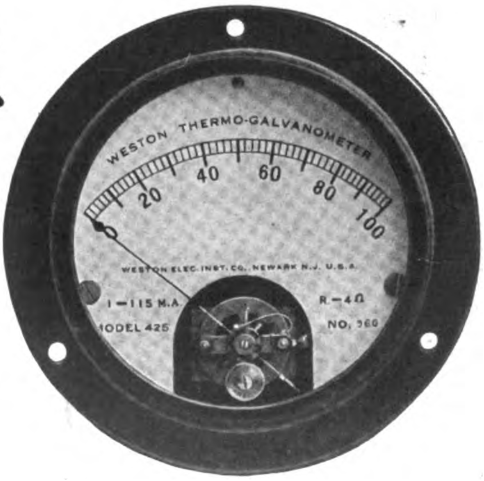

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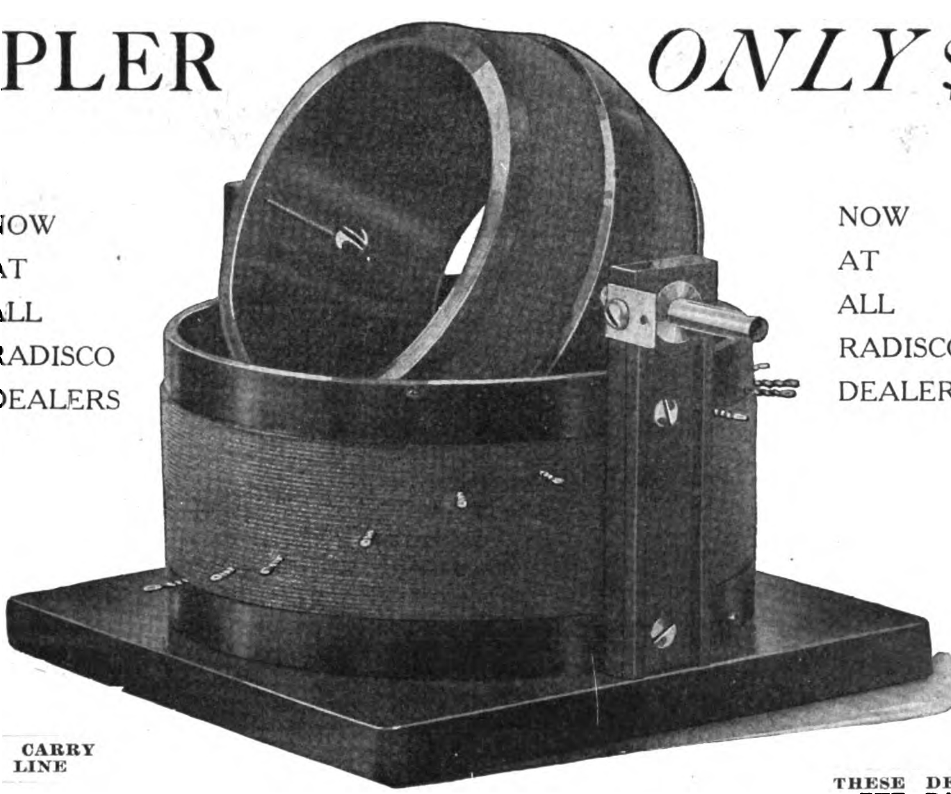

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Northwest Radio Service
609 Fourth Ave.

SCRANTON, PENN.
Shotton Radio Mfg. Co.
P. O. Box 3
Branch, 8 Kingsbury St.
Jamestown, N. Y.

WASHINGTON, D. C.
Eastern Radio and Electric Co., 1405 Florida Ave., N. W.

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Vol. 8. No. 7. APRIL, 1921

THE WIRELESS AGE

WORLD WIDE WIRELESS

Direct Radio Service Between Poland and America

DIRECT wireless communication between the United States and Poland is forecast in the announcement of the signing of a contract between the Polish Government and the Radio Corporation of America made public by Hipolit Gliwic, commercial counselor of the Polish Legation in Washington. The American company will construct at Warsaw one of the largest radio stations in the world, and as part of the agreement, will provide equivalent facilities for the receiving and sending of messages on this side.

The contract ends negotiations which have been proceeding for more than a year. In discussing the contract Mr. Gliwic, the Polish commercial counselor, said:

"At present commercial cable communication, handled by relays through France, England or Germany have established an arbitrary distance of four or five days between Poland and the United States, from which both have suffered. The American radio station will remove this distance, providing direct and instant communication between the two countries. Commercial relations which depend to a large degree on the case of communication are bound to be benefited.

The manufacture of the material for the station has already been started. The first shipments to Poland are expected to be made within six months. The Warsaw station will be practically a duplicate of that now under construction in Long Island. It will consist of twelve 400-foot steel towers and two Alexanderson machines, equipping it for high-speed transmission and reception. The station will be able to handle a couple of hundred words a minute.

The Radio Corporation at the request of the Polish Government will operate the Warsaw station during a term of years.

Bombardier's Crew Saved by Radio

THE story of a radio operator's exploit in rigging an emergency set and summoning rescue after the wireless aerials had come tumbling down during a cyclone that finished the steamer's career, will go down as one of the thrilling tales of the sea.

The Bombardier, a former Shipping Board steamer, with Edward Herno aboard as radio operator, left New York in February, heavily freighted with grain and general merchandise. When 400 miles southeast of Halifax she ran into a hurricane which at times blew with almost unbelieveable force. Plunging into the raging seas, her seams opened and water poured into the engine room. Pumps were started, but became clogged with coal, and the men had to stop to clear them, losing ground with each halt.

While the gale was at its height the wireless was stripped off the masts and came hurtling to the deck, twisted and useless, cutting the battling craft from communication. A lifeboat torn from its davits was sent crashing into the wireless house, and water poured through the opening, soaking the delicate mechanism, and down below the rising waters stopped the electric generator.

Then it was that Herno, by the use of storage batteries and with a set of spare instruments, managed after hours of feverish working to send out a despairing call for help. The steamship Mount Clay, bound from Hamburg to Boston, 50 miles away, picked up the S O S at 8 o'clock and started quickly for the scene, and arrived at midnight. Only two of the Bombardier's lifeboats remained intact, and it would have been impossible for all the crew to have been taken in case they were driven to abandonment.

Professional operators handling traffic aboard ship

At daylight the rescue began. Chief Officer Soewtway and nine men put off to the relief steamer and were quickly taken aboard. A big boat from the Mount Clay, in charge of Junior Second Mate Ralph Kelty and manned by six volunteers, went to the settling Belgian and picked off 16 men and "Tom," the ship's cat. The other boat remaining on the Bombardier was then launched with two officers and eight men, Captain Henry Matthus being the last person to leave. He was preceded by the dauntless radio man.

As Herno stepped on the deck of the Mount Clay he was saluted by her wireless operators and greeted by the passengers and crew as a hero. He took the honors lightly, however, inquiring laconically, "When do we eat?"

Warm food and a chance to sleep after three wakeful nights soon restored the little band, and when they reached Boston they had practically recovered from the effects of their harrowing experience.

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Dr. Goldsmith's Radio Megaphone

FOURTEEN years of diligent research at the College of the City of New York, in the department of electrical engineering, of which Professor Alfred N. Goldsmith is director, have been required to incubate a new marvel of science—the radio megaphone. Professor Goldsmith makes no claim to the invention of the new apparatus in the radio megaphone. He has taken material devised by others, developed and arranged it. But the result has been a "loud talking" receiver which has astonished the scientific world. The transmission of the human voice over many thousands of miles has been made possible by the development of a new type of vacuum tube. According to the number of vacuum tubes employed depends the multiple of the intensity.

The new amplifier is distinguished from others by its extreme selectiveness, its reliability, the high power of its amplification, the evenness and clearness of its tones, and its ability to receive from long distances. Using a set which has a relay of ten vacuum bulbs, Professor Goldsmith tunes up until he has caught Nauen, the great German station some 20 miles from Berlin. The code which the operator at the New Brunswick, N. J., receiving station is straining his ear drums to hear under a cumbersome headphone is roaring about you. A deft turn of the dials and we hear an American station—that at Marion, Mass., which is in communication with the outfit at Stavanger, Norway. The change of tone and the increase of volume are marked. The station is a mere 300 miles away instead of the 4,000-mile span to Nauen, and the strident, weird intoning is so loud as to be unbearable at close proximity. It is a clear, piping sound, not unmelodious. The Marion operator is "fast" and the message fairly pours along.

If you want you may select the Tuckerton, N. J., station and hear its clarion sweep to its receiving station at Lyons, France. Or we might pick up the New Brunswick station and listen to what other business it is doing, for it transmits to the powerful British station at Carnarvon, Wales, as well as to Nauen. Selection is no trouble for the radio megaphone. Tuning to 600 meters you hear a bit of tinned music from the messroom of the steamship Gloucester plying 150 miles off the Atlantic Coast. One of the "gobs" has hitched it up on the radio telephone. The men of the Gloucester like to use the radiophone, for their ship was the first to establish direct wireless telephone between the Atlantic and Pacific oceans, with the breadth of North America between. Using transmitting tube sets and a duplex radiophone, the Gloucester sent a vocal message which was received at the Foxhurst, N. J., station, relayed along on land wires to Los Angeles and then sent on by radio telephone to Avalon, on Catalina Island in the Pacific. During the conversation the operator on the Gloucester and the operator in Catalina Island were in direct vocal touch. A single radio megaphone would be heard throughout Madison Square Garden, but to prevent the deafening of those nearest it a better way would be to have a string of supermegaphones of lesser intensity about the hall.

Radio concerts, in fact, are one of the most promising possibilities for the super-megaphone. A throng jamming the largest hall could delight itself with the limpid voice of the world's most talented diva, although she might be singing 2,000, even 5,000, miles away.

Another more prosaic use, but one of great commercial benefit, is to relieve the operators at wireless stations of the cumbersome head phones.

To Professor Goldsmith as a scientist the supermegaphone is particularly of interest in demonstrating how the vacuum tubes, as developed in the laboratories may be used to amplify signals. The new "eavesdropper" is another step in his work to perfect the wireless telephone.

Daily Radio Marketgrams

A DAILY market report prepared by the U. S. Bureau of Markets is now being sent by radio from Washington at 5 P. M. each day except Sundays and holidays. This report is known as the Daily Radio Marketgram. It is about 500 words long and gives prices and market conditions of fruit and vegetables, grain, dairy products, hay, feed, and seeds, livestock and meats of the principal markets in the nation. Any radio operator within a 200-mile radius of Washington can receive the report. It is transmitted on a wave length of 400 meters at a rate of 15 words per minute. A 2 kw. 500 cycle transmitting set is being used with a non-synchronous rotary spark gap. The report is opened by the general call signal to all stations (QST) and the call signal of the Bureau of Standards (WWV).

Fort Stevens Compass Station

THE Navy Department has just completed a radio compass bearing station at Fort Stevens, Oregon, situated at the mouth of the Columbia River. With this new station in operation boats several hundred miles from the mouth of the harbor will be able to ascertain their exact locations during the worst fogs and gales. The naval tug Mahopae was sent to calibrate the apparatus.

Owing to the presence of a wireless station at North Head, not far from Fort Stevens, receiving equipment only has been installed at the new station. The operator upon receiving a call from a vessel at sea, determines the exact position of the inquirer, then telephones the information to North Head from which point the boat will receive its information.

The Navy Department has in active operation a number of radio compass bearing stations on the dangerous Washington coast as well as several in Oregon. It is understood that other plants will be erected along the Oregon coast in the near future.

U. S. Radio Press to South America

THE Permanent Committee on Communications, formed on recommendation of the second Pan American financial conference, has adopted a resolution providing that Congress be urged to pass the pending bill authorizing the navy to accept press messages, at a fair rate, to and from South America. The resolution was introduced by Senator Fletcher of Florida, Chairman of the Sub-Committee on Radio and Cable Communications.

The committee also adopted a resolution recommending the enactment of legislation which would enable the erection of a high-powered radio station on the west coast of Africa. Rear Admiral Bullard, Director of Naval Communications, urged that the United States acquire as soon as possible radio stations, cable service and privately-owned trade papers in Latin-American countries so that the United States point of view on general trade questions might better be presented to those countries.

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Signal Corps Needs Lieutenants

A COMPETITIVE examination will be held beginning April 25, 1921, for the filling of 114 vacancies in the grade of Second Lieutenant in the Signal Corps of the Army.

Candidates must be graduates, or members of the senior class, of educational institutions maintaining four-year courses of instruction in electrical engineering and physics and conferring the degree of bachelor of science in these two courses. The following will not be required to take any special examination:

(1) Graduates who have graduated within four years of the date of examination and who have a bachelor of science degree in electrical engineering.

(2) Graduates who have graduated within four years of the date of examination, who have a bachelor of science degree in physics and who have majored in electrical subjects.

(3) Graduates who have graduated more than four years prior to the date of examination, who have a bachelor of science degree in electrical engineering and who have been employed in electrical industries.

(4) Graduates who have graduated more than four years prior to the date of examination, who have a bachelor of science degree in physics, who have majored in electrical subjects, and who have been employed in electrical industries.

The following will be required to take a special examination in one of the following subjects elected by them—electricity and magnetism; telephone and telegraph engineering; radio engineering:

(1) Graduates who have graduated more than four years prior to the date of the examination and have received a bachelor of science degree in electrical engineering, or in physics, but who have not been employed in electrical industries.

(2) Members of the senior class in good standing who will graduate within six months and the quality of whose work is such as to place them in the upper fourth of their class of educational institutions maintaining a four year course of instruction in electrical engineering and physics and conferring the degree of bachelor of science in these two courses.

Full particulars relative to the examination may be obtained by writing to the Commanding Officer of the nearest military post, or direct to the Chief Signal Officer of the Army, Washington, D. C.

Successful candidates will be announced or appointed, or nominated for appointment about two months after the final examination. Candidates attending school or college will therefore have an opportunity to complete the present school year before being appointed.

The Signal Corps offers an extremely attractive career for young men trained along electrical lines, as it combines the advantages of Army life which are common to all branches, with the opportunity for study and achievement along scientific lines. The advances in electrical communication are proceeding with an almost unbelieveable rapidity and the Signal Corps is not only keeping abreast of these advances, but is making every effort not to follow but to lead. Well equipped laboratories are maintained and constant work is being done in development, both in the laboratory and in the field, of better types of signalling equipment.

The pay of a Second Lieutenant at present is $2,120 a year, and in addition thereto, free quarters, heat and light, and medical and dental treatment are supplied. These last items raise the actual value of the salary considerably above that shown by the money figure alone.

Hammond's Radio Controlled Torpedo Accepted

THE War Department has accepted the Hammond radio controlled torpedo, which has been under investigation for many years. It is planned to use the device of the young inventor for coast defense purposes.

A gas engine of 1,600 h. p., the most powerful of its kind in the world, will be installed in a fair-sized boat, to cost three or four hundred thousand dollars, and to have a speed of some thirty-five knots an hour. By the use of wireless this boat can be controlled without anyone on board to operate it. It will carry in its bow an immense torpedo. Directed either from shore or another warship, the boat is designed to be aimed at a hostile battleship, the torpedo being exploded on impact.

The wireless room showing the transmitting set aboard the Eagle Boat, No. 26

Chicago High Schools Connected by Radio

CHICAGO'S twenty-two high schools are to be equipped with radio telephone and telegraph instruments. Stations already have been established at the Lane Technical high school and at the Sheldon High school.

Delivery of apparatus for installation at the Schurz, Senn and Tuley high schools is expected soon. Bids on wireless equipment for the remaining schools are being received. It is estimated the Chicago school wireless system, the first of the kind, will be installed at a cost of about $50,000.

The plan to connect all high schools by wireless is said to have been fathered by A. G. Bauersfeld, supervisor of technical work in the high schools.

Mr. Bauersfeld believes the system will make it possible to transact virtually all inter-high school business by radio telephone. The board of education specifications call for the very latest in wireless equipment. The radio telephones being installed have a day range of about 100 miles for transmission of intelligible speech. The telegraph instruments have a day range of approximately 200 miles.

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IN REPLY ADDRESS
THE SECRETARY OF THE NAVY
AND REFER TO NO.
Op-20-A
28761-93:126

MFC(O) WKH/B

NAVY DEPARTMENT
WASHINGTON

MAR 22 1921

Dear Sir:-

I have received your letter of March 9th with reference to the attitude of the Navy Department toward amateur radio operators, and I take great pleasure in outlining for your information and for the information of all amateurs in the country the following policy which it is my purpose to pursue in this connection.

It will be the desire of the Navy Department to further in every way practicable the interests of the amateur radio operators throughout the country, and with this principle established, it is hoped that the closest co-operation may be had between the Navy Department and the amateurs.

My knowledge of the patriotic and valuable services rendered by the amateurs during the World War is sufficient to convince me that, as a factor in the national defense, the promotion of the interests of the amateurs is not only desirable, but necessary, and I can assure you that this Department will advocate the freest practicable development of the radio art by all amateurs.

Very truly yours,

R. E. Coontz

Acting Secretary of the Navy

Mr. J. Andrew White,
Editor, Wireless Press,
326 Broadway, N.Y.

AMATEUR RADIO A NECESSITY—

HERE is a letter that makes amateur radio history. No need for further worry now about the future, so far as the Navy Department is concerned. In the beginning, amateur radio was merely tolerated by the Navy. It was looked upon as an unnecessary evil. Then, in emergency, came the big test. The amateurs made good. But since the war ended they have never felt entirely satisfied and secure as to their future. Now, however, they have won for themselves a national status, a fixed place in the policies of the government. The letter above not only states officially that the Navy will "further in every way practicable the interests of the amateur radio operators" but also that they are "not only desirable but necessary."

Amateur radio is now a national institution.

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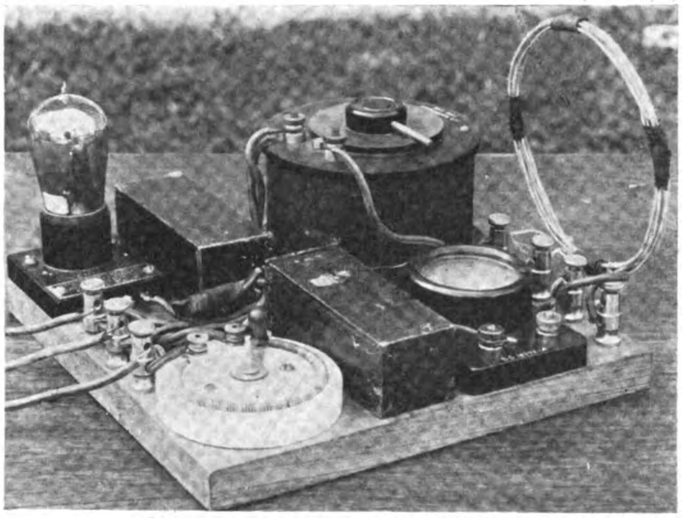
New Type of Condenser Antenna

By S. R. Winters

THE practical use of a condenser antenna when adapted to wave lengths below 400 meters has been conclusively demonstrated by the radio communication section of the National Bureau of Standards, the experimental equipment being built and installed on the grounds of the government laboratory. The designing of a small antenna in which the capacity is of large geometrical dimensions instead of the usual high inductance, compared with the condenser, used in receiving with the coil antenna, has been given tangible shape by the Bureau. Historical significance is attached to the story that Oliver Lodge used an aerial consisting of a pair of metal plates elevated from the ground in 1897.

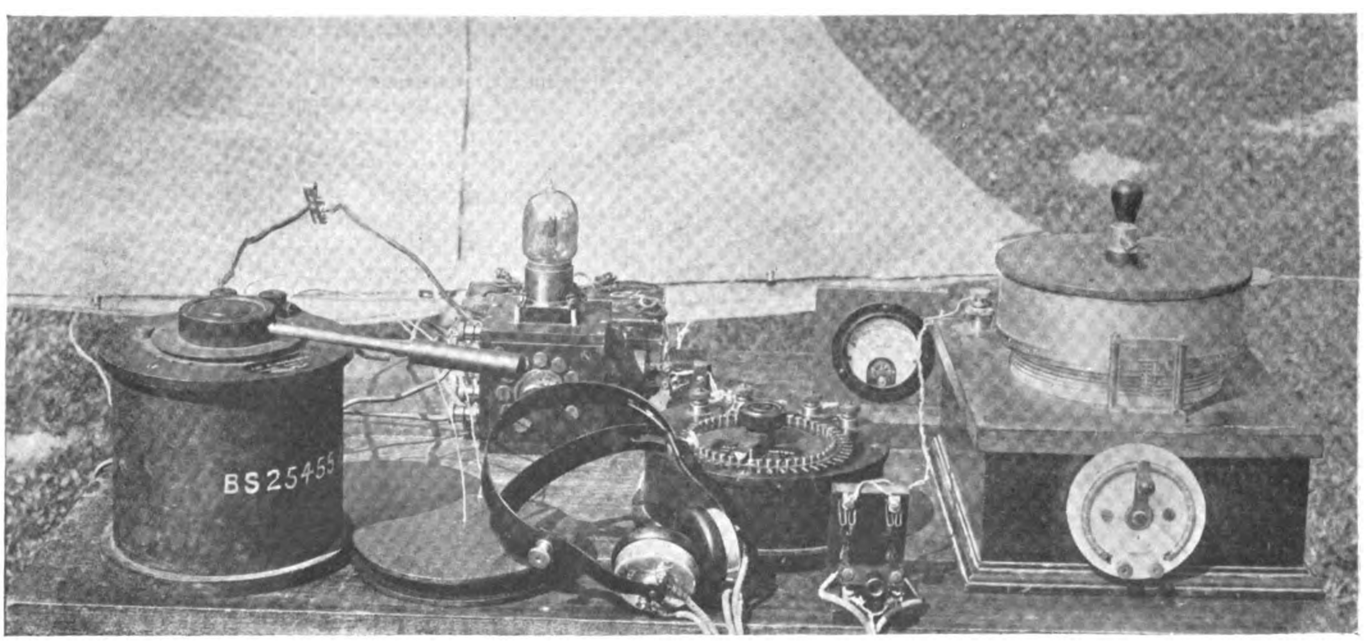


Generating set to measure constants of the condenser antenna

The efficacy of a condenser antenna of small dimensions when adapted to wave lengths below 400 meters is excellent. With longer wave lengths the newly-designed condenser antenna suffered by comparison with the coil antenna when restricted to apparatus of portable dimensions. In directional operation the outfit proved worthless unless used with a coil antenna; however, this makes it useful where the sharp directional characteristics of the coil are objectionable. By careful designing to reduce dielectric losses the effective resistance is less than either with the coil arrangement or the common elevated antenna. Low resistance and ease of construction makes this form of antenna serviceable in portable short-wave stations.

In designing a condenser aerial it was recognized that in reducing the height of an antenna the strength of the received signal is sacrificed, inasmuch as the current in the receiving antenna bears a direct relation to the elevation of the latter. A flat-top antenna 30 meters above the ground operating on a 600-meter wave is equivalent to a four-turn coil 24 meters long by 30 meters high. Large structures for effective transmission and reception of wireless communication can be avoided by one of two methods. The coil aerials can have a lower resistance than is commonly employed, and its size reduced in proportion to the lessening of resistance. This is possible because the condenser used in the coil aerial circuit may be one having practically no resistance while the condenser consisting of antenna and ground has a large resistance. The other alternative for obviating the building of substantial radio structures is to pursue the antenna principle, erecting a special construction appreciably lower in height.

The usual antenna-ground structure, where the antenna is one plate of a condenser and the ground the other one, was displaced by an aerial much lower in height, having two horizontal metal condenser plates. The "condenser aerial" is its adopted name. Apparently, an inferior antenna is the result, recognizing the claim that effectiveness in wireless structure is proportional to the height. This failing is counterbalanced by special construction designed to reduce the resistance as much as possible. The resistance of an antenna is influenced by imperfect dialectrics, such as vegetation, buildings, and shoddy insulators, present in the field. This unwholesome environment is eliminated in a "condenser aerial." The latter has lower conductor resistance than the common antenna, and inasmuch as it has an en-



Receiving set, the slide wire and galvanometer of the audio frequency set and the audibility meter. Comparisons were thus made between the coil and condenser antenna, employing the telephone shunt or audibility meter method

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larged capacity a small inductance is used in series with it which also has smaller resistance. Thus the resistance of the circuit is appreciably curtailed. By way of eliminating dielectric loss, the lower plate was made appreciably wider and longer than the upper

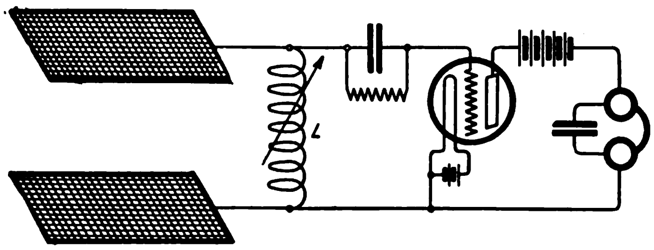


Figure 1

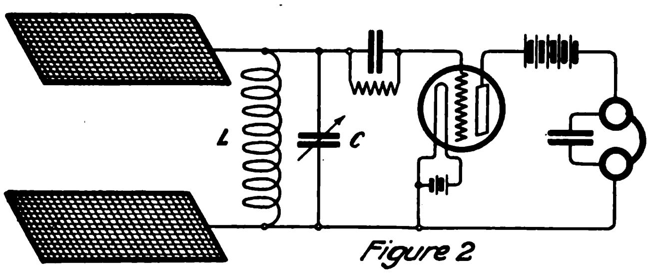


Figure 2

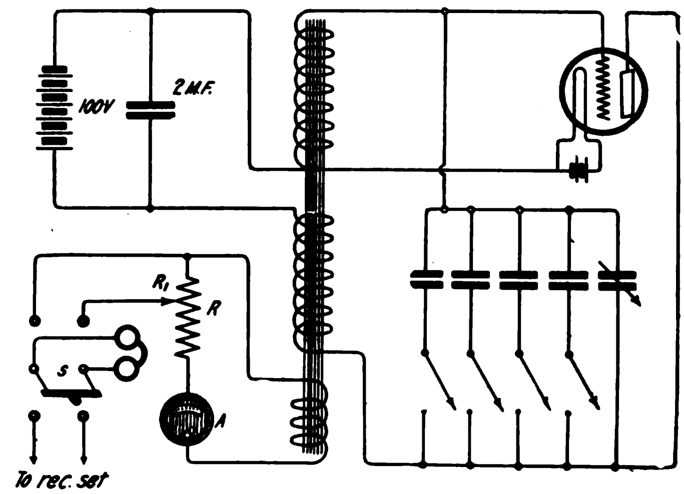
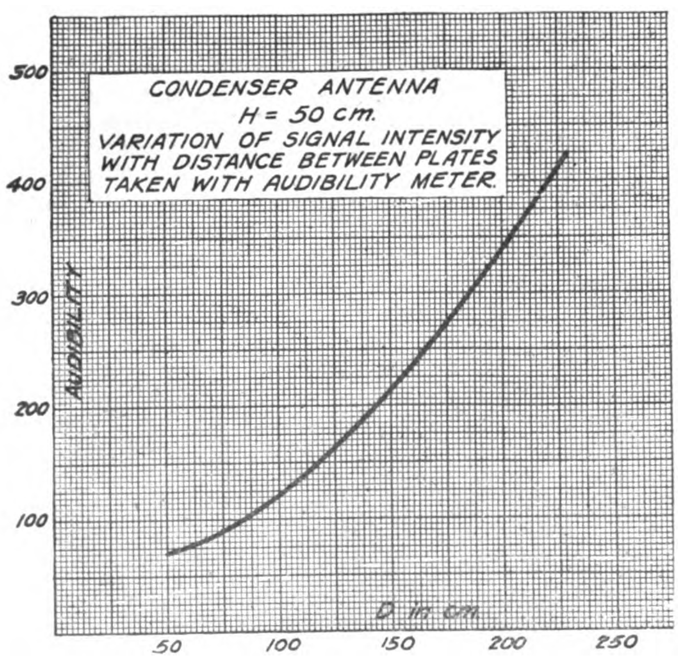


Figure 3

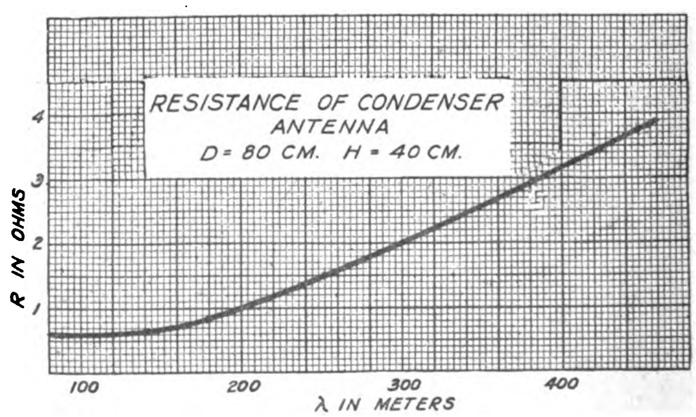
Figures 1 and 2—Preferred circuits for the condenser antenna. Figure 3—Circuit for measuring antenna resistance by comparative method

plate. Otherwise, both plates may be stationed a considerable distance above the ground, keeping the space between the plates free from poor dielectrics.

The size of the "condenser aerial" is compared with other aerials in this fashion: An antenna 30 meters high is equivalent to a four-turn coil 24 meters long by 30 meters high, both operating on a 600-meter wave and with circuits of the same resistance. Similarly, with an equal wave length and with an inductance of 100 microhenries, in series, the capacity of a "condenser aerial" would need to be 0.00102 microfarad, afforded by a pair of square plates one meter apart and 10.7 meters on a side. Consequently, the height is chopped off in the ratio of twenty-five to one, and the horizontal dimensions three to one in comparison with the coil aerial. The "condenser aerial" can be constructed as small as desired. If a specified coil is to be employed in series, the capacity of the aerial is maintained constant by reducing the distance between the plates when the area of the latter is reduced. Experiments with a small "condenser aerial" as a receiving device inside of the radio laboratory of the Bureau of Standards with no ground connection, yielded interesting results. The plates were of copper netting, the top one being 250 centimeters square and the distance between the two 15 centimeters. Signals received, using either a crystal detector or vacuum tube were approximately of like intensity as those recorded with a simple coil aerial of the design and dimensions commonly employed as a direction finder. An inductance coil of somewhat large dimensions used in series with the condenser served as a receiving aerial. As the coil was rotated, the signal varied from maximum in one angular position to zero in a position 180 degrees from the first, instead of 90 degrees, as is true when a coil aerial is used independently of any antenna action. The assumption is that the action of the "condenser aerial" reinforced that of the coil in one position and neutralized it in the opposite position. When the connections to the coil were interchanged, the effect shifted 180 degrees. The customary laboratory type of condenser used in radio circuits is not suitable as a "condenser aerial," because the interleaving of the plates results in the current in each portion of the dielectric being balanced by the current in a neighboring portion.



Variation of signal intensity with distance between plates taken with audibility meter



Resistance of condenser antenna. D=80 cm. H=40 cm.

Measurement tests were recently completed in de-

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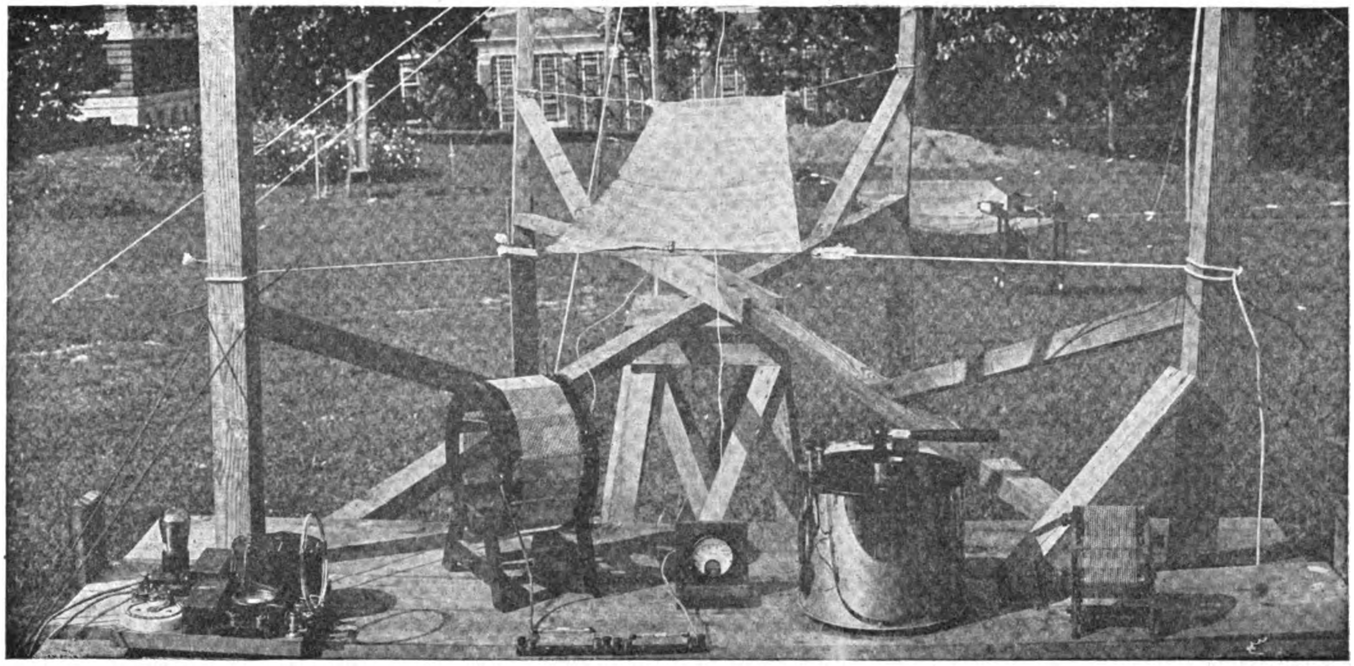
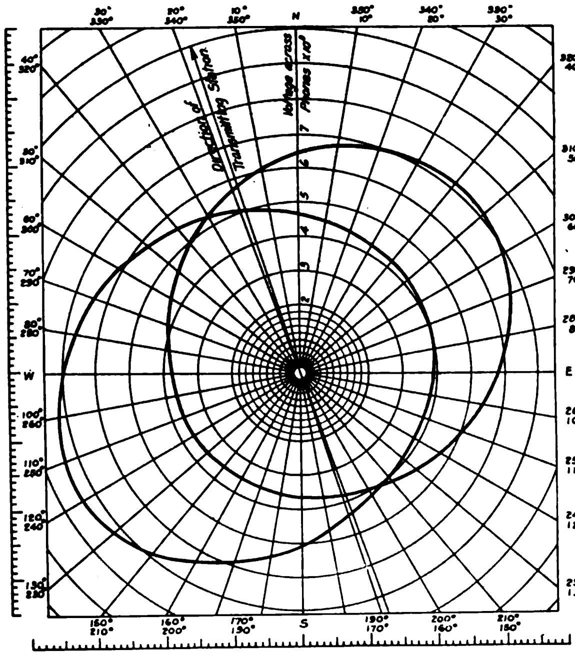
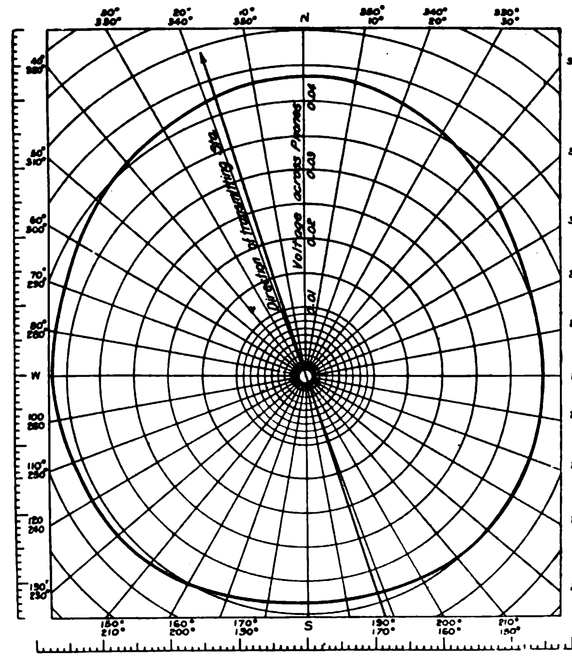


The complete audio frequency comparison set for studying the directional properties and effect of height on signal intensity of coil and condenser antennas

termining the electrical properties, usefulness for receiving signals, and essential factors entering into the design of the condenser antenna. The experimental equipment was made of screen wire, the netting mounted in a suitable supporting frame. The screens were of galvanized iron. There were varying sizes of antennas in the tests, some having two plates of equal dimensions while others were included with the upper plate smaller than the lower one. A small generating set was designed to determine the constants of the antenna. The device was capable of being operated over a range of wave lengths from 50 to 500 meters. Three sets of inductance coils were made up for the following ranges of wave length: 50-150, 100-250, 200-500 meters. A 5-watt transmitting tube was the source of high frequency current, power being supplied to plate circuit by a 200-volt storage battery. The current in the oscillatory circuit was from 100 to 350 milliamperes throughout the range of wave lengths covered. The fineness of the inductance rendered it impractical to measure by the ordinary method; that is, by adding two known values and computing the inductance from the wave length thus obtained. However, as the inductance increases its apparent capacity at low wave lengths, it was possible to determine the inductance and pure capacity from the values of apparent capacity obtained at two or more wave lengths.



Directional properties of the condenser antenna in vertical position



Directional properties of the condenser antenna in horizontal position

Determinations as to the resistance of the new form of antenna were made by the resistance-variation method. First, the resistance of the whole circuit, including the inductor and thermogalvanometer, was measured. Forthwith the standard variable condenser replaced the antenna, the remainder of the circuit being unchanged. By determining the resistance of this circuit and comparing it with the resistance of

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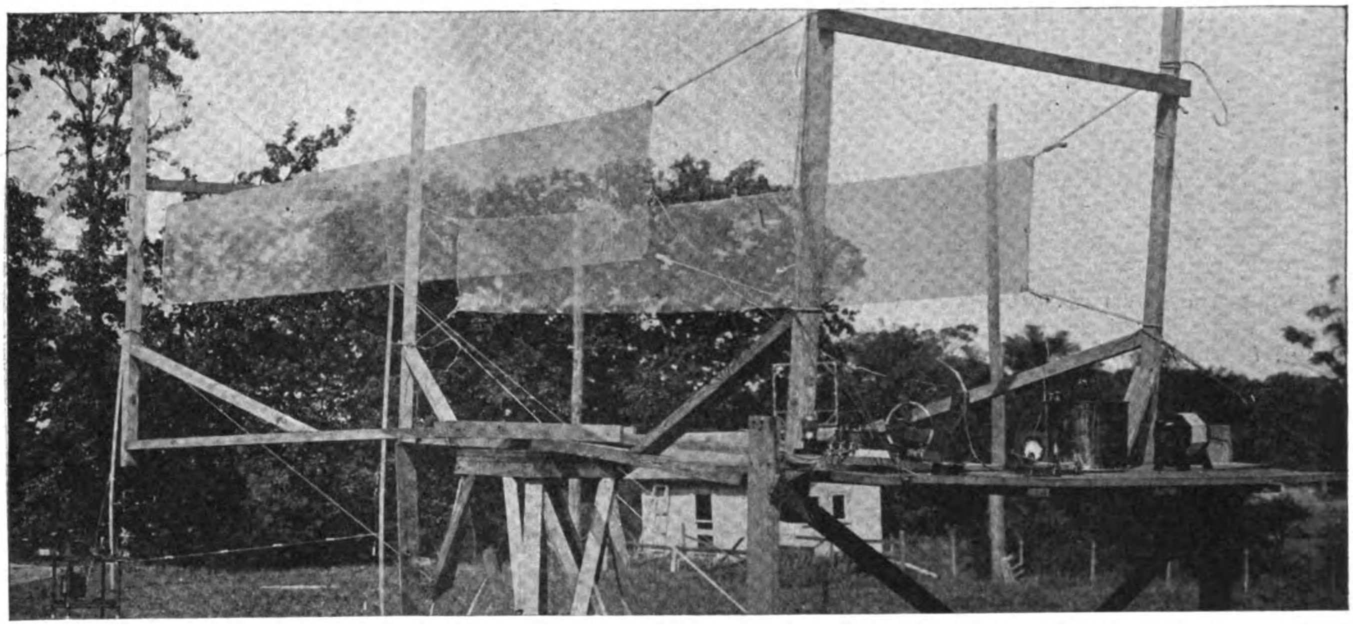
the antenna itself, and subtracting the second value from the first, the resistance of the antenna was made known. Measurements were made at four or more varying wave lengths, the value for each wave length being measured with three different values of external resistance. These results were added and the average of the three values was the basis for plotting a curve indicating the variation of resistance with wave length. Extreme accuracy was difficult, the investigations being conducted in open air when the screens were subject to the swinging effects of the wind. The results, however, are accurate enough to indicate what may be expected of an antenna of this kind. The shape of the resistance curves would seem to show that the dielectric loss component of effective resistance is large compared with other components. Resistance of the conductors is small and the wave lengths at which measurements were made were too far above the fundamental wave length of the antenna for the radiation resistance component to substantially affect the total value. Measurements made on iron screens before and after several weeks exposure to the weather increased the resistance values, a factor attributed to losses in oxide which had formed on the zinc coating. The observations emphasize the caution necessary in keeping imperfect dielectrics from the field of the antenna. Two copper screens, with the upper plate half the width of the lower, showed a resistance lower than any antenna measured—0.14 ohm at 178 meters and 0.68 ohm at 458 meters.

A series of practical tests were conducted to determine the value of a condenser antenna in receiving signals. Varying sizes of plates were used, the coil antenna forming a basis for comparative studies. Two coils were thus engaged, one having two turns of No. 14 copper wire, spaced two centimeters apart, and wound on a rectangular frame 90 by 123 centimeters. The other coil was 80 centimeters square and consisted of seven turns of No. 14 copper wire spaced one centimeter apart. Resistances of these coils were determined and the results plotted in curves. A variety of receiving circuits were hooked-up with the condenser antenna, the conclusion being that the circuits commonly used with an ordinary antenna was altogether satisfactory. Comparative studies between the coil and condenser antennas, involving directional properties, effect of height on signal intensity, etc., necessitated a reliable method for comparing signal intensities. By reason of its simplicity, the telephone shunt or audibility meter method was adopted. The method involves shunting the telephone with a variable resistance, so adjusted as to give "just audible" signals. By way of keeping tab on the results, an audio-frequency comparison set was installed, using an audio-frequency oscillator giving frequencies between 400 and 1,200 cycles a second.

The transmitting station used in these measurements was located one-eighth of a mile from the receiving point. The transmitting antenna being of comparatively large dimensions (25 meters high and 30 meters long), it was essential to use very low power on the transmitting set. A circuit was designed for the specific undertaking whereby a 5-watt vacuum tube was operated from the 100-volt D. C. line. A motor-driven interrupter was connected in the ground circuit to afford an audible note on the non-oscillating detector at the receiving station. The transmitting set supplied a current of 0.1 ampere in the antenna circuit, the power output being a fraction of a watt. Thus signal intensities of a magnitude easy to measure with the comparison measuring set were made available. The result of these measurements shows the condenser antenna of small dimensions has superior advantages over the coil antenna when wave lengths less than 250 meters are employed; when these figures are exceeded, however, the coil antenna is superior. Scattering tests on the condenser antenna at wave lengths of 1,100 and 2,500 meters yielded signals quite weak compared to those received with a one meter coil of eleven turns. This obstacle, however, can be surmounted by designing a condenser antenna of increased dimensions for successful adaptation to long waves. Such procedure, obviously, would sacrifice the advantage of portability and ease of construction—outstanding virtues of the new form of radio-transmission structure.

Actual tests have not determined the value of the design as a transmitting antenna, although in the absence of experimental data, the Bureau of Standards is willing to risk its judgment in concluding

(*Continued on Page* 16)



Frame used in determining the directional characteristics of the new form of antenna, which was rotated at will, in order to measure the signal intensity when the antenna was set at various angles. The screen is seen in one of two positions used in the tests

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Concerning Grid Leaks

By Pierre H. Boucheron

THE grid of any vacuum tube, whether employed as a detector or an amplifier, is the controlling member of the tube, that is to say, it controls the current flowing between the plate and filament. The character of the control depends directly upon the *bias* potential maintained upon the grid. Thus one value of grid potential will be found most suitable for radio detection, while still another value must be maintained to secure maximum amplification. The requisite bias potential for varied conditions of use may be obtained in several ways, the most common of which are:

(a) To insert in series with the grid circuit a small battery usually called a "C" battery.
(b) To tap one terminal of the grid circuit from a fixed resistance in series with the filament rheostat through which the filament current flows.
(c) To employ a grid leak connected across the grid condenser or between the grid and negative side of the tube filament.

Experience has demonstrated that the use of the grid leak is the more practical method of controlling the grid potential of a vacuum tube. The function of the grid leak is to present a leakage path across the grid condenser so that the potential of the grid member in respect to the negative side of the filament may be maintained at some desired value. The potential maintained on the grid is computed by Ohm's law and is therefore equal to the grid current times the grid resistance. With a grid resistance of two megohms (2,000,000 ohms) and a grid current of one microampere, the bias negative potential will be two volts.

Different detection and amplification circuits require grid leaks of different value and in order that the experimenter may have access to a complete line of resistance units from 100,000 ohms to 6,000,000 ohms, a radio corporation has standardized a number of different values which are certain to meet all possible requirements on radio reception.

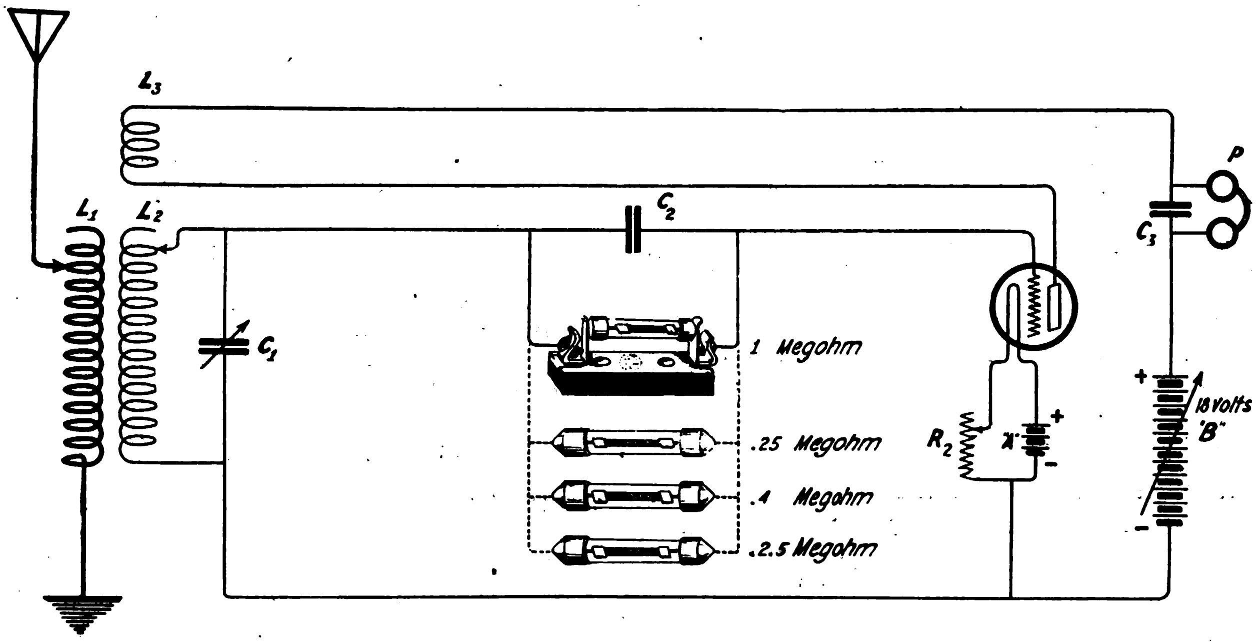

Figure 1—Typical tickler amateur receiving circuit equipped with a standard grid leak and base. Three suggested additional grid leak units of varying resistance are "standing by" ready for immediate use

The grid leaks developed and manufactured exclusively by this concern have been accepted as standards of uniformity in the country's foremost radio laboratories and are today used extensively throughout the commercial, experimental, and research fields. Some exclusive features are:

1. Uniform and permanent resistance.
2. Ease of mounting and changing.
3. Rugged construction.
4. Contact between "leak" and terminals absolutely certain and constant.
5. Particularly adapted to Radiotrons.
6. Absolutely moisture-proof.
7. Compactness.

These units have recently been placed on the market and they may be obtained in varying sizes, .15, .125, .2, .25, .3, .35, .4, .6, .7, .8, .9, 1, 1.2, 1.6, 1.5, 1.7, 2.5, 3, 3.5, 4, 5, 6. These figures are in megohms.

The Second District Amateur Radio Convention and Exhibition

will be described fully in the May WIRELESS AGE

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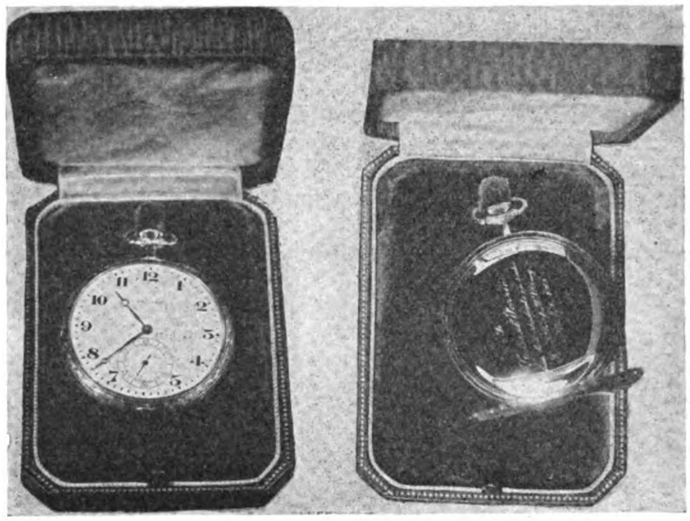
A Presentation to General Ferriè

GENERAL Ferriè of France, after completing his duties with the International Conference on Electrical Communications held in Washington on his return trip stopped off in New York City where he was met by Colonel Edgar Russell, formerly Brigadier General, Chief Signal Officer, American Expeditionary Forces, who escorted him to the French Line pier. Here a group of former students of the Sorbonne Radio Course, together with former officers of the Signal Corps who were associated with General Ferriè in France, greeted him with the presentation of the gold watch shown in the photographs. Major Edwin H. Armstrong made the presentation and Captain R. H. Ranger did the interpreting.

After the presentation General Ferriè bid General Russell a fond farewell, kissing him upon both cheeks, before embarking to sail for France. Among those present were Colonel Edgar Russell, Signal Officer, Eastern Department, Major Edwin H. Armstrong, Captain R. H. Ranger, Lieutenant Colonel Shreeve, Major O. Buckley, Lieutenant Miller and Captain W. H. Taylor, Jr.

Another get-together of the members of the Sorbonne Radio Course students was held March 2, 1921, preceding the regular Radio Institute meeting in New



Gold watch presented to General Ferriè

York City. Further details of gatherings will be sent out by R. H. Ranger, Radio Corporation of America, 233 Broadway, New York City, and all members who are not in touch with the New York members are asked to send in their names and addresses so that they can be advised.

Amateur Achievements in Radio Communication

Transmitting Range Extended by 2ZL Station

NEW distances for amateur C.W. transmission have been made by the 2ZL amateur radio station located at Valley Stream, L. I. The equipment of this station was described in last month's issue of The Wireless Age. Signals from 2ZL have been reported by Mr. Louis Falconi, operating amateur station 5ZA, Roswell, New Mex., and by Mr. Norman R. Hood, station 7KX, at Casper, Wyo. The airline distance between 2ZL and 5ZA, is 1,625 miles and between 2ZL and 7KX, 1,700 miles. As stated last month the total plate and filament input at 2ZL is 350 watts.

Amateur Cross Continent and Return Message in 23 Minutes

AN amateur radio relay message has been flashed from Hartford, Conn., to Los Angeles, Cal., and return in 23 minutes, according to John C. Stroeble, Jr., wireless operator, of Wheeling, W. Va.

The message was started by Hiram Percy Maxim, at his private station in Hartford, Conn., and sent direct to Chicago, from where it was relayed to Roswell, New Mexico. The next station was the Los Angeles Times.

The message left Hartford at 3.08 a. m. and was delivered back in Hartford at 3:31 eastern time.

Lacey, Wash., Amateur Station Receives 7,000-Mile Message

AN unusual distance in amateur radio reception has been accomplished by St. Martin's College at Lacey, Wash., where Father Sebastian "listened in" on a message sent from Batavia in the Island of Java, approximately 7,000 miles to the southwest of Olympia, Wash. The message came in very clearly. However, it was sent in Dutch, Java being a colony of The Netherlands.

A copy of the message was sent to the operator at Batavia and the authenticity of the message will be established, if possible. The message which reached Lacey, in the morning at 8 o'clock had been sent from Java at 6 o'clock the day before, according to Java time reckoning, there being eight hours difference in time between Lacey and the little Dutch island.

The receiving of the message from Java is the more remarkable because it came in on a single bulb instrument without the use of any amplifier.

The station can still be heard at the same hour every morning, Father Sebastain says. The call letters of the Java station are PMX and the messages, which seem to be press notices, are directed to PCG a station in the Netherlands. The sending wave length of PMX is approximately 6500 meters.

New Type of Condenser Antenna

(Continued from Page 14)

that it should prove very effective when so engaged by reason of the extremely low resistance. The latter is less than half an ohm when the antenna is properly designed, whereas the average 200-meter elevated antenna may have a resistance of from 5 to 30 ohms, depending on the character of the ground connection. So, according to the adherents of the new form of wireless structure, what is sacrificed in sawing off the height of the antenna is in a measure counterbalanced by an increased antenna current admitted by low resistance. The experimental outfit offers a realm for speculative interest—moreover, a wide feld for investigation. Here are examples suggested by the foster parents of the design: Signal intensity measurements should be made with a calibrated detector set or with a radio frequency comparison method so that the actual current or emf. in the antenna is measured; suitable designs of antennas for a specified wave length and for a minimum resistance The subject also invites exploration into the field of the electromagnetic wave as well as in the checking of transmission formulas.

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Radio Telephony Systems Employing Thermionic Vacuum Tubes

By John Scott Taggart

Editor's Note: This article contains a portion of the matter embodied in a complete volume on vacuum tubes by the writer. The volume will very shortly be published.

Continued from March WIRELESS AGE

WE now come to various methods of modulation which are particularly applicable to high power work or in cases where the source of oscillations is not necessarily an oscillating vacuum tube but possibly an arc of high frequency alternator. The first arrangement is a very old one—connecting a microphone in the earth lead; this is not to be generally recommended. An improved form of the circuit is obtained by shunting the microphone by several turns of an inductance included in the earth lead. Still another variation of similar character is to connect

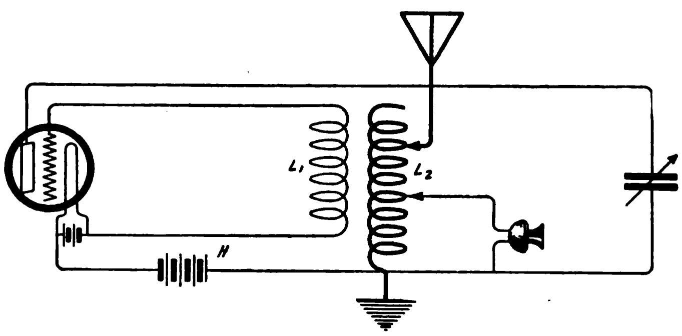

Figure 18—A practical circuit for low power experimental work

the microphone across several turns of the aerial tuning inductance. One practical circuit for low power experimental work is shown in figure 18. The ordinary oscillatory circuit is employed and the microphone is connected across a portion of the aerial tuning inductance L_2. The minimum amount of apparatus has been shown in the diagram. Instead of connecting the microphone where indicated, it may be connected across an inductance coupled to L_2 or L_1; this arrangement becomes more suitable, especially in the case of high powers. Where it is

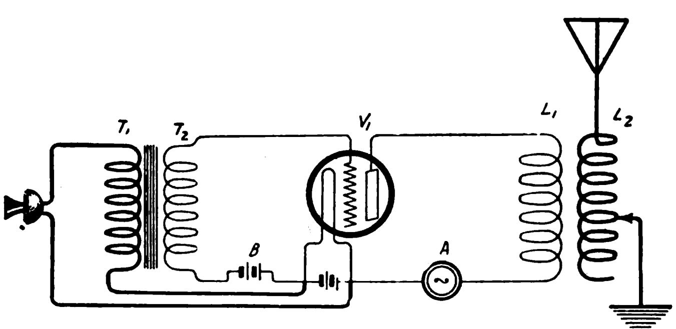

Figure 19—Circuit using a vacuum tube as a conductor of high frequency oscillations supplied by a generator

only desired to use a single vacuum tube the circuit of figure 18 is to be recommended, although the speech is not so good as some of the other arrangements.

A method of radiotelephone signaling which is of some interest is shown in figure 19. The vacuum tube V_1 is now used as a conductor of high frequency oscillations supplied by a generator A. The oscillations in the closed circuit L_1 depend for their magnitude on the conductivity of V_1, which, in turn, is proportional to the grid voltage. This grid voltage is controlled by the microphone M, and we thus see that a system of modulation is obtained. A considerable amount of energy, of course, is lost in the tube V_1 on account of its resistance. If it is desired to make the system quiescent when not speaking, a source of electromotive force B may be connected in the grid

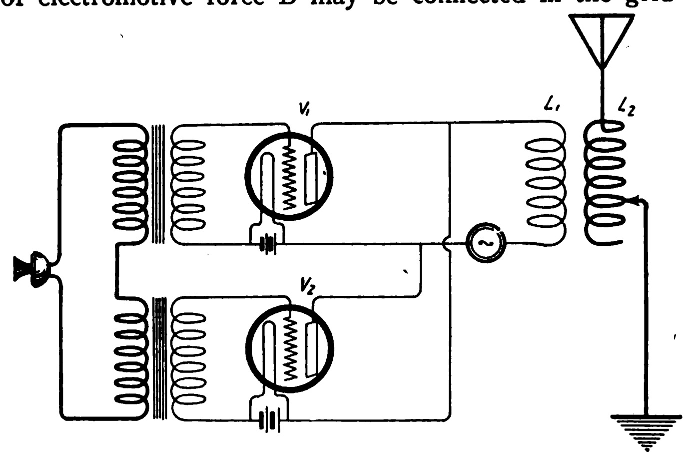

Figure 20—Circuit with two tubes arranged in parallel, but connected in a reverse direction

circuit of V_1 so as to make the grid sufficiently negative to prevent the tube conducting. Since V_1 has a certain capacity between the plate and filament feeble oscillations are bound to be set up in L_1 but do not affect the operation of the circuit. It will be realized that the tube V_1 will only conduct in one direction; this however will not prevent the establishment of continuous oscillations in the aerial circuit. It is preferable, nevertheless, to employ two tubes so as to conduct both half cycles of oscillating

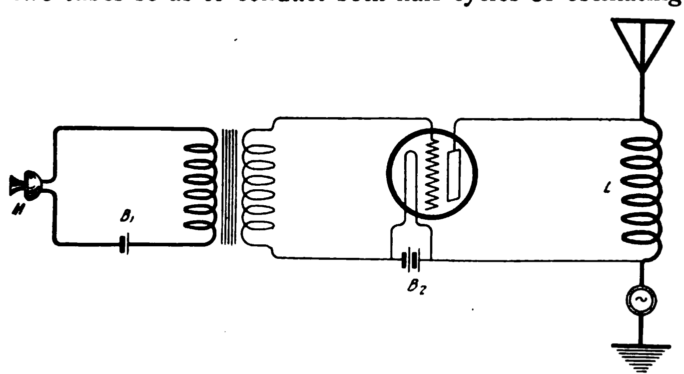

Figure 21—Modulation secured by diverting energy from the oscillatory circuit

current. Instead of using a single tube V_1 another may be arranged in parallel but connected in a reverse direction. Such a circuit is shown in figure 20. The top end of L_1 is connected to the plate of V_1 and the filament of V_2; thus when the top end of L_1 is positive, V_1 acts as a conductor, but when the top of L_1 is negative the lower tube V_2 will be the conductor. Two microphone trans-

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formers are connected as shown, the primaries being connected in series.

We now come to a form of modulation which depends for its action on the absorption of energy from the aerial circuit. Three electrode vacuum tubes are used as the absorbing conductors and a portion of the aerial current is diverted and dissipated in these tubes. The simplest

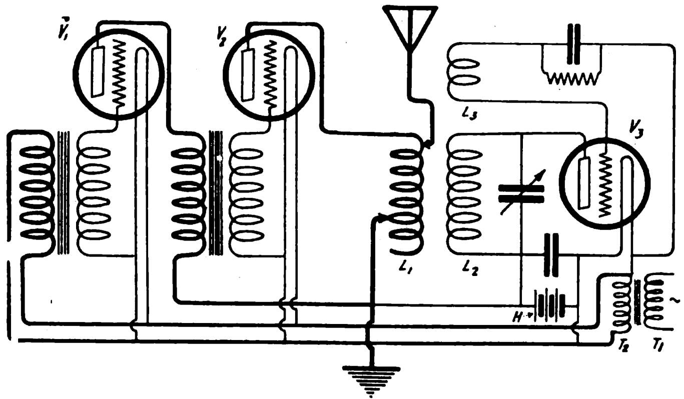

Figure 22—A practical circuit for the absorption method of modulation

circuit is shown in figure 21. The tube is connected across the aerial inductance L in which is flowing the high frequency oscillatory current produced in some manner or other such as, for example, by connecting the high frequency generator A in the position shown. The amount of energy diverted from the oscillatory circuit will depend on the conductivity of the tube, in other words, on the microphone potentials applied to the grid. If desired, the tube may be conducting under normal conditions when not speaking and the amount of current dissipated on the plate of V will be governed by the potentials on the grid. A battery may, if desired, be connected in the grid circuit of V_1 so that under normal conditions no energy is diverted from the aerial, the output being decreased when speaking. When a single tube is used energy will only be dissipated when the plate is made positive; thus those half cycles which make the plate negative are not modulated. To overcome this, we can connect two tubes in parallel across the aerial circuit or across the circuit coupled to the aerial. We then have an arrangement similar to figure 20 except that the source of oscillations is included in the aerial circuit. If we desire to do so, we could connect a resistance, some-

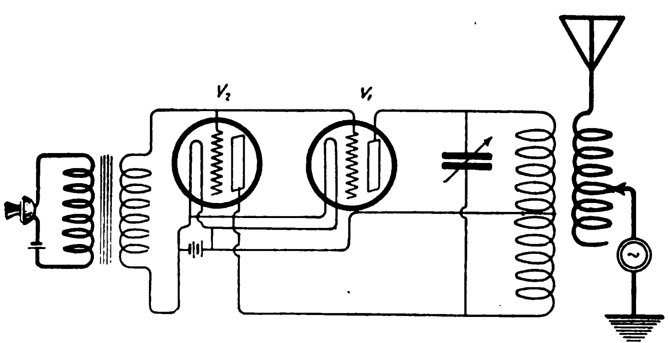

Figure 23—Circuit having two tubes connected across half the inductance

times shunted by a condenser, in the plate circuit of the tube. This usually improves articulation and helps to dissipate the current passed by the tube. A practical circuit which has been used up to 15 kilowatts is illustrated in figure 22. The fundamental arrangement is really the same as figure 21 but a steady anode voltage has been given to the plate of the absorption valve. There is thus a certain amount of current always being passed by the tube quite apart from the oscillations. The oscillations first oppose and then assist the steady voltage applied to the plate of the absorption valve V_2 by the source H of direct current which may be a dynamo or reservoir condenser fed by current from a rectifier system usually employing two electrode valves. The tube V_3 and its circuits are of the usual type. It is preferable in the absorption schemes to couple the valve output circuit loosely to the aerial circuit. An additional tube V_1 for the purpose of amplifying the microphone potentials is shown. The filaments of the three tubes are heated by alternating current through the transformer T_1 T_2. Instead of using two three electrode tubes across the whole of an inductance in or coupled to the aerial circuit, we may employ two tubes each connected across one-half of the inductance as shown in figure 23. A mid-way tapping is taken from the inductance L_1 to the filaments of two three electrode tubes as shown. The plates of these tubes become positive in turn and so the two tubes conduct alternating half cycles and the extent to which they conduct these half cycles depends upon the microphonic potentials on the grid of the operating tube. Instead of using two tubes a single tube may be used with two plates and a common grid. As before, resistances may be connected in the plate circuits. Instead of connecting the tubes in parallel to enable modulation of higher powers to be obtained, it has been suggested that tubes might be arranged to conduct oscillations progressively by arranging graded negative potentials on the grids. It is claimed with this arrangement that the power modulated, in-

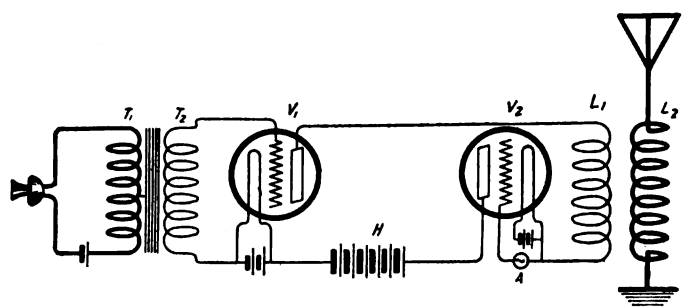

Figure 24—Circuit having a source of high frequency current connected across the grid and filament of one tube modulated by the microphone potential of another tube

creases, as the square of the number of tubes used instead of in direct proportion.

A circuit which does not appear to find place in any of the classes described is shown in figure 24. Two tubes are arranged in series so that the electron current flows through both tubes. Across the grid and filament of one tube V_2 is connected a source A of high frequency current. Across the grid and filament of the other tube are applied the microphone potentials. The current in the output circuit L_1 will be those produced by the high frequency oscillations of A modulated by the microphone. These may be passed out to the aerial or be amplified by some amplifying arrangement.

In conclusion, it may be proper to state one or two general facts in connection with the circuits here described. One is that, whenever direct coupling has been used, it is possible to use indirect coupling. Also that minor details of arranging the circuit are left to the designer. Actual practical examples have been given as a guide for those whose experience of this work is limited. When dealing with high powers it is very frequently necessary to employ high power rectifying tubes instead of the conventional battery shown. It is not proposed to give any description of these rectifying units which will form an independent subject.

The author of this article desires to acknowledge indebtedness to the Wireless Press for permission to extract some of the details which are given in the author's book on vacuum tubes which is very shortly to be published and which enters into the detailed use of these tubes in all branches of radio telegraphy and telephony.

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Control Means for Vacuum Tube Generator

IN circuits using vacuum tubes for generating high frequency oscillations, brought out by bringing the circuit into the so-called singing condition, it is customary to have a coupling or feed-back connection from the output to the input circuit of the vacuum tube. The frequency is generally determined by using a resonant or tuned circuit connected with the vacuum tube.

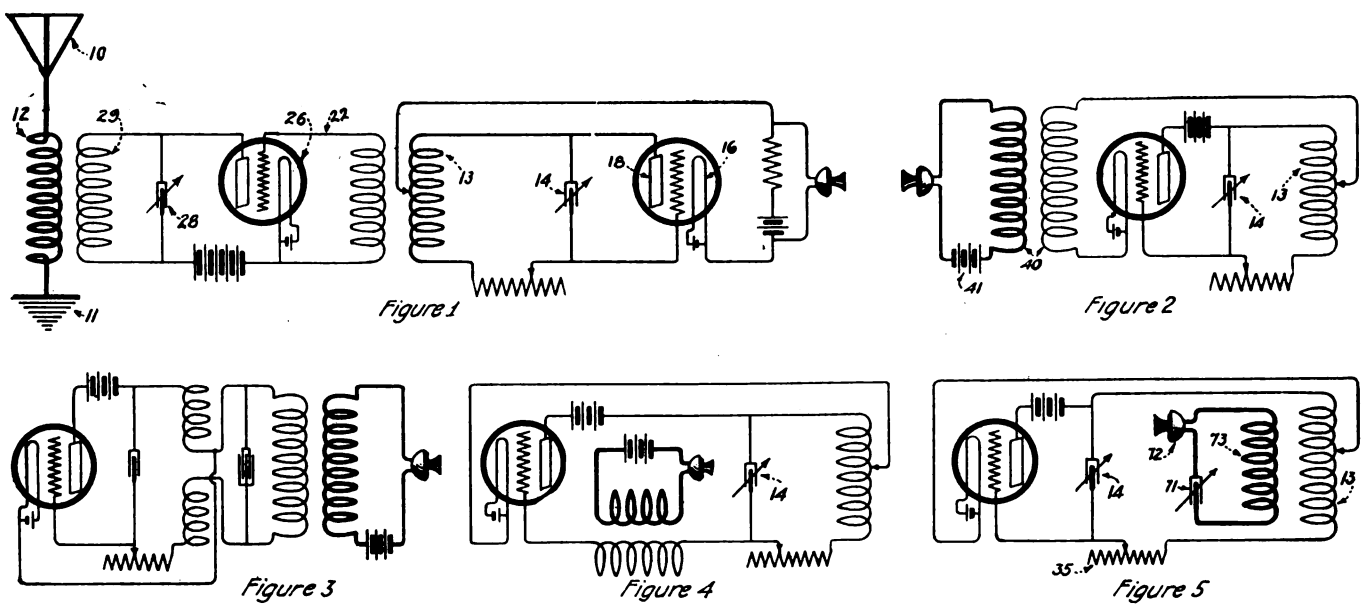
A method has been described by R. A. Heising, which under different circumstances, according to the use to which this system is to be placed, it may be desirable to change its characteristics by bringing it to the oscillatory, slightly oscillatory, near oscillatory or non-oscillatory condition. A ready means for doing this consists in placing in the tuned circuit an adjustable resistance, so that the circuit may be readily brought into one or another of the conditions desired.

This will be better understood by reference to the accompanying drawings, in which figure 1 shows a system adapted for radiating high frequency oscillations, figures 2 to 5 show various modifications, and figure 6 shows the application of the system to a receiving station.

In figure 1 the aerial is connected to earth through the inductance 12. A tuned circuit comprising the inductance 13 and the condenser 14 may be connected to the inductance 12 through amplifier 22. Conductors leading from one side of the condenser and from an intermediate point in the inductance 13, lead to the input of a vacuum tube amplifier, the input electrodes comprising the usual heated element and grid. The output electrodes, 16 and 18, of the amplifier are connected to the middle of the inductance and the other side of the condenser 14. The usual battery is placed in the output circuit.

The frequency of the oscillations in the output circuit is determined primarily by the period of the tuned circuit 13, 14 and the connection from this tuned circuit to the input circuit of the vacuum tube causes the oscillations to be maintained. Modifying the amplitude of the oscillations is accomplished by means of a resistance and battery connected in series with the element 16. In parallel to the resistance and battery is connected the microphone transmitter. Signals may then be transmitted by speaking against the microphone, thereby causing the impression of low frequency oscillations, in accordance with speech variations, upon the input circuit of the vacuum tube. These low frequency oscillations will then bring about a corresponding modification or modulation of the power in the output circuit. Inserted in the tuned circuit is a non-inductive adjustable resistance. By means of this variable resistance it is possible to bring the circuit into an oscillatory, slightly oscillatory, near oscillatory or non-oscillatory condition. In case of transmission, however, it is usually desirable to adjust the resistance to such a point that the system will be in the oscillatory condition. The oscillations then set up may be radiated directly into the antenna. In general, the quality of signals transmitted by the modulated waves will be better when the system is slightly oscillatory than when the system is highly oscillatory.

In view of the small amount of power in the output circuit of the amplifier, it is generally desirable and necessary to have the inductance 13 connected to an amplifying circuit which may then be connected to the radiating antenna.



Various circuits of the vacuum tube generator control

Such an arrangement is shown in figure 1 in which 22 is the amplifying circuit inserted between 12 and 13. This amplifying circuit comprises the inductance connected inductively to 13. The inductance is connected to the input terminals and of the vacuum tube amplifier 26. The output electrodes feed into the circuit consisting of the condenser 28 and inductance 29, tuned to signaling frequency. This circuit is inductively connected to the antenna as shown.

In figure 2 a modified method for impressing the low frequency signaling oscillations upon the input circuit is shown. In this case the resistance and battery are replaced by the secondary of a transformer 40, the primary of which is included in a circuit containing battery 41 and the microphone. In this circuit also the high frequency oscillations, fed back from the tuned circuit 13, 14 are impressed upon the input circuit of the amplifier. It is then amplified and sent into the plate circuit, resulting in a continuous oscillation of power at a frequency determined by the network. The amplitude of these oscillations is altered, however, by the low frequency oscillations impressed upon the circuit by means of the transformer 40.

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In both of the circuits described, the voltage impressed upon the circuit by the telephone circuit changes the potential of the plate as well as the grid with respect to the filament. The effect upon the grid and plate will be additive, but the same amount of energy when applied to the plate circuit will cause less effect than when applied to the grid circuit. Since the amount of low frequency energy supplied by the microphone circuit is limited, it may be desirable in some cases to operatively associate the microphone circuit with the grid circuit only so that the total modulating effect may occur through action upon the grid and plate. The desirability of so doing will depend upon a number of factors such as the amplifying power of the tube and the constants of the tube, associated circuits and microphone or variable impedance device. An arrangement for doing this is shown in figure

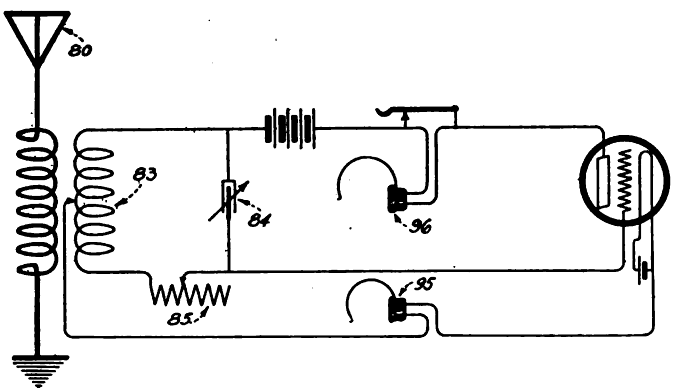

Figure 6—Circuit for the receiving system

3. In this case the inductance is split in the middle and a large condenser which has practically zero impedance for the high frequency currents, is in circuit. Since such a condenser will not be of zero impedance for voice frequency currents, the transmitter with its associated battery and transformer may be connected in parallel to the condenser as shown in the figure. The telephonic frequencies are thus impressed across the condenser by the transformer, and the potential variations are introduced on the grid circuit without being introduced also on the plate circuit.

In figure 4 the telephonic potential variations are impressed on the grid by a transformer between the condenser 14 and the grid. In the modification shown in figure 5 the variation of the oscillations is caused by varying the effective resistance in the oscillator circuit. In this case the resistance of the transmitter is introduced into the oscillator circuit by a tuned circuit coupled thereto. The circuit includes the condenser 71, microphone 72 and the inductance 73. The whole circuit may be tuned to the signaling frequency, and is coupled to the inductance 13. Changes in the resistance of the circuit containing the microphone transmitter will produce corresponding changes in the amplitude of the oscillations taking place in this system as a whole.

In all of the modifications described, the frequency of the system is adjusted by means of the condenser 14 and amplitude of oscillation can be adjusted by the resistance 35.

Figure 6 shows the application of this system to a receiving system. In this figure, 80 shows an elevated conductor connected to earth through an inductance. Coupled to this inductance is a resonant circuit including the inductance 83, condenser 84 and adjustable resistance 85. Conductors lead from the one side of the condenser and from a point in the inductance to the input terminals and of the amplifier. The output circuit of the amplifier has the plate electrode connected through the battery to the other side of the condenser 84 and the filament to a point in inductance 83. A telephone receiver is placed in series with the filament. This receiver may, however, be placed as shown at 96, the switch serving to short-circuit this receiver when receiver 95 is being used. However, two receivers may be employed, one in the position 95 and the other in the position 96, in which case either one may be employed for the reception of signals, or both may be used simultaneously. This circuit arrangement provides a means for heterodyne or beat receiving without the use of an additional generator to furnish the superposed, beat producing oscillations. It also provides means for amplifying and sustaining the signals, and is so arranged that these two methods of operation may be obtained in the same circuit. The action for heterodyne receiving is as follows: The resistance 85 is adjusted so that the circuit containing it and the variable capacity is oscillatory at a frequency near that of the signals to be received. Then, when the received signals at high frequency combine with the oscillations of the frequency set up in the local oscillatory circuit, the interference of these two inaudible oscillations produces beats which are audible in the telephone exactly as in the usual heterodyne receiving system, using a separate source for the local frequency.

In the heterodyne method it has been found preferable to have the circuit adjusted to the slightly oscillatory condition so that the received signals may be amplified to a great extent. In case the system is to be used as a self-amplifying one, it is desirable that the system be so adjusted that the circuit of the condenser is near oscillatory. As pointed out, this is accomplished by varying the resistance 85 until the circuit is nearly in the singing condition, in which condition a disturbance entering the system starts oscillations which are nearly undamped and die out more slowly, resulting in an amplified signal which is more easily received. In either method of operation, the tuning can be done entirely with the variable condenser, and the adjustment to bring this system into the required state may be made with the resistance alone. In this latter case the state of the system is indicated by the reading of an ammeter placed to record the space current. The condition of free oscillation or singing is shown by a sudden increase in the magnitude of the space current.

Receiving Circuit for Frequency Selection

A RECEIVING circuit tuned to receive one or more predetermined tone frequencies to the exclusion of all other frequencies and thus cut down interference has been developed by F. E. Pernot.

The receiving circuit has certain portions which are in ordinary use and these portions will be described so that the combination of the old and new elements will be readily understood. Figures 1 and 2 show an aerial which is connected with one of the windings of an air core transformer, the opposite end being grounded. The secondary winding of the transformer is connected with one terminal of a vacuum tube, the opposite terminal of the coil being connected to the filament which is heated by a battery in a local circuit. A condenser is bridged across the terminals of the winding L_1 and a B battery is connected in the plate circuit as shown. The receiving circuit thus described is ordinary and has been used as a type of circuit which may be employed in connection with this improved receiving system.

The vacuum tube instead of being connected directly to the telephone receiver is connected to an

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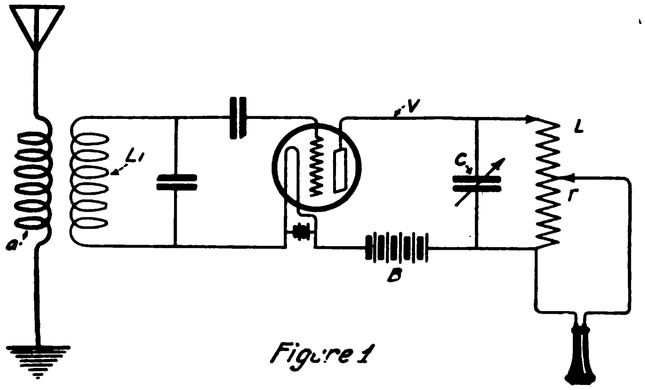
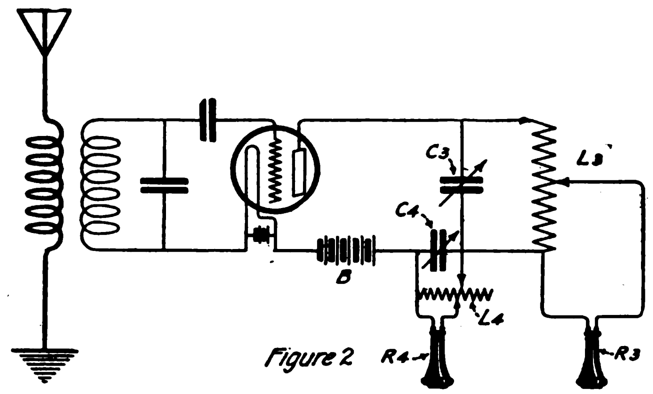
auxiliary circuit, which serves to separate the different group frequencies delivered to it by the tube. Each auxiliary circuit as shown in figure 1, includes an inductance coil L which is connected at one end to the B battery, the other end of the coil being connected to the plate with the wire V by means of a movable contact B. A variable condenser C is bridge across the terminals of the coil L to one end of which a telephone receiver has one terminal connected, the other terminal being connected to an adjustable contact r.

In the operation of the circuit the impulses are received by the aerial in the usual manner and transmitted to the vacuum tube. The current from the tube pulsates at the tone frequency of the sending set and serves to excite the circuit L, C, at this frequency. The circuit L, C, may be adjusted either by varying the capacity of the condenser C or by shifting the contacts B or r.

Figure 2 shows an arrangement by which more than one operator may receive at the same time. This is accomplished by providing a plurality of circuits similar to the circuit L, C, of figure 1, these circuits being shown at L_3, C_3 and L_4, C_4, the former having the receiver R_3 and the latter having the receiver R_4. Each auxiliary receiver circuit is sensitive to one group frequency only, so that a single station may receive simultaneously a plurality of group frequencies.

A succession of electrical impulses emanating from one station may be at a certain radio frequency such as one million cycles per second, and at a certain group frequency such as five hundred cycles per second. Another station may send out impulses at the same radio frequency but at a group freqeuncy of eight hundred cycles per second. When these impulses reach the antenna of the set in figure 2, they will of course be unintelligible until they pass the vacuum tube detector. It is now that the auxiliary circuits L_3 and L_4 perform their separating actions. Each circuit being tuned to the group frequencies of five hundred and eight hundred cycles per second respectively, make only those impulses of these particular group frequencies audible in the respective telephones R_3 and R_4.





Figures 1 and 2—Receiving circuits for frequency selection

Radio Controlled Recorder

AN interesting radio circuit employing a mechanical vibrator as a recorder has been devised by H. Pratt.

The currents induced in radio receiving systems are ordinarily of too high a frequency to enable them to produce direct mechanical movements; but the tendency of radio during recent years has been toward lower frequencies, so that at the present time, frequencies are being employed for long distance communication which are sufficiently low to enable them to produce mechanical motions directly. Radiotelegraphic stations have been in continuous operation for trans-Atlantic communication for over ten months past, which have been regularly employing radio frequency currents between 17,000 and 20,000 cycles per second. This recorder is worked from currents of such frequencies.

Figure 1 shows a receiving circuit. The aerial tuning inductance has its terminals connected to the input of a radio frequency amplifier and transferred through transformer 1, to an electrically tuned circuit containing a condenser and an electromagnet 2. Associated with this electromagnet is a mechanically tuned armature, 3, of steel permanently magnetized, and placed so that one of its magnetic poles may be acted upon by the electromagnet. An alternating radio frequency current flowing in the electromagnet produces a magnetic field at the end of its core which is also alternating, thereby causing vibrations of the magnetically polarized, mechanically tuned armature. These vibrations are made possible through the spring action of the armature as the latter is fastened rigidly to a fixed base with its upper end free to vibrate. The mechanical tune of the armature must be such that its vibrations will be in synchronism with the radio frequency current used. This mechanical vibration may be dampened by immersing the armature in a fluid, so that such vibration will not continue after the flow of radio frequency current in the electromagnet has ceased. If this armature is arranged for tracing an inked record upon a moving cylinder 4 advanced by

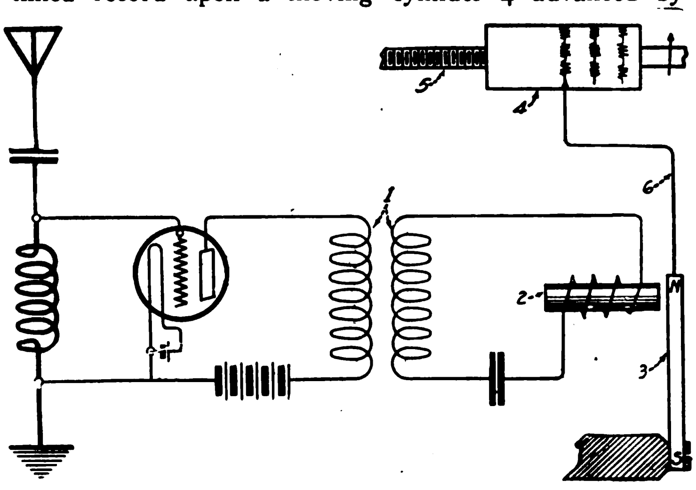


Figure 1—Circuit employing a mechanical vibrator as a recorder

screw 5, the radio telegraphic signals may be recorded in a legible manner by means of a pen 6 from the groups of radio frequency currents generated in the system.

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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

Construction of a Synchronous Rectifier

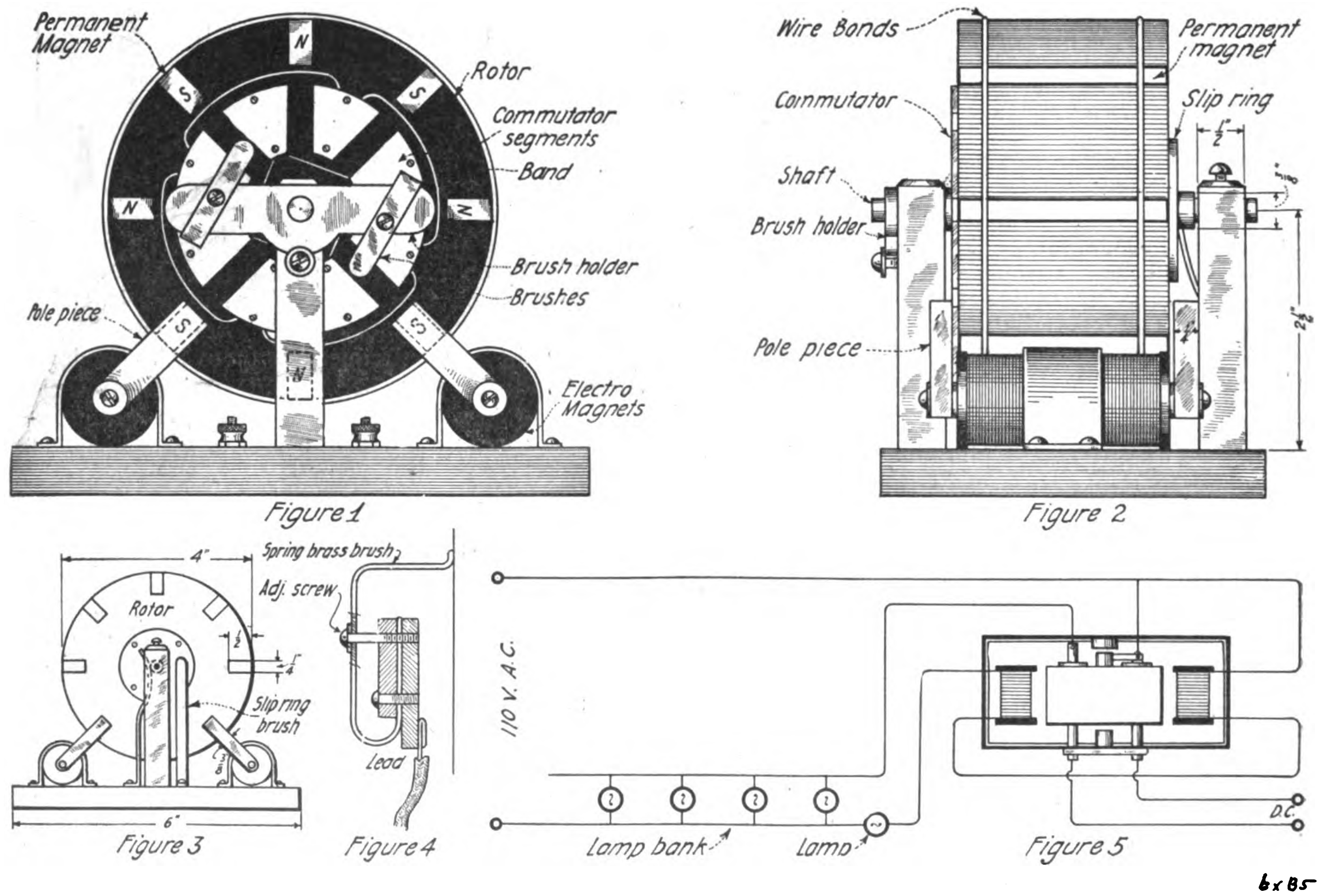
By Thomas W. Benson

EVERY experimenter at one time or another has faced the problem of constructing a rectifier for storage battery charging or other purposes where direct current is a necessity. The electrolytic rectifier is possibly the simplest to construct though it rarely gives satisfaction except in the hands of an expert. The vibrating type of rectifier requires not a little experimental work to be performed before a satisfactory instrument can be built. Building a rectifier from a polarized ringer has been described from time to time, but it is rarely successful. The theory of how they operate looks well on paper but does not work out in practice because the armature of a polarized ringer is designed to operate or vibrate at a much lower frequency than the usual house lighting current. Hence the armature simply sticks and buzzes instead of oscillating. However, should one be able to obtain a ringer tuned for a 60-cycle current a rectifier can be built without much trouble.

The rectifier to be described in this article is nothing more nor less than a synchronous motor fitted with a commutator to give direct currents. This type of rectifier is something new but presents no real constructional problems.

By utilizing a continuous rotary motion we overcome the greatest trouble in building mechanical rectifiers. Any rectifier using a vibratory motion, such as an armature oscillating in step with a 60-cycle current, is mechanically wrong. Since the moving part possesses weight the factor of inertia increases rapidly with the speed of the armature. Considering that the armature of a vibrating rectifier on 60-cycle current has to make one complete cycle in 1-60th of a second or change its direction of movement 7,200 times per minute, the difficulty of building a vibrating rectifier will be realized. However, by using a rotary motion we are able to take advantage of any inertia present to give a steadier action of the device, and by arranging a simple commutator to make properly timed connections to the A. C. source, we are able to draw a unidirectional current.

The dimensions as well as constructional details are given in the illustrations. The only part that offers any difficulty to the construc-



Constructional details and circuit diagram of the synchronous rectifier

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tor is the rotor. This is preferably turned from some close grained wood to the dimensions shown, but it can be cut with a coping saw and built up to the proper thickness. The width of the rotor will be determined by the length of the field magnets. To reduce the work a pair of 1,000-ohm ringer magnets can be used and after obtaining them the rotor can be made up.

The face of the rotor is laid off into eight equal parts and slots cut to take the steel bars forming the poles of the rotor. Before inserting in the slots the bars are strongly magnetized. After coating with a good grade of glue the bars can be slipped into place and firmly held there by a few turns of copper wire wound in slots filed in the face of the rotor as shown. The ends of the bars should come flush with the ends of the rotor.

A three-eighth inch hole is drilled in the exact center of the rotor to take a brass tube. This tube should be a snug fit and held in place with glue. The tube extends a half-inch at one end of the rotor to form a contact ring, as will be understood later.

The commutator is made by taking a disc of copper and laying off the holes for fastening to the rotor. After drilling and countersinking the holes, the copper disc is attached to the rotor, in the position it is to occupy, with a small flat head brass screw. Now with a scriber and straight edge mark off where the segments are to be cut, allowing one-quarter inch between each segment. Mark each segment and the corresponding part of the rotor, remove the disc and cut the segments apart. This method secures proper alignment of the segments when replaced, in spite of any slight inaccuracies in the location of the screw holes.

The other end of the rotor is fitted with a slip ring cut from copper sheeting and attached with four screws as shown. Alternate bars of the commutator are banded together with copper wire securely soldered to each segment. One band is connected to the tube through the rotor, the other to the slip ring on the opposite end.

A steel shaft should be obtained to support the rotor. It should fit snugly into the tube and still permit the rotor to turn easily. Grinding in with a little fine emery and carefully removing all traces of the emery afterwards will assure a good fit. A little vaseline on the shaft will serve as a lubricant. The rotor should then be balanced by supporting it by the shaft on two parallel straight edges and turning it to various positions. Should one side turn to the bottom, add solder to one of the top band connections or remove a small amount of wood on the heavy side. This operation should be repeated until the rotor will remain in any position. The rotor can then be mounted on the base by means of brass uprights.

The brush holders permit of varied treatment, possibly the simplest form being shown. A strip of fibre, drilled to pass the shaft, supports the brushes cut from spring brass, the tension on the brushes being varied by means of a small machine screw. Flexible leads are soldered to the brushes and connected to terminals on the base. The brush holder is clamped in any desired position by means of a screw tapped into the upright. At the opposite end of the rotor are provided two brushes, one pressing against the slip ring, the other bearing on the brass tube.

It remains now to mount the field magnets. As previously mentioned, two ringer magnets are used, fitting them with pole pieces that extend one-half inch over the edge of the rotor. The magnets are clamped to the base by two brass strips, connections from the magnets being made to two terminals on the base. It is important that the poles on the same side of the rotor are of the same polarity at any instant.

The diagram of connections is shown in figure 5. Although a lamp bank is used to control the current it is advisable to use a step-down transformer having a secondary voltage of 12 or 18 volts. With the lower voltage it is best to connect the field magnets in parallel.

The device is now ready for use. Adjust the brushes by first turning the rotor till a rotor magnet lies directly between the poles of the field magnets, then swing the brushes till they lie between segments. Clamp the brushes in this position by means of the clamping screw. Connect the device to the A. C. supply by closing the switch and spinning the rotor by hand in the direction of the arrow or away from the brushes. If properly wired the rotor will rapidly pick up and fall in step with the A. C. pulsations and run synchronously at a speed of 900 R.P.M. on 60-cycle current. Now test the D.C. terminals for polarity and mark them. Then give the device a light load by means of a resistance or lamp bank, gradually increasing the load and watching the brushes for sparking. Any sparking can be remedied by shifting the brushes slightly so the make and break will occur at the zero point in the cycle.

The instrument as shown will operate nicely up to ten amperes, where sparking and heating will become troublesome. By carefully adjusting the brushes and making sure that they contact properly on the commutator, the device will work very efficiently. The rotor is not self starting and must be mechanically started into motion. A slight spin with the finger is sufficient for it to "pick up the cycle," and it will then continue to operate until switched off.

Always be sure to get the rotor up to speed before closing the switch to the D.C. apparatus. This usually takes but a few seconds with a free running rotor, the tone given by the rotor being an easy method of judging the speed after a little practice.

This rectifier will operate in any position and requires but an occasional cleaning and oiling. If mounted on felt pads or blocks of art gum it will operate silently. The simplicity and high efficiency of this device ought to recommend it to every experimenter as the true solution of the problem of obtaining direct current for experimental purposes.

An Intermediate Wave Receiver

By William E. Diehl

THE design of a receiver which will be efficient on amateur wave lengths and yet include in its range the longer wave-lengths (up to and including "time") is an old problem. Some experimenters, in an attempt to adapt their instruments for the reception of longer waves, load up the primary and secondary circuits. Such a scheme entails considerable loss of efficiency through the addition of switching mechanisms, and the results obtained are generally disappointing.

In the type CR-5, by the use of bank-wound inductance, a high ratio of inductance to capacity is maintained throughout the entire range, and the distribution of the units is such that the tube coupling increases automatically with the

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wavelength—thus making the regenerative action smooth and evenly distributed on all wavelengths.

Figure 1 shows a front view of the receiver. It will be noted that considerable thought has been given to balance, and general appearance, yet each unit is placed in the best position for efficient operation. Although a comparatively small outfit, the CR-5 is a complete receiver. To put it into operation all that is necessary is an antenna ground system, a vacuum tube, phones, and the usual "A" and "B" batteries. In operation, it is the last word in simplicity. There are but two controls to adjust, namely wavelength and amplification. The switch in the centre of the panel, used in conjunction with the condenser dial to the left controls the wavelength. The dial to the right is for the control of regeneration or amplification of signals. All knobs, binding posts, and dials are of the recent Grebe design, calculated to insure positive and easy adjustments. The switch in the centre has two contact arms, the purpose of which is the elimination of dead-end losses. In the upper right hand corner of the bakelite-dilecto panel is located the vacuum tube socket, and directly beneath it the rheostat for controlling the filament current.

Figure 2 shows the interior of the receiver. The elements are all carefully and rigidly secured to the main panel. To the left will be noted the tube socket base, on which is also mounted the grid and by-pass condensers. To the right is mounted the tuning variable condenser. The inductance unit, mounted in the centre, is quite novel, consisting as it does of a standard rectangular variometer and bank wound inductance. This inductance is a three-bank winding of 20/38 litz. It is securely fastened to the stator block and is a continuation of the stator winding. The rotor of the variometer serves as a tickler coil and on account of its position with relation to the stator, allows an even feed-back throughout the entire range of wavelengths. On the lower or amateur wavelengths the rotor is so designed that it serves as pure plate inductance, and by reason of the adjacent windings its action is similar to that of a plate variometer. The point of maximum regeneration on the lower range takes place when the rotor is at right angles to the stator winding, thereby eliminating wave-length changes when regeneration is obtained. As the wave-length is increased, the mutual inductance between the fixed and movable coil is automatically increased, thereby permitting high amplification over the entire range. The elements are all connected with heavy bus wire and flexible stranded pig tails eliminate all bearing contacts.

Figure 3 shows the wiring diagram. C represents the tubing condenser, L the variometer section of the inductance, L_1 the bank wound section, L_2 the tickler coil. C_2 is a grid condenser and C_3 the by-pass condenser. The normal wavelength range of this receiver is obtained with an antenna of .0004 mfd., but it will function satisfactorily with antennae of larger or smaller capacity. Very excellent results were obtained with an antenna consisting ot two wires 25 feet high and 40 feet long, and the receiver also was efficient when used with a single wire antenna, 30 feet high and 100 feet long. The CR-5 is admirably adapted to loop reception—the loop being connected to the terminals marked "Ant." and "Gnd." With the addition of a loading coil in the antenna circuit, this receiver may be made to respond to wavelengths well beyond its rated range.

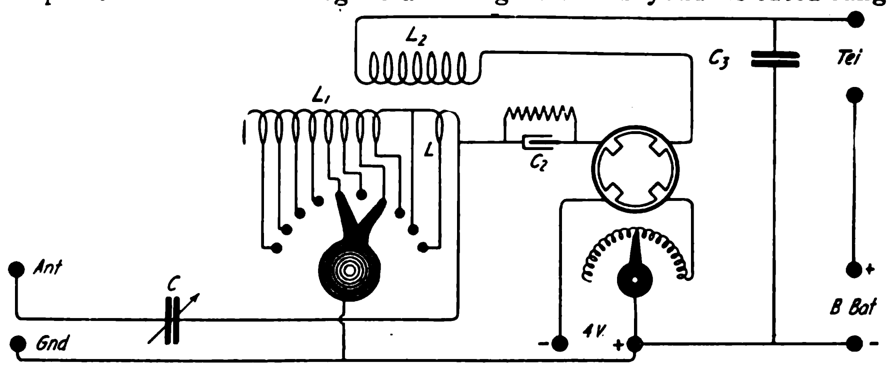
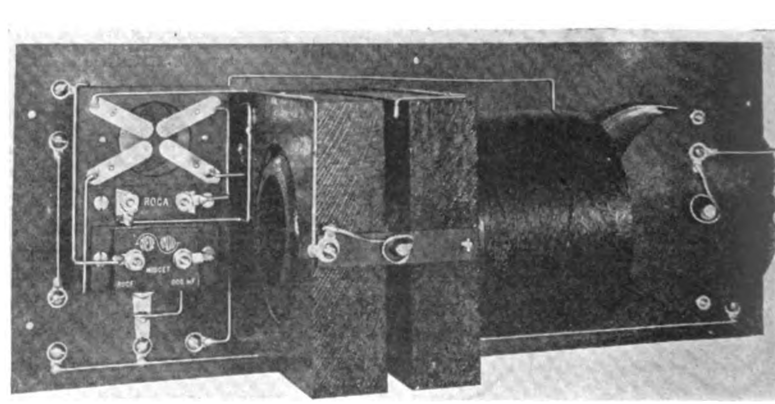


Figure 3—Wiring diagram of the receiver

The operation of tuning with this receiver is extremely simple. The switch marked inductance is set on one of the contacts—assume contact No. 1, the condenser dial is then rotated until the signal is heard, and when the correct setting for maximum strength is found, the dial marked "tickler" is rotated to a point where maximum amplification is secured. In tuning for C. W. stations it is better to reverse this order, i.e. rotate the "tickler" to about 80 and starting at a setting of about 80 on the condenser rotate the dial until the CW note is heard, and then decrease the "tickler" until maximum signal strength is obtained. It is to be noted that distant stations will often be inaudible until amplified, so a better method of tuning in spark stations is to rotate both dials simultaneously, keeping the "tickler" well in advance of the "condenser." Using this method, signals will be picked up but with the tone distorted, which is overcome by adjusting the tickler dial.


Figures 1 and 2—Front and interior views of the receiver

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Delegates and visitors attending the second annual convention and banquet of the Third Amateur Radio District at Turngemeinde Hall, Philadelphia

Continuous Wave Transmitter

By A. Machson

First Prize $10.00

IN building a continuous wave transmitter one must consider carefully the various types of generators possible for his set and choose the one which will give satisfactory results. The matter is quite an expensive one at best. The consideration of expense and results desired led to the choice of a vaccum tube generator.

There were three possible means of radio frequency generation which I had to consider, arc, radio frequency sparks, and vacuum tubes. The arc was ruled out on account of difficulty and instability of operation on the low wave lengths. The radio-frequency spark, either timed or multi-spark, is not very much in use by amateurs, because to secure really good results requires very high grade mechanical construction of the spark generator. This left the vacuum tube system, which was satisfactory.

Intending to use the set ultimately for telephone, and having No. D. C. generator, I had to use rectified A.C. on the plate. I had 5 Moorehead tubes in all and decided to use 2 as rectifiers, 3 in parallel for telegraphic transmission, and these 3 arranged 2 in parallel and one as modulator for telephony. I had used three element valves as rectifiers before by connecting the grid to one end of the filament, and the operation as rectifier was very satisfactory.

The rectifying circuit which I used is shown in the first figure. The transformer design will be explained later in detail. As seen from the diagram, the low-tension secondary S_1 lights the rectifier bulb filaments. S_2 lights the oscillator and modulator bulb filaments, and high tension secondary supplies the plate voltage. The smoothing out circuit is a standard one originally described by Hull in which C_1 and C_2 were condensers of ½ microfarad each. These condensers easily stood a voltage of 750 volts. For the inductance L, which should be very high, I revived an old Mesco ½-inch spark coil and used the secondary for the inductance with the primary open. This circuit gave very satisfactory results, the hum of the 60 cycles being practically negligible.

The transformer design was chosen essentially to economize in space, material and labor. Therefore instead of making two transformers having two cores, as is usually done to supply plate voltage, rectifier and oscillator filament voltages, one transformer with all the windings was made. This saved considerable iron and also saved copper since only one primary had to be wound. A combination shell and core transformer was designed, having one primary, two low tension secondaries for the filaments and one high tension secondary for the plate voltage. It is absolutely necessary to have two separate lighting sources well insulated from each other, for the filaments, for if the same source is used the oscillator plate potential will be shortened to ground.

The details of the transformer are as follows: Silicon steel, number 29 gauge was used for the core. Double cotton covered wire was used on all the coils. The three legs were wound first with the three low tension windings, the primary on the center leg,

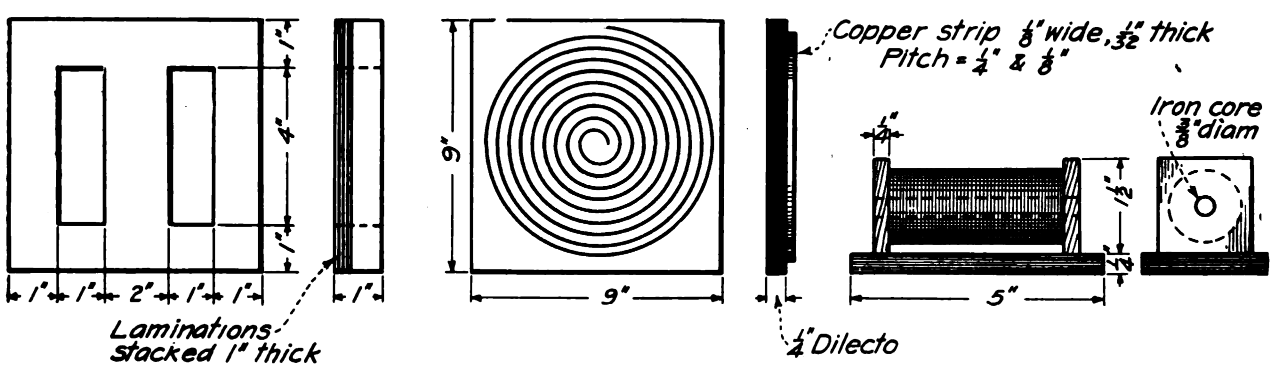

Figure 2 Figure 4 Figure 6

Constructional details of the transformer

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the two low tension secondaries on the outside legs. Between the core and each winding there was one layer of linen tape binding the steel sheets together and one layer of oak tag paper for insulation. The high tension secondary was wound over the primary, there being two layers of oak tag paper between primary and secondary. The dimensions of the transformer are shown in figure 2, the sheets being stacked up one inch high. The primary consisted of 110 turns of No. 18 D.C.C. wire the high tension secondary having 880 turns of No. 26 D.C.C. wire. Making a transformation ratio of 8.0, giving a voltage of about 880 volts for the secondary, or since one-half this is used for the plate, a voltage of 440 volts for the oscillator. Allowing for voltage fluctuations and voltage drops the voltage across the oscillator bulbs was about 400. The primary was wound in two layers, 55 turns each, and the secondary was wound in 6 layers. The low tension secondaries were both wound with 12 turns of No. 12 D.C.C. This gave a low tension voltage of 12 volts for the filaments, allowing sufficient leeway for variations and for the filament resistances. Taps were brought out at the center of each of the secondaries as required.

Figure 3 is a simplified wiring diagram of the radio hook-up when in the C.W. telegraph position. The three tubes are used in parallel and with 400 volts on the plate and about 0.8 ampere per filament, the radiation was 1 ampere in the antenna. The circuit is the regular feed-back type, inductively coupled to the antenna. For coils I used two flat copper strip spirals which I had, mounted so that the angular separation between the coils could be varied, in this way controlling the coupling between antenna and plate. One coil had 16 turns, the other had 28 turns. The coils were made of $\frac{1}{8}$-inch copper strip, about 1/32-inch thick. The pitch of the smaller coil was $\frac{1}{4}$-inch, that of the larger about $\frac{1}{8}$-inch. Figure 4 shows the dimensions of the dilecto board on which they were mounted. It was necessary to use the larger coil in the plate-grid circuit, in order that the proper transformation ratio could be obtained for oscillations. The smaller coil in the plate-grid circuit would not allow enough plate and grid voltage to induce oscillations. C_p is a moulded Murdock condenser of 0.001 mfd. capacity, C_g is a variable condenser adjusted to about 0.0007 mfd. GL is the grid leak, a wire resistance about 10,000 ohms resistance. RF is a radio frequency choke coil.

In order to get the maximum output from this set, I found it necessary to fix the antenna loading coil first to give the working wave length. Then the plate grid taps had to be adjusted properly to get maximum output. For a given wave length there is a best adjustment for plate and grid inductances and antenna coupling. This adjustment is only found by experimenting and once found it is advisable to keep it fixed. As seen in figure 4 the telegraph key is in series with the grid leak. When the key is pressed the leak circuit is closed, which allows the negative charge of leak off the grid, and the circuit oscillates. When the key is not pressed the grid leak circuit is open, the high negative charge on the grid is unable to leak off, resulting in very small plate current, and the circuit does not oscillate. Thus when the key is not pressed very little energy is consumed by the tube. At first I wanted to place the key in the primary of the transformer, but this would mean throwing on and off the filament currents which is undesirable and furthermore it would not work well because it takes time for the filaments to reach full brilliancy, and the oscillations would not follow the key signals. The key in the grid circuit gave excellent results.

For telephony I used the Heising system of modulation. Now this system requires an extra tube as modulator, and as stated at the start, one of the oscillator tubes was used for this purpose. The method by which this was accomplished is shown in figure 5. A two-pole switch was used and when thrown to the right all three tubes were connected in parallel for telegraphy, when thrown to the left one oscillator tube was disconnected from the three, and automatically connected in as modulator. A low frequency choke coil, L_a was used in the modulator plate circuit, it having

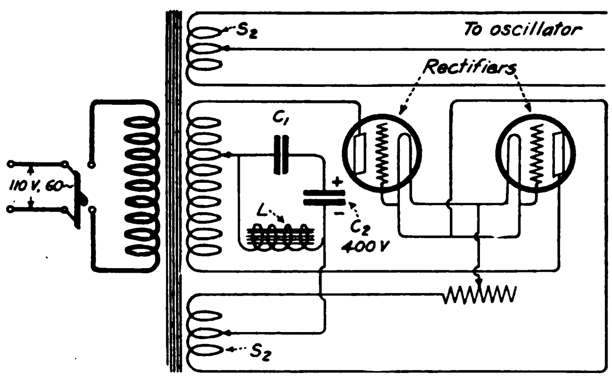

Figure 1

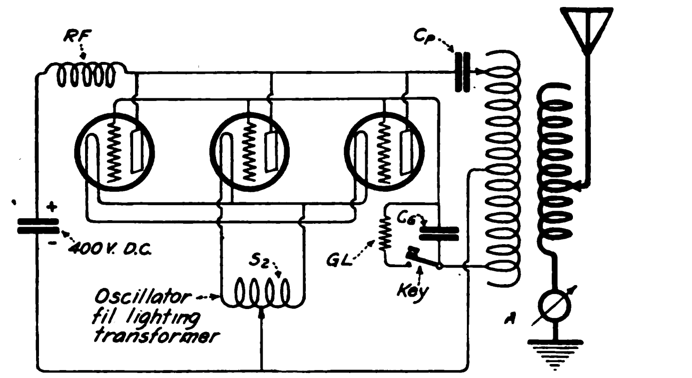

Figure 3

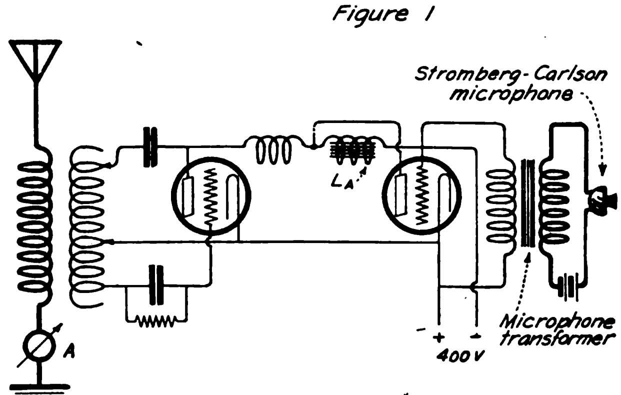

Figure 5a

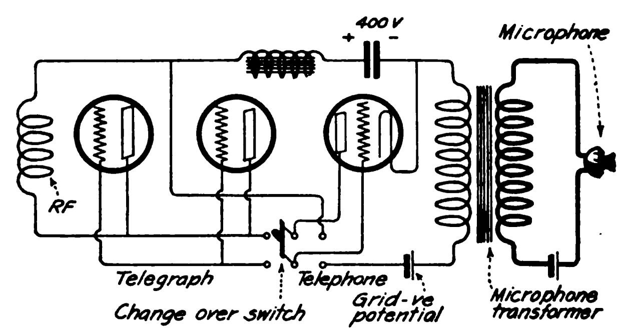

Figure 5b

Wiring diagrams of various hookups for C. W. transmission

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an inductance of about 4 henries roughly. A low resistance Stromberg Carlson microphone was used in series with about two or three dry cells. I had to make my own microphone transformer, and tried various ratios in winding and found a ratio of about 10 to 1 gave very good results. Figure 6 shows the construction of this coil. There were 180 turns of No. 20 D.C.C. in the primary, and 1800 turns No. 36 silk covered wire in the secondary. The iron core consists of iron wires stacked together to give a diameter of about ⅜-inch.

Best results were obtained when the modulator grid was set at a fairly definite negative potential, from 10 to 15 volts. Lower negative potentials resulted in considerable distortion of speech, although fairly loud, and higher negative potentials seemed to reduce the percentage of modulation as measured by loudness of signal. The telephone operation would have been very much better if I had had two tubes as modulators instead of one. For this system requires as many modulating tubes as oscillating tubes, and one tube as modulator cannot handle completely the output of two oscillators, which accounts for the low percentage of modulation.

Tone transmission was not used on this set, but there is no reason why a buzzer could not be substituted for the microphone, and modulation at audio frequency say 800 cycles, could be easily obtained.

Amateur C. W. Transmission

By L. R. Felder

Second Prize $5.00

UNDAMPED wave transmission is steadily being adopted more and more by amateurs, not only because of the numerous advantages derived in transmission, but also because it lends itself readily to beat reception. And from the point of view of the amateur the vacuum tube is the most desirable type of radio frequency generator to use because of the reliability of the oscillations thus produced, and also because vacuum tubes are easily available for amateurs.

Considerable progress has been made in the development of the theory and practice of vacuum tubes from a commercial standpoint, but relatively speaking it is still in its early stages, especially from the amateurs point of view. Consequently it is desirable for amateurs of limited experience with vacuum tube circuits to utilize existing circuits and obtain all possible help from reliable sources.

It was with this consideration in mind that I designed my own little radiophone set described in this article. For my first set I decided to use a simple circuit which had been developed for Moorehead tubes by the Research Department of the Marconi Wireless Telegraph Company of America. The wiring diagram of this set is shown in the attached diagram.

I have two tubes working in parallel as oscillators, the plate voltage supplied by the D.C. generator being 350 volts. The filaments are supplied by a 6-volt storage battery, the current per filament being about 0.75 to 0.8 amperes. The terminals of the generator are shunted by a high capacity of about 1 microfarad, which is effective in eliminating entirely the noises due to the commutator ripple.

From an examination of the circuit the set is simplicity itself. C_a is the antenna series condenser, and C_g is the grid condenser both being approximately 0.0003 microfarad. Since they are in a transmitting set where the voltages are considerably higher than in receiving sets it is preferable that they be mica condensers. Lacking mica condensers I used variable air condensers with large spacing between the plates, so that there was no danger of any sparking over. R is a wire resistance grid leak of 10,000 ohms. L_a-L_p is the plate to antenna transformer, which has the object of tuning the antenna to the desired wave length and also of fitting the antenna to the tube. That is, it is found that in such circuits the load circuit resistance must bear a definite relationship to the tube resistance in order to obtain the maximum output.

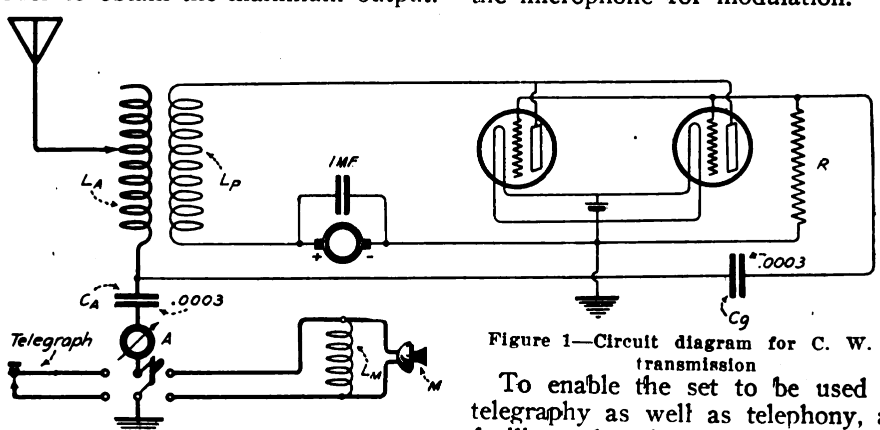

Figure 1—Circuit diagram for C. W. transmission

This is obtained by varying the coupling between antenna and plate. The antenna is tuned and adjusted to work on the required wave length and then the coupling is varied to give the maximum antenna current.

The coils L_a and L_p are both cylindrical and wound on dilecto tubes about 5 inches in diameter. They may be either concentric and slide within one another, or they may lie one alongside the other, in which case the coupling is varied by altering the distance between the two coils. L_a has 25 turns of No. 18 D.C.C., and L_p has about 40 turns of the same size wire. Taps at every two turns are brought out on the antenna coil for tuning purposes. It will be found that the entire 40 turns on the plate coil can be effectively used, the important adjustment here being the coupling.

The telephone arrangement is of the simplest type shown. The microphone M, which is of the usual low resistance variety, is placed in the earth lead of the antenna, and is shunted by a very small inductance, L_m—a few turns of copper wire on a small diameter tube. This shunt serves the purpose of deflecting a portion of the antenna current, since it is not necessary to have all of it pass through the microphone for modulation.

To enable the set to be used for telegraphy as well as telephony, and facilitate changing from telegraphy to telephony without trouble, a D.P.D.T. switch is used as shown in the diagram. When thrown to the left the key is in the earth lead and the set can be used for telegraphy. When thrown to the right the microphone is in circuit and is ready for telephony.

With my two tubes I have been able to get about 0.6 amperes in the antenna when telegraphing. My antenna has a capacity of about 0.0004 microfarad and a resistance of 12 ohms. This gives a good telegraphic range of over 35 to 40 miles. With telephone the antenna current is somewhat lower, due to the added resistance of the microphone and the telephonic range was at least 15 to 20 miles.

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Amateur C. W. and Telephone Transmission

By J. Greenfield

Third Prize $3.00

THE amateur is easily confused when he goes through the mass of complex circuits and hook-ups used with vacuum tube oscillators. It is no simple matter choosing a circuit for his set, especially considering the apparatus required in complicated tube circuits.

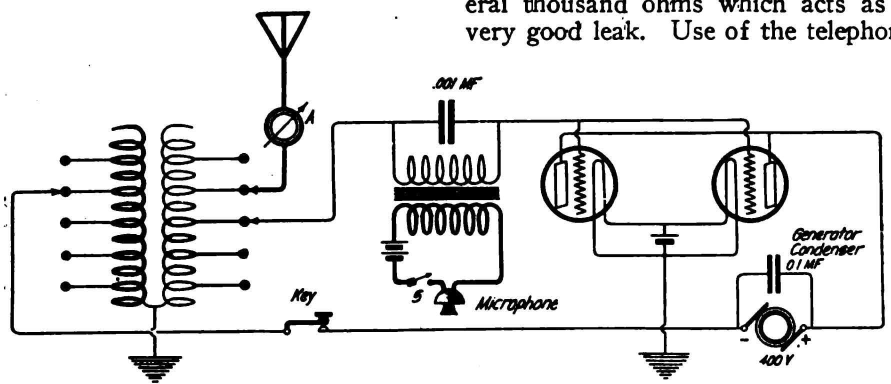

Figure 1—Circuit diagram for C.W. transmission

This was my predicament and I had to choose a circuit having the least number of elements in it, as my apparatus is very limited in quantity. Furthermore I did not want a set where there were a large number of condensers, coils, and other things to adjust. These considerations necessitated my experimenting a bit and working out, with the help of existing circuits, the simple working circuit herein described. It gives very excellent results both for telegraph and telephone.

There are two five-watt bulbs in my set with a plate voltage of 400 volts D.C., the voltage being derived from a small motor-generator set. The generator terminals are shunted by a 0.1 microfarad condenser to reduce commutator hum. The filaments each take 0.8 ampere and are supplied from a twelve-volt storage battery. The two tubes are used in parallel both for telegraphy and telephony, both tubes acting as oscillators.

The circuit finally selected is shown in figure 1. The oscillatory circuit is very simple, and consists of two coaxial, cylindrical coils one sliding within the other. Both coils are tapped at every three turns to permit of the necessary adjustments being made. The three taps, antenna, plate and grid, are varied, and also the coupling, until an adjustment is secured which gives the best output as measured by the antenna ammeter A. For telegraph the key is placed in the negative lead of the generator.

For grid leak and condenser in the oscillating circuit the telephone transformer secondary shunted by a .001 microfarad condenser is used. The secondary of the telephone transformer is wound with extremely fine wire and has a D.C. resistance of several thousand ohms which acts as a very good leak. Use of the telephone transformer serves a double purpose. That is, the secondary of the speech transformer and the grid leak of the oscillator are combined in one unit.

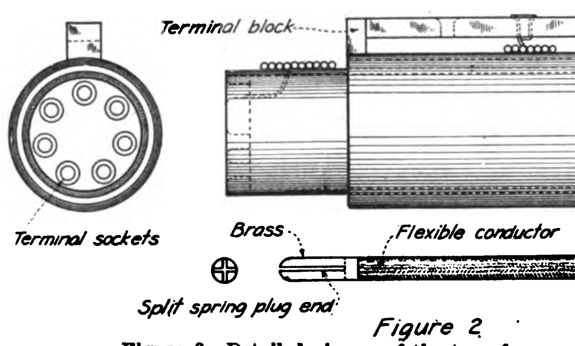

Figure 2—Detailed views of the transformer

For telephony, grid modulation is used. This method, although not very satisfactory for high powers, is the simplest and the best for the low powers which amateurs use. It is as good as the plate modulation schemes and requires much less apparatus. A low resistance microphone is connected in series with the primary of the telephone transformer, the current being supplied by two dry cells in series. When the microphone is spoken into the voice currents in the primary induce high speech voltages in the secondary, which voltages are applied to the grid of the oscillator tubes. These audio frequency voltages are superimposed on the radio frequency grid voltages and in this way modulation of the radio frequency output is effected.

When the primary switch S is open the set is ready for telegraphy, and when it is closed it is ready for telephony.

Prize Contest Announcement

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

CAGE AERIALS AND COUNTERPOISE GROUNDS

Closing date, May 1, 1921.

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

Prize Winning Articles Will Appear in the July Issue.

The subject of antennas and ground connection is as old as radio. Why amateurs spend money and time on high grade apparatus and connect it to a poor earth lead and string antenna wires between chimneys, and expect to radiate energy is a mystery. It is in the class of thought that suggests using an aerial on a row boat. For the May issue we desire as prize articles, papers regarding cage aerials and counterpoise grounds giving capacity, radiation, resistance, inductance and comparative results as compared with the standard four wire aerials and water pipe earth connections.

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

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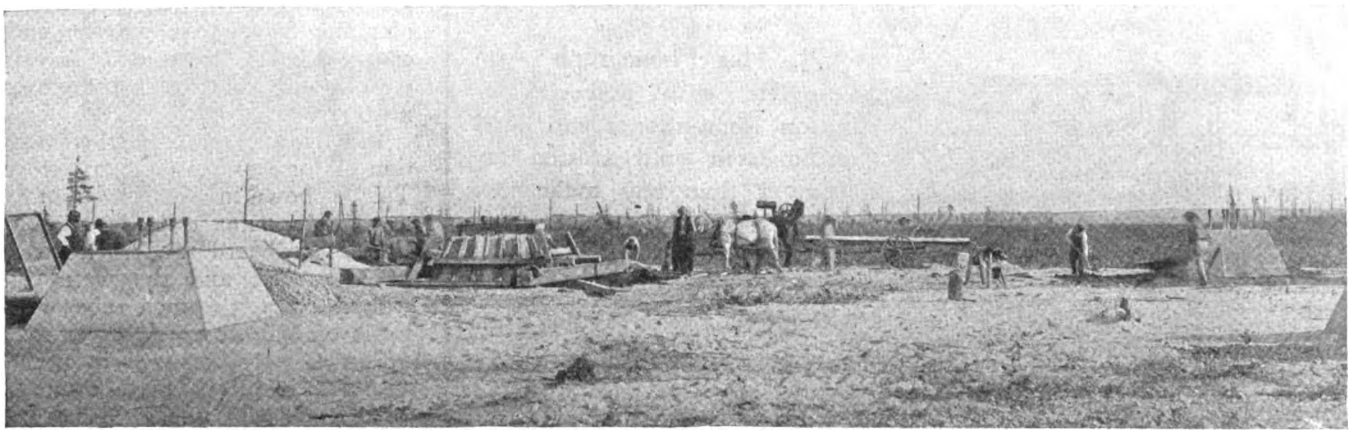
First View of the "Promised Land"



That is what the professional operators call the New York Radio Central Station, on Long Island. The picture shows the mast foundations going in. Soon the giant steel towers will rise high into the air. The new four-continent station is rapidly becoming a fact. When completed, this station will be the largest and most powerful radio station in the world.

It will be equipped to work simultaneously with five other nations in widely separated and distant parts of the world, and will be epoch-making in the field of international communication.

A large number of trained men will be required for its operation and maintenance.

A position at this station is the height of every operator's ambition, for it means unlimited opportunity to succeed and progress to higher, more responsible and better paying positions in the radio industry. So far as opportunity goes the successful future of these men is assured.

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Right now, today, radio offers you big opportunities—if you are properly trained. Radio companies need trained executives, engineers, draftsmen, operators and mechanics. Hundreds of positions in the ever-broadening field—from ship operator to general manager—are open to you, if you have the required training.

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The graduates of the Radio Institute of America enjoy a great and exclusive advantage in the close connection existing between the Institute and the Radio Corporation of America, world's largest radio manufacturing and commercial radio company.

Prominent executives in the radio field are former students of the Institute. The Radio Corporation employs thousands of men, in its executive departments, on ships and at shore stations and in factories and laboratories. A large percentage of these men are graduates of the Institute.

The Radio Institute of America has been an established and successful institution for over fifteen years. The year round average attendance in its classrooms is now 298 students per month. It has trained over 6,000 men, 95% of whom have successfully engaged in this new branch of science and industry.

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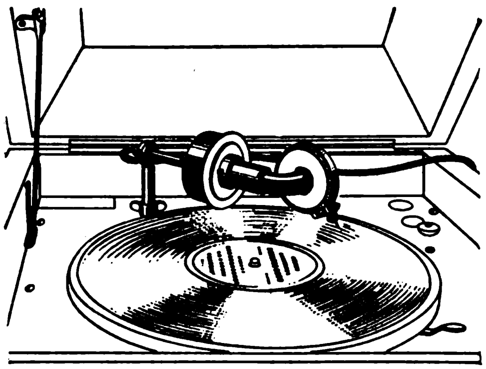

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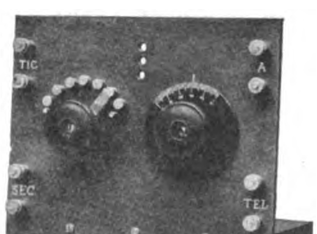

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Using the set as a C.W. transmitter both tubes put about 1 ampere in the antenna. This carried easily a distance of 30 miles or more. With telephone of course the range is considerably reduced, due to difficulty in obtaining complete modulation and because speech is more easily interfered with by atmospherics than the musical notes produced by the C.W.

It is of interest to note the construction of the antenna-plate transformer. This is shown in sketch form in figure 2. The antenna coil is wound on a 4-inch cardboard tube with 20 turns of bell wire, and the plate coil is wound on a 3½ inch tube with 30 turns of bell wire. A larger number of turns were required in the plate coil than in the antenna or grid coils, in order to get sufficient coupling and transformation to produce oscillations. Taps are brought out at every three turns. On the antenna coil they are brought out to a terminal block running across the top of the coil. On the plate coil they are brought out to one end of the coil. The terminals are in the form of metallic lined sockets. The ends of the flexible conductors end in a spring plug. The outside coil is mounted on legs which are firmly clamped to the table by wood screws.

The beauty of the circuit described is that it is simple, easy to handle and it works. Just two coils are required to be adjusted, and once they are adjusted there is nothing further to do. There are no intermediary circuits or modulation amplifiers, or a variety of tuning condensers. This is an ideal circuit for one who wants results with a minimum of apparatus and labor.

Elementary Radio Measurements

By "Anon"

It is surprising that so many amateurs and even professionals in radio profess ignorance when asked about some of the simplest radio measurements or formulas. This is probably due to the fact that a knowledge of them is not absolutely essential in order to secure a government license. Nevertheless a brief consideration of the most important, and simplest will prove helpful in radio work. The relation between the volt, ampere and the ohm is given in Ohm's law, which states that

$$E = I \times R.$$

Volts equals amperes times ohms.

$$\text{and } I = \frac{E}{R} \text{ and } R = \frac{E}{I}.$$

The measurement of the voltage of a dynamo depends upon the strength of the field magnets and the number of revolutions per minute.

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TWO GOOD BOOKS— Principles of Radio Engineering (Lauer & Brown) Price $3.50. Artificial Electric Lines (Prof. A. E. Kennelly) Price $4.00. Wireless Press, Inc., 326 Broadway, New York.

The voltage of electro-chemical cells depends upon their method of construction and its elements.

The current strength, amperage, depends upon the amount of voltage and the resistance.

The resistance of a circuit is, of course, dependent upon the material, size, and length of the current carrying conductor.

Capacity is that property of a circuit by which it stores up energy in electrostatic form. The unit of capacity is the farad.

For the measurement of capacity we have the following formula:

$$C = Q \div E$$

where C = capacity in farads.
Q = quantity in coulombs.
E = voltage.

The capacity is equal to the quantity in coulombs divided by the voltage.

For finding the capacity of a condenser, we have the following formula:

$$C = Ka \div 36 \times 3.1416 \times 100{,}000 \times T.$$

where C = capacity in mfds.
K = dielectric constant.
A = area in cms.
T = thickness of dielectric in cms.

For practical calculations we use the term microfarad, which is a millionth part of a farad. Mfds. is the abbreviation.

In electrical calculations we use the "watt" to denote the rate of doing work, or the power of doing the work. A "kilowatt" is a thousand watts. One horsepower is equal to more than two-thirds of a kilowatt, or to be exact it is equal to seven hundred and forty-six watts.

Inductance may be defined as that property of a circuit by which energy is stored up in electromagnetic form.

It will be seen that capacity is the property that deals with energy in the electrostatic form, while inductance has to do with energy in the electromagnetic form.

The "henry" is the unit of inductance.

Like the farad, the henry is too large a unit to be used in any practical work, so we have the centimeter which is equal to one billionth of a henry; the microhenry, which is equal to one millionth of a henry; the milihenry which is equal to one thousandth of a henry.

In damped wave transmitters we encounter very high frequencies, except in the key and charging circuits, where the frequency varies between sixty and five hundred cycles.

In regard to frequency we have two kinds of currents, the radio frequency currents, and the audio frequency currents. Those currents whose fre-

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APRIL, 1921

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Model 301 0-5 amperes flush 8.50
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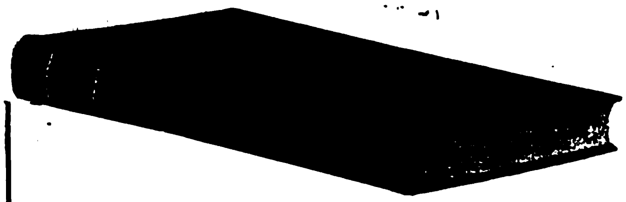

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quency is below ten thousand oscillations per second are termed audio frequency currents, while those whose frequency is about ten thousand oscillations per second are called radio frequency currents.

We also have two kinds of oscillations, the damped and the undamped. The damped oscillations are those which occur in trains, each train showing a decrease in amplitude.

The undamped oscillations are those which are of constant amplitude and whose formation is continuous.

In radio transmitting sets the following measuring instruments are used: the voltmeter, the ammeter, the wattmeter the frequency meter and the hot wire or thermo couple ammeter.

The voltmeter is connected across the terminals of the alternator, and it measures the voltage delivered at that point. The ammeter is connected in series with the primary winding of the transformer, and it measures the amperage of the key circuit. The wattmeter is in the charging circuit and it measures or indicates the amount of power flowing through the key circuit. The frequency meter is connected across the terminals of the alternator and it indicates the frequency of the alternating current at that point. The hot wire or thermo couple ammeter is placed in the aerial circuit, and it indicates the strength of the current.

South American Time Signals

THE International List of Radiotelegraph Stations fails to mention the Rio de Janeiro, Brazil (SOH) station sending time at 00:00 and 14:00 (G.M.T., Radio) on 1900 meters. This station can be received 400 to 600 miles on a crystal detector and with an amplifier it is possible to pick up SOH time signals as soon as NAA is normally out of range. This would be likely to occur at the equator making it possible to have a means of checking the ship's chronometer always at the disposal of the captain.

The method used is similar to that of Eiffel Tower. From the 57th to the 58th minute "X"s are sent at intervals followed by a group of three dashes of which the last dash marks the 60th second. "N"s are sent at intervals during the next minute with the three dashes as before. During the last minute "G"s are sent. The last dash of the group of three marks the hour precisely.

The only other South American Atlantic Coast station sending time is Buenos Aires (LIA) on which data will be found in the Berne List. Neither of these stations send time signals on Sundays or holidays.

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Commercial Operating In Alaskan Waters

By HOWARD S. PYLE

IT may be of interest to know what the Pacific Coast operators in the Alaskan service have to contend with in the way of mountain ranges and other natural causes that affects the facility of carrying on radio communication. The writer calls to mind an experience several years ago while serving as operator aboard the *S.S. Rush*—in the cannery tender service—running from Everett, Wash., to Herendeen Bay, Alaska, in the Bering Sea. The same conditions are slightly overcome by the use of present-day multi-stage amplifiers.

We left Everett in April, going north by way of what is known as the Inside Passage and hugging the coast of British Columbia for its full length, between Vancouver Island and the mainland. Heavily wooded mountains towered above the ship on both sides and in places, notably Seymour Narrows it was almost possible to reach shore with a pike pole on either side. The ship was a small craft, about 95 feet long, and her masts didn't clear the water by more than thirty feet. A four wire antenna 60 feet long was swung between the sticks and the radio outfit was housed below decks. 2kw. 500 cycle Mercury Arc transmitter was installed, radiating about 14 amperes. A standard inductively coupled crystal receiver with an untuned secondary, and a silicon arsenic detector was used for receiving.

Passing through Seymour narrows during the first week I was practically in a dead hole, except for signals from the *SS. Zupora*, WPQ, a fishing schooner just ahead of us. Leaving the Canadian coast and entering Alaskan waters, we approached Ketchikan, the first port of entry into Alaska, where KPB (then) was located. He was equipped with a 25 kw. rotary on 3000 meters, which could be heard down the coast, but his marine set of 5kw. capacity, on six hundred meters, could only work ships about 75 miles south and about 30 miles north. A vessel close in, as we were, had difficulty working KPB, while he was often heard on the same set five and six hundred miles out at sea or down the coast, and often worked directly over the Inside Passage route handling business with Seattle KPA direct on 600 meters. Up the Alaskan coast we attempted to work with Sitka, NPB, but found it almost impossible except when almost opposite him on the east side of the island where the station is located.

When off Hoonah, Alaska, we set a

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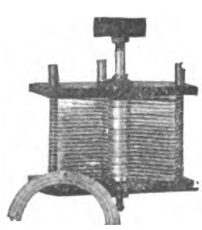
41 " " " 3.20



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course into the open Pacific on a line to Cordova. Here we had no difficulty working NPB, NPA and Kodiak (NPS), all the way across. When we entered the water between Kodiak Island and the mainland, Kodiak's signals were lost until we were opposite him, where a little business was handled. I lost him again directly afterward, although we were closer than before. I then tried to get in touch with NPR at Dutch Harbor, but could hear nothing of him until within 200 miles when he came in strong. We kept him during our approach and also during two hundred miles travel in the Bering Sea and then lost him to pick up NPQ at St. Paul Island. This station was favorably located on an island in the Bering Sea, clear of any mountainous country and was able to work with us into Port Moller where we anchored for a few days on account of ice in Herendeen Bay.

When we finally proceeded into Herendeen Bay we immediately lost everyone. While at anchor in Port Moller good signals were obtained from NPQ, NPR and the steamers *Windber* (WND), and *Norwood* (WSG), both about three hundred miles away on the other side of the arm. Five miles up the bay everything faded except KWR, the two KW. installation at Port Moller. The *SS. Windber* at that time was only fifty miles south of me using 2kw. on full power, and vacuum tube receiving equipment, but neither of us could hear the other.

Our trip ended at Herendeen Bay and shortly afterward I left the *Rush* which was to remain all summer, and joined the *Windber*. The outside route was used on the return trip and no difficulty was experienced in radio work over the open sea. It is quite evident that the geographical and mineralogical formation of the Alaskan coast holds the key to the explanation for the erratic operating conditions to be found on that run.

Homemade Jacks and Plugs

THE advantages of jacks and plugs in a radio set are many, but the disadvantage is that they are too costly for most of us to buy and too hard to make. This article tells how a different kind of plug and jack may be constructed. They work well and look as good as the expensive ones.

The plug is made by first obtaining a piece of bakelite, or fibre, 1/4x3/8x2 1/2 inches long. 1/16 inch is cut off both sides for a distance of 1 1/2 inches so that one end is 1/4x1/4 inches. The end is then rounded and a small notch cut near each side.

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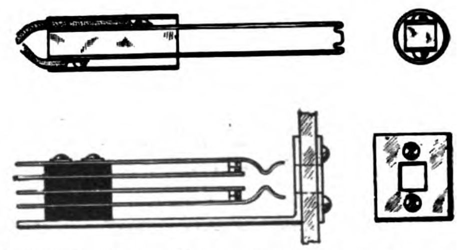

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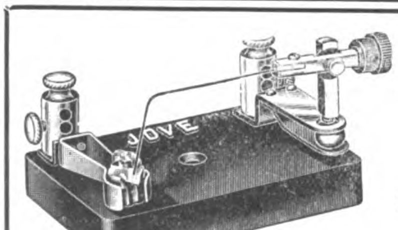

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voltage while with insufficient emission it varies as the square root of the voltage.

For best results it is necessary that the amplitude of the high frequency oscillations for moderate speech be double the amplitude for no speech.

Capacitative coupling is better for long waves; inductive coupling is better for short waves, and a combination coupling for all waves.

—*Bulletin 13th Naval Dist.*

Receiver Tuning

IT seems to be common practice among present day operators to so adjust their receiving apparatus that signals which they are copying are picked up on a setting of the various controls which gives a fairly tight degree of coupling. Loud signals are thus obtained with a fair degree of selectivity. However the advantages of loose coupling are such that every operator should become familiar with the correct procedure, and the results obtained with loose coupling will be found to be far superior to a tight coupling. Tight coupling is inefficient, although effective for pick up work and sometimes necessary when working fast, involving various changes of wave length.

Many operators try loose coupling at times making other variations to compensate for the change in inductive relation between the primary and secondary, but the majority will condemn a loose coupling as being less efficient and satisfactory when compared with tight coupling. This is because the correct method of receiving signals with loose coupling is not generally known. Numerous experiments have shown the writer that the method outlined below will produce results far superior to the general method of tuning and in many cases even louder signals than from a tight coupling. The reduced interference from other stations is a big factor in favor of loose coupled tuning and should not be disregarded.

The signal should be picked up on the broadly tuned setting which involves a tight coupling. The coupling is then loosened to a point where the signal is just audible. The primary and secondary are now retuned to produce the best signal at this loose degree of coupling. The coupling is then closed to the point where the loudest signal is obtained, slightly retuning the secondary if necessary, but the primary should not be changed in any way. With this method of tuning the best coupling will always be found to be much looser than with the close coupling method.

This method is slightly longer than the general practice of tuning in the

The tube you have been waiting for!

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signal and then loosening the coupling, but the results will be found to repay the extra effort involved. Loose coupling will be found to be much more important on the shorter wave lengths also as the primary and secondary reactances are stronger at a short wave.

The writer is indebted to a paper of Dr. Austin's for the information on loose coupling and is now a strong booster for it. Perhaps this will help eliminate some of the QRM signals that we so often hear. —*YB*

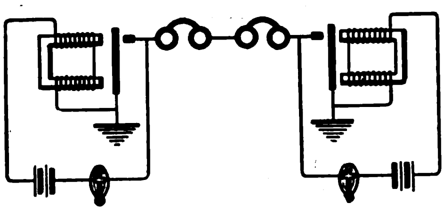
Queries Answered

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.

R. S., Modoc Point, Oregon.

A better circuit for your purpose is given below.



R. S., Brooklyn, N. Y.

Your request for data regarding the simple construction of a two-tube radiophone, run from a sixty cycle source of power is to say the least, a rather large order. A lengthy article would be required. We suggest that you obtain Bucher's "Wireless Experimenter's Manual,' 'in which will be found valuable information regarding the answer to your questions; also get in touch with radio men who are operating radiophones under the conditions specified.

* * *

H. M. P,. Sewaren, N. J.

Your questions fail to give all the necessary data needed in order to calculate the sizes, etc., of the various pieces of apparatus you desire to build. When writing to us always state the purpose of each individual part giving frequency input and output voltage and amperage, also all sizes of various parts intended to be used. It is impossible to answer generalized questions with any degree of accuracy.

* * *

A. E. L., New York City.

The diagrams you speak of, are to our knowledge patented, also the one requested using two variometers and one coupler. A very large electrolytic rectifier will have to be built to supply enough current for an arc and if the current is not smoothed out by means of large choke coils and condensers, the frequency changes in the supply current will be troublesome at the receiving station, for the undampt energy radiated will be modulated by the supply frequency.

* * *

E. J. and E. T., Watertown, Wis.

Note the answer to R. S., this issue. It would be better to use a harder tube and eighty to one hundred volts obtainable from ordinary flash light cells and operate filament on a storage battery.

MESCO RADIO BUZZER

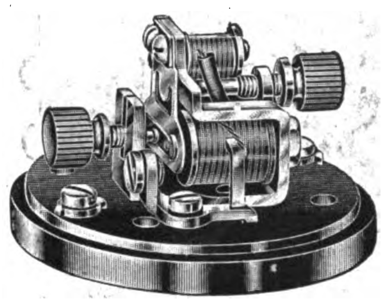


Illustration Shows Buzzer With Metal Cap Off

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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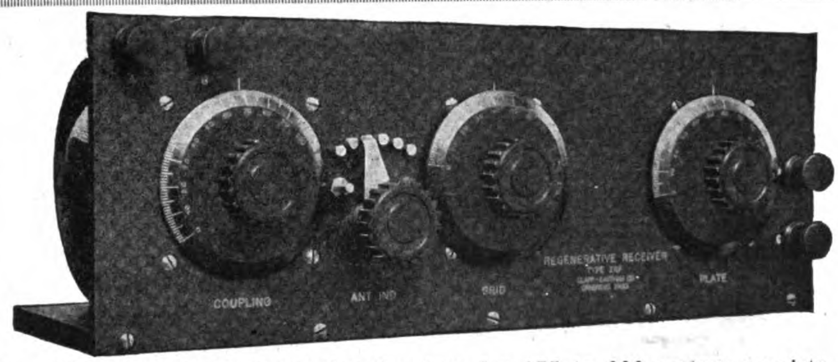

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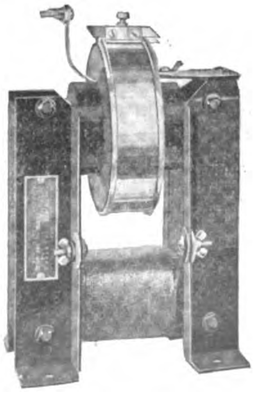

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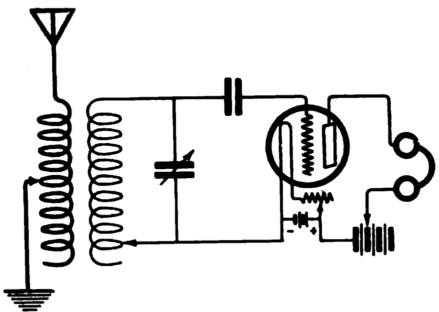
F. B. S., New Orleans, La.
There are so many things to take into consideration in your case that it is almost impossible to give any correct data. Rather than make a false statement we suggest that you write the Western Electric Company directly. You will obtain better modulation by using the Heising method, having two of the tubes modulate the two oscillators.

* * *

R. W. H., Brooklyn, N. Y.
The impedance coils you speak of will be all right for the purpose desired. There should be no difficulty when using one A and B battery for both circuits. The exact voltage for resistance coupled amplifier is a matter of trial, depending upon tube characteristics and the coupling resistances.

* * *

B. B., Wichita, Kansas.
Diagram requested is given below:



L. D., Kinsale, Va.
Any plain regenerative circuit will operate satisfactorily. Some suggested diagrams are shown on page 21, January issue of The Wireless Age. Radiophone can be received. The plate voltage depends upon the tube. Exact data regarding location of radiophone stations and at what time they operate is not at hand. Your communication has been referred to the N.A.W.A., but we suggest that you write them again.

* * *

F. C., Springfield, Ill.
We doubt if using the automobile lamp as suggested will give results. Why not try it? Regarding your question about crystal and three element tubes, the exact figures vary with different crystals and tubes, but the vacuum tubes win every time, especially when using regenerative circuits.

* * *

P. M. W., West Branch, Iowa.
There is no published data explaining fully the construction and theory of the De-Forest buzzer radiophone that we know of. The high plate voltage is produced by means of a spark coil with vibrator. The book, "Valves and Valve Apparatus, No. 11," by R. Stanley, published by the Wireless Press, contains some information on the subject.

* * *

W. F. G., Fort Moultrie, S. C.
As to dependability of your circuit we suggest that tests be made in comparison with a standard tickler coil hook-up. Let us know what results are obtained. The condensers can be of .001 microfarad capacity, although the grid condenser may be a fixed capacity of about .00025 microfarad.

* * *

L. E. S., Memphis, Tenn.
Regulation ten ohm rheostats for the filaments may be used. Standard variometers will operate successfully. Voltage of A battery from 6 to 8 volts. Hot wire or thermo coupled ammeter reading up to one or one and one-half ampere will be sufficient.

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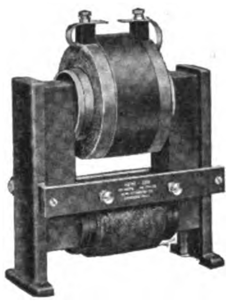

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All this work is due to you, gentlemen, and I wish to thank you and offer you my best wishes for continued success in the future. *Your ACME can't be beat!*

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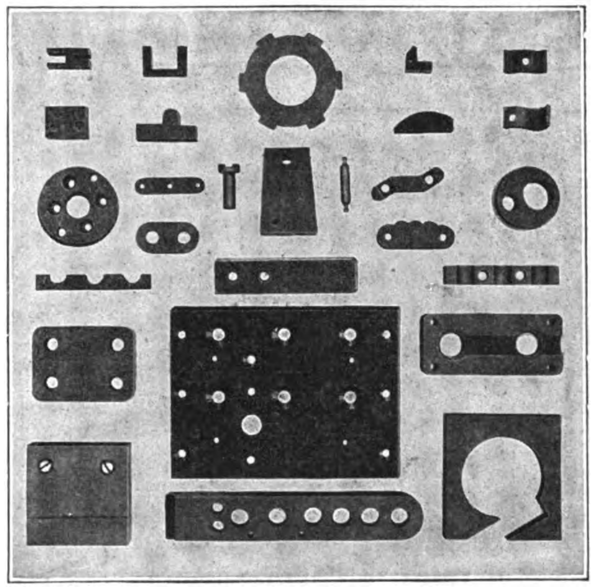

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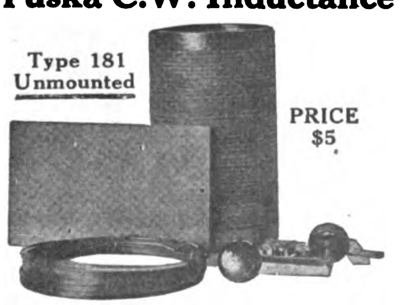

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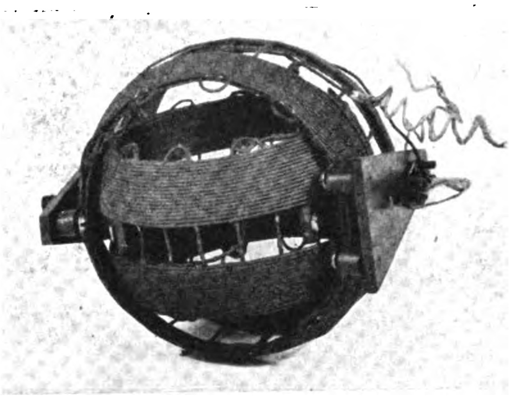

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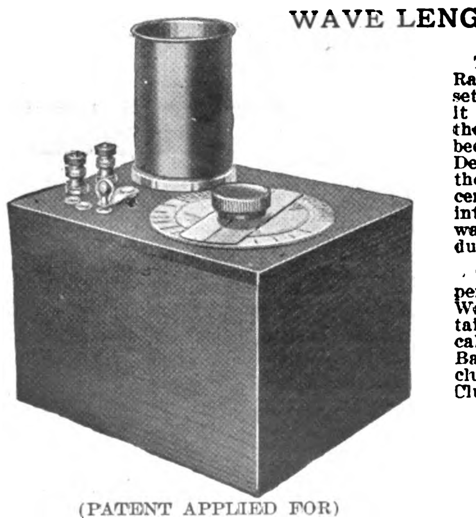

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The Doolittle Decremeter is both a superior Wavemeter and a Decremeter. The Wave-Length and Decrement can be obtained simultaneously, without complicated calculations. The range is 130-300 meters. Bakelite panel and insulation are used exclusively. An ideal instrument for Radio Clubs as well as individuals.

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RECEIVERS	
Murdock, No. 55, 2000 ohm	$4.50
Murdock, No. 55, 3000 ohm	5.50
Brandes Superior	7.00
Baldwin C	16.50
Baldwin E, improved	20.00
Brownlie, New	12.50
Shipping weight 2 Pounds	
CONTACT POINTS	
CP-No. 1 Brass, dozen	25c
CP-4 Brass, dozen	35c
CP-5. Nickel Plated, dozen	45c
Postpaid.	
VARIOMETERS	
Radisco No. 1	$7.00
Radisco No. 1D	8.50
3 pounds.	

All orders for apparatus not listed as postpaid must be accompanied by postage charges.

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After much experimental work, we have succeeded in adopting the Armstrong Regenerative circuit to a receiver having a wave-length range of 150-3,000 meters. The result is the

GREBE RADIO

Type CR-5
Regenerative
Receiver

This is a complete receiver. The only additional equipment needed are phones, batteries and a detector tube.

Included in its range are amateur, navy and commercial wave-lengths, special land stations, ship CW stations, navy low-wave arcs, all radio phone work and "Time." In operation, it is the last word in simplicity.

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Hurlburt Still Electrical Co., Houston, Texas.
Kelly & Phillips, Brooklyn, N. Y.
The Newman-Stern Co., Cleveland, Ohio.
Klaus Radio Company, Eureka, Ill.
Manhattan Electrical Supply Co., New York, Chicago, St. Louis.
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J. H. Bunnell & Co., New York City.
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A NEW MODEL, JONES SHORT WAVE REGENERATIVE RECEIVER,

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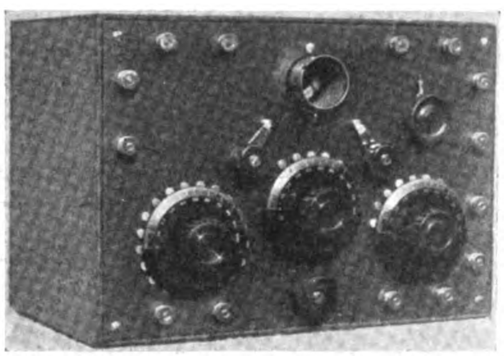

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A superlative Cabinet Receiver, built with the same technical skill and care that characterizes our higher priced sets. Model "H" will hold its own against the best in the market. NO SEALS, NO SECRETS—Just standard, approved circuits arranged intelligently in compact manner that materially reduces the cost. Bulletins on request.

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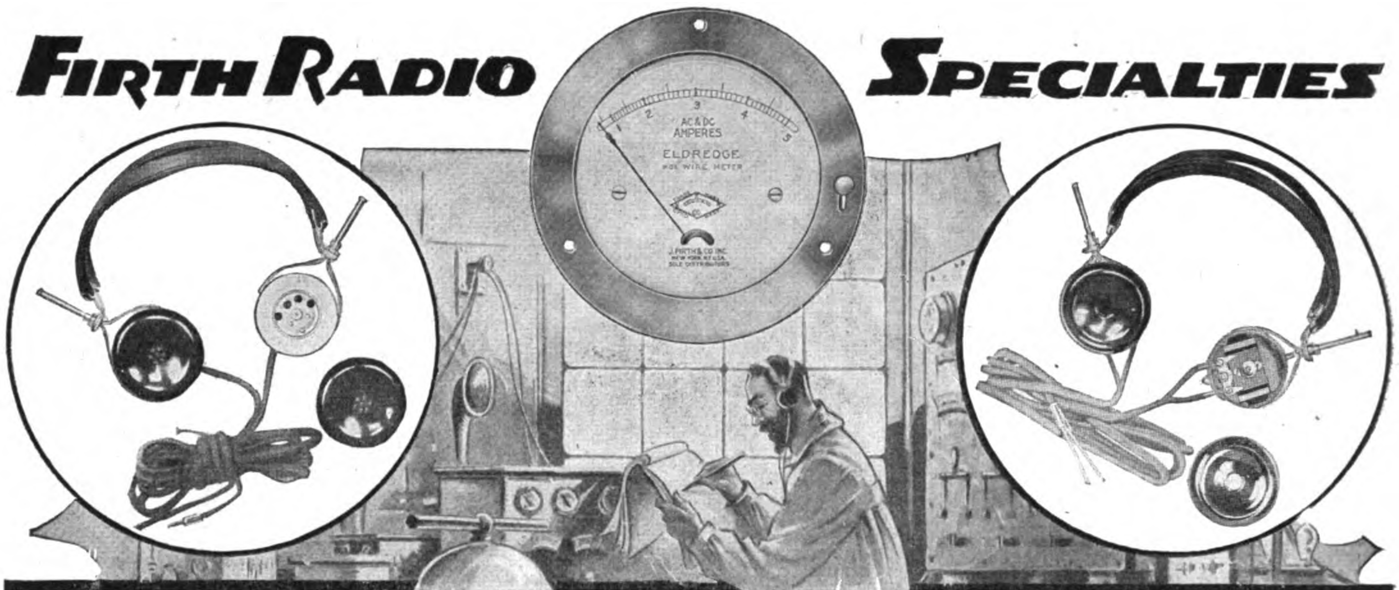

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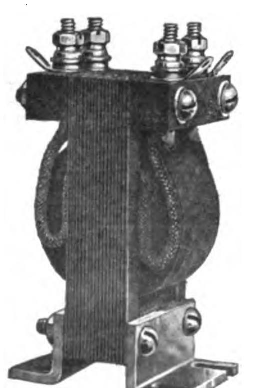

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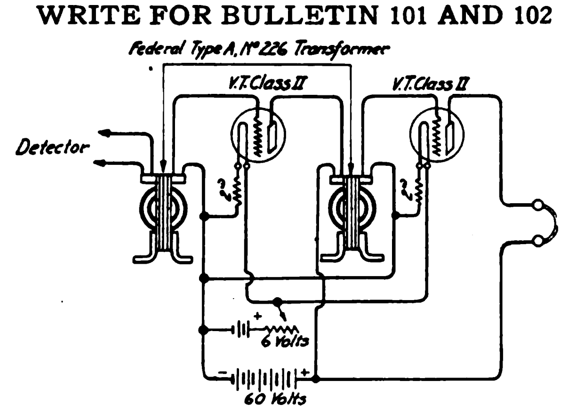
AUDIO FREQUENCY
Transformer
$7.50 each



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Radio :- Your { Spark / C-W / I.C W. / Voice } were heard at this station on ....

at......A. M. / P. M.......time with audibility weak / fair good / excellent when you were working / calling..........

Fading was bad / moderate / n... Local QRM / QRN was bad / moderate / ...gible Wave ap...ately..............

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2ZL

..................................ps amplification audio / radio

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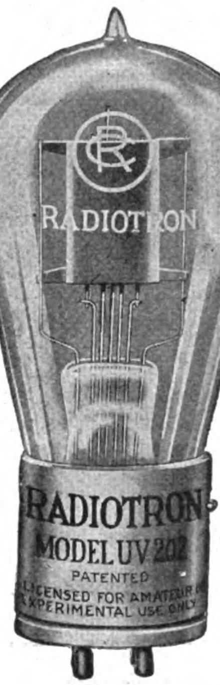
RADIOTRONS

POWER TUBES



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