December, 1920 25 C

The WIRELESS AGE

Volume 8 Number

Singing Into the Wireless Telephone—Miss Mabelle Burch, Brilliant Young Coloratura, Radiophoning a Private Concert for Her Brother at Sea on the Submarine F2

Radio America Shown to Foreign Experts

And Many Exclusive Features in This Issue

THE WORLD'S ONLY MANUFACTURER
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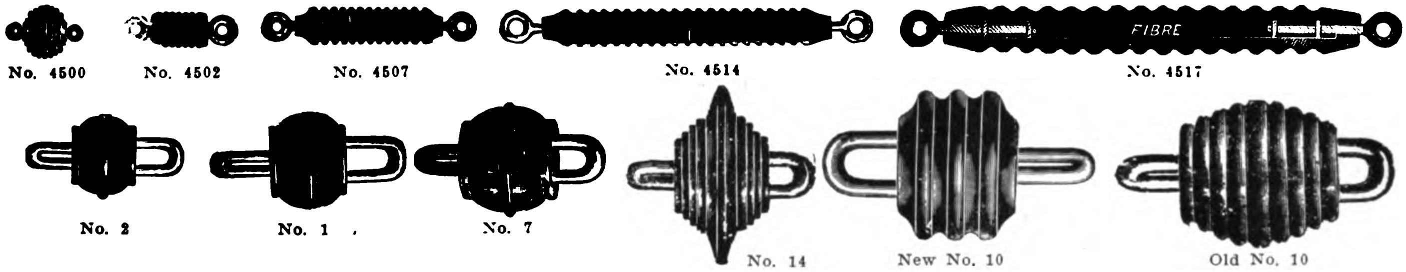

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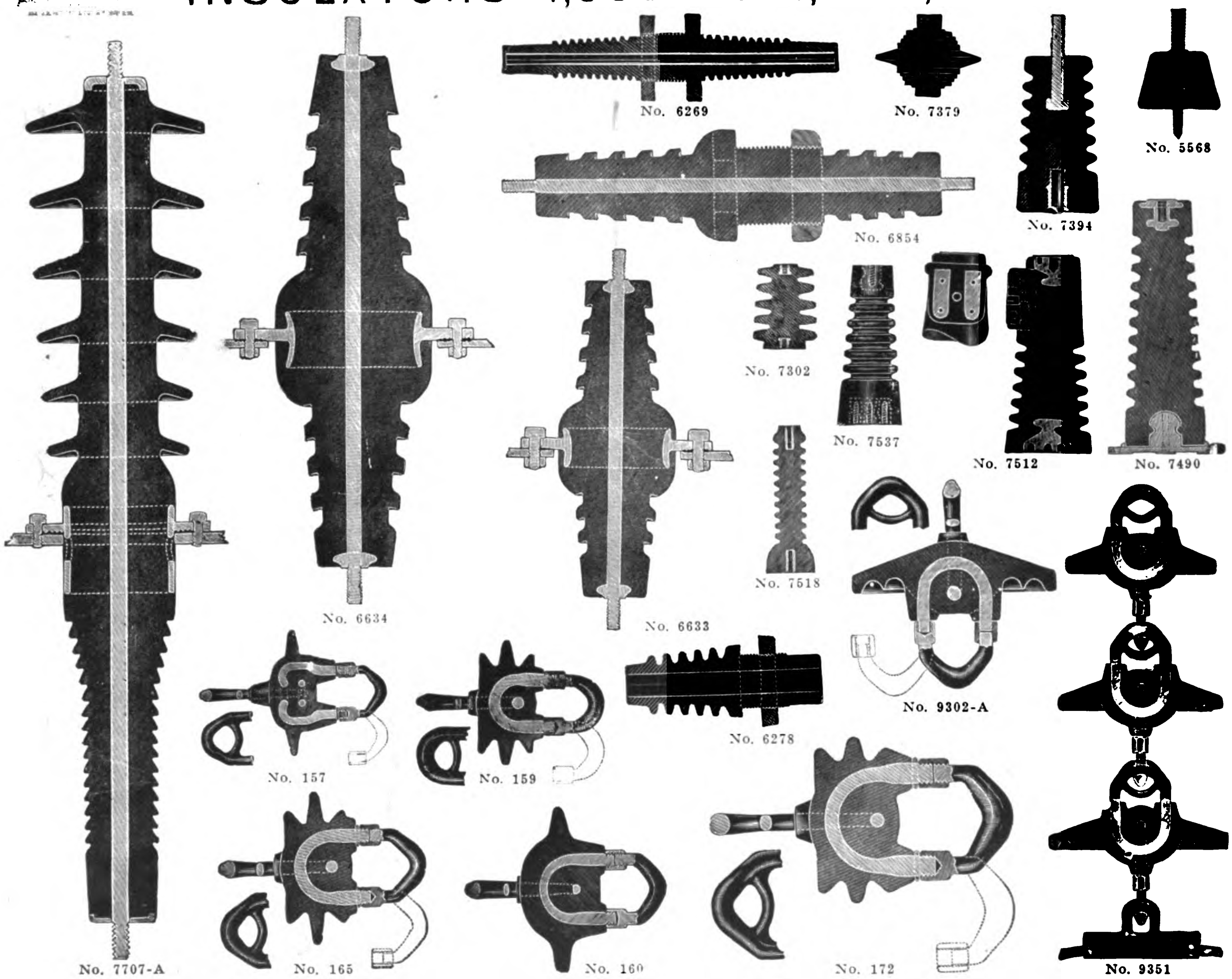

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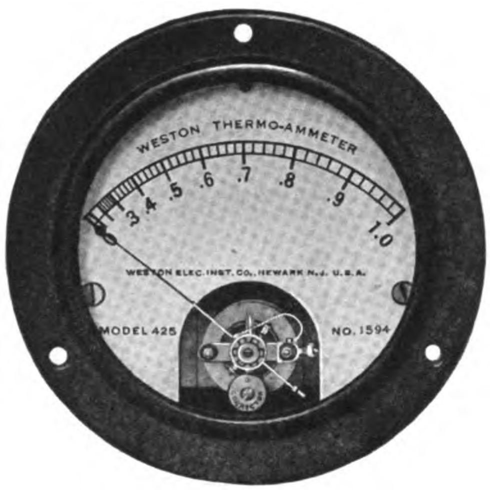

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Vol. 8 Contents of **The Wireless Age** for Dec. 1920 No. 3

Edited by J. ANDREW WHITE

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Owing to the fact that certain statements and expressions of opinion from correspondents and others appearing in these columns from time to time may be found to be the subject of controversy in scientific circles and in the courts, either now or in the future, and to sometimes involve questions of priority of invention and the comparative merits of apparatus employed in wireless signaling, the owners and publishers of this magazine positively and emphatically disclaim any privity or responsibility for any statements of opinion or partisan expressions if such should at any time appear herein.

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Receiver

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Every set sealed and guaranteed for two years

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For out-of-town Amateurs, we maintain the same standard of personal service in our Mail Order Department. Your order will be accurately filled and shipped within forty-eight hours. Twenty-five cents brings our 112-page catalog. We list a few different instruments below, see other current radio publications for a more complete listing.

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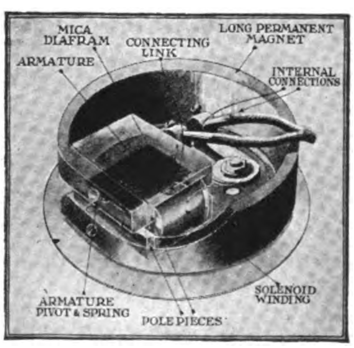
Now Dad-Hear the tenor

"I can listen in on all the radio concerts now, Dad. Those Baldwin phones you bought me for Christmas are corkers. Just listen to that famous tenor singing over the wireless telephone. Every note records just as clearly as though it were a phonographic reproduction right here in our own home."

Actually Baldy Phones reproduce in identically the same manner as do the high grade phonographs. Instead of a heavy iron diaphragm, as in most phones, a selected grade of mica is used. This is much more susceptible to distortion and as a result responds more readily to the thousands of overtones and harmonics of the human voice or any musical instrument.

Baldy's are the most sensitive phones in the world. This is attested to by the fact that the leading radio engineers, with every facility at their command for testing the audibility and sensitiveness of every make of phone, choose Baldwin for their personal use.



Study this X-Ray photo of a Baldwin ear-piece and you will see why they are world famed for their sensitiveness.

Our new booklet will give you some interesting facts about Baldwin Phones, in addition to prices. Ask your dealer for a copy. If he can not supply you write direct, giving his name and address.

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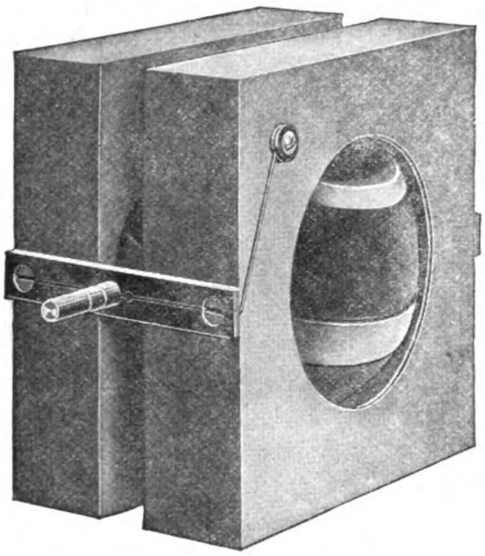
One distinct feature of Radisco Service is the close co-operativeness of each individual Radisco instrument with the other, and the strength of signal derived from such contact is marvelous.
The other two are the Radisco Variometer and Coupler described below. It is impossible to go wrong when you use them together.

Radisco Variometer



Like all other Radisco products it has been produced to anticipate and supply the demand for a good short wave instrument, qualified to stand the acid tests of radio work, and built at a price consistent with the cost of manufacture, which has always been a radisco characteristic.

For the radio man who desires an instrument of this character, our Variometer makes a distinct appeal. It is made in one size and of one quality, the best. The extreme dimensions are 4¾" high, 3" wide, 5" deep and the shaft is of ¼" brass, just the right size to fit the number 69 dial; forms are carefully turned from thoroughly seasoned wood and substantial brass bearings provided. The price is strictly an innovation and should appeal to the most conservative.

No. 1 Variometer $7.00
No. 1D Variometer with dial $8.50

Shipping weight 3 pounds

Radisco Coupler

Specially designed for use with No. 1 Variometer

The stationary winding consists of 37 turns in groups of six turns and single turns. Strength and high insulation insured by use of Bakelite tubing. Brass bearings support thoroughly seasoned wooden ball; brass shaft of standard size to fit the No. 67 Corwin dial projects far enough for Coupler to be readily mounted. The whole instrument is finished off on a neatly varnished wooden base.

No. 2 Coupler (as illustrated) $8.50
No. 2D Coupler with dial $9.75

Shipping weight 3 pounds.

The agents listed below carry all Radisco products and they will be glad to consult with you on the new Radisco Coupler

ALBANY, N. Y.
Shotton Radio Mfg. Co.,
8 Market St.

ASHEVILLE, N. C.
Hi-Grade Wireless Instrument Co.

BALTIMORE, MD.
Radio Engineering Co.,
614 No. Calvert St.

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Canadian Radio Mfg. Co.

BOSTON, MASS.
Atlantic Radio Co.
88 Broad Street

BROOKLYN, N. Y.
Kelly & Philips,
312 Flatbush Ave.

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Chicago Radio Laboratories,
1316 Carmen Ave.

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PITTSBURG, PA.
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RADIO DISTRIBUTING COMPANY : : Newark, New Jersey

Vol. 8 No. 3. DECEMBER, 1920

THE WIRELESS AGE

WORLD WIDE WIRELESS

Radio Exhibits at the N. Y. Electrical Show

THE sign that once graced a downtown store, "If it's electrical, we have it," might well have been hung above the wide entrance to the thirteenth annual Electrical Show, in Grand Central Palace, New York.

Three floors of the building were devoted to the 151 exhibits, and on each of them there was enough to hold the interest for half a night. It might be said that the show developed more candle power than any of the previous twelve shows.

The exhibition showed the development in standardized wireless apparatus, a center of attraction being the exhibit of the Radio Corporation of America with panel equipment and new vacuum tubes.

Of particular interest were the three different exhibits of wireless telephoning. Practical demonstrations of their working was made and many scores of visitors had the opportunity of picking up a few words out of the air.

A compact wireless telephone set operated with current from the batteries of an automobile and transmitting and receiving over an aerial wire stretched from the top of the windshield to the radiator cap is the latest equipment provided for the modern motor car or truck.

This apparatus, exclusive of the batteries and aerial wire, is contained in a box a cubic foot in size and the weight complete is sixty pounds.

Bolinas Station Begins Operating

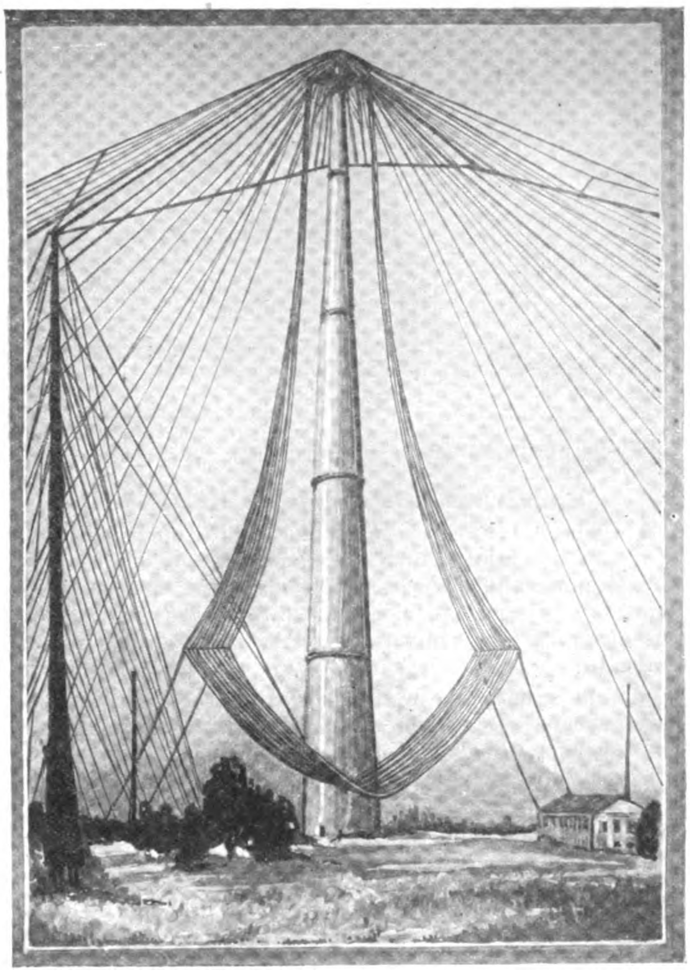
THE Radio Corporation of America's giant wireless station at Bolinas, one of the largest wireless plants in the world, commenced operations in October. According to Arthur A. Isbell, general superintendent of the Radio Corporation of America for the Pacific Coast, in the future all commercial work heretofore handled by the Naval Communication Service will be performed by the Radio Corporation. Tests of the new plant, made by operators of the company during daylight hours, was held with a steamer 900 miles at sea. All transmission of messages are made through the Bolinas plant, while the company receives messages through the station at Marshall, twenty-five miles north of Bolinas. Communications are sent and received daily by the plant to and from the Japanese station in Funabashi, Japan.

Radio Reports of Geneva Proceedings to Be Secret

DEVELOPMENTS in the rapid automatic transmission of press messages by wireless telegraphy that are proof against eavesdroppers will be employed by the English Marconi Company at its new station erected near Geneva to transmit to London reports of the League of Nations Assembly, beginning Nov. 15.

In a room adjoining the Assembly hall the newspaper correspondents' reports will be punched by a machine in the Morse code cipher on paper tape, which will be fed into a transmitting instrument at the rate of 100 words a minute. Anyone listening to the telegraphing of these messages will hear a high-pitched constant singing note that no operator, however expert, can transcribe.

A special station is being erected in Essex to receive the messages, which will be taken down first on a high-speed phonograph record and transcribed by operators on a slow-speed phonograph.



Keystone Photo
Iwaki Station, Japan, installed for American and British service. The concrete tower is 664 feet high

Washington, D. C., Radio Station Robbed

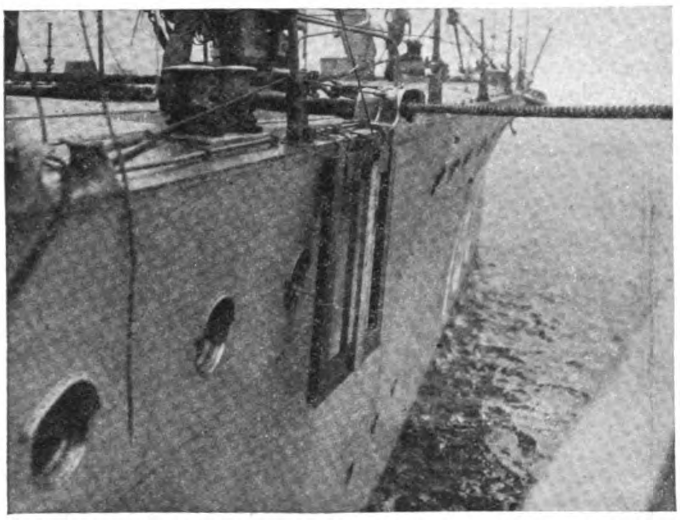
THIEVES recently broke into the field radio station at 36th Street and Grant Road, Washington, D. C., and stole radio instruments valued at $3,000. The robbers gained entrance by removing hinges from a rear door.

The robbery was discovered when Corp. George Cook went to the station. He immediately reported it to the police. No trace of the thieves has been found.

French to Control Radio Interests in France

OPPOSITION is being raised in Paris against what is believed to be the intention of the Minister of Posts and Telegraph to grant a concession for the operation of French wireless telegraph stations to the English Marconi company, the stock of which is largely held by British interests. The question appears to be of great interest to the French, as the Government has received one of the world's largest wireless telegraph stations near Bordeaux, the plant having been constructed by Americans.

It is understood that an interpellation is possible as soon as Parliament reconvenes, and that an effort will be made to organize a purely French concern. It was stated that 90 per cent. of the inter-continental telegraphic correspondence was being handled by the American or British cables, and that a large part of this business might be diverted to a French company if it were properly organized.



International Photo

The U. S. S. Semmes sailing through Ambrose Channel guided by radio signals automatically transmitted from a submarine cable. One of the receiving coils is shown on the side of the vessel

Danish Inventors Improve Radiophone

ACCORDING to a cable dispatch from Copenhagen, an invention which it is believed will do much toward perfecting wireless telephony and increasing the capacity of wireless telegraph stations has just been announced by K. Rahbek and A. Johnson, two Danish inventors.

In the summer of 1820, Hans Christian Oersted made his famous discovery in the field of electro-magnetism, a discovery without which the work of Ampère and his disciples would have been impossible. The Danes celebrated the hundredth anniversary of Oersted's achievement in a most substantial way. But the chief event of the celebration was the announcement by Rahbek and Johnson, of their discovery in the field of wireless telephony and related sciences.

Following the discovery in 1917 of a new force resembling electromagnetism, the inventors say, they constructed an electroscope by which extremely minute quantities of electricity may be detected.

Experts think that this discovery may mean the more rapid transmission of messages by wireless and also that an installation of low power will be sufficient to send messages to far greater distances than is now possible.

Mr. Rahbek says he is now at work on a device which will permit of dispatches by wireless being received twenty times more quickly than is at present possible.

Johnson and Rahbek are said to have evolved what is pronounced the "loudest speaking" telephone yet devised. Rahbek demonstrated this invention before the Polytechnic Academy at Copenhagen recently when he made a violin "talk."

The discovery of this new "principle" by the two Danish experimenters and their application of new instruments to a utilization of that principle is but cumulative evidence that radio transmission of signals and sounds is nearing a degree of perfection little dreamed of when Marconi sent his first signal across the Atlantic only a comparatively few years ago.

"Resonance Wave Coils" to Replace Aerials

DISCOVERY of a new method of sending and receiving radio messages was announced recently by Major-Gen. George O. Squier.

Through development, it is probable that wireless will be improved so as to permit the confining of messages to the parties directly interested.

The discovery came about through investigations made early in the war on the uses of submerged bare wires. Out of it grew what is now known as a "resonance wave coil." Discussing some of the powers of the new invention, the scientists list the following: It is possible to locate an aeroplane in flight, to tell the direction of the flight, to tell how high it is flying and to tell by the use of two coils and mathematical deductions the distance of the aeroplane from the wave coils. The instruments can be used as range finders and in the same manner they can be used for aeroplane finding. Radio messages can be handled from aeroplanes without the trailing wires now used. Static interference can be reduced.

Radio to Replace Lighthouse

SOME of the Atlantic coast lighthouses and lightships have been equipped with automatic wireless, so that no matter how foggy or dark the weather, a skipper on approaching the coast can, by listening at a wireless receiver in the pilot-house, ascertain his exact position.

The radio scheme obviates the necessity of compass stations and their operators. Lighthouses and lightships equipped with sending apparatus in foggy weather send on short-wave length a flash signal which can be picked up by vessels along shore.

Ships would not have to lay outside waiting for a fog to lift, or proceed at a snail's pace by sounding, if all lighthouses were equipped with wireless. In the deepest fog a captain could adjust his compass according to the automatic signals from the lighthouses, and without fear of danger proceed at full speed to port.

Graded System of Operator's Licenses Approved

THERE has been an extended conference between the officials of the United Radio Operators' Association and the representatives of the American Steamship Owners' Association over the new graduated system of licenses.

All danger of a strike of radio operators was removed, the wage and working agreement between the radio operators on the American ships being extended to May 1, 1921, without any change in compensations, according to announcement of Winthrop L. Marvin, Vice-President and General Manager of the Owners' Association.

"This action," Mr. Marvin said, "affects not only the privately-owned vessels of the American Steamship Owners' Association, but the steamers of the Shipping Board, which is a party to the understanding." He said that under the agreement the radio operators aboard ship would receive the same consideration, accommodation and general treatment as the deck and engineer officers of the vessel. Operators are to have a subsistence allowance of $3 a day in port when meals are not served aboard ship, and where no room is provided the operators are to receive the same room allowance given to officers—$2.50 a night. Wages of chief operators under the extended agreement will be $125 a month, and wages of assistant operators will be $100.

"Bringing Up Father" by Radio

GETTING the news by telephone that he was the father of a new baby while down at the bottom of the sea working in a diver's suit was the unique experience of Frederick W. Whitehead, 36 East Twenty-eight street, Brooklyn, chief machinist's mate of the U. S. Submarine S-5, which went to the bottom off Cape Henlopen early in September after the crew had been safely rescued.

"Come home to Flatbush," was the message that vibrated into Whitehead's ear while several fathoms of water surged above him. He was down beside the hull of the S-5, but quickly had himself hoisted to one of the ships standing by engaged in raising the sunken submarine. He was told that on Friday his wife, Dorothy, had given birth to a girl and both were doing well. The message had been sent broadcast by the Navy Department, and was relayed to Whitehead when one of the rescue vessels picked up the original wireless flash.

Treatment Sent by Radio Cures Mariner

ON THE last voyage of the American liner St. Paul, to Southampton, when about in mid-Atlantic, she picked up a wireless from the American tramp steamer Schroon, bound from New York to St. Nazaire, saying that one of her crew was seriously ill and appealing for medical assistance. The ships were about seventy miles apart at the time.

The medical officer of the St. Paul, Dr. Stump, asked for the man's symptoms and diagnosed the case as one of appendicitis. He gave directions for treatment and for four days treated the case by wireless. At the end of four days the Schroon wirelessed that the man's fever had abated and his pain had disappeared and that he was well on the road to recovery.

Radio Compass Locates Lost Ship

RADIO compasses were used to locate the destroyer Isherwood, which was forced to anchor off the North Carolina Coast because of the shortage of water for her boilers. These new instruments detect the source of wireless waves and from this the exact location of a vessel sending radio messages can be determined.

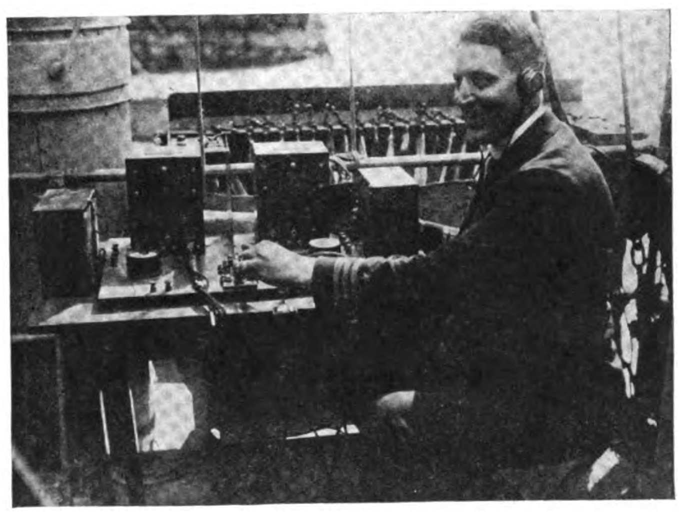
First reports that the Isherwood was in trouble were received from an unidentified steamer. A later report gave the location of the destroyer and naval officials assumed this had come from the ship via a shore station, but it developed that the wireless compass had been used in determining the vessel's position. Shore stations, it was said, had been unable to communicate with the destroyer as she had kept her wireless busy sending out calls for assistance.

Edison's "Spirit Wireless"

JUST as communication between distant points on our earth is a matter of delicately constructed instruments, so also communication from the spirit world to our own earth must be accomplished through scientifically constructed instruments of even greater ingenuity and much more minute delicacy than the telegraph, the telephone or the wireless apparatus.

This is the belief of Thomas A. Edison, who has recently stated that the problem of receiving messages from the dead is a problem of pure science and that he is endeavoring to perfect apparatus which will make it possible to record messages from the spirit world if there are any spirits and if they desire to communicate with us. It is Mr. Edison's belief that only through some specially constructed scientific instrument will a message ever come from the realms of the departed, and that it will be from some spirit of a dead scientist—some wireless expert or telegraph expert or physicist—that the first messages will come.

Mr. Edison is not yet ready to divulge the details of his invention or reveal the exact principles involved in its operation. He has, however, said enough to lead to the belief that he plans to accomplish this modern miracle by means of a wonderful "spirit wireless"—an adaptation to communication between the world of the living and the world of the dead of the wireless telegraphy now in use on this earth.



International Photo

Receiving the automatic submarine cable radio signals through a two-step amplifier aboard the U. S. S. Semmes on the trip through Ambrose Channel

Overseas Radiophone Transmission on 100 Watts

HUGH ROBINSON, of Keyport, N. J., who helped develop the hydroaeroplane and is credited with being the first man to carry the United States mails in an airplane, has been notified that his radiophone messages have been heard in Scotland, 3,500 miles away.

Mr. Robinson became interested through his sixteen-year-old son, in wireless telephony. They have an amateur station at Keyport, and recently began sending out messages. They would talk into the phone, give their names and address, play a selection on a phonograph and ask any recipient of the message to communicate with them.

They soon began getting answers, the first being from operators within 100 miles of Keyport. They then began using wave lengths of from 280 to 290 meters, and the first long distance reply came from Ashland, O., 650 miles away. Then came one from Ontario, 1,150 miles away, and now G. W. G. Benzie writes from Aberdeenshire, Scotland, that he and a friend received the transmission of Oct. 6. Mr. Benzie gave the gist of the message and the name of the phonograph selections.

Mr. Robinson has agreed to try it again on a certain date.

International Communication Delegates photographed at the Schenectady Works of the General Electric Co.

Radio America Shown to Foreign Experts

EPOCHAL in the annals of international radio communication was the recent gathering together of the experts of five nations for a three days' inspection trip, beginning October 18th, to gain a first hand view of this country's communication resources. Amazed at what they saw in their inspection of the high powered radio plant of the Radio Corporation of America at New Brunswick, and at the Schenectady works of the General Electric Company, where the radio apparatus is developed and manufactured, these leaders of inter-nation radio—as delegates to the preliminary International Communications Conference—returned to Washington highly elated with their trip as guests of the Radio Corporation of America, the International General Electric Company and the General Electric Company.

The trip was started early Monday morning, October 18, in special cars from Washington. Breakfast was served at the Hotel Klein at New Brunswick and the party, numbering about 80, was then taken by automobile to the New Brunswick Station. An hour or more was spent there during which the delegates were greatly impressed with the low resistance of the capacity ground. Captain Uyeda, of the Japanese delegation, displayed keen interest in the device for heating the antenna wires to melt ice and sleet in the winter, and all the delegates found many details for close investigation in this most modern assembly of American wireless equipment, especially the Italian delegation, who expressed a desire to make arrangements for communicating with the United States through the station which is nearing completion at Coltano.

At noon the party visited Rutgers College and then returned to the special cars and continued the trip to New York. Arriving about 1 o'clock, the delegation was transferred by automobile to the Grand Central and proceeded to Albany, where the members were registered at the Ten Eyck.

At an informal dinner that night, the principal address was given by E. F. W. Alexanderson, chief engineer of the Radio Corporation of America, in which he said:

"Wireless achievements are often referred to as belonging in the realm of mystery. Whenever knowledge conquers a new force of nature for the use of humanity, it ceases to be a mystery; but the pursuit of this knowledge makes an even greater appeal to the imagination.

"The telephone and cables have introduced a new era in human affairs. They have, to a degree, conquered space and time, but only with certain serious limitations.

"An ocean cable runs only from one landing place to another, and it can be cut in times of war; its use can be censored by its owners and controlled by military and naval power. When, on the other hand, you send a radio message it reaches all parts of the world. Depending upon whether it has been sent in code or in plain language, it may be a confidential private message or a press message intended for the world at large; but nobody can prevent the electromagnetic waves that carry the message from reaching their destination. It is thus not exaggeration to say that the emancipation of the human spirit, begun by the invention of the printing press, has found its fulfillment in radio communication. Radio makes the transmission of ideas from man to man and from nation to nation independent of any frail material carrier such as a wire; but above all it renders such communication independent of brute force that might be used to isolate one part of the world from another."

"It was these ideal aims which inspire the engineers engaged in the development of the radio technique, said Mr. Alexanderson, noting that this also was the explanation for some of the foremost lawyers, executives, financiers, officers and statesmen of this country having found incentive in the human aspects of the radio technique to devote a great deal of their time and thought to its promotion and development on a world-wide scale.

"The interest that is evidenced by all concerned in this subject," he continued, "has become much more serious since it has been established that the laws and forces with which we are dealing are within the control of our knowledge, so that engineers can now proceed with the design of a radio communication system with the same deliberate accuracy as in the design of electric power transmission from a waterfall to a railroad."

He traced the close connection which now exists between electric power engineering and modern radio engineering to demonstrate how the development of the Central Station for radio communication is as logical and inevitable as was the development of the central electric power station. He explained that the entry of the General Electric Company upon the field of radio communication has been one of a gradual growth and a natural consequence of its general activities in power engineering. The engineers specializing in alternating current power technique were in a natural position to take up the problem of designing the alternators and transformers needed in radio. "These differ from the one used in the power technique principally in the fact that the number of alternations per second is about one-thousand times as great," he observed. "This speeding up of the performances one thousand times involved many new problems, but the most remarkable fact to record is that the generally established principles of the alternating current power technique could be applied to radio almost without change. It meant that the magnetic properties of iron which had been reduced to an exact science by Steinmetz thirty years ago had to be studied again at radio frequencies, but it was found that the Steinmetz laws of hysteresis, eddy currents and skin effect were as accurate at 200,000 cycles per second as at 25 cycles.

"It was furthermore found that the established conceptions of phase displacement power factor leading and lagging currents were as applicable and useful in the high frequency as in the lower frequency technique.

"It is true that radically different methods had to be devised for measuring power factors of a fraction of one per cent from the methods used for measuring power factor of 50 to 100 per cent, but the new methods of investigation verified the well known principles.

"The starting point of this development work was the time when Fessenden brought to the General Electric Company the problem of generating alternating currents for radio transmission. In doing so Fessenden realized that a practical solution of this problem could be worked out only by an organization of specialists."

Some of the problems that presented themselves in the evolution of the radio power plant were outlined. These were:

The design of a dynamo-electric machine or alternator generating electric power in the form of alternating currents of frequencies 1,000 times as great as those used for motors and lights.

The development of magnetic amplifying devices capable of translating telephone and telegraph currents into corresponding modulations of the high frequency energy flowing from the power plant into the radiating antenna.

The development of a regulator so sensitive as to hold the speed of an ordinary induction motor constant within a few hundredths of one per cent, this being necessary in order to maintain the proper phase relations in a load circuit working at one-third of one per cent power factor.

Improvement of the tuning of the antenna so as to transform as large a part as possible of the generated energy into electro-magnetic waves.

"The realization of Fessenden's vision, the radio power plant of today, became thus the result of the combined effort of leading electrical and mechanical engineers," said Mr. Alexanderson.

He stated that the radio power plant which resulted from this was shown to Marconi during a visit to Schenectady, and because of his interest in its performance, it was transferred to the Marconi radio station in New Brunswick, where it had no sooner been installed than it was taken over by the U. S. Navy for war service. From this time on it was largely due to the interest and support of the Navy that this work was continued and expanded. The Navy was at that time in cooperation with the Inter-allied council organizing a trans-Atlantic telegraph service, in order to supplement the already crippled cable service. "It is to be recorded," he observed, "that the trans-Atlantic radio communication service thus organized was the first international radio communication system that has been effectively and reliably operated on a large scale. On the initiative of the Navy a larger and more powerful radio plant was ordered from the General Electric Company and installed in the New Brunswick station. This resulted in the plant which is now being operated by the Radio Corporation."

Mr. Alexanderson noted how two schools of engineering pursuing different aims with widely different modes of thought, had been brought before a common problem. One had been thinking in terms of power factor kilowatts and phase displacement, the other in terms of wave length decrements and tuning.

International Photo

Rear-Admiral William G. Bullard, U. S. N., Director of the Communication Division of the Navy, and E. F. W. Alexanderson, chief engineer of the Radio Corporation of America, at the New Brunswick station

"In this radio fraternity," he said, "there is one name that I wish to mention: that of Roy A. Weagant. To appreciate his contribution we must realize that there is a force of nature that our knowledge has not conquered—the lightning—and that is the worst enemy of radio communication. But a characteristic of radio men is that their faith and imagination carries them across where knowledge fails. They are like the Norse Vikings who discovered America without a compass—after all were they not greater sailors than the navigators of today? They arrived, and so did Weagant. Some day we hope to arrive by a shorter course, but the monument of the first arrival—the Lakewood receiving station of the Radio Corporation—will always be remembered.

"A third school of knowledge was at that time brought into contact with this technique and added new impetus to it. As soon as such scientists as Coolidge and Langmuir begun to study the Fleming valve and the remarkable little device invented by Lee de Forest, known as the audion, the foundation was laid for the vacuum tube technique which has so profoundly influenced the art of radio communication.

"These scientists tell us that electricity is not the mysterious power fluid that we may have imagined flowing smoothly in our wires, but miniature planets or comets of condensed material electricity of definite charge and mass shooting across a miniature universe inside of a glass bulb and following orbits that can be calculated as accurately as the orbits of the stars."

He referred to the essential parts of the modern art of radio communication in these three widely separate realms of knowledge—power engineering, radio engineering and electro-physics—as, first, a modern electric power plant working at high frequency; second, a network of wires a mile long, supported on tall masts; third, on the opposite side of the ocean a little glass bulb full of shooting stars. This led up to the question: "What does really happen?" Does the electricity generated by our power plants emanate from the antenna and flow in an undulating stream through the air or through the water or through both? If we search for it in an aeroplane we find it, and if we submerge ourselves in a submarine and search for it, we find it; and yet we are told it is not so.

"If I knew what really does happen, and should try to tell you, then sooner or later somebody would claim that I was altogether mistaken. Therefore, I will only try to tell you how I imagine that it happens, wondering if any of you will see the same mental picture of the process that I see.

"We were once told by the physicists that all space was filled by a fine substance that was called ether, and that the light and heat that radiated from the sun was a wave motion in the ether.

"The physicists now tell us that there is no ether, but still they say that light is a wave motion.

"Be this as it may, for the purposes of visualizing what takes place in radio transmission, it is convenient to cling to the theory of the ether.

"We are familiar with other forms of wave motion—the air waves that carry sound to our ears and the water waves on the ocean. Thus the carrier of the radiated electric energy must not be likened to the flowing stream of water, or to the wind or to a bullet shot from a gun, but likened to a wave, in a uniform medium where each particle of the medium oscillates around a stationary base line while the wave rolls forward.

"The distance that a wave can travel before it fades out is proportional to its length. We may, therefore, introduce the idea of wave length, which is the distance from the crest of one wave to the next. The long swells of the ocean travel for hundreds of miles, whereas a pebble dropped on a still surface of water produces a ripple that fades away in a short distance.

"In radio communication it has been observed that the distance over which reliable communication can be maintained is about 500 times the length of the ether-wave that is used. It may be more than a coincidence that the distance to which a sound wave travels in air, and a wave on the surface of water will travel before it fades out, is also about 500 wave lengths. The average wave length of sound of the human voice is about one foot, and we know that if we speak loud our voices will carry a distance of about 500 feet. The exceptions to this rule that will occur to anybody are also significant. We know what distances voices will carry over a lake on a quiet evening. We also know what extraordinary distances radio signals will carry sometimes on a quiet night. These are exceptions that prove the rule and the rule refers only to reliable communication under normal conditions."

The practical application to a radio transmitting system is the production of waves in the ether, which we call electromagnetic waves, and for controlling the rate at which the waves are produced, in such a way that a train of successive waves will carry the meaning of articulate speech or telegraphic code. "If we wish to send a message a long distance," Mr. Alexanderson said, "we must select a long wave. The distance to Europe is 5,000 kilometers. If this distance is to be bridged by 500 wave lengths, each wave length must be at least ten kilometers (six miles) or as it is usually expressed, a wave length of 10,000 meters. The waves used for trans-Atlantic communication are, as a matter of fact, 10,000 meters or longer. He noted that "we can produce water waves by rocking a boat. If we rock a canoe we get a short wave, but if we rock a larger boat we get a correspondingly longer wave. To rock the boat requires energy, but in order to produce a wave of suitable length the energy must act through an intermediate member which has suitable size and proportions.

"In radio transmission," he explained, "the energy is furnished by the high frequency power plant, but in order to transform this energy into waves there is required the intermediate member which makes contacts with a large volume of the medium which carries the wave motion. This medium is the ether, and corresponds to the water, or the air, in the more familiar forms of wave motion. The member that transfers the energy to the ether is the antenna. The antenna corresponds to the hull of the rocking board or the sounding board of the piano.

"The analogy with water waves may be carried still further. The wave is a successive displacement of the medium and the initial displacement produced by the member acting upon the medium is proportioned to its volume. The water displacement of the boat corresponds to the effective volume of the antenna. The maximum voltage at which the antenna can be operated corresponds to the maximum angle to which the boat can be rocked before it ships water. This is the voltage at which the surrounding air breaks down under the electrostatic pressure. In electrical units the displacement in the ether is expressed in ampere meters. This is really a measure of volume, as is apparent from the consideration that the amperes charging current at the limiting voltage is proportional to the two horizontal dimensions. The third dimension, or the height, appears directly in the product and is expressed in meters.

"The height of the antenna is the most costly of the three dimensions by which we may create electric displacement in the ether. The tendency in stations designed for greatest economy is therefore towards structures of moderate height and great length, whereas the tendency in the past, when dynamic efficiency was the principal consideration, was towards towers of great height.

"The unit of performance on the old basis was kilowatts consumed by the antenna. The unit on the new basis is ether displacement. This modern measure of antenna radiating capacity is the number of ampere meters of ether displacement that can be produced at the voltage which is limited by the breakdown of the air.

"The antennas of the stations of New Brunswick and Marion, which are now used in trans-Atlantic service, are each one mile long. In the new Radio Central Station, which is being built by the Radio Corporation on Long Island, there will be ten or twelve antennas, each a mile and a quarter long. This station is intended to communicate efficiently with all parts of the world.

"When very long distances are to be spanned correspondingly long waves will be used. For efficient transmission of these long powerful waves an antenna will be needed that makes contact with a large volume of ether. This will be accomplished by combining several of these antennas into one unit. At other times the same antennas will be used for the simultaneous transmission of several messages over shorter distances.

"The shifting of radiation power, which has been referred to, is made possible by the use of the multiple tuned antenna. The New Brunswick and Marion antennas are now tuned so that each acts as six single antennas operating in multiple. The combining of several such groups in multiple is only a further extension of the same principle.

"When two such antenna groups are connected in multiple, the ground resistance loss is reduced to one-half. Hence the efficiency of the antenna is increased so that a given power produces more radiation. Still more important, however, is the fact that more power may be utilized at this increased efficiency, and so the net result is that the amplitude of the radiated wave is doubled; which means that four times as much energy is radiated.

"The economical factors that point to the radio central stations as the practical solution of the problems of long distance communication are practically the same as those that created the central electric power station. Broadly speaking, they provide for the utilization of the plant investment and operating force to the utmost by shifting the equipment from one service to another and combining it to meet various demands."

He characterized New York as a natural communication center for service that must extend to Europe, South America and westward, and announced that another radio central station at Hawaii is being equipped to serve as a relay for all points on the other side of the Pacific Ocean.

"While it is winter on the northern hemisphere, the radiating power to Europe can be much reduced," he explained, "but this is the season when the South American traffic requires a maximum radiation because of summer conditions then existing on the southern hemisphere. The New York Radio Central Station can then divert some of its radiating power from the European to the South American circuits. There will also be daily fluctuations in traffic load which will occur at different hours, due to the difference in geographic longitude. Thus the peak load of European traffic will occur at different times than the South American and western traffic. The central station equipment can be utilized so as to take advantage of this."

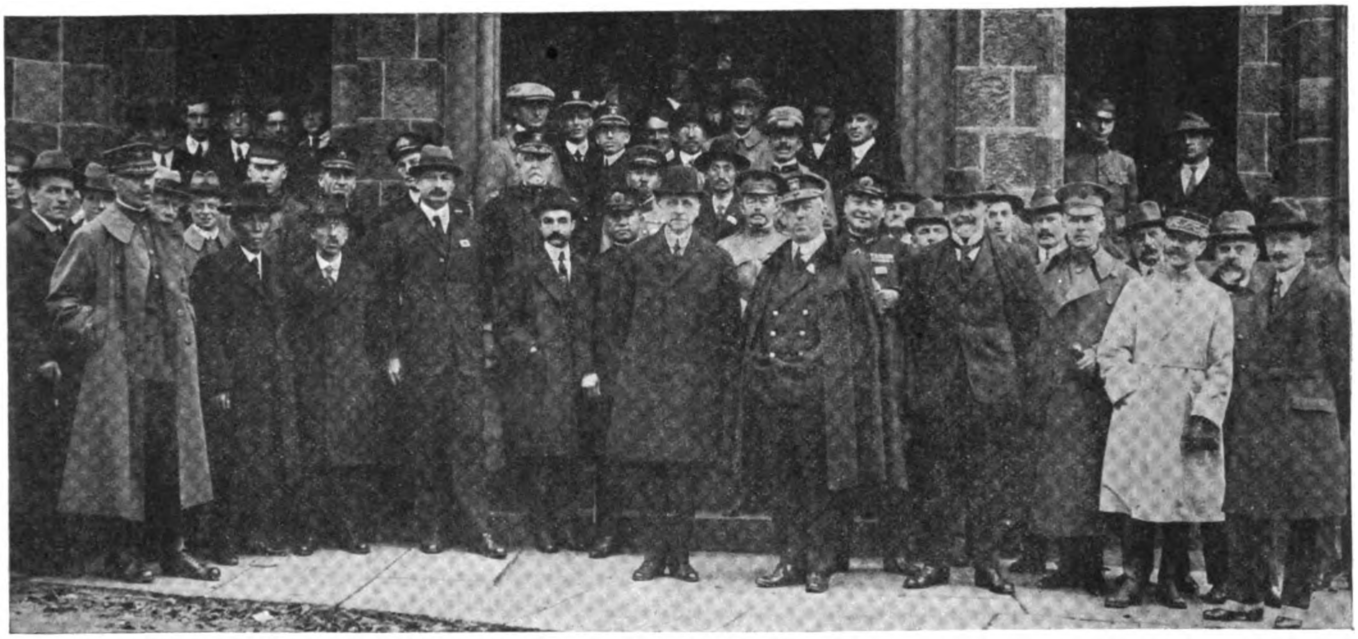
In addition to Mr. Alexanderson's talk, W. D'A. Ryan, director of the Illuminating Laboratory of the General Electric Company, gave an interesting talk on the development of the searchlight and other illumination. Lantern slides were shown, which gave the delegates an idea of Mr. Ryan's wonderful achievement in lighting the Panama-Pacific exposition in a way far different from any system of illumination ever before attempted. The new G. E. motion picture, made by use of the X-ray and showing a human skeleton in action, was shown, concluding the program.

The party visited the Schenectady works the next day, where they were shown the remarkable strides made by the company's experts in radio development. Dr. Irving Langmuir, assistant director of the Research Laboratory, and W. C. White then made addresses on the development of the vacuum tubes used in radio.

Dr. Langmuir spoke of the future possibilities of several types of vacuum tubes which are at present more or less undeveloped. He mentioned the pliodynatron and the magnetron, and discussed their relation to the pliotron, which is at present in actual use. The first three, he pointed out, are still in the experimental stage, being subjected to laboratory study, but have interesting prospects, particularly the pliodynatron.

All of these tubes, Dr. Langmuir declared, have usually been operated at low voltages, as distinguished from the high voltages of the kenotron and the Coolidge X-Ray tube. By increasing the voltage it is possible to increase the efficiency of the tube, and in the future efficiency will undoubtedly become a factor of more importance than it has been in the past, he said, adding that further improvement of the tubes will be brought about by using filaments which are better adapted for furnishing thermionic current.

He announced that the General Electric research laboratories are developing a new and more efficient filament and explained that to use it effectively it is important to obtain a particularly high vacuum and especially to guard against contamination by water vapor. This, he added, is accomplished by distilling a little metallic magnesium into the tubes during their manufacture.



Foreign and American Delegates to the Preliminary International Communications Conference on the arrival at New Brunswick, N. J., from Washington

Third row (in doorway)—E. P. Edwards, G. E. Co.; Lieut.-Com. T. A. M. Craven, U. S. N.; Com. S. C. Hooper, H. Smith, Dr. T. Nishioka, Col. Mackworth, C. M. G., D. S. O.; Col. C. Bardeloni

Second row (left to right)—Com. L. Robinson, R.N.; Mr. Edwards, R. A. C. Sperling, Mr. H. Madge, Captain Geo. Bicknell, Com. Draemel, U. S. N.; Lieut.-Com. E. W. M. King, R.N.; Admiral W. S. Griffin, U. S. N.; Major Takagi, Mr. Sugino, Dr. N. Mirabelli, Marchese di Targiani, E. F. W. Alexanderson, M. Poulaine, M. Broin

Front row (left to right)—Com. A. Hoyt Taylor, U. S. N.; Mr. Kojima, Mr. Kageyama, Captain Franck, Lieut. Robin, Com. Hatton, Pres. of Rutgers College; Admiral W. H. G. Bullard, U. S. N.; Captain Y. Uyeda, General Ferrié, Maj.-Gen. Geo. O. Squier, U. S. A.; General Collardet, Col. di Bernezzo

Mr. White, in the course of his talk, said:

"The reason the vacuum tube is playing such an important rôle in radio communication is principally because of three of its properties which, in combination, do not exist in any other piece of electrical apparatus. These three properties are: first, its electrical characteristics are independent of the electrical frequency of the currents employed. A tube will handle a current of one million cycles a second as efficiently and in the same manner as a current of ten cycles per second. Second, it will control the flow of, or generate, an electrical current that flows continuously and smoothly throughout its range, in comparison with most electrical relays and controllers that give a step-by-step action. Third, compared with the electrical effects produced, only a relatively very small amount of electrical energy is required to effect the control just mentioned. Therefore the tube has the properties of an amplifier."

Tuesday night the party returned to Albany, where a formal dinner was given with E. W. Rice, Jr., president of the General Electric Company, presiding. Short talks were given by Gerard Swope, president of the International G. E. Company; Owen D. Young, vice-president of the General Electric Company and chairman of the board of directors of the Radio Corporation; Rear Admiral W. H. G. Bullard, Director of Naval Communications; the several delegates, and Edward J. Nally, president of the Radio Corporation, who reviewed the development and expansion of the organization from the date the Government turned back the radio stations to private ownership, noting that, at midnight on February 29, "the first organized system of commercial long distance wireless communication between the United States and foreign countries was inaugurated." He explained that prior to April, 1917, when the United States entered the war, there had been a few weeks of commercial wireless service between this country and Japan, but the service could hardly be said to have been fully started before the stations were taken over by our Government. Attention was called to the fact that transoceanic wireless communication is practically a new art and that everything in the organization, from the messenger boy up, had to be found—created, as it were, over night. "The staff which took over the stations from the government at the last minute of the day which was set for the transfer," said Mr. Nally, "had no opportunity to rehearse the multifarious duties connected with such a huge undertaking. We marvel that it could be done; but it was done, and the service has continued to this day practically without interruption, everyone fitting into his or her duties as though they had always performed them."

He explained that the first long distance commercial wireless circuit out of the United States was with Hawaii, which was soon extended to Japan. The second circuit was with England; the third, beginning in May of this year, with Norway; and the fourth, a few months later, with Germany, and that it is now planned to start a fifth, with France, at the beginning of next month.

"This nation is today the only country in the world carrying on commercial communication by wireless with four other nations," he said, "and the Radio Corporation of America is the only company in this country owning and operating high power radio stations that communicate with other countries. In addition it has under way the erection of a huge multiple station in the vicinity of New York City, which, when completed, will enable it to communicate with many other foreign countries, including South America. All of this service has been developed practically within the year."

Mr. Nally expressed the belief that never in the history of initial industrial development in any country have there been such large expenditures of time and money as those called for by the radio art. "The first high power radio stations required the expenditure of millions of dollars and verily they were built on faith," he observed, "but the faith which removes mountains justified itself in radio, where the obstacles to successful operation were stupendous. The pioneers were men of vision and their hopes, though great, have been in great measure, realized."

He viewed the business of international radio communication as one wholly different from any other scheme of communication, in that each nation, by the nature of things, is limited to the building of its own station—only one-half of the circuit. The other nation must supply the complementary station. For the guests—whom he characterized as the "doyens of communication"—he developed the thought that:

"Any nation, having erected its station with all the skill and technical experience at its command, must trust in sublimest faith to the other nation to make its station a complementary one—and a full complement. To the extent that this is done the purposes of both nations shall have been accomplished; but, if instead, one station has less power or is less efficiently organized and maintained, or for any reason fails to meet the full standard requirements of the corresponding station, it renders abortive the best plans and the highest skill of the other nation."

He stated that, primarily, there must be organization with a trained staff and up-to-date apparatus and devices, and coupled with this there must be the closest and most intelligent supervision and co-ordination on the part of governmental and private connecting land lines.

"It is not enough to provide stations of the greatest power if that power be drained and dissipated by leaky and wasteful systems of pick-up and delivery or by slow service through the transfer offices of connecting lines," he continued. "We all know that many relays, whether manual or mechanical, are as brakes on the wheels of traffic progress. A speedy main line circuit contributes to minimize delays, but such contribution is in turn itself minimized, indeed made abortive, if not adequately supported by the feeding and distributing ends of the circuit. By eliminating the necessity for inspection and checking, and the accounting processes, we reduce delays, disbursements and waste.

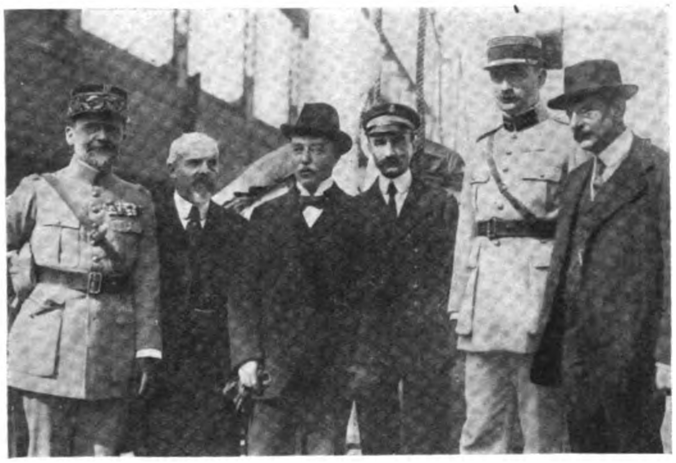
"If the remedy were in the hands of one organization it would be easy to place responsibility and bring about needed reforms; but, speaking for the Radio Corporation as a typical instance, though it constructs its stations in accordance with the latest improvements in the art, sparing neither effort nor money, and though it provide a twelve-inch main for traffic, if it must feed it through a one-inch pipe at either end, its efforts and accomplishments are reduced to the capacity of the one-inch pipe.

"Therefore, I respectfully but earnestly suggest to you who control the communication of your respective countries, and are in daily touch with the developments in every art and every method which are contributing to the progress of communication, the imperative necessity at this time, when so much is expected and so much has already been accomplished in radio, of supplementing its great potential possibilities with every improvement which intensive study and careful supervision can bring about, to the end that every link in the chain of service will be of equal strength and all unite to form the highest standard of excellence.

"I suggest, as the most definite and satisfactory plan which will bring all connecting companies into line and coordinate their organizations, that we inaugurate a system for the exchange of engineers, supervisors, and even operators; thus enabling our staffs to obtain a complete insight into the working conditions and the local difficulties of the station or stations with which international communication is exchanged. Fortified by such complete understanding we shall be better able to iron out the minor defects which oft-times become very troublesome in their cumulative form.

"The expense of making this exchange can be lessened for all concerned by an arrangement under which the personnel exchanged would assume definite duties at their temporary posts and be carried on the local payroll."

Mr. Nally then discussed the human element in radio. Is it enough, he said, to have highly skilled engineering and research departments constantly engaged in overcoming mechanical and natural difficulties incident to the operation of high power radio stations, calling for vast expenditures of time and money and, regardless of cost, regularly consigning to the scrap heap the development of today for the improvement of tomorrow? He maintained that the logic of the case calls for the building up of a highly competent, contented and capable staff, where the members will feel upon entering the service that it is a business to which they can devote their lives and their best efforts, with assurances of a fair return in the way



Keystone Photo
French Delegates (left to right)—Gen. Ferrié, M. Broin, E. Lane, Lieut. Robin, Capt. Franck, and M. Poulaine

of income during the time they serve and a substantial pension to take care of them when, through years or other incapacitation, they are unable to work.

"While I know that in many countries such a scheme has been applied, to a degree, perhaps, beyond anything that is in practice here," he added, "I nevertheless have the feeling that nowhere has enough attention been given to the human element in the vast machinery of communication; and before we can expect the full measure of performance from highly developed apparatus there must be an equally developed organization, complete in every part, cooperating with highest enthusiasm and skill in every step of the march of progress and improvement. In view of the large investment in high power radio stations anything short of a coordinating organization of trained experts is economic waste."

His observation, he stated, had been that the traffic has suffered greater delay through physical failure of landlines and their operation than from physical failure of radio transmitting apparatus, including aerials, and that radio service is made or marred by the careless or incompetent operator or messenger, or both.

He explained: "Telegraph service, as I know it (and I have been intimately connected with it for forty-five years) while perfected to the last degree mechanically, is dependent upon the human element for its best expression, and while great progress has been made in training the operator—and the average operator is capable, and conscientious—the messenger boy, alas, is the same unknown quantity he was in the beginning, and evermore shall be!

"We should carefully and systematically study ways and means to substitute for the messenger a trained man of the type used for the delivery of mails and supplement him by all available mechanical devices, such as telephones, pneumatic tubes and intercommunicating systems or automatic recording devices between the main office of the telegraph company and the business office of the customer, for sending and receiving messages.

"I am strong in the belief that the ideal telegraph service, wire or wireless, will not be realized until we scrap the messenger boy. He is the one antiquated piece that remains of the human side of commercial telegraphy. The period of his obsolescence is contemporaneous with the birth of the first messenger!

"Having been a messenger, I speak from experience, as well as from conviction born of many years of association with the species of the dear, derelict and delayful darlings to whom we telegraph people have entrusted the star part in the whole drama of service.

"I do not want, however, to lay all the stress on scrapping the messenger," he concluded. "I would scrap *every* antiquated, and therefore obsolete, feature of the system which has been built on tradition and is still religiously followed. In other words, I would match the new art of improved apparatus and devices with up to date methods of operating same in coordination with the new ideas and systems to be regulated by the improved human machine."

On Wednesday the delegates visited West Point, where they were shown the principal points of interest and witnessed a review by the corps of cadets, 1,200 strong. Wednesday night an informal dinner was held at the Waldorf in New York.

The party was entertained on the following day by the American Telegraph and Telephone Company in New York.

Some remarkable developments in American long distance telegraphic and telephonic communications, as well as wonders of research laboratories seeking to improve better transmission of wire, phone and radio messages were exhibited.

One of the demonstrations arranged was the setting up of communication by wires and wireless between the Catalina Islands in the Pacific Ocean and a ship in the Atlantic Ocean off the New Jersey Coast. The Catalina operator talked to the skipper of the Gloucester over 4,000 miles of telephone wires and radio distances of about 100 miles, while the guests listened in from a dining room in the Waldorf.

Each place at the table was equipped with a receiver and as Colonel Carty called the roll of the district chiefs along the route of the transcontinental line, the guests heard each answer and learned from each the distance from New York, the local weather condition and the local time. As the roll was called a large map hanging on the wall was illuminated so that the course of the connection across the continent could be followed.

When the connection with San Francisco had been established, conversations were held between the British Consul there and a representative of the British Delegation, between the Italian Consul and a representative of the Italian Delegation in the Italian language, between a Frenchman and the representative of the French Delegation in the French language.

Then the connection was carried down from San Francisco to Los Angeles and Santa Catalina Island. After the Catalina operator had told the skipper of the Gloucester, who was riding a heavy sea in the Atlantic Ocean's darkness of 11 o'clock, that the sun was just setting off California, Colonel Carty cut in with:

"You, Captain Nichols on the Gloucester, and Operator Spiker on the Catalina Islands, are taking part in an epochal event in wireless telephony. You are the first men to talk to each other from the Atlantic to the Pacific, across the waters of both oceans and the stretches of the continent."

The two men talked for about four minutes, and then Operator Spiker closed up his apparatus to go to supper and Captain Nichols to go to bed. Their conversation had been hampered somewhat by amateur operators both on the Atlantic and Pacific coasts. Static interference prevented the Gloucester from hearing well, but Catalina was able to hear every word with ease.

By automatic devices of American invention, the conversation was taken off the ends of the land wires and transmitted by radio to the ocean stations. The wireless distance on the Pacific was about thirty miles between wires' end and the Catalina Island Station. The distance between the wires' end at New Brunswick, N. J., and the Gloucester was more than fifty miles.

The delegates representing the United States included: Van S. Merle-Smith, Dr. Walter Wallace McLaren, W. W. Andrews, and Walter S. Rogers, State Department; Major General George O. Squier, Brigadier General D. E. Nolan, Captain George W. Bicknell and Rear Admiral W. H. G. Bullard. The French delegates were: M. Broin, General Ferrié, Brig. General L. Collardet, M. Poulaine, M. de Lapradelle, Captain Franck and Lieut. Robin. The Italian delegates included: Commandatore N. Mirabelli, Colonel Marquis Vittorio Asinari di Bernezzo, Colonel Bardeloni and Commander Raineri Biscia. The British delegates were: F. J. Brown, Major General H. K. Bothell, R. A. C. Sperling, Lieut. Col. B. C. Gardiner, C. B., Lieut Col. Mackworth, C. M. G., D. S. O., Lieut. Commander E. W. M. King, Commander L. Rob-

(*Continued on page* 40)

Universal, Honeycomb and Lattice Coils

By O. C. Roos,
Fellow I. R. E.

FIFTH AND LAST INSTALMENT

(*Continued from November* WIRELESS AGE)

THE TWELFTH AND LAST COIL

For layout scheme of semi-manually wound coil, see figure 33.

The given data are:

$P=.4''$; $G_e=10°$ or .173 radian; $y=4$; $D=.16''$; $r=4$; $k_e=25''$; $s=94\frac{14°}{19}$.

We immediately deduce:—$v=18\frac{18°}{19}$ or 19° approximately. $m=10$; $n=40$; $b=.64''$. $t=2.56''$.

From 13A, $w=K_e \sin G_e—P=4.35''—.4=3.95''$.

From 19 B, $\theta_e=\sin^{-1}\frac{(P+D)}{K_e}=\frac{.56}{25}=.0224$ radian.

$\cos \theta_e$ approximately$=1$.

From 20-B, $\phi=G+\theta=.173+.022=.195$ radian or 11.2° approximately.

From 6 C, $M=l_{avu}=(P+D) \csc \phi=.56 \csc 11.2°=2.87''$.

From 14 B, $l_{asu}=K_e \cos G_e=.985\ K_e=24.4''$.

From 14 B, $d_e=\frac{360\ l_{avu}}{\pi\ v}=17.5''$.

N. B. We do not use $d_m=d_e—t$ to get F_u directly, as in ordinary machine-wound coils. We get, however, K_m from K_e, first using 4C to get

$L=K_m \cos \theta+(P+D)\phi$ approximately $K_m \cos \theta$
$=K_m$ very closely in this case

But $K_m=K_e\frac{d_m}{d_e}=25\times\frac{17.5—2.56}{17.5}=21.5''$

Hence $L=21.5''$.

From 5C, $F_u=30\ myL/s+\frac{5v_u}{18}\%\ 30\times10.5\times4\times21.5/95$
$=285$ approximately.

From 8B, $H=2w/m=\frac{3.95}{5}=.79''$.

Hence c=approximately 5 which is a good value.

From 7B $h_m=H \cos G_m=$approximately $H \cos G_e\frac{d_m}{d_e}$.

$.79 \cos 8.8°=.78''$ approximately.

N. B. At the outer layer the factor h_e would be just a shade greater than h_m or .78+". In figure 37 there is shown the reason why the special length $M=l_{avu}$, allows the wires to leave the pins at lower levels so that they only touch on the "outer" side, whereas at the outer level of diameter, d_e, all the wires A, B, C, etc., touch all the pins on both "inner" and "outer" sides.

The preceding results have been mostly obtained with "cross-step" or simply "step" lattices rather than with cross-spiral or simply "spiral" lattices.

In step lattices in general, the advance cannot be greater than the swing; i. e., half the pitch. This ultimate case is obtained when the swing is 360°, the pitch 720° and the advance 360°. The coil has now, however, taken the structure of the simplest case of a spiral lattice.

In all spiral lattices the pitch is a multiple of 720° or more. If of 720°, we have a spiral "uni-lattice"; if greater, and obeying lattice laws, we have a cross-spiral multi-lattice, as in the staggered cross-step multi-lattices.

It is theoretically a gain to reduce the distributed capacity of the lower "layers" of a lattice coil, by artificially separating these layers by "low loss" dielectrics, such as for example an insulating "lattice layer" or by using several shallow separate lattices. Generally speaking, this does not pay for receiving coils after the radius of the coil layer has increased more than about 30 per cent of its initial value. The average diameter of the two "levels" composing the lattice "layer" is understood, when taking the radius or diameter of a "layer" in a lattice coil. We thus get the true value of $\sin G_m$ from d_m.

This added insulation not only decreases the capacity by increasing the rate of change of G between layers—which is one factor determining the smallness of the distributed capacity—but it reduces the extra capacity due to the effect of the increased value of the potential gradient between layers at the lower "levels."

There is another factor, which operates to produce a very slight reduction of capacity in the outer layers and which, therefore, naturally reduces the relative efficiency of the inner layers. It is the fact that with a given number of turns per layer, m, and hence a given spacing $H=2w/m$ for a given width, w, the actual wire separation, b, becomes slightly greater ($=H \cos G$) for the outer layers. This reduces the distributed capacity in any given level. The change of G principally affects the distributed capacity between levels by contrast.

The rate of change of tanG is of course inversely proportional to the square of d, as shown in figure 35, hence the relatively greater influence of the lower levels in reducing capacity—other things being equal. In like manner G itself varies as the function $\frac{1}{\sqrt{d^2+1}}$ or less rapidly than tanG varies.

Since the inner layers in general contribute for a given inductance a disproportionate amount of capacity, it is evident that a more efficient coil electrically might be designed on the basis of a varying width with change in diameter as shown in figure 38. The cross-hatching shows the wiring section which is simply enlarged along the straight lines C1, C2, C3 and C4. There is nothing to prevent winding-pins as shown in figures 33, and 37 from being arranged on the elements of right circular cones.

By grading the size, axial spacing and swing angle of the wire in several separate flat sections of a coil where $\frac{t}{w}=3$ to 6 a further improvement is possible, though a costly one from a commercial standpoint. Handwound lattice coils are commercially unprofitable except in large sizes and relatively few turns for loop-work.

We may also note the fact that the adjacent levels have less mutual capacity as the angle between them, which is double the swing angle G, increases. We have discussed the change of G between similar steps at various levels, but it must be remembered that the direction of similar adjacent levels changes suddenly by the angle 2G. We have seen how alternate levels make a slight change ΔG, which is proportional to $f^1 (G)=\frac{wk_x}{\sqrt{k_x^2-w^2}}$.

Both these changes, favorable to low capacity at the bottom layers with $\frac{t}{d}$ varying between three and six, are partially offset by the low inductance per unit length in this part of the coil.

It is evident that if the two cross-steps spanning the pitch-arc, p_a, could be at right angles the coil would have, in one respect, the lowest distributed capacity possible. Doing this, however, with the old law 2s=p in control, wastes wire. In figure 39 we change this law but keep the fundamental law $\frac{p}{v}=m$.

In figure 39 the second step k_2 is at right angles to the first k_1 but is as short as possible. This type of coil may be wound by machine or as in figure 33.

We have $s_1+s_2=p$

$l_{as_2}=w^2/l_{as_1}$

$l_{ap}=k_{x_1} \csc G_x$

If G is less than 3° the wasted wire k_{x_2} is negligible.

Limitations of Lattice Coils.

Lattice coils have their engineering limitations just as bankwound coils have. These limits are reached when the dielectric losses in insulation are more than in a bankwound coil.

By separating each "pattern layer" of a lattice coil by at least three times its own radial thickness the dielectric losses and capacity may be reduced. These losses are very appreciable at low frequencies and unless the coil is specially designed it may not be suitable for eliminating interference by sharp tuning. They are useful for external high impedance rejector circuits to balance internal impedances in tube radio engineering.

It is not sufficiently realized that sharp tuning is secured in a coil at the expense of its electrical flexibility, so necessary in wireless telephony. In other words, a small decrement does not allow a wide band of frequencies to be almost equally well transmitted. In modulating such a circuit the time constant may be so large that the voice is followed with serious distortion by the amplitude of the carrier waves. This amplitude can only change to $\frac{1}{2.72}$ of its value in $\frac{2L}{R}$ seconds where L is in henries and R is in ohms.

A U. S. 1500 bi-lattice coil would have a time-constant in the neighborhood of .002 second. If the note C with 256.12 cycles per second were sounded, it would be distorted in a transmitter or receiver by the above coil whenever efficient conditions of modulation were imposed. Fortunately the higher components of the voice or audio current are also the weaker and in most cases the action of the coil's time constant in limiting the rapidity of modulation is taken care of. Radiotelephone and radiotelegraph critics differ widely on the above points.

Flexibility and Exactness of System

The writer hopes that his efforts to give precision to the somewhat vague ideas on the nomenclature and factors used in classifying universal coils may be helpful in calling attention to the elements and principles involved in the production of these coils.

All repeated cell pattern coils, which are universal wound, no matter what the pitch, are called lattice coils. As an aid to consistency in definition there may be considered to be two families of lattice coils.

1st—Cross-step lattices or lattice coils proper;

2nd—Cross-spiral lattices like that shown in figure 19 (August AGE) which are not in practical use to any extent as yet, but are distinctly "promising."

In this classification either of these forms, if its successive "turns" are "staggered," may be called a "bi-lattice," "tri-lattice" or "multi-lattice" coil, and if every lattice staggered winding is throughout kept separate—i. e., has its own terminals—we may have a radio frequency transformer of a 1-to-1 or greater ratio when we unite several lattices into a single secondary.

To illustrate the flexibility of this system of classification let us consider a coil combination with six staggered windings made from the chart of figure 8.

This consists of six lattices, each of which when finished has its own terminals, at OL-OR, 2L-2R, 4L-4R, 6L-6R, 8L-8R, 10L-10R and 12L-12R respectively. These will be called, for brevity, lattices A, B, C, D, E and F.

These sections taken together in series, constitute a sextuple lattice, or if you like Greek, a "hexa-lattice." Cut them between C and D and we have A, B, C and D, E, F, each as tri-lattices, and the whole combined arrangement is now a 2-wire, "tri-lattice." Then restore the original arrangement leaving out lattice A, and see if you can accurately classify it under the old system—or rather lack of system. You can scarcely name it.

Under the above system, however, we can call it a "two-wire, one-to-five lattice" or a "one-to-five lattice coupler." For the practical man, with no particular leaning toward the classics, there is no need to call the combination B to F, a "penta-lattice" coil. He may just let it go as a "5-lattice" coil or simply a "5-lattice." The above remarks apply to cross-step lattices, but are equally true in principle for cross-spiral lattices; since these can be staggered if desired. Thus, we can have a "3-wire," spiral "bi-lattice" or a "3-wire," step "bi-lattice."

The writer is conscious of the superior claims of the word "helical" versus "spiral" in the above classification, but only academical purists need quarrel about the geometrically rigorous use of these words, or the association of "uni-" with "bi-" or "sexa-" with "hexa," as prefixes for engineering terms. These strange etymological bed-fellows, even though inheriting Latin and Greek animosities, are after all, in the engineering trenches for work and not dress parade!

A Static Preventer Buried in the Earth

AN improvement in his apparatus designed to prevent static interference has been worked out by Roy A. Weagant, applicable to the system he developed in 1917, when he called attention to the fact that, whereas signal waves travel in a horizontal direction, and therefore affect successively the two parts of a divided antenna or collector disposed in the line of propagation of such waves, static waves affect the two parts of such an antenna simultaneously, and appear to be propagated in a vertical direction only.

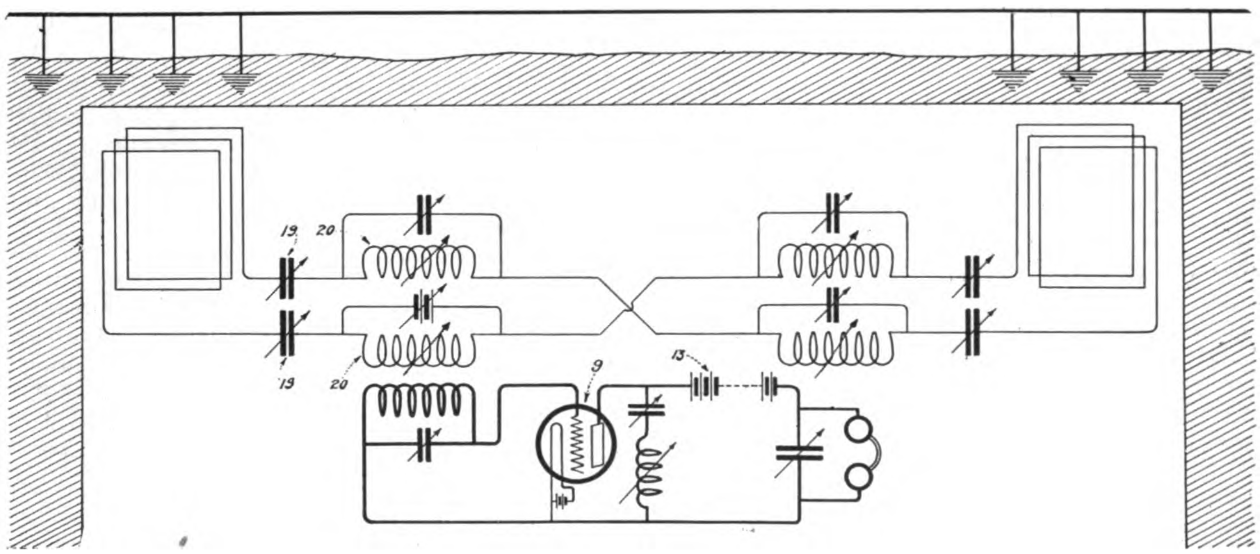


Figure 1—A diagrammatic view of the receiving station

The new invention is based on the further observation that the force or effect of static disturbances is very greatly diminished beneath the surface of the earth, whereas, horizontally traveling signal waves, such as are now commercially used in radio, penetrate a substantial distance below the surface of the earth with small diminution in strength. In order to make practical use of these observations the receiver including the antenna or collector is placed beneath the surface of the ground, and to further protect it from atmospheric disturbances, the surface of the ground above the receiver is covered with a metallic screen.

Figure 1 is a diagrammatic view of the receiving station. A divided collector is shown associated with receiving and detecting apparatus. Figure 2 is a modified receiver in which a single collector is employed.

Referring in detail to the apparatus shown in figure 1, 1 is a chamber beneath the surface of the ground. Within this chamber there is disposed a divided collector having two coils disposed in a single vertical plane in the line of the signal waves to be received. The ends of the coils are crossed and conductively connected so that a horizontally-extending portion of one collector opposes a similarly placed horizontal portion of the other collector. In the leads from each collector are variable capacities 19 and variable inductances 20, one of the inductance coils serving as the primary of a coupling transformer, the secondary of which is connected in the circuit of a detector—the one shown being a receiver of the vacuum tube type, comprising a vacuum tube 9 and an energizing battery 13. As this receiver and its mode of operation are now well known, it need not be described in detail.

A metallic conducting screen is disposed on the surface of the ground above the receiving apparatus just described, this screen being grounded at a large number of points. This screen may take the form of a net work of wires resting directly on the ground or a metallic screen of any kind supported immediately above the ground, as shown in the drawing.

Referring now to the modified apparatus shown in figure 2, this is in general the same as that shown in figure 1, except that the collector consists of a single coil 3 vertically disposed in the line of the signal waves to be received, instead of a number of coils as shown in figure 1. The ends of the coil in this modified arrangement are connected to the oscillation transformer 4, the secondary of which is connected to the vacuum tube of receiver 9, which is the same type referred to in connection with figure 1. The arrangement shown in figure 2 likewise comprises a screen disposed along the surface of the ground.

It will be apparent that the effects of atmospheric disturbances in both arrangements will be greatly reduced by reason of the fact that the collectors are beneath the surface of the ground, and from the fact that the apparatus is protected by a conducting screen against disturbances propagated in vertical directions. In addition, the arrangement shown in figure 1, embodying the principle of earlier developments, still further eliminates the effect of static disturbances by the use of divided collectors. By reason of this arrangement static disturbances which succeed in penetrating the earth are balanced out or canceled. That is to say, impulses set up in the collectors 3′ simultaneously, as by static disturbances, are made to oppose each other, whereas oscillations set up by signal waves being out of phase, act cumulatively on the detector. While the collectors have been shown inclosed in a chamber beneath the surface of the ground, it has been demonstrated that they may be buried in the ground, and successfully operated.

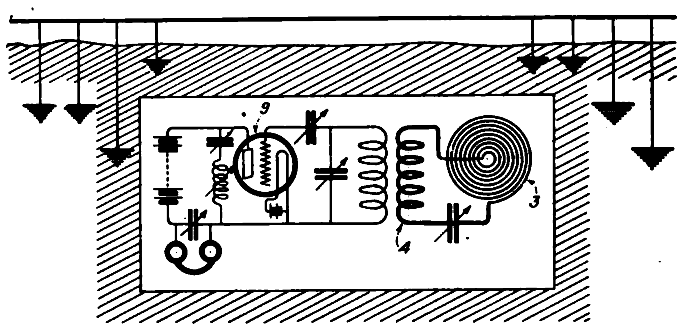


Figure 2—Modified receiver in which a single collector is employed

The Production and Control of Radio Frequency Oscillations

A SYSTEM for the production of radio frequency continuous electrical oscillations and a method of controlling the amplitude of these oscillations has been developed by Dr. Alfred N. Goldsmith. He refers to the production of radio frequency continuous oscillations by use of the pliotron, noting that in order to utilize such oscillations for radio telephony, it is necessary to modulate or vary the amplitude of the oscillations supplied to the radiating system in accordance with variations in the signaling current. Also that a pliotron may be used to advantage as an amplifier of variable currents by reason of its property of being operable at high voltages. His system is one in which pliotrons are used for supplying modulated radio frequency currents to a radiating system, and he provides a circuit arrangement in which a single source of energy may be utilized for supplying the operating current or potential for a number of pliotrons which are used for different purposes.

In practice, a pliotron is used for producing radio frequency oscillations, an oscillating potential obtained from this oscillator is impressed upon the secondary of a transformer which is connected to the grid circuits of a number of pliotrons connected in parallel in order to produce an amplified radio frequency current which will supply the desired amount of energy for the operation of the radiating system. The radio frequency potential which is supplied to the grid circuits of the amplifiers is modulated by means of another pliotron whose plate circuit includes the transformer secondary. The resistance of the modulating pliotron is varied by varying the potential of its grid in accordance with variations in the signaling current. As the resistance of the modulating pliotron is varied a variable amount of current is caused to flow through from the transformer secondary and the potential across the secondary is varied accordingly. As a result, the current output of the amplifiers will vary in accordance with the variations in the signaling current. In order that a single source of current may be utilized for heating a number of filaments of the different pliotrons the system is arranged in such a way that one terminal of each such filament is at earth potential. This arrangement also enables a single source of energy to be utilized for supplying the operating current for the oscillators and for the power amplifiers.

This will best be understood by reference to the following description taken in connection with the accompanying drawing.

One pliotron is employed for producing radio frequency oscillations, and is termed the "master oscillator." The anode and grid of the master oscillator are connected to a circuit which comprises an inductance 5 and a variable condenser 6 by means of which the circuit is tuned to the frequency of the oscillations which are to be produced. Energy for the operation of the master oscillator is supplied to the plate circuit by the direct current generator 7 which is connected to the cathode and anode, the cathode being grounded at 8. Condenser 9 prevents the direct current component of the plate current from flowing through inductance 5. An inductance 10 in series with the generator and a condenser 11 in parallel therewith serves to smooth out any irregularities in the current supply and a choke coil 12 which is termed a "radio frequency choke coil" prevents the radio frequency component of the plate current from flowing through the generator. It has been customary heretofore to regard any large inductance as a choke coil for radio frequency currents. All inductances however, have distributed capacity between the turns which may be considered as a condenser in parallel with the inductance. This capacity will serve to by-pass a considerable amount of radio frequency energy unless the capacity is such that the natural period of the coil resulting from its inductance and capacity is approximately equal to that of the frequency which is to be choked out. If the coil is so designed, it will act as a high impedance to the desired radio frequency currents.

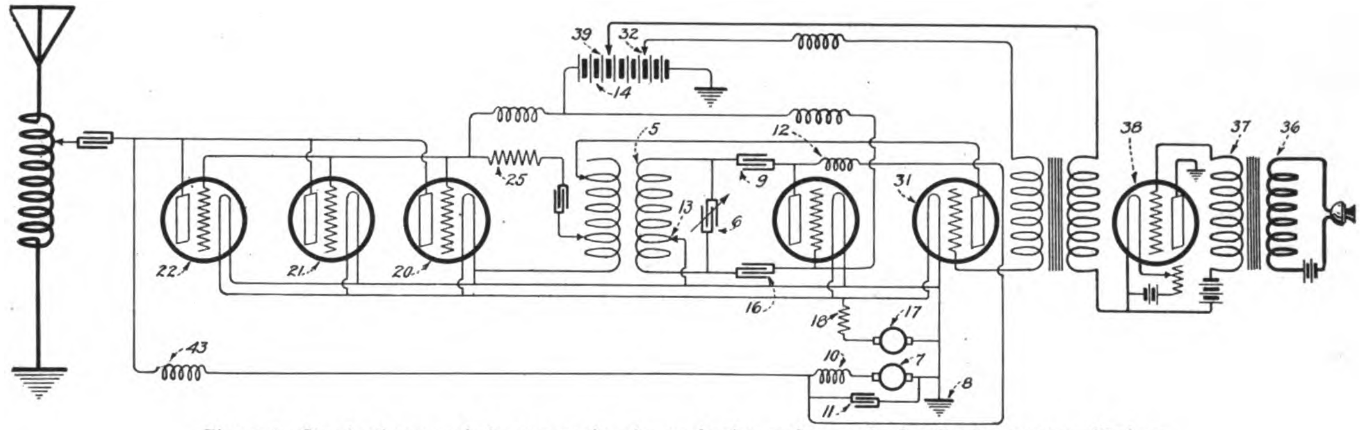


Figure 1—Circuit diagram of the system for the production and control of radio frequency oscillations

The cathode of the master oscillator is connected to a point 13 in the inductance 5 which point may be varied as desired in order to obtain most efficient operation. It will usually be found desirable to apply to the grid a definite potential with respect to the filament in order to adjust the normal current through the pliotron to a point on its operating characteristic which will be most favorable for its operation. This potential, usually negative, may be obtained from the battery 14, a radio frequency choke coil being included in the circuit to prevent radio frequency currents from flowing through the battery. The condenser 16 prevents the short circuiting of battery 14 through inductance 5. The direct current generator 17 with an inductance 18 in the series therewith furnishes current for heating the cathode of the master oscillator and also for the cathode of the other pliotrons.

The inductance 5 forms the primary of a radio frequency transformer, one end of the secondary of which is connected to the cathodes of a series of amplifying pliotrons 20, 21, 22, which are all connected in multiple. While only three pliotrons are shown thus connected, as many may be used in this way as may be necessary to secure the desired output in the radiating system. A suitably selected point 23 in the secondary 19 is connected to the grids of the amplifiers through a condenser and a resistance. The grids of these amplifiers are maintained at a definite potential with respect to the cathodes by means of a battery and a radio frequency choke coil in series therewith preventing radio frequency currentsfrom flowing through the battery and the condenser 24 preventing the short circuiting of the battery through secondary 19 of the transformer. Without the resistance there is a tendency for the amplifiers to oscillate at an audio frequency or to oscillate at radio frequency because of the internal capacity coupling of the pliotrons between the electrodes. The resistance 25, however, effectively prevents the setting up of these undesirable oscillations.

The generator 7 furnishes current for the operation of the plate circuits of the amplifiers and the anodes of the amplifiers are connected through a condenser and a variable contact to inductance 29 which is in circuit with the antenna. By connecting the plate circuit of the amplifiers to the antenna in this way a definite best impedance may be secured as a load on the amplifiers. It has been found that the amplifiers operate most efficiently when the impedance of the load circuit has a particular value, this value depending upon the characteristics of the amplifiers. Since the antenna system as a whole may not have the desired impedance only enough of the antenna impedance is included in the load circuit to give the desired value. It will, of course, be apparent, that the output of the amplifiers may be supplied to other load circuits than an antenna if desired.

The output of the amplifiers is a function of the voltage impressed upon their grids from the transformer secondary 19, this voltage being due to the alternating current of radio frequency produced in inductance 5. If the transformer secondary be shunted by a variable resistance the voltage across it will vary as a function of the value of the resistance. For a very high resistance the voltage will be practically the same as for an open circuit and the output of the amplifier will be a maximum. For a short circuit the input voltage and high frequency output of the amplifier will both be zero. For intermediate values of resistance the amplifier output will depend upon the particular value of the resistance.

A pliotron is employed as a variable resistance shunt to the transformer secondary 19, the resistance of the pliotron between cathode and anode being a function of its grid voltage. When this voltage is highly negative with respect to the cathode the resistance is very high. As the grid voltage is made less negative or even positive the resistance becomes correspondingly smaller. A definite operating potential may be supplied to the grid of pliotron 31 by means of the connection 32 to a battery through the radio frequency choke coil. This pliotron is termed the "modulator."

In the system illustrated, the potential of the modulator grid is varied in accordance with the variations in a telephone current produced by the telephone transmitter which is included in a local circuit with a battery and the primary 36 of an audio frequency transformer. The telephone current thus produced is amplified by impressing the potential of the transformer secondary 37 upon the grid of a pliotron amplifier 38. Current for the operation of this amplifier is derived from a battery through the connection 39. The plate circuit of amplifier 38 includes the primary of a transformer, the secondary of which is in circuit with the grid of modulator 31. The grid of amplifier 38 is given a definite operating potential by means of a battery. By this arrangement the potential of the grid of modulator 31 is made to vary in accordance with variations in the telephone current. The resistance of the modulator and hence the radio frequency potential applied to the grids of the amplifiers and the output of the amplifiers are, as a result, all varied in accordance with the variations in the telephone current. Radio frequency choke coil 43 prevents the alternating component of the amplifier current from flowing through the generator.

It will be noted that the modulator is connected across all of transformer secondary 19 while only a portion of the secondary is connected in the grid circuits of the amplifiers. This arrangement may be reversed if desired or both connections may be made to the same point in secondary 19. The object of varying the points of connection is to secure the most efficient operating voltages for the modulator plate circuit and the amplifier grid circuits. It will usually be found desirable to connect the circuits in the manner indicated, as by this connection the modulator plate circuit will operate at a higher voltage than that applied to the amplifier grids and this condition will be most suitable for efficient operation.

A Double-Anode Rectifier and Generator

JOHN SCOTT-TAGGART writes from London describing a vacuum tube for rectifying alternating or oscillating currents. Two cylindrical anodes (figure 1) surround a common filament. This construction is for receiving and radio telephony circuits. The second figure illustrates a circuit for the production of high voltage direct current from alternating current which is fed into the primary of a step-up transformer having two secondary windings 6 and 7. The alternating currents in these windings give the anodes 13 and 15 potentials of different signs with respect to the filament at any given moment.

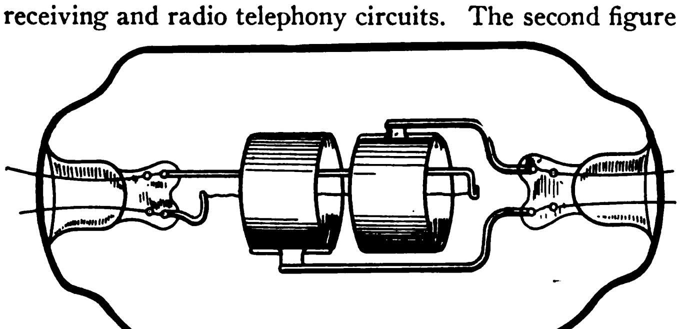


Figure 1—The cylindrical anodes surrounding a common filament

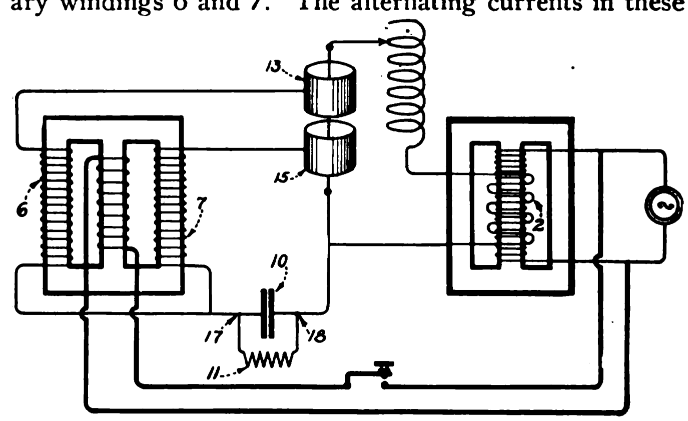


Figure 2—Circuit of the double-anode rectifier

The electron current from the filament flows to the anodes 13 and 15 in turn, but always charges the condenser 10

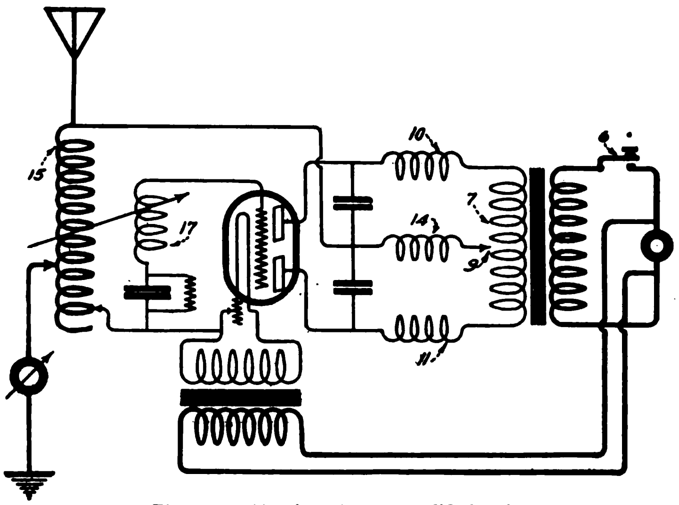


Figure 3—Circuit using a modified tube

in the same direction. This condenser acts as a reservoir of the high voltage direct current and has a capacity of several microfarads. The load 11 will usually be the anode circuit of a high-power three-electrode vacuum tube. The point 18 will be positive and 17 negative. In the figure the filament is also shown heated by alternating current through a step-down transformer 2. By means of this vacuum tube both half-cycles of alternating current are utilized. The electric current from the filament passes almost wholly to the operative anode, so that no wastage occurs. The vacuum is identical for both anodes and the construction is much cheaper than that of two separate rectifiers.

Figure 3 shows a circuit in which a modified tube is used. A grid common to both anodes is now inserted and controls the electric current flowing to the operative anode. The figure illustrates a continuous wave transmitter which employs alternating current and a single tube as described. The rectified direct current passes through 15 to which a coil 17 is coupled. The result is that the tube will generate almost pure continuous waves without a separate rectifier. A tapping 9 is taken from the midpoint along 7, an alternative arrangement to using two secondaries. The air chokes 10, 14 and 11 protect the transformer. Signaling is accomplished by the key 6. The other details will be readily understood.

A New Generator for the Heterodyne

MARIUS LATOUR, of Paris, has developed a generator for producing sustained waves of very low intensity for use in the receiving apparatus of the heterodyne or beat system.

Although the principle of this system was indicated some time ago, it has been carried into practice only when it has been found possible to produce undamped oscillations with a local generator occupying only a small space and of irreproachable regularity of working. Meissner suggested such a generator by employing a suitable connection and a lamp with three electrodes such as the vacuum tube.

A primary object of the Latour apparatus is to provide a small local generator of low power undamped waves equivalent as regards simplicity in its construction and in its setting to work to the Meissner generator. The metal-vapor tube with incandescent filament is employed in combination with an oscillating circuit.

The new device operates well in practice for the very low intensities of oscillation that are required in the heterodyne system, and provides a solution of the difficulty of obtaining undamped oscillation of all frequencies with the necessary stability. It is to be observed that these oscillations are obtained without there being an arc from the anode to the cathode, and that this working must not be compared with that of a Hewitt or Wehnhelt arc.

Figure 1 shows how the metallic mercury serves as the vapor emitting metal and as the anode, and figure 2 shows how the vapor emitting metal is arranged within the bulb, but a separate metal plate serves as the anode. Referring to the drawings the apparatus comprises a bulb exhausted of air containing filament made incandescent by a source of current.

As is shown in figure 1, there is placed inside and at the bottom of the bulb a small body of mercury. The filament when incandescent acts as a cathode and the body of mercury serves as an anode, the voltage of a source of current being applied between the two electrodes, with the interposition of an impedance which may be a resistance or inductance or a combination of both resistance and inductance.

It has been experimentally verified that the characteristics of the discharge in the mercury vapor are, under these conditions, those of the arc, viz: that the voltage between the cathode and anode diminishes when the current increases, that is to say, the apparatus behaves like a negative resistance.

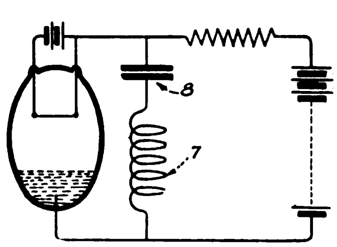


Figure 1

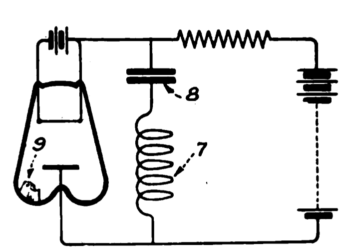


Figure 2

Figure 1 shows mecury acting as the vapor emitting metal and anode, Figure 2 has a separate plate for the anode

Sustained waves may therefore be obtained in the branched circuit, comprising an inductance 7 and a capacity 8, as shown in the drawing. Instead of a body of mercury the same results may be obtained by arranging in the bulb either a small amount of amalgam or metals emitting vapors, for example calcium. In figure 2, 9 indicates this amalgam or vapor emitting metal. It is necessary in this case to add to the generator an anode, having a function analogous to that of the plate in cathode generators.

An important question in these mercury vapor lamps is to insure the constancy of the characteristics of the discharge. For this purpose, any suitable form may be given to the bulb and to the electrodes, and the bulb may furthermore be heated externally, for the purpose of keeping all the volume in which the discharge takes place at a constant temperature.

A Sensitive and Compact Portable Receiver

By Howard S. Pyle

TO the radio amateur attending college or training school or one who is frequently away from home, the question of the practicability of including an efficient, but necessarily light and compact receiving set, in the traveling trunk, presents itself. Many highly efficient and very complete receiving sets are installed in the home stations, but comparatively few readily lend themselves to portability. With this in mind, the writer endeavors to present herewith a design for a marvelously efficient portable set which takes up little space and weighs but a few pounds. The design follows the popular trend toward the panel type, and is strictly up to date. A receiver of this type, may, after serving as a portable set, be erected at home, making a very desirable permanent receiver for practical work. Such a set may be fully constructed in half a day, as all the parts are standard articles, and no machine work other than drilling is required in the construction.

The first step is the construction of a suitable cabinet to house the apparatus contained on the panel. A very good type is merely a square box with an inside dimension of eight by nine inches, by six inches deep. Three sixteenths or half inch stock is recommended, and may be either stained and varnished hardwood, or what is more practical for portable sets, a cheap soft wood, treated with several good coats of black enamel, which presents a neat business-like appearance. A small block of wood, half or three quarters of an inch square by a length sufficient to

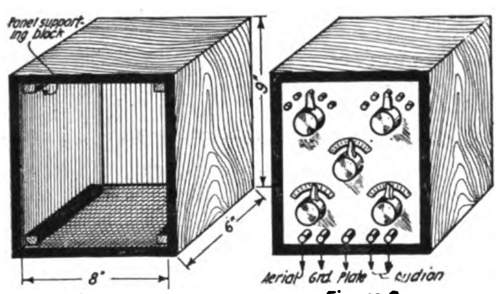


Figure 1 Figure 2

View of the cabinet and complete panel layout

come within three sixteenths of an inch from the outer edge of the cabinet should be secured to the four inside corners by screws or glue. These form a simple and effective means of support for the panel, and are clearly shown in figure 1. If the builder is not handy with carpenter tools, such a cabinet may be constructed by a cabinet maker for a small sum, and finished by the builder.

The panel itself is of polished Formica or Dilecto, size 8 x 9 inches and three sixteenths inch thick. This may be secured, accurately cut to this size, with nicely finished edges, from Sears Roebuck and Co., who stock it as a standard size. Four holes are drilled, one in each corner, located to strike the middle of the supporting block secured inside the cabinet, when the panel is in position. These holes should pass a ¾-8 wood screw, preferable nickel plated round head to match the balance of the controls.

The tuning coils are of the well known Tresco type, which are advertised in The Wireless Age, and one particular advantage of this outfit is that it is equally adapted to all waves from 200-meter amateur length, to 20,000 meter long distance undamped. The experimenter may purchase the coils separately for the Tresco tuner, boxed in a small wooden container, waxed, tapped and marked, at a very reasonable amount. In buying, he should be governed by the wave-length range desired, there being three sizes of these coils. The container which holds the coils, is mounted in the center of the panel near the rear top, and leads connected to two five point switches, one on each side of the upper part of panel. Two brass angle brackets do very well as mounting brackets for the coils. Three variable condensers of .001 microfarad capacity are required with this set, using the Tresco hookup, which is furnished with the coils. These may be of any of the 43-plate popular make panel type of variable. For convenience in ordering, they may be obtained also from the Tresco agency, with the additional advantage of being supplied in knock-down form for assembly by the purchaser, which represents quite a saving in cost.

The variables may be mounted on the lower part of the panel, two being placed, one on each side of the lower part, in line with the centers of the five point switches, and the remaining condenser being mounted in the middle of the panel. The knobs, pointers and scales are furnished with these condensers, and are readily secured in place on the front of the panel.

No work further than drilling the necessary holes and assembling the condensers and mounting is required in the construction of the set, and the hookup, being simple, can be effected in half an hour, easily. All connections should be made with number 14 bare copper (aerial wire) and soldered. For appearance sake, the connecting wires may be enameled black after soldering in place.

Four binding posts are mounted near the bottom of the panel, two under each of the lower condensers. The left hand pair connect to aerial and ground, and the right hand pair to the audion control cabinet. An extra binding post is provided in the middle of the lower edge of panel, which connects to the plate of the audion bulb, to produce the necessary oscillations. Usually a connection from this post to the phone post of audion cabinet which connects with the plate, will serve very well.

The complete layout of the panel is shown in figure 2.

No audion controls or mountings have been incorporated in this design, as it is intended to offer an opportunity to use any existing audion panel which the builder may have. It is also generally conceded that the circuits function better with the audion controls entirely separate from the tuning apparatus.

It will be noted that no coupling arrangement is required, the coils mentioned having been pre-adjusted to the most efficient degree of coupling before being sealed in. This, of course, considerably simplifies the construction.

A single wire antenna, thirty or forty feet high, and a hundred or so feet long, is ideal for use with the above described set. Using the 20,000 meter coils in its construction, it will be found possible to copy the European as well as all domestic arc stations, and several of the long distance, high wave sparks.

With the 3,000 meter coils, commercial and navy traffic pounds in, and the shorter wave arcs will be heard. The 200-meter coils are particularly adapted to amateur reception, but are very efficient on 600 meters also.

The writer has built several of these sets for local permanent use, and they are giving the greatest satisfaction. Their chief advantages are extreme simplicity, which tends to greater efficiency and less constructive troubles, and their total immunity from damage. In transporting such a set as in the case of portable work, no harm can come to it from rough handling, other than the possible slight bending of condenser plates, which is easily remedied. Such a set should be ideal for the boy scout camp and all outdoor activities.

EXPERIMENTERS' WORLD

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

A Wireless Telephone Set

By Edward T. Jones

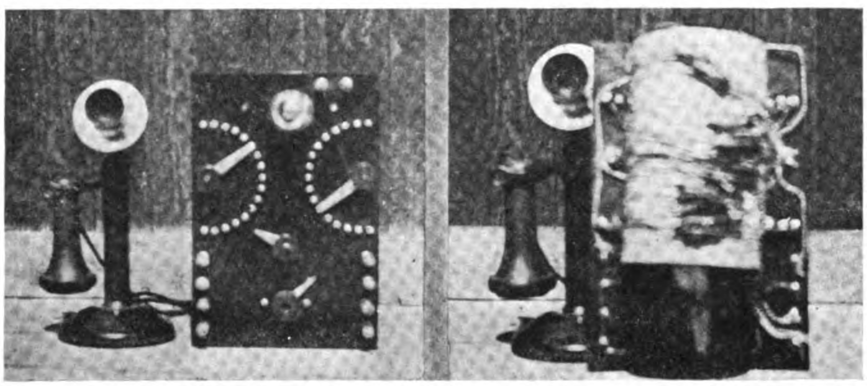
WE are all aware of the advancements brought about in this new field. However, in one particular class, wireless telephone sets are still very scarce. This alludes to the amateur class.

It is a known fact that transmission of speech by this method is possible over several thousand miles commercially, but where amateur radio-telephony is concerned, it has not been possible, to our knowledge, over a distance of more than several hundred feet. In most cases, the induction system has been employed, which, of course, is not guaranteed for any great distance.

It appears at first, that there must be something terribly complicated with the mechanism and apparatus employed in amateur work. This condition does not exist and it is really gratifying to know from experience that this word "complicated" can only and must be applied to the larger expensive commercial sets. The amateur transmitter explained herein certainly is out of the complicated class and any one with screw driver, pliers, wire, and a few accessories found in the "Bugs" junkshop will suffice.

The panel is of bakelite 8"x9"x⅛", a very small affair indeed. Angle supports made of brass are employed in preference to the usual box casing. This permits one to have the various parts under observation at all time; which will be found necessary when employing apparatus of this type in an experimental stage. It makes possible experiments which otherwise could not be made. These, of course, will be worked out along the general line of wireless telephone circuits.

A complete list of parts required is given below:



Front and rear view of the radiophone set

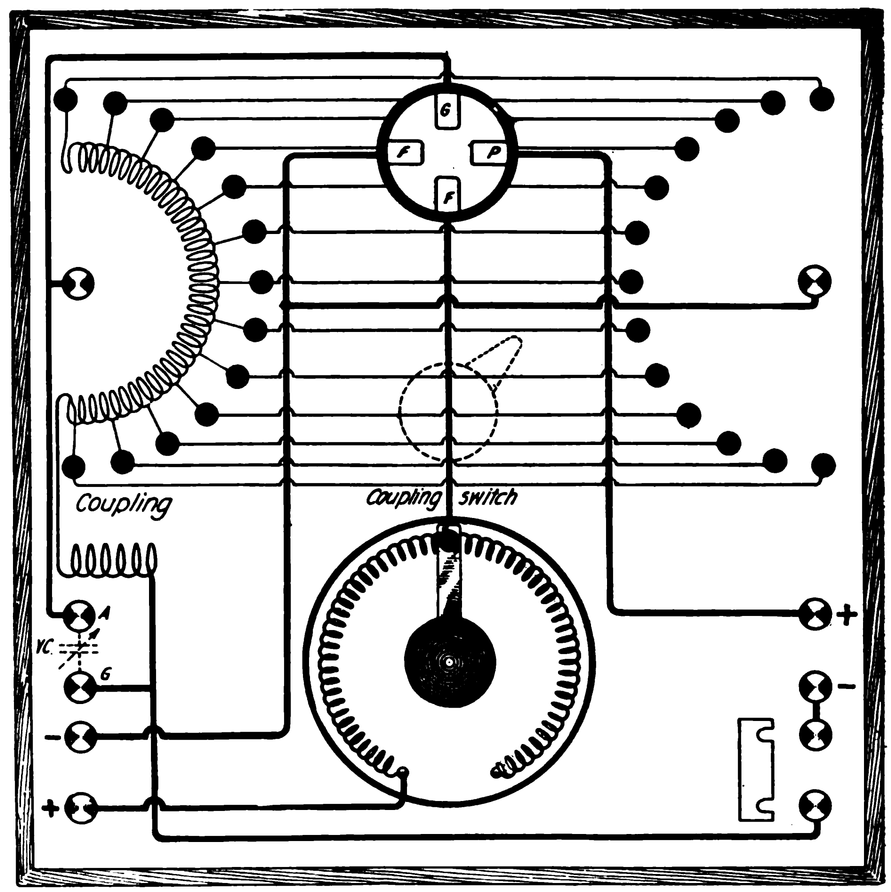


Figure 1—Panel layout and connections

1 Bakelite panel 8"x9"x⅛" . . . $ .75
1 Audion socket, 4 prong 1.50
2 Switch contact arm blades, ea. .50 . . . . 1.00
30 Contact points 50
8 Binding Posts 40
1 A Battery rheostat, panel mounting 1.60
1 Piece cardboard, 4.5" dia. by 6" 10
200 Feet Litzendraht 20 strand No. 38 enamelled wire . . . 2.50
1 Piece cardboard 3.5" dia. by 1" long 05

$8.40

This does not include the A and B batteries, nor does it take into consideration the audion bulb. These, of course, are absolute necessities and are not permanently attached to the panel and are not described herein. They are in other words, "replaceable articles".

Inductance Units

Litzendraht is employed throughout, in both the windings and the wiring of the panel. Twenty strands of number 38 enamelled with one cotton covering over the strands is employed. This was purchased from Sears & Roebuck, Chicago, Ill., as were the remainder of the parts employed on the set.

The inductance unit which is employed for tuning the circuit to certain

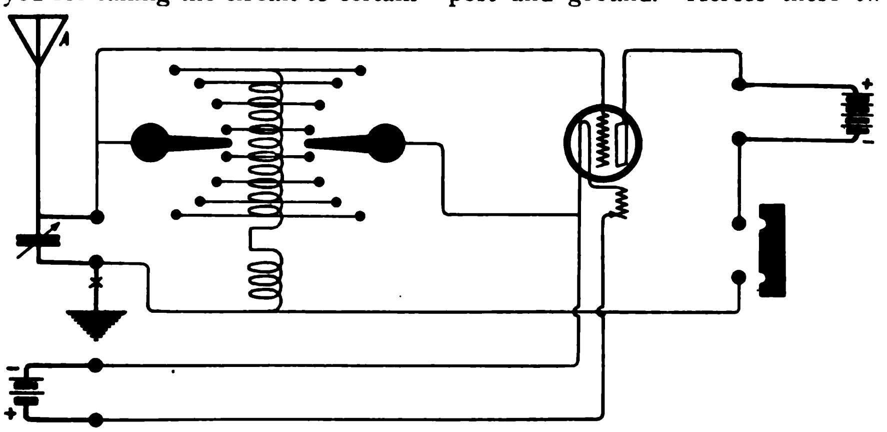


Figure 2—Elementary diagram of connections

wavelengths and also providing autocoupling has fifteen taps taken off as follows: 5,5,5,5, 10,10,10,10,10,10,10, 10,10,10,10. These are brought to two sets of contact points on either side of the panel as shown in figure 1 and more clearly shown in the elementary diagram of connections figure 2. The left hand switch with its contacts is termed the wavelength or tuning switch, and that on the right the coupling switch proper.

The inductance unit terminal tuning with its coupling switch is mounted behind the panel as shown in figure 3. This permits the coupling coil to be placed in the end, off which tap number 1 has been taken, and at the same time allow for a suitable shaft with hard rubber handle to protrude from behind the panel to control the degree of coupling.

The coupling unit has but ten turns of the same Litzendraht cable mentioned above and serves as an inductive feed back in conjunction with the coupling switch which permits greater coupling than that of the inductance unit. However, it will be found that they are both necessary for the correct functioning of the circuits, and that there is a critical position for both at each change of wavelength.

The connections of these inductance units are evidently clear from the two drawings. The switch of the tuning side goes to the grid of the audion and thence to the antenna binding post. The switch blade of the coupling switch goes directly to the filament (negative side), the two connections terminating at the "A" battery binding posts on the lower left hand side of the panel. The coupling coil is connected to the *first* tap of the tuning inductance, the other end going to the "B" battery supply through the telephone binding posts and finally to the plate of the audion. This end of the inductance unit which goes to the plate is connected to the binding post just under the antenna post on the lower left hand side of the panel and the telephone transmitter or carbon transmitter is connected in series with this post and ground. Across these two

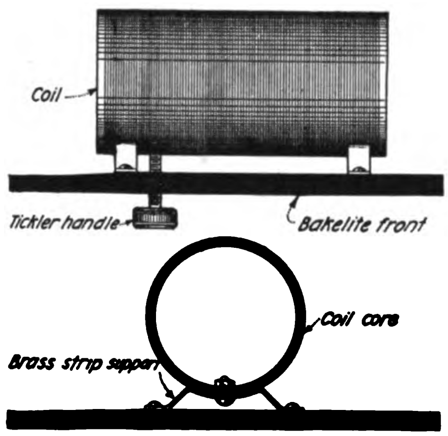


Figure 3—Side and end view of the coupling coil

posts (A and G) a variable condenser can be connected. However, it has not been found absolutely necessary when the receiving operator has a selective receiving set.

If a variable condenser is employed, it should be of the .001 mfd. maximum type, especially the type sold by the DeForest Company with calibrated curves for capacitance values per degree of the condenser scale.

Socket

The regular bayonet socket is employed to support the vacuum tube and as stated, this can be procured for $1.50. Sears & Roebuck have them for $1.40—the panel mounting type employed in this set.

Rheostat

The rheostat employed for control of the filament current is of the panel mounting type sold by Sears & Roebuck at a cost of $1.60. This fits very well onto the back of the panel, bushings, etc., being furnished with each unit. As shown, it is mounted at the lower center portion of the panel and permits the variance of the resistance and hence the current entering the filament. This is accomplished by a handle protruding from behind the panel on a shaft connected to the sliding arm of the rheostat. The resistance has a maximum value of 10 ohms which is very suitable for the purpose, permitting a minimum of .4 ampere with a 4-volt battery and .6 ampere with a 6-volt battery, with all the resistance in the circuit. Since the filament draws from .9 to 1.3 amperes it can be realized that a very good portion of the unit will be in use at all times.

Binding Posts

There are eight of these on the panel, two for the antenna and ground, two for the A battery supply (on the lower left hand side of the panel), two for the B high voltage supply and the remaining two for the telephone receivers—these are on the right hand side of the panel.

The telephone binding posts are placed on the panel, so that it is possible to make use of the circuit in laboratory work when it is not desired to employ the set as a radio-telephone transmitter. When it is employed as the telephone transmitter, the small brass strip shown in figure 4 is employed to short circuit the two binding posts provided for the telephone receivers. A condenser of .001 mfd. maximum capacity can be shunted across the antenna ground binding posts. This will give greater selectivity of wavelengths and permit you to vary the wavelength accordingly, to attract the attention of the operator listening in.

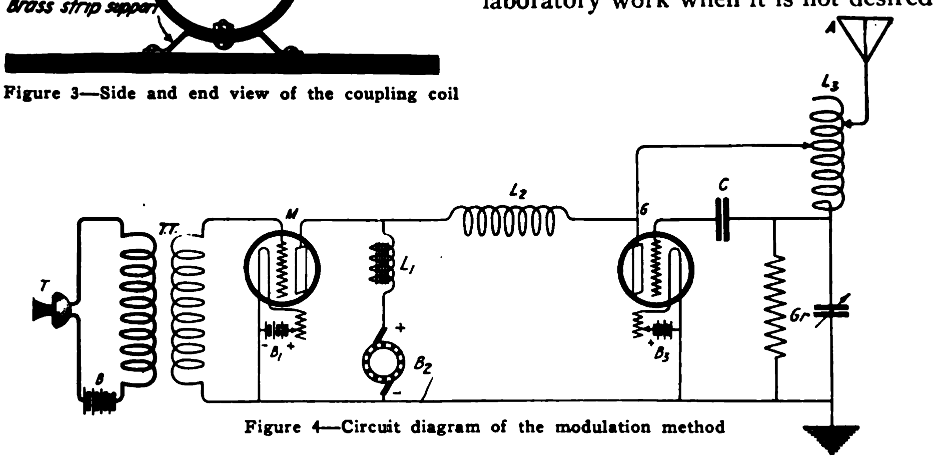
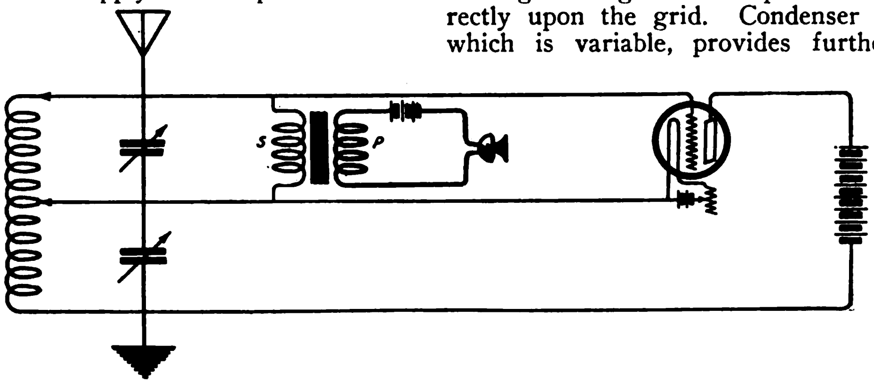


Figure 4—Circuit diagram of the modulation method

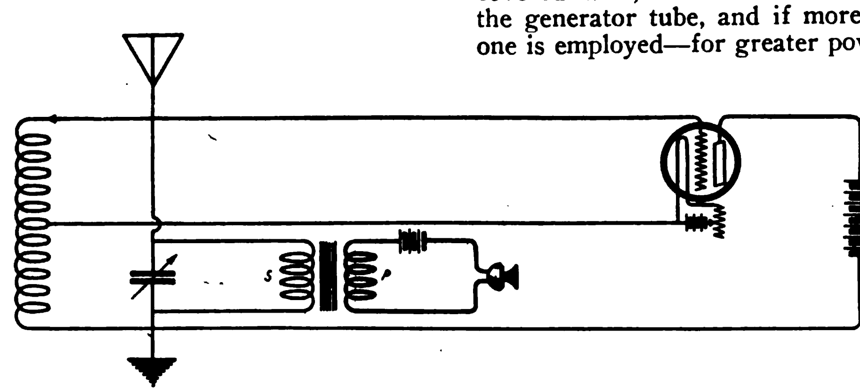
Better Method of Modulation

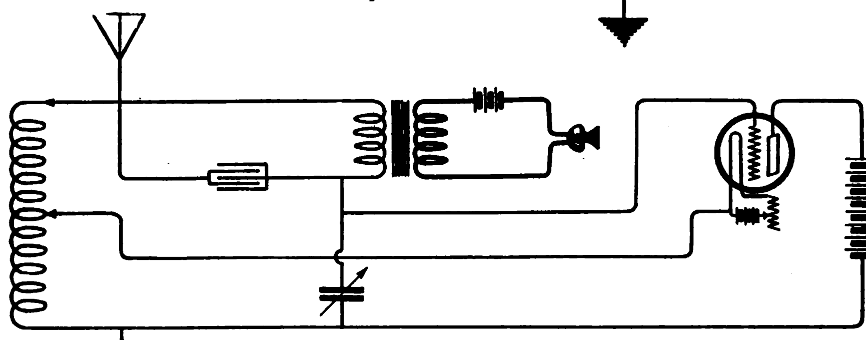
One of the best methods employed for modulating the telephone current is shown in figure 4. Here one tube is employed as an oscillator and the other as a modulator. The 500-volt motor generator or "B" battery supply of any desired voltage shown at B-2 in the drawing forms the supply of direct current energy and is connected in series with the choke coil L-1 of large inductance—2 henries—so that the direct current supplied by the d.c. supply to the plates of the



tubes is kept constant even if the resistance of the external circuit is varied at audion frequency. The direct current from B-2 divides between the two tubes in inverse proportion to their respective internal d.c. plate resistance.

The tube (M) modulator, has its grid circuit connected to the secondary of an ordinary telephone transformer, the primary of which is connected in series with a telephone





Additional circuits for modulation experiments

transmitter and batteries. By talking into the transmitter the direct current flowing from the battery B-1 is varied and a varying potential is induced between the grid and filament of tube M. This, in turn, alters the internal plate resistance of this tube, and therefore, the distribution of the total constant current supplied by the generator B-2 to the two tubes M and G. The tube G is connected for oscillation generation and is the generator. This is coupled to the antenna oscillatory circuit, direct coupling being employed. The grid and plate circuits of the generating tube, G, are coupled for the generation of oscillation through the inductance L-3, grid coupling condenser C and the aerial to ground condenser capacity which forms the plate coupling condenser. The functions of the grid stopping condenser C and the grid leak Gr and the plate coupling switch P and wavelength adjusting switch WL are explained in what follows:

Switch P is varied until the bulb is generating. This provides coupling between the grid and plate of the generating tube. Condenser C keeps the circuit open and does not permit the high voltage to be impressed directly upon the grid. Condenser C which is variable, provides further coupling between the grid and plate and also affects the wavelength.

After the tube is generating, the antenna contact is varied until a point is found which permits maximum radiation of the energy being generated by tube G. This will be noticeable if a small battery flashlight lamp is connected in series with the antenna and ground lead. However, it should not be permitted to remain in the circuit, due to the internal resistance of the filament. The tubes employed throughout should be Marconi class two.

Description of the Parts and Where They Can Be Purchased

No photograph is possible as the apparatus is of the unassembled type, scattered all over the table. However, it is believed that since even better results were had with this circuit, mention of it is worth the time.

Beginning from left and reading across the diagram, figure 4, towards the right, T is the telephone transmitter which should be of good design, General Electric preferred. B, dry cells from one to four; TT, telephone transformer from any electric supply house. The primary goes to the transmitter and batteries and the secondary to grid and filament of modulator tube. M is the modulator tube. B-1 is the storage battery, 4-volt for lighting filament tube M. L-1 is the inductance of large value, about 2 henries, and can be purchased from the General Electric Co., or can be made by winding 16,000 turns number 40 enameled wire on an iron-laminated core 2" long by ½" in diameter. B-2 is the high voltage generator or B battery supply. L-2 is five turns of number 14 rubber covered wire, 3" in diameter. G is the generator tube, and if more than one is employed—for greater power—they should all be connected in parallel, that is, all the grids to one terminal, etc., the filaments all in parallel, with separate resistance units to vary the current in each. B-3 is a 4, 6, or 12 volt storage battery to light filament. Gr is the grid resistance of 2 megohms. This can be bought from the Marconi Co. for $1.00. C is the condenser which should be of small dimensions if one tube is employed. Take two plates copper 4" x 4" square and separate them ½" giving an air dielectric. The variable condenser C-1 is best made up of several small fixed condensers of .0009 mfd. values and switched in at will until best radiation is had. However, for amateur work, this can be accomplished by using a condenser of .005 mfd. value immersed in castor oil, for best results. L-3 is the inductance for tuning the circuits. It should be made in the form of a helix with copper ribbon 20 turns 6 inches diameter, held by bakelite posts. The turns should be spaced ¼ inch apart.

In order to put the amateur on the right track, let me offer some of the reasons why medium or large power radio telephone sets are out of the question for amateurs at the present time.

Having followed very closely the work performed by the many scientists in this particularly interesting branch of the art, I can convincingly prove that, at the present time, there is very little hope for amateur medium or long distance radio telephone sets. Of course, this is not in reference to the foregoing set, which worked satisfactorily over two miles, and what is meant by medium distances in the above is between 10 and 50 miles.

The cost of a complete radiophone set for reliable operation over say, 10, 15, or 25 miles, is beyond the average amateur's pocketbook. The many problems involved at the present time in this installation, demand the attention of experts to maintain the apparatus in a reliable and efficient state of operation.

The radiated modulated energy is considerably smaller than that which could be effectively employed for radiotelegraphy, therefore, the latter is by far the most efficient and economical and the problems of speech distortion, etc., are eliminated. These detrimental effects being minimized only by the constant watch of expert attendants.

The short life of vacuum tubes, due to the ionic bombardment of the filament is another great drawback. The majority of amateurs are not in a position financially to meet expenses of such proportions. For low power sets, as would be employed in amateur communication, the control or modulation of the radiated energy is accomplished by the insertion of the transmitter directly in the antenna-ground circuit. While simple and void of extra apparatus, it is a very poor method, since the microphone resistance for most efficient operation must be equal to that of the remainder of the radiating system. This was proven by actual tests and accounts for the decrease in effective range of a given transmitter, with reference to telephone work as compared to that of telegraphy.

It has been authoritatively stated that radio-telephony requires from 4 to 10 times the input for a given range as is required for telegraphy by the same generating system.

The disadvantage encountered in the arc, spark, direct current and alternating current systems make the vacuum tube most desired for such work, and the cost of the latter for constant work with its short life and expensive initial cost practically bars the amateur from the present medium of the long distance radio telephone field. The poor efficiency experienced in the use of granular carbon transmitters for modulation of the radiated energy (for considerable power) due to the "frying" or "packing" of the granular carbon, makes them very inefficient for this purpose when employed in this manner.

The plate voltage supply (500 volts) will be another necessity to meet in the average amateur residential district. This can, however, be supplied from numerous small Everready batteries, which last but a very short while. The price of the quantity for so short a life is absolutely exorbitant. There is a small motor generator giving 500 volts DC which is fairly costly. There is a method of reproducing a constant source of high potential from an alternating current supply which require more vacuum tubes in the circuit and therefore, is considerable more expensive and out of the question when we have reference to the strictly amateur installation. While at the present writing it is possible to commercially modulate or control very large radiated power, this cannot be said to have any bearing on the amateur situation, as here, too, the question of expense is involved and not very easily overcome. As a whole, it might be stated that medium or long distance radiotelephony is at the present time far from the reach of the average amateur. It will be of much more benefit to the amateurs at large to employ the tube as a radio telegraphy transmitter if it is desired to employ the vacuum tube for communication. The highly desired tuning qualities will more than offset the cost of the outlay in respect to the advancement of amateur operation without the usual noticeable and disagreeable interference problems.

Vacuum tube transmitters which at the present time permit the full output energy to be radiated are highly desirable and should be employed by every amateur, but unfortunately, radio-telephony over favorable distances has not at the present writing reached the stage where it can be successfully and economically employed for amateur communications.

Therefore, from the set outlined which has a range of from one to two miles without any preposterous exaggerations, it is well to become acquainted and see if there is not some little improvement which you might bring about for the advancement of the amateurs telephone communicating system. It is only in this way that we are going to get anywhere with radio telephones operated by and for the amateur.

I remember well when wireless was new to me and numerous others, back in 1907, that it was only possible to transmit about one or two miles and it was a wonderful sensation. The fault with us today is that we expect too much at first. In comparison to the distances covered by wireless telegraphy, it is, of course, discouraging today to find ourselves limited to but one to five miles with wireless telephony. However, this is the truth and we might as well face it with our minds set on one ending, that is, communication over favorable distances with a small amateur outfit.

A few additional circuits follow for those desirous of making various experiments along modulation.

An Indoor Receiver for the Winter

By Edward Thomas Jones, A. M. I. R. E.

FIRST PRIZE, $10.00.

IN the following I will describe the construction of a receiver which has proven highly efficient in operation and selectivity of adjustments. The receiver is shown in the photograph. I have used it for the last two years indoors during the winter time and have carried on many experiments with it in connection with loop antennae. To say that it comes in handy is putting it mildly, for one cannot begin to appreciate a tuner and complete receiver so constructed until it has been in service for at least one winter.

Most amateurs and experimenters have their radio apparatus in the back

View of the receiver assembled

shed, or some room especially constructed for that purpose. Many have no heating arrangements and are forced to remain away from the set a part of the winter and stick close to the old grate fire. With a tuner of this kind you will have a real winter companion and you can take it anywhere.

The dimensions furnished are the exact sizes of the parts which make up the receiver shown in the photograph. It is an easy matter to build such a cabinet with the exact dimensions before you.

A description of the receiver and the

position of the various switching parts will be of value before considering the constructional details, for from it the constructor will grasp an idea of what he is to prepare for and what can be expected from the receiver when completed. Looking at the photograph, in the upper left-hand corner is shown the protective device—a needle spark gap for high voltage surges which might traverse the antenna-ground circuit at any time. Just below this is the 6-point loading coil switch, and further tector and it is made fast to the receiver in this manner, when the receiver is being transported. In the lower left hand corner are four binding posts. The two top ones are for the telephone receivers, the two lower ones for the crystal detector. Also in the lower right hand corner are four binding posts, the two top ones for a variable condenser across the secondary windings, and the two lower ones for the vacuum tube detector. On the back of the tuner, left hand side, can The bottom, with the exception of the smaller piece extending, measures the same as the top. The bottom is cut to 5½ inches wide by 17½ inches in length. Beginning from the left side, when the 11-inch point is reached the board is cut on each side to a depth of 1½ inches, leaving a piece 2½ inches wide by 6½ inches in length protruding from the 11 x 5½-inch piece.

The end piece is shown at 3c. It measures 2½ inches wide by 3½

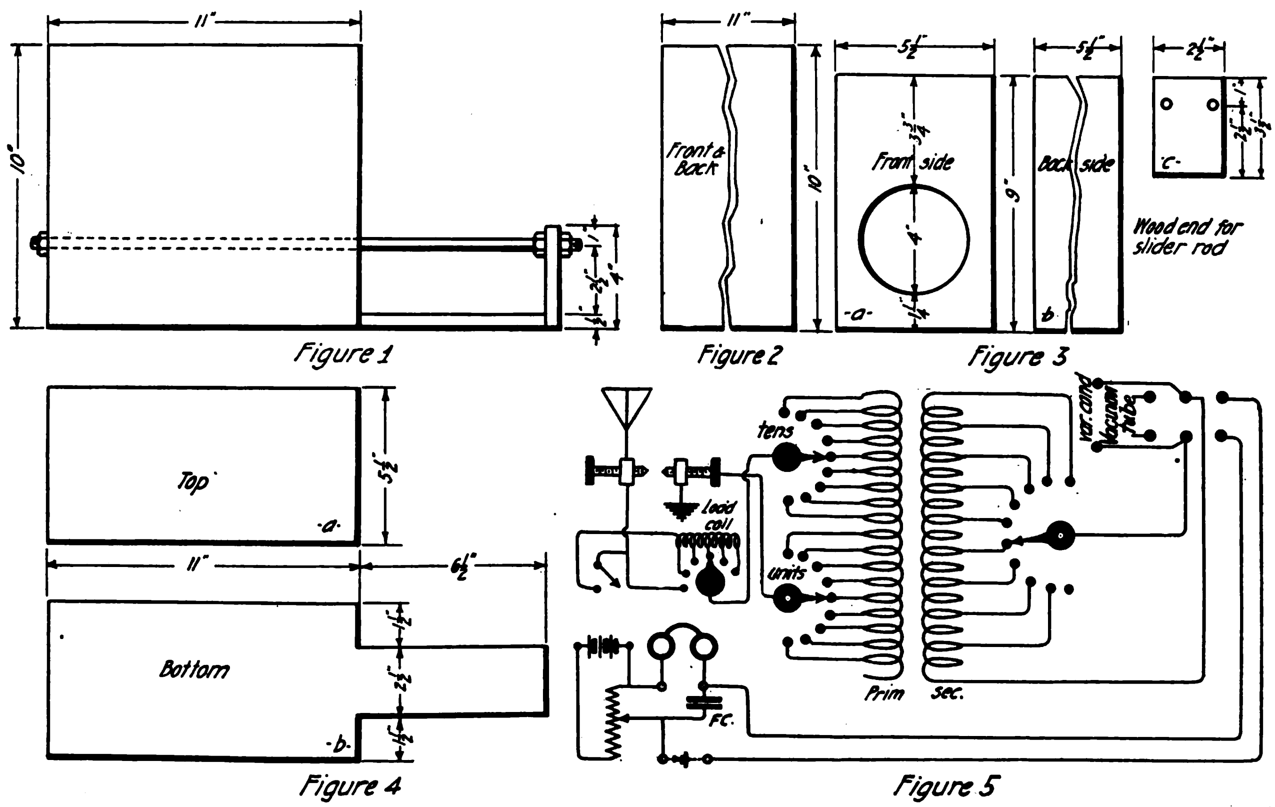


Figure 1 Figure 2 Figure 3 Figure 4 Figure 5

Constructional details and hook-up

toward the left of this switch is a small one-point rotary switch. This switch cuts out the entire loading coil windings when working on short wavelengths; that is, up to 2,400 meters. At the top center is shown the primary tens switch. The switch in the drawing differs from the one shown in the photograph simply because the switch actually employed by me and shown in the photo, was already mounted on a hard rubber base. Instead of remounting the switch I cut a hole in the front panel of the receiver and permitted the switch knob to protrude through so as to allow for adjustment of the inductance. In the drawings an ordinary switch is substituted. Just below this switch is the 11-point primary units switch. In the upper right hand corner can be seen the double-pole double-throw switch. This switch changes the secondary of the receiving transformer over from crystal to vacuum tube. The small post shown under the switch is employed for carrying the detector. A small hole is drilled in the base of the silicon de-

be seen the potentiometer, and just above it two binding posts for the dry cells.

The cabinet can be made of oak, mahogany, or any kind of hardwood which will not warp and which can be worked easily without the fear of breaking the parts before completion. The cabinet shown in the photo is made from mahogany. The front and back panel measure 10 inches high by 11 inches wide. All wood used in the making of this cabinet measures ½ inch in thickness. The front panel is hinged. The side towards the right, in the photo, also shown at a in figure 3, measures the same as b; that is, 9 inches in height by 5½ inches wide. However, there is a 4-inch hole cut to permit the primary cardboard tube to fit into it and in that manner permit the secondary to pass into the primary windings, which are enclosed in the cabinet. Piece b can be identified in the photo by referring to the piece the potentiometer is made fast to.

The top shown at 4a measures 11 inches in length by 5½ inches wide.

inches in height. Two holes are bored as shown to permit the rods to pass through and be made fast thereto. The other end of these rods are made fast at 3b.

The primary is composed of a cardboard tube of 4-inch diameter, 6 inches long, wound with No. 22 single cotton covered magnet wire. There are 10 units taken off and 10 tens, making a total of 110 turns of wire on the tube. The winding is started ½ inch from the end and this ½-inch portion is forced into the end of wood-piece 3a and made fast with carpenters' glue. The taps are brought to the contact points of the rotary switches and all leads are enclosed in the cabinet.

The secondary cardboard tube measures 5 inches in length by 3½ inches in diameter. It is wound with No. 28 single cotton covered wire and tapped in seven places. The points are indicated as follows: ¼, ¼, ½, ½, ½, 1 and 1 inch; making a total of 4 inches of winding. The taps are brought out inside the tube in the usual manner and then soldered to the con tact points mounted on the wooden piece which fits in the end. Two wooden pieces are cut round to fit in each end of the secondary tube. They measure 3 inches in diameter by ½ inch thick. These measurements hold good when the thickness of the cardboard tube is ¼ inch. If the tube you have selected is thicker or thinner, merely alter the size accordingly. Two holes are bored in each of these pieces measuring the same distance apart as the holes in piece 3c. This permits the brass rods to pass through and likewise permits the secondary to slide with ease up and down the rods—in and out of the primary coil.

The brass rods are 10/24 stock and measure 18 inches in length, threaded to a length of one inch at both ends.

The loading coil measures 4 inches in diameter by 6 inches long. It is wound with one layer of No. 24 single cotton covered wire. Five inches of winding with five taps taken off every inch. This coil fits in the upper left hand corner of the cabinet, just above the primary.

The particular potentiometer employed on this receiver was formerly employed on an English Marconi tuner. It was recovered from the remains of a burned commercial radio station and proved of extreme value in connection with crystal detector operation. It is very doubtful whether the amateur can obtain a similar instrument on the market. However, he can purchase one which will serve the purpose. A potentiometer is indispensable when employing crystal detectors, with the exception of galena, cerusite and radiocite.

By referring to figure 5 the complete circuit is obtained and it is an easy matter to trace it out. It is of special interest to note that this tuner has been designed for operation with crystal and vacuum tube detectors. A variable condenser can be shunted across the secondary and by tapping off the two top contacts of the double-pole double-throw switch one can obtain the detector potentiometer-phone circuit to be connected to another tuner or receiving device. Taking everything into consideration I am sure this is an ideal rceiver which will more than satisfy the constructor. In fact, it can be used as the main receiving element during the summer months, for if the standard methods of construction and operation are employed throughout it can be used as an all-around receiver. For loop operation the loop can be connected to the two-top posts of the D.P.D.T. switch or it might be cut in series with the secondary when it is on the vacuum tube position. This receiver affords methods of connections not possible with ordinary types.

A Crystal Receiver for Beginners

By H. E. Ernstrom and T. J. Murphy

SECOND PRIZE, $5.00.

MUCH has already been written concerning crystal detectors in this magazine. As we have had the pleasure of being "hams," we will jointly describe a panel set which gives very good results.

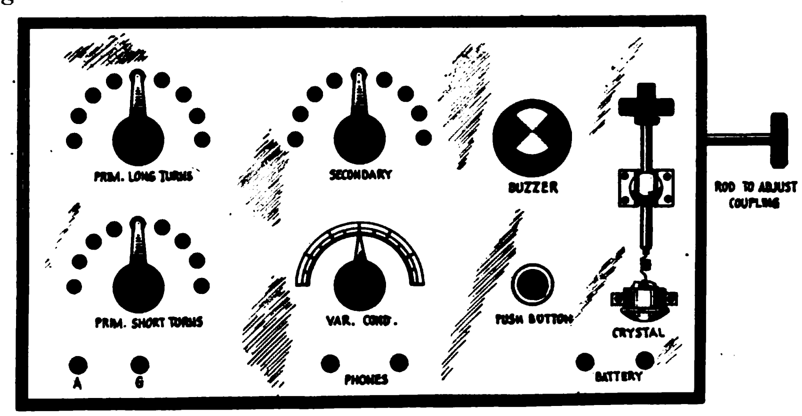


Figure 1—Panel arrangement of the crystal receiver

The cabinet should be made of well seasoned spruce or white pine to prevent the wood from shrinking when it becomes dry. You can obtain this wood from almost any lumber yard, cut to any size, planed and ready to be assembled, for a reasonable price. It will save time and trouble, because the average fellow starting in hasn't the tools necessary to do this work. Having obtained the pieces necessary for the cabinet, put them together, using wood screws instead of nails. Get a fine piece of sand paper and rub the wood until it becomes smooth, wipe the dust off and give the cabinet a coat of stain and before applying the second coat rub the surfaces very lightly with fine sand paper. We prefer dark mahogany stain with two coats of varnish. If care is exercised in painting the cabinet it will have a striking appearance. The panel should be made of hard rubber as it is much easier to work with than bakelite, but wood may be used. If stained with ordinary black shoe polish and two coats of varnish, it will resemble rubber.

The size of the cabinet is 8 inches high, 12 inches long and 6 inches wide. The loose coupler is made to tune to 2,500 meters, as most of the beginners wish to copy Arlington time signals and press. The primary is made from a cardboard tube 4 inches in diameter and 6 inches long, wound with B&S No. 24 D.C.C. Taps should be taken for the first 12 turns, then every 15 turns making 15 single taps, and 15 taps with 15 turns of wire to each, making a total of 240 turns. The secondary is made from a cardboard tube 3½ inches in diameter and 6 inches long, wound with B&S No. 26 D.C.C. Taps taken every 15 turns making 15 taps, and total turns of 225. It is advisable to give the coils a light coat of shellac to keep the wires from falling apart.

Holes are drilled in the panel for the contact points, which should be marked with a compass to insure even spaces between the points. The taps should be soldered to the contact points, using hydrochloric acid in which zinc has been dissolved; or use plain grease for

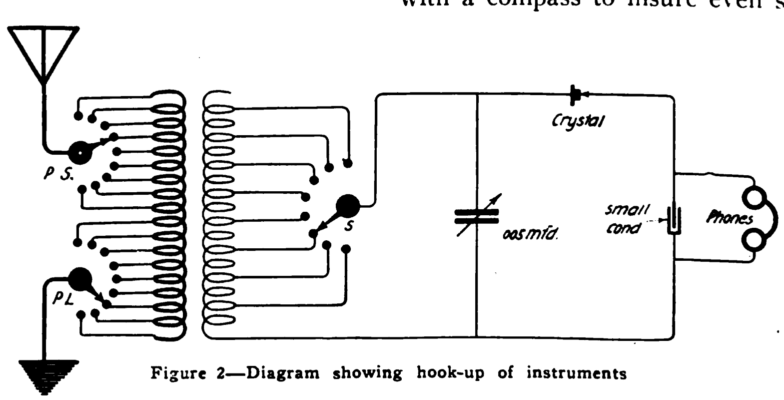


Figure 2—Diagram showing hook-up of instruments

flux. The acid will not eat up the wires and a very neat soldering job can be done.

A detector, same style as used by the U. S. signal corps, is mounted on the face of the panel in such a position that the operator's hand does not knock the crystal out of adjustment while tuning. The varying of the coupling between the primary and secondary is by means of a brass rod which extends through a bushing on the right side of the panel. A high frequency buzzer, such as the "Century," is used to adjust the crystal and is mounted with a push button on the right side of the panel. Two binding posts are mounted directly underneath the push button for the battery. A variable condenser of the 43-plate type is mounted on the panel and shunted across the secondary to assist in tuning.

The hookup is of the ordinary type—the crystal in series with the head telephones. A galena crystal was used in our set and gave very good results. Also a small fixed condenser shunted across the 'phones will give louder signals.

The beginners should have no difficulty in making this set because it is very simple to construct and it will give very good results on almost any type of aerial. It can be used with advantage until the mystery of the vacuum tube has been mastered. The diagram gives the hook-up and a sketch of the cabinet is included.

Crystal Set for Indoor and Outdoor Aerials

By Chas. Mulligan

THIRD PRIZE, $3.00.

DID you ever try to run your station without having a good, reliable crystal set on hand? If you never did, don't! And if you ever did you will know better than to try it again.

One night I was working with other radio stations and suddenly my bulb began to flicker. At first I thought that the trouble was caused by a loose connection, but I finally found that my storage battery was run down. This put me out of the game for two days while it was being charged. Shortly after, my vacuum tube burned out. This put me out of business until I could buy a new bulb. When it finally was delivered I was ready to start away for the summer and found it impractical to take my vacuum tube set along. I thought I would forget wireless during the time I was swimming, sailing and rowing. But I did not, and in the end I decided that I needed a crystal detector set to fulfill the following requirements: portability, sensitivity, and receptivity on wavelengths from 125 to 800 meters. Here's how I went about it:

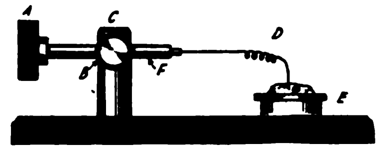


Figure 1

Method of mounting the crystal detector

The inductance was the first thing considered. I purchased a bakelite tube 3⅛ inches in diameter and 2¾ inches long. On this tube I wound about 110 turns of No. 28 D.S.C. wire and took off a tap at every tenth turn, being sure to coat the coil well with shellac to hold it. Next was the detector. This may be any small type but the one showed in figure 1 proved very satisfactory. A small condenser such as is used in the grid circuit of a vacuum tube may be put across the phones and a variable condenser will help if shunted around the inductance. The entire set may be mounted on a

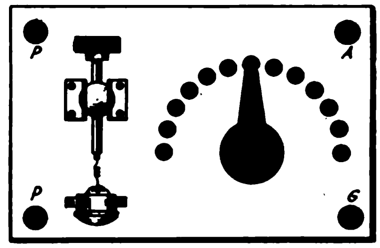
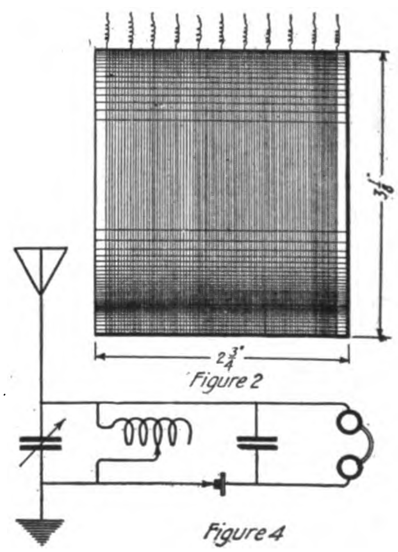


Figure 3—Panel layout

bakelite panel 4¼ inches by 2¾ inches, and supplied with a small nickled switch and nickle trimmings, which makes a very nifty set. Since the variable condenser is optional it is not mounted on the panel.

If it is desired to make the set a little cheaper, a cardboard tube may be substituted for the bakelite and a



Coil dimensions and circuit diagram

wooden panel for the more expensive kind. Brass fittings, enameled wire and smaller knobs may also be used. The results produced with this little set were remarkable.

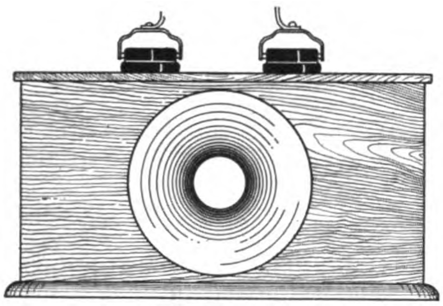
While away on my vacation this year I worked with a portable aerial for inside use, made as follows: No. 18 B&S enameled wire was used. Spreaders were made of light wood. The wires were connected as in the regular flat top aerial and a short lead taken off. Our summer home has a very low roof, so this 18-foot aerial was only 17 feet high. With this aerial I got many stations. Tuning is also very effective in this set.

A Homemade Loud Talker

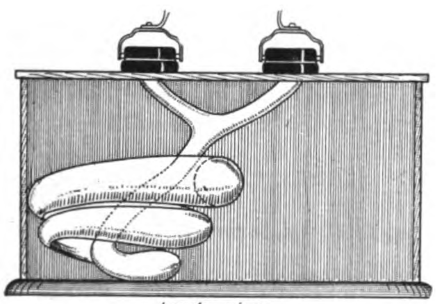
By Warren Wood

A LOUD talker, so that signals may be heard throughout the room, is a wished-for accessory to every radio station, but the high cost prohibits many from having this apparatus. Every amateur can construct at a very small cost, one that will look and work as good as any.

An old automobile horn is first obtained. The kind, used on the first cars consisting of a brass horn with



Front view



Inside view

Perspective of the loud talker

several curves to it is preferred. This was blown by mashing a rubber bulb. One of these can probably be found at some junk shop or old garage. It should be mounted in a cabinet just large enough to hold it and with the front of the horn flush with the front panel of the cabinet. If the balance of the radio set has bakelite or hard rubber panels on the front, this panel should be bakelite, but stained wood gives good results.

At the back of the horn a Y is made of brass the same diameter as the small end of the horn and soldered to it. This is then bent so that it will come to the top of the cabinet near the front and be about four inches between the openings at the end of the Y. When the top of the cabinet is put on holes are cut for the two parts of the Y to stick through. The brass ends are then cut off level with the top of the cabinet. The cabinet should be stained a color to harmonize with the rest of the set. The loud talker is then ready for use. With the ordinary receivers the signals are tuned in as loud as possible and then the headphones are put on top of the loud talker cabinet with the holes in the earcaps of them over the holes in the top of the cabinet. The loud talker should then work fine.

The advantages of this loud talker over bought ones are: Its low cost, extra receivers not being needed; it is unnecessary to tune the set again as is done when receivers of different ohmage are plugged in; no change has to be made in connections; use of two receivers instead of one.

A Short-Wave Regenerative Receiver

By William F. Diehl

THE rabid base-ball fan spends the greater part of each Winter ruminating over the results of the season just closed and speculating on the pennant-winning chances of his favorite team for the coming Spring. The radio enthusiast, forced to suspend operations during the static-ridden Summer, whiles away the "dog-days" in dreams of improved apparatus and methods. The past Summer has been marked by much gossip about loop aerials, multi-stage radio frequency amplifiers, elaborate static eliminators, and "trick" receiving circuits. It is strange, then, that the opening of the radio season of 1920-21 should find the amateur content with the usual types of antenna and regenerative receiver.

However, a description of what is probably the only "new" regenerative receiver developed this season may prove interesting. It is a radical departure from standard design and is an extremely compact and efficient instrument, and is priced at a figure within reach of all.

The Grebe Type CR-3A is a regenerative receiver, designed for short-wave reception. It employs continuously variable inductances for tuning the plate and grid circuits and a novel form of coupling coil of fixed value so designed and located as to give a coupling constant automatically varying with the wave-length, thus making sharp tuning possible without the sacrifice of signal strength. The size of the CR-3A is 5x14x5½ inches, which makes it easily the most compact, practical receiver on the market today. It is ideal for experimental work where a portable receiver is desired. Tube-socket, grid condenser and leak have been mounted in the cabinet, and the only additional apparatus needed are the vacuum tube, batteries, and rheostat.

It will be noted from the following descriptions that in spite of its size and

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moderate price, this receiver has been built along standard lines. In figure 1 is shown the front view of the receiver. All the knobs are of the latest type, insuring easy adjustment and accurate control. The knob to the left controls the grid variometer, the one to the right controls the plate variometer. In the upper center of the panel is mounted a vacuum tube socket which will accommodate any standard tube. Directly below the tube

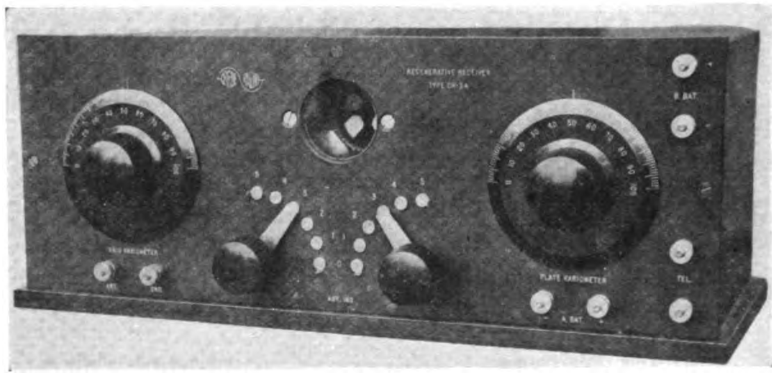

Figure 1—Front view of the cabinet

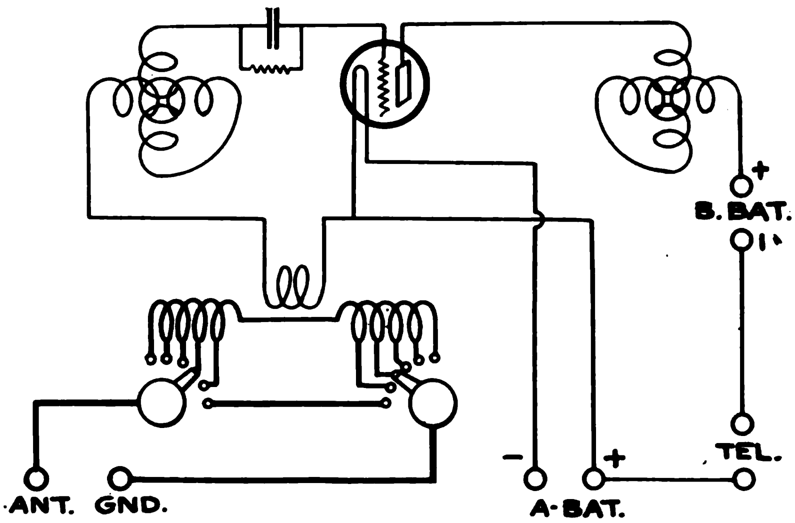

Figure 2—Circuit diagram of the short-wave regenerative receiver

Prize Contest Announcement

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

METHOD OF MOUNTING AND SECURING COUPLING BETWEEN COILS OF THE "LATTICE WOUND" VARIETY

Closing date, January 1, 1921.

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

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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

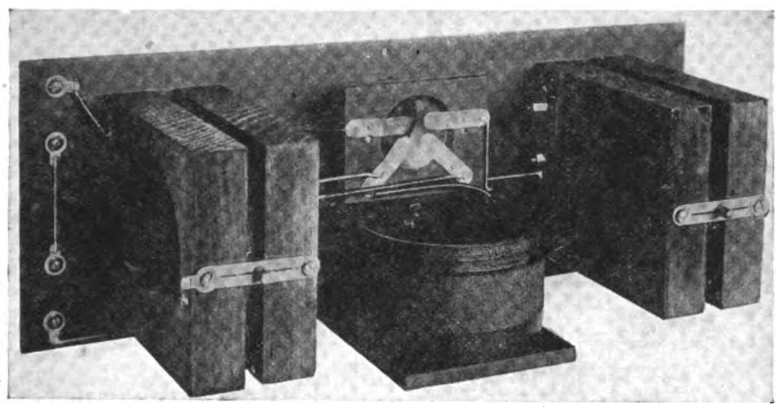

Figure 3—Rear view showing arrangement of instruments

socket are two switches controlling in single and multiple turns the primary coil. There is no adjustable coupling coil in this receiver, energy being transferred from primary to secondary by means of a fixed coil located between the single and multiple turn sections of the primary. The self-inductance of this coil and the mutual inductance between it and the primary coil are such that a highly desirable percentage coupling is obtained. This permits extremely sharp tuning and at the same time allows sufficient energy to be transferred.

In figure 3 is shown the interior of the receiver and the location of the various elements. The central location of the vacuum tube socket makes possible the use of extremely short leads to the variometers. The variometer stator forms are made rectangular so as to guard against the serious capacity effects which would result with the use of a grid circuit with practically no capacity, except that of the tube and socket itself.

The entire assembly is mounted on a bakelite dilecto panel which is screwed to a mahogany-finished cabinet of birch. The general appearance of the receiver is excellent and its first tests have shown it to be a thoroughly reliable receiver on the wave-length range for which it is designed —150 to 375 meters.

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January Wireless Age

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The Monthly Service Bulletin of the

National Amateur Wireless Association

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

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

TO give wireless amateurs a chance to practice, the New York Naval station and others send out news for boy scouts and other boys every day at slow speed. All that is necessary in order to take advantage of the plan is to form a connection with the nearest scout headquarters which has a wireless receiving station and obtain the weather reports, finals in athletic events and other news. All boy scout headquarters are expected to get their information either by wireless direct or from some other scout radio station.

As there are 175,000 amateur radio stations in the United States it is not difficult even for a single troop to connect with the navy headquarters and to pass information along for the benefit of the public. The sea scout commodore, 200 Fifth avenue, Manhattan, sends free information sheets for wireless amateurs who want copies of the confidential code in which the messages are sent out.

The Community Radio Club of White Plains, N. Y., an organization of local amateur operators, recently held a meeting at the residence of Fred Sipp, No. 107 Westmoreland Avenue. R. W. Emerson Decker was re-elected president, Charles Storey was elected vice-president and Mr. Sipp was elected secretary and treasurer. Short talks on the science of radio, which were enjoyed by the members, were given by Mr. Decker and Mr. Storey.

Meetings will be held weekly hereafter.

The club is desirous of including on its roster all the amateur operators of the city and the surrounding towns, such as Mamaroneck, Harrison, Scarsdale, etc. Anyone desiring to join is requested to communicate with Mr. Decker either by phone or radio. His radio call number is 2UA.

Operators in charge of the radio station at St. Martins college, Lacey, Wash., have been informed by mail from Wichita, Kansas, that wireless signals sent out by the college station on Wednesday evening, September 22, were distinctly read in Kansas City. H. Paul Willis, of Wichita, was the operator who picked up the signals (a distance slightly over 1,500 miles).

The college station has made other

records in transmitting, having reached Phoenix, Ariz., not long ago.

Many improvements and pieces of new apparatus have been added to the college station, greatly increasing its receiving range. European stations are copied direct, under favorable weather conditions, while stations on the Atlantic coast, in Panama, and as far east as Japan and the Philippine Islands are copied at almost any time of the day or night.

Conversations over the wireless telephone system now in use between Los Angeles and Avalon on Catalina Islands are plainly heard any evening. The official call of the operator in Wichita who copied the college signals is 90E and the outfit used at the time consisted of a two step amplifier in connection with a mid-west radio regenerative receiver and Baldwin phones. The message from the Lacey station received by the operator in Kansas was the usual local weather report sent out at 9 o'clock each evening. This local report is broadcasted on 375 meters and is picked up by most of the amateurs on the coast and far inland. Ship radio operators as far north as Prince Rupert have acknowledged receipt of the report.

The interest in radio matters of the Radio Club of Hartford has been maintained throughout the summer season by its members, who have rebuilt and improved their sets, and in some instances perfected regenerative circuits for the reception and amplification of undamped, or "CW" signals. Not a little of the interest is the result of C. D. Tuska's experiments in this line, his station being in operation practically every evening, broadcasting matters of interest pertaining to radio communication, as well as music, and it is not uncommon to hear wireless telephone conversation between this station and that of L. D. Fisk of Bloomfield avenue, and that of J. L. Reinartz in South Manchester, familiarly known as "IKP" Conversations and concerts are clearly heard in Springfield, Meriden and Bristol and probably much further.

Present interest in radio matters assures the club of a most successful year, more so than any of the preceding seven years of its organization.

It has been proposed to establish an engineering department to advise and instruct members in increasing the efficiency of their apparatus, and to continue with the code practice, which was found to be of great assistance to its members in qualifying them for the various grades of government licenses.

With the idea of linking up all amateur radio operators in Georgia in a chain of communication, the Atlanta Radio Club and the Georgia School of Technology has issued a request to all amateur radio operators in Georgia to send their names and a description of their radio sets to E. H. Merritt, at Tech.

Mr. Merritt is one of the chief operators at the Georgia Tech radio station.

Atlanta is the natural center of the Government's fourth radio district, which includes the states of North Carolina, South Carolina, Georgia, Florida and Alabama.

For the purpose of bettering conditions of amateur radio in Morristown, N. J., and to act as a reliable link in a direct line of communication between distant cities, a meeting was held at the home of Merritt E. Gregory on Pine Street, at which the Morris County Radio Club was organized.

Mr. Gregory was elected president; R. M. Lacey, secretary and M. W. Cilso, treasurer.

It is felt that with an efficient organization of this character relay messages can be more promptly handled. It is proposed to have at least one member stand watch at an official station of the club every evening so that stations in other towns may be assured of a good route through this vicinity.

At a meeting of the Ridgewood Radio Club, of Ridgewood, N. J., Robert Muns, of 99 Lincoln Avenue, announced that he would open his station to visitors every Tuesday night from 8 to 11 o'clock. He will also receive visitors on Saturday nights by appointment. This will give an opportunity to any one interest to see a real radiophone station in operation.

One of the best amateur wireless stations to be found in the southwest has been installed at the Missouri Military Academy. Cadets Karshner and Browning have been working on the installation of the outfit since school opened and are now able to do excellent work with it.

Messages sent by ships at sea and by foreign stations have been copied.

(*Continued from page* 16)

inson, C. B. E., Captain J. A. Echaverri, H. Madge, C. B. Edwards, C. B. E., and F. W. Phillips of the General Post Office. Japanese dele-

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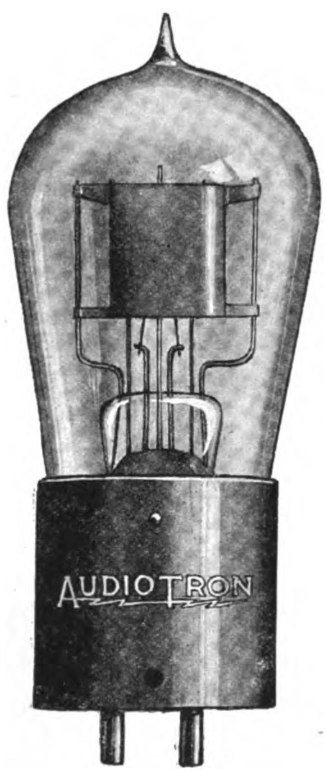

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Queries Answered

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.

I. P., Ray Brook, N. J.

If you decide to study wireless telegraphy with the idea of becoming a professional operator you should go to a regular school, as the results will be better and quicker. The Marconi Institute, 98 Worth Street, New York City, graduates hundreds of operators each year and will correspond with you on this subject.

* * *

P. L., Lansing, Mich.

Same as above.

* * *

B. B. D., Chicago, Ill.

An ordinary regenerative circuit using primary, secondary and tickler coils, will prove easy to handle, and good results can be obtained. The size of honeycomb coils needed depends on the range of wavelengths you desire, and this may be determined from the De Forest catalogue. For short and long wave work diagram No. 3 on page 28 of our October issue gives very good results, considering the fact that only one coil is used.

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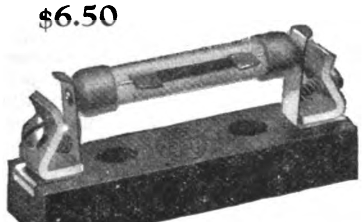
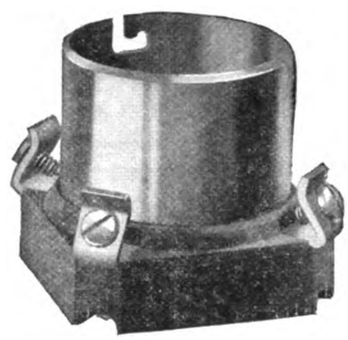


Standard Grid Leak



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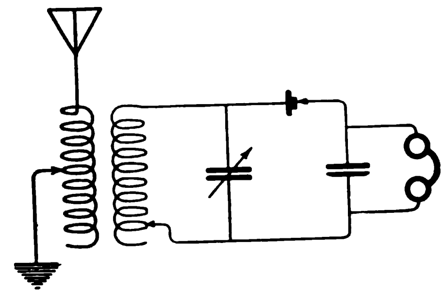
* * *

F. A. K., Elizabeth, N. J.
The diagram you sent in is wrong. Connect as shown. It is possible to hear amateurs and radio phone transmitters if your crystal detector is sensitive.



* * *

R. B., So. Charleston, Ohio.
At the present writing we have no information as to the type of arc or bulb transmitters desired by the Department of Commerce under the new rulings about to become effective. It is impossible to say, therefore, just what is required, but we believe that the questions will be of a general character.

* * *

R. J. O., San Antonio, Texas.
There was something published sometime ago, about a radio printing machine, but we have no data about the details of operation. Would suggest that you file patent papers, for it may be that your type of apparatus and principle of operation are entirely different. Such a device would be of great value.

* * *

E. O. S., Newman, Ill.
"The Wireless Experimenter's Manual," by E. E. Bucher, contains all information regarding vacuum tube operation on A. C. The "Consolidated Radio Call Book," second edition, is the most recent publication covering all radio call letters.

* * *

R. H. S., Santa Barbara, Cal.
The circuit that you speak of in the February issue is audio frequency amplification. For the choke coil try the secondary of a one or two-inch spark coil. Better results can be obtained by using a regular amplifying transformer having primary and secondary connected in the conventional manner.

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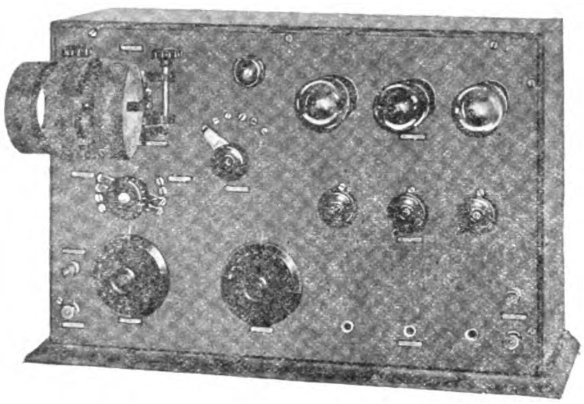

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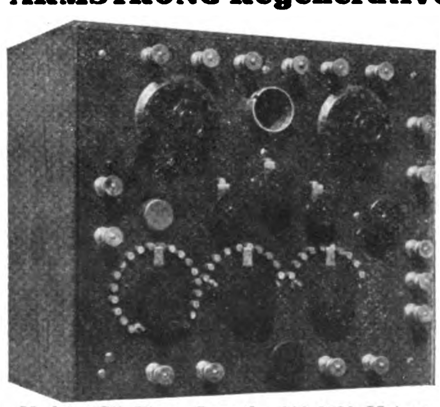

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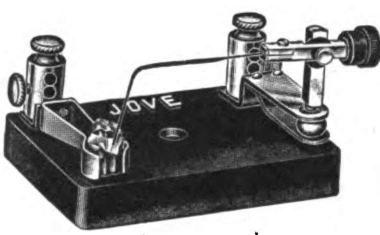

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