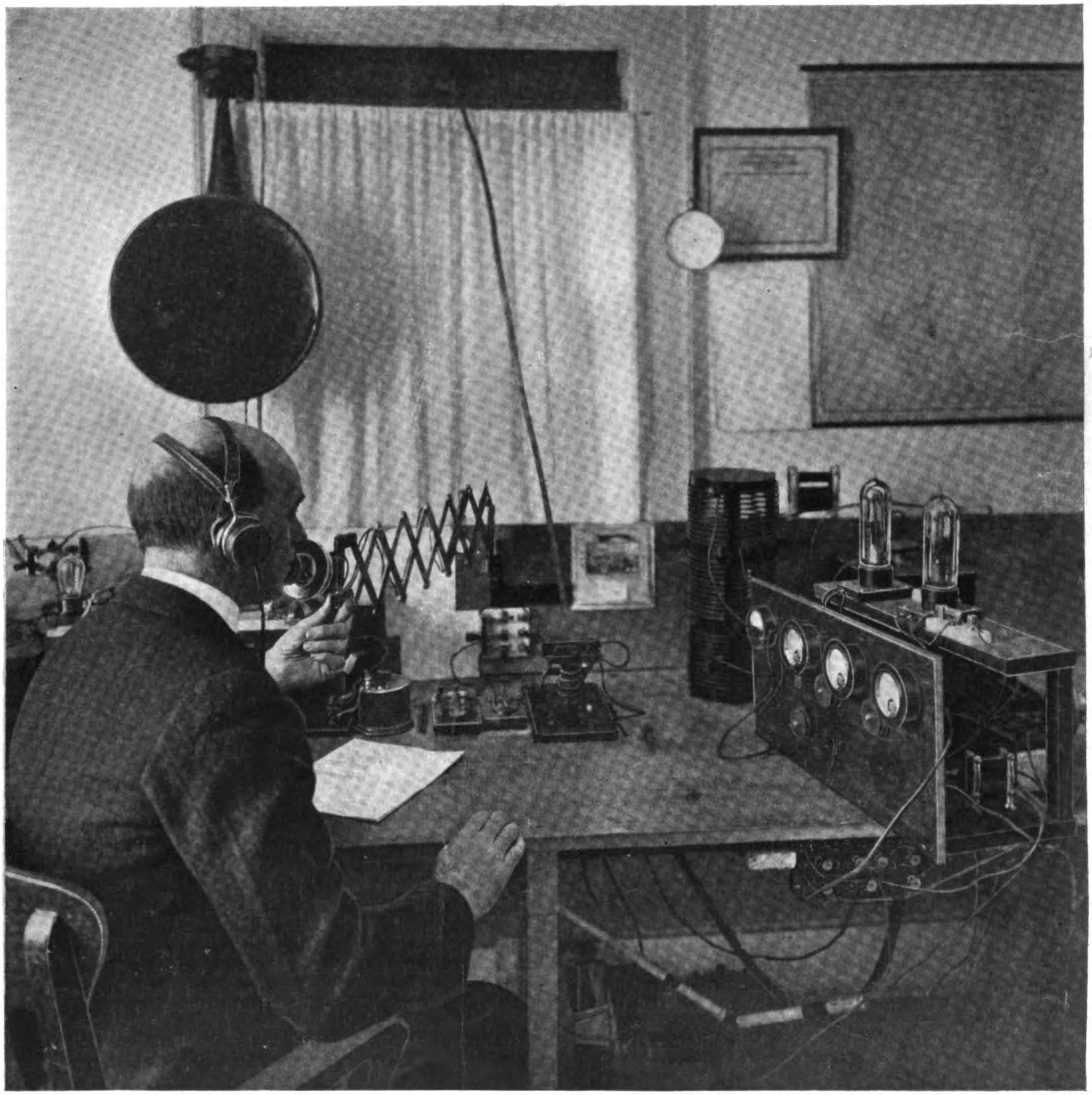
March, 1921 25 Cents

B9

The WIRELESS AGE

Volume 8 Number 6



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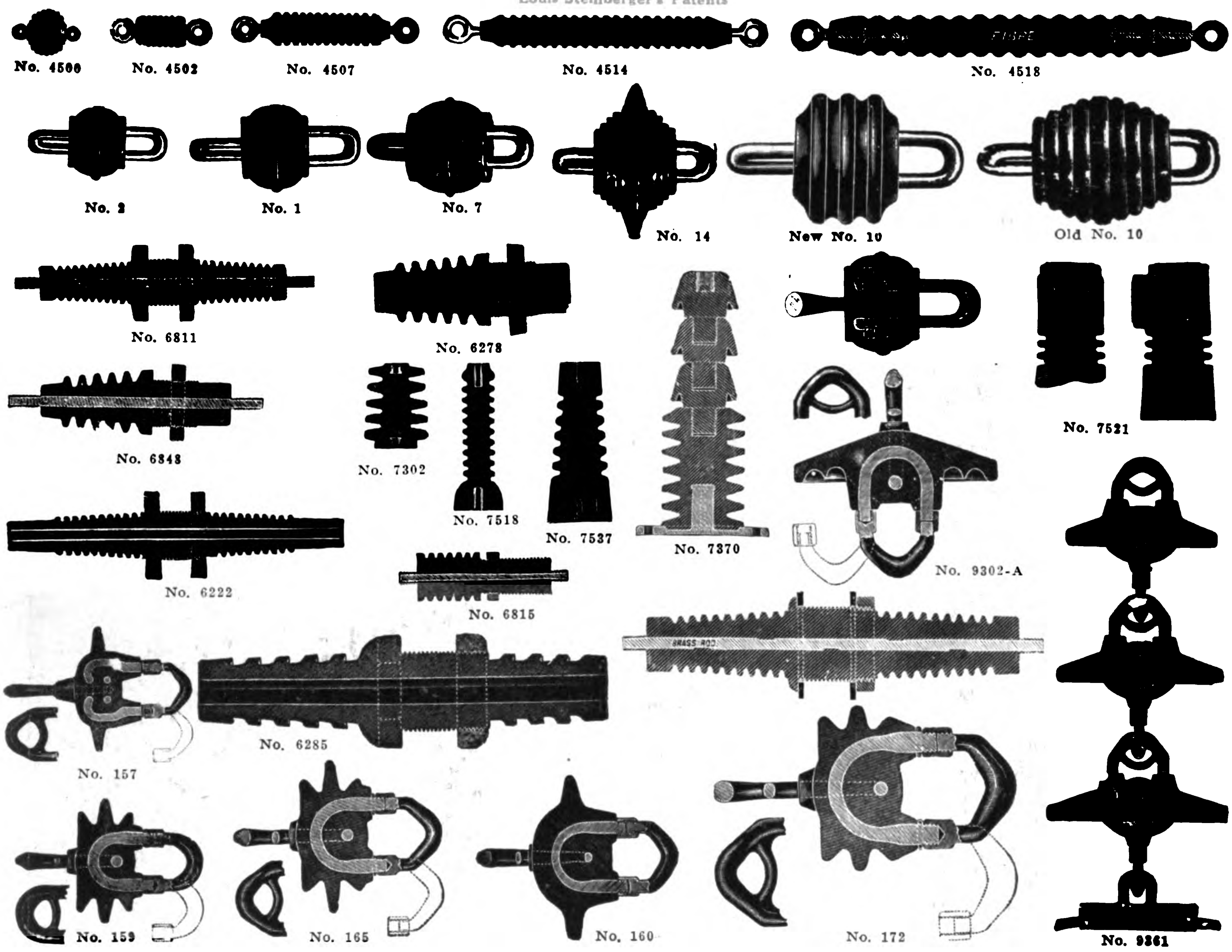

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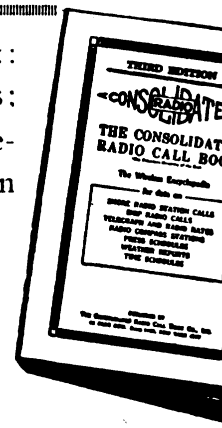

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Edited by J. ANDREW WHITE

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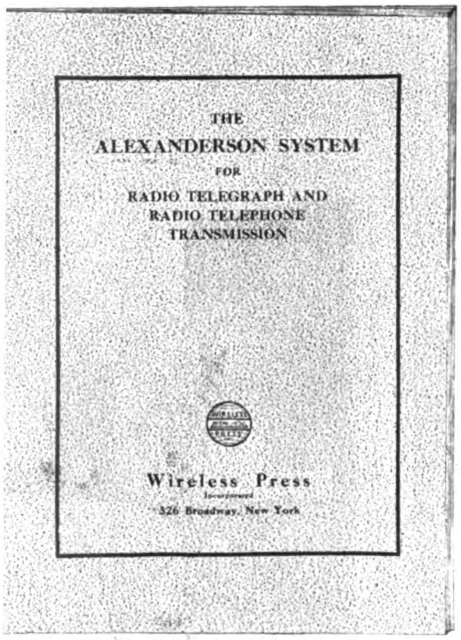

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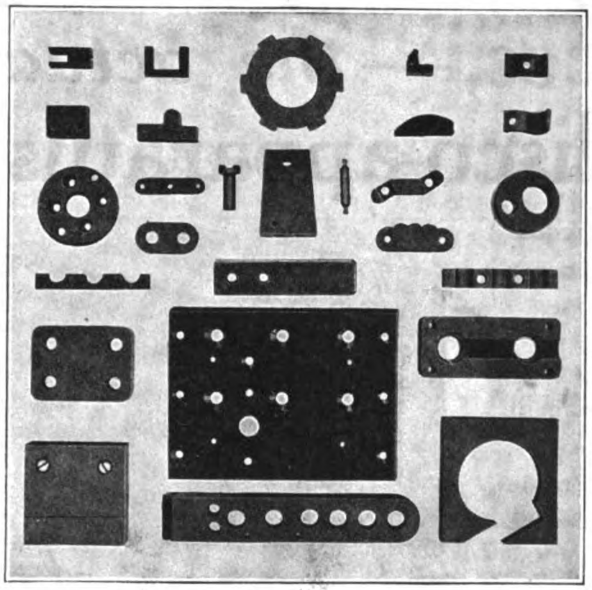

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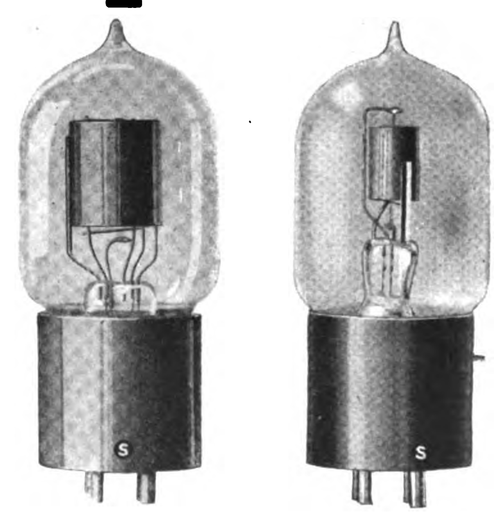

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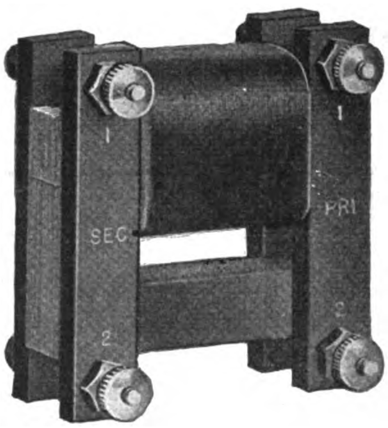

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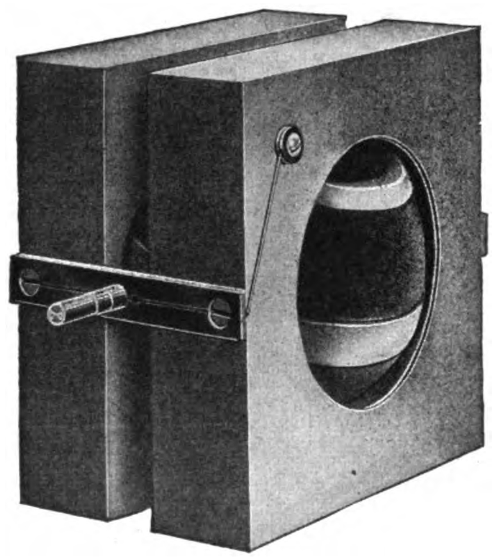

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Vol. 8. No. 6. MARCH, 1921

THE WIRELESS AGE

WORLD WIDE WIRELESS

Wireless Telegraphy at Danzig

ACCORDING to the Danzig press, the Danzig telegraph office has recently installed a wireless press receiving station. These receiving stations, of which there are said to be about 120 in Germany, receive, for transmission to newspapers, press news distributed by wireless by the press service. In addition, the stations receive commercial news of the Bureau of Foreign Commerce in Berlin, intended for chambers of commerce, and also weather reports. News is sent out by the main station in Köningsmusterhausen.

The Danzig telegraph office is now operating four wireless stations: A station for the domestic telegraph service of the German wireless system; a coast station for communicating with vessels; the wireless press receiving station referred to above and a special receiving station maintained by the *Danziger Zeitung*, a local newspaper, for its own messages.

The Polish authorities also possess their own wireless station, situated in the port district at Danzig-Neufahrwasser and used largely for communicating with vessels bringing government supplies. According to the press. the Polish station was specially authorized by the high commissioner and is subject to certain regulations in order to prevent interference with the operations of the Danzig German, and British naval stations. For instance, the Polish station may communicate with Warsaw only between 1 and 3 A. M., and its conversations with vessels at sea must be confined to 10 minutes.

New Wireless Service Between England and France

A NEW public telegraph service between England and France, using high-speed duplex wireless transmission, has recently been installed. It is hoped that this additional means of communication between England and the Continent will afford considerable relief to the present congestion. The service will be conducted by Marconi's Wireless Telegraph Company, Limited, and the Compagnie Generale de Telegraphie sans fil, operating under licenses from the British and French Governments. The current telegraph rates between the two countries will apply.

Telegrams to France intended for transmission by this new service may be handed in at all times at the Marconi Company's London offices, Fenchurch Street and Marconi House, Strand. They will also be accepted at any Postal Telegraph office within the United Kingdom. Messages so tendered, however, must be marked "Via Marconi."

For this service the latest high-speed automatic apparatus, as used so successfully between Geneva and London during the sitting of the Assembly of the League of Nations, is employed.

The following Marconigrams were exchanged between King George of England and President Millerand of the French Republic on the occasion of the opening of the service.

The message from the French President was as follows:

To His Majesty George V.,
King of the United Kingdom of Great Britain and Ireland,
London.

The wireless service which this message inaugurates will still further facilitate the exchange of ideas and promote commercial relations between our two countries. I am desirous that the first message dispatched from France should bear to Your Majesty the expression of the wish that the intimate ties formed between the British and the French people during the war shall not cease to become more and more close and that they may be strengthened during a long and fruitful peace. I am happy on this occasion to offer to Your Majesty the renewed assurances of my faithful friendship. I beg you to convey to Her Majesty the Queen my respectful homage.

ALEXANDRE MILLERAND.

Central building of the Lafayette Station at Croix d'Huis, France

The following reply was sent by King George:
By Wireless (Urgent).

To the President of the French Republic, Paris.

I have received with great interest and pleasure. M. le President, your telegram inaugurating today a regular wireless telegraph service between our two countries. I share your conviction that the new service cannot fail to strengthen still further if possible the ties which bind us together in friendship and intimacy and to increase the prosperity of both countries by furthering their commercial and intellectual intercourse. On behalf of the Queen and myself I heartily thank you for your friendly greetings and ask you and Madame Millerand to accept our cordial salutations.

GEORGE, R. I.

Newfoundland Wireless Plants for Ship Reporting

THE Newfoundland Government has now under consideration an agreement with the Marconi Wireless Company for the establishing of new stations for commercial and shipping business.

The scheme is somewhat comprehensive and proposes a big new ship news installation at Bay Bulls, twenty miles from St. Johns, with directional stations at St. Johns and at Port Union, fifty miles north, and an increase in the power of the station at Battle Harbor, Labrador, at the eastern entrance of the Belle Isle Strait. This will make possible direct communication between Labrador and Newfoundland through the present wireless station at Fogo Island, on the east coast of Newfoundland. Messages at present must be repeated through Belle Isle.

The big feature of the project is the proposed station at Bay Bulls, which it is thought will represent an outlay of $100,000. It will provide for an installation of the continuous wave type, with a range of 1,500 miles, which will enable unbroken communication with Atlantic liners almost the whole way across the ocean. All the biggest ships now in the trade between the two hemispheres are fitted with this system instead of the spark system formerly used.

A still more ambitious feature of the project, but one which may not see immediate fruition, is that for utilizing the big British Admiralty station at Mount Pearl, seven miles from St. Johns, for the purpose of direct transatlantic communication with some of the Marconi stations on the British coast.

The plan would be to maintain a vigorous transatlantic commercial business in competition with the cables which carry most of the telegraphic traffic at the present time. It is proposed to handle business at a rate of 18 cents a word, as compared with 25 cents charged by the cable companies at present, and to have the same rate operative in regard to all messages sent or received between ship and shore.

It is believed that as a result of this it will become possible to make this the first link in the big world encircling project which the Marconi Company has been planning for the past year or two, and respecting which proposals have been made to the British Government and the governments of the various oversea dominions.

In other words it is proposed to make it an auxiliary to the "all-red" cable system now in effect throughout the British Empire and which has proved so satisfactory that it is planned to extend its operations very considerably. Some aspects of this proposed development will end the cause of most of the friction between the American and British Governments in regard to the problem of a distribution of the cables belonging to Germany which were seized at the outbreak of the war and which the victorious powers are now planning to divide among themselves.

Montana Commercial Club Installs Radio

WIRELESS telephone service connecting several towns and large ranches within a radius of 60 miles of Malta, Mont., is being planned by the Malta commercial club and will very probably be put into effect in the near future.

The wireless telephone circuit is planned to connect Lovejoy, Zortman, Phillips, Landusky, Lonesome and several other inland towns, as well as a number of the larger ranches, within a radius of 60 miles of Malta. It is planned to have the circuit open at certain periods each day with Malta as the central station. All important news, business transactions and emergency calls of every nature will be taken care of. At the present time there is no telephone service between the towns the proposed wireless circuit will include.

Seamen's Medical Advice by Radio

THE Seamen's Church Institute in New York City has established a wireless service of medical advice delivered to coastwise and transatlantic vessels, and will establish a twenty-four-hour telephone service between physicians and ships that don't carry their own doctors.

At present a doctor remains on duty from 9 A. M. to 5 P. M. Eastern standard time, or 2 to 10 P. M. (Greenwich mean time), listening for the call, KDKE, which is wireless for "Help wanted for an individual." This call is to be second only to the SOS of a ship in distress in precedence over other ethereal messages.

Four operators will be required to be on duty in different shifts as sentries awaiting the distress signals, and will also serve as telephone centrals connecting the vessel with the doctor.

Since less than 30 per cent of the oceangoing ships have doctors and all have wireless, and an unknown proportion of coastal vessels have wireless but no doctors, it is expected that this service will be the means of saving many lives.

A course of instruction for ships' officers has been arranged by the Seamen's Institute to teach them how to carry out the doctor's instructions once they have been received. The classes may be extended later, but at present they are half hour demonstration lectures twice a week.

Vessels calling in from as far as 2,000 miles away can expect to get aid once the new instruments are installed.

Eagle Harbor to Have Compass Station

THE new radio compass station to be built by the Navy Department at Eagle Harbor, Mich., is one of the first of a chain to be built by the department as an aid to navigation on the great lakes. It will guard one of the most dangerous spots on the lakes and therefore is one of the first to be established.

For some reason not yet fully understood, although the presence of iron along the coast may have something to do with it, there is a tendency for compasses on boats to vary when the vessels are rounding the tip of Keweenaw Peninsula. For this reason mariners have long mistrusted this spot and are always apprehensive when sailing near it at night or in a fog.

The radio station at Eagle Harbor will be a big help in enabling ships in this vicinity to learn their exact position and to avoid the end of the peninsula in rounding the point.

The Eagle Harbor station is to have two 250-foot steel towers. It will be equipped with a five kilowatt set.

Arrested in Mid-Ocean by Means of Radio

RADIO messages flashed by Chicago Federal officials recently to the steamer Manchuria, in midocean, asked the arrest of Walter Osterler, an enemy alien and former officer in the German Army. The officials believe he was trying to reach Germany with nearly $100,000 alleged to have been obtained from American citizens by dubious schemes.

A complaint filed with Commissioner Mason by Orma Roma Shellman Osterler, the Crown Point wife of Osterler, who was adjudged the second most beautiful girl in Chicago at the home exposition in 1915, led to issuance of the warrant. Her father, Adolph Shellman, a baker, charges that Osterler borrowed $16,000 from him and stole $3,000 from his daughter on the pretense he was the sole representative in America of certain German automobile concerns.

The Government messages directed that Osterler be taken from the Manchuria.

New High Power Station at St. Assise, France

A NEW double wireless station at Saint Assise, near Melun, France, will be one of the most powerful in the world.

It is intended to erect sixteen towers somewhat higher than those of the American built station at Bordeaux. It will have a wave length sufficient to reach the most distant receiving station. The apparatus to be installed will be capable of quadruple transmissions.

The Lafayette Station, which is now the most powerful in France, has a maximum range of 15,000 miles, but experience has shown, according to the Ministry, that it cannot be depended upon for more than 4,500 miles regularly, being unable, for instance, to work satisfactorily with Argentina. The Sainte Assise Station, when completed, in 1923, will, it is calculated, work easily and regularly with all stations in the world.

The station will be erected for the Compagnie Generale Telegraphe sans fil (General Wireless Telegraph Company). Thirty per cent of the capital invested in the company is English and 70 per cent French, the French Cable Company holding 20 per cent of the total capital. The company has a working agreemnt with the Radio Corporation of America.

The striking physical features of the plant will be sixteen steel towers 820 feet high. A number of special telegraph wires will conect the station with the central telegraph offices.

In addition to this large plant, small wireless stations will be commenced, to be completed in six months. They will be used merely for the handling of business between European countries, the present station in Lyons being inadequate.

Longest Overland Radio Route

AFTER three months' interruption of communications caused by the Russian incursion into Mongolia, the wireless station at Urga is now able to communicate with Peking. This marks the successful completion of the first span of the longest overland wireless telegraph route in the world.

The Marconi Company is under contract to construct stations at Urunchi (in the Chinese Province of Sungaria, Central Asia) and Kashgar (in Eastern Turkestan), for which construction parties are being organized.

Norwegian Ship's Crew Saved by Radio

A RADIO received at the Otter Cliffs Me.) station from the steamer Imperator and forwarded to the naval authorities at New York, told of the sinking of the Norwegian steamship Ontanedo, which sailed from New York in January.

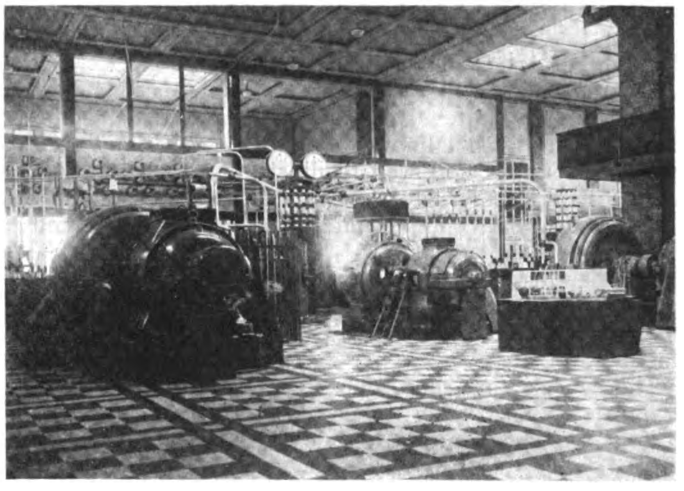
The radio operator of the Imperator learned from the English steamship Fanad Head that the Ontanedo had been abandoned in a sinking condition. The crew was taken aboard the Fanad Head which was bound for Belfast.

Training in Radio for Military Aeronautics

THE use of radio communication, both telegraph and telephone, on the military airplane is perhaps, the latest application of radio science, increasing tenfold the usefulness of the airplane and already influencing the design of military aircraft. Airplanes have been called the eyes of the army, but eyes without means of instantly communicating images and impressions registered upon the retina would find but a limited sphere of application. It is in the performance of this function that radio finds such an important place in military aeronautics. The dots and dashes of the Morse code transmitted from the trailing aerial of the airplane carry to the ears of the artillery battery commander the correction for each shot fired, enabling him to group his hits on an invisible target with a degree of accuracy as great as is possible when the target can be seen, or bring to a waiting general news of enemy troop movement observed from the air.

Bombing planes lost in the fog or darkness are directed unerringly to the home airdrome by the radio direction finder and airplanes without pilots, controlled entirely by radio, are already a reality.

The Air Service of the Army, realizing the importance of this newest phase of radio, has established a school for the training of personnel to install, operate and maintain the radio equipment of airplanes at all the flying fields throughout the country. Radio engineers and operators, as well as experienced amateurs, may qualify for attendance at this school upon application to any army recruiting officer or to the office of the Chief of Air Service, Washington, D. C.



Power plant at Nauen, Germany, showing the high frequency generators

Tuckerton Working France

THE Radio Corporation of America in opening its new radio service to France, has added another link to its worldwide wireless chain.

This new radio service is being accomplished through the huge transmitting station located at Tuckerton, New Jersey, which makes use of a 200-kilowat alternator of the high frequency type—a comparatively new invention developed by the General Electric Company—which has revolutionized the art of wireless communication. The receiving station on the American side is at Belmar, N. J. On the French side the receiving station is located at Ville Juif, which is near Paris, while the transmitter is at Lyons, France.

"The bonds of social and commercial understanding which existed between these two countries for centuries are now firmly cemented by the modern science of wireless communication," said President Edward J. Nally, shortly after the sending of the official messages of congratulation exchanged between himself and French officials.

"There is a vital need for additional means of international communication between Europe and the United States, and I am glad that this country has taken the lead. The Radio Corporation's plans for an efficient worldwide wireless system are materializing rapidly, and it will not be long before every important section of the business world will be quickly bridged by wireless."

The Radio Corporation now offers radio communication between the United States and France, England, Germany, Norway, Denmark, Sweden, Finland and Poland, as well as between San Francisco and Honolulu and Japan.

Speaking of Wage Scales

By Charles Aiken

THE majority of recent articles dealing with various proposals for a new wage scale for radio operators have been based largely on the assumption that long experience means maximum ability and short experience minimum proficiency; that the men who have been to sea for several years are always good operators and the men who are comparatively new at the game are necessarily poor ones.

A little observation will make it plain that often this is not the case. Many a man drops into a rut and makes no improvement during long periods. Some of the "old timers" are over-confident and feel that it is only necessary to work just enough to draw their pay every trip.

At one time I became involved in a discussion over a very simple matter with a man of long experience. He claimed that in a given circuit, with a given voltage, the same current flowed regardless of variation in resistance. Finding that he had no regard for Ohm's law I suggested that we refer to some standard text book on electricity or to some person of our mutual acquaintance who was in a position to know what he was talking about. "I don't care what he says, I know," was his reply. This was a small matter, but it served to illustrate his attitude, and that of many others. He "knew," and he held the humble beginner in great contempt and never lost an opportunity to say so.

Another man who had left the sea after several years of service to conduct a class in radio informed his pupils that an alternating current was one "which was always starting and stopping."

There are many men who were already expert telegraphists or electricians, or both, before they entered the radio game who would be tied down and held back by any scale of wages based entirely on actual experience as a wireless operator. Some men become expert operators in a surprisingly short time. A few trips to get the proper technique and they rank among the best.

I am not trying to condemn all of the Old Guard nor even the majority of it. The really expert operators who stand in a class by themselves are for the most part men of long and wide experience. Neither am I defending that class of novices who know little and care less. The point I wish to make is: Any scale of wages based only on actual radio experience is unfair and detrimental to wireless in general.

Under the proposed system, what incentive has a man to study for self improvement? He will gain little by it because he cannot show service records. Why should he not sit back in some job on a cargo boat where there is very little work involved and take things easy? His salary will increase automatically as he drags out his existence whether he really deserves a raise or not. Such a system would assume that all operators possess the same natural ability and desire for advancement and would preclude the recognition of individual proficiency. Experience is an important factor, but it is not the only one to be considered. Would not a system having four classes of operators as outlined be more desirable?

Class A. Men who have shown themselves to be of the first quality and who are capable of handling any sort of position.

Class B. Men who have shown themselves to be good operators, who know their business and who are able to handle any ship position.

Class C. All men with first grade licenses during their first six months of service, and others who have failed to qualify for class B.

Class D. All men with second grade licenses regardless of kind or length of service, and all first grade men who have shown themselves unfit to be in class C.

The assigning of men to the proper class might prove somewhat difficult, but it could be accomplished with a little co-operation between the operators and the radio companies. When an operator leaves the employ of a company he would be given a service record showing the kind of ship on which he has served, the type of apparatus, the general nature of the traffic handled and a record of his own personal conduct and efficiency with a suggestion as to what grade his service tends to qualify him. Or it might be possible for the companies and the operators to get together on this matter.

As for the rate of pay I would propose the following:

	One-man ships.	*Two-men ships.*	
		Chief.	*Assistant.*
Class A	$150	$165	$150
Class B	130	145	130
Class C	110	125	110
Class D	80	—	—

Extra first grade licenses should entitle the holder to 10 per cent increase.

I believe that this system would improve radio more than one based entirely on time served with only indifferent regard to ability.

Easthampton Radio Station

A NEW commercial radio coastal station has been recently opened at Easthampton. The location is about one mile from the south shore of Long Island. Two galvanized steel towers 300 feet apart and 160 feet high surmounted with wooden masts bring the total height of the antenna to 175 feet above the heavy concrete foundations. The antenna is the cage type found so efficient on battleships during the war, the counterpoise radiates from one corner of the operating building and practically covers six acres.

Easthampton Radio Station in course of construction

The power supply is obtained from the local electric light company and is brought to the station in a conduit 1200 feet long. Twenty-two hundred volts alternating current is stepped down to 220 volts, from which a motor generator unit produces the 110 volts direct current used in the operation of the radio set. A Delco light unit in conjunction with a storage battery is used as an auxiliary to provide against breakdown.

Thousand-Mile Amateur Radiophone

Detailed Description of the Development and Operation of the Set Used at 2ZL Station, Valley Stream, L. I.

By J. O. Smith

THE remarkable distance records made by amateur radio stations using continuous wave transmitters with several 5-watt tubes in multiple, are matters of common knowledge. The fact that a set, employing two or three of these small tubes, with approximately an ampere or more of current in the antenna, has been heard and worked by stations 400-500 miles away, causes no special interest at the present time. Such distances are covered only occasionally in amateur work, however, and usually during particularly favorable conditions, such as would affect the transmitting distance of an amateur spark transmitter emitting damped waves.

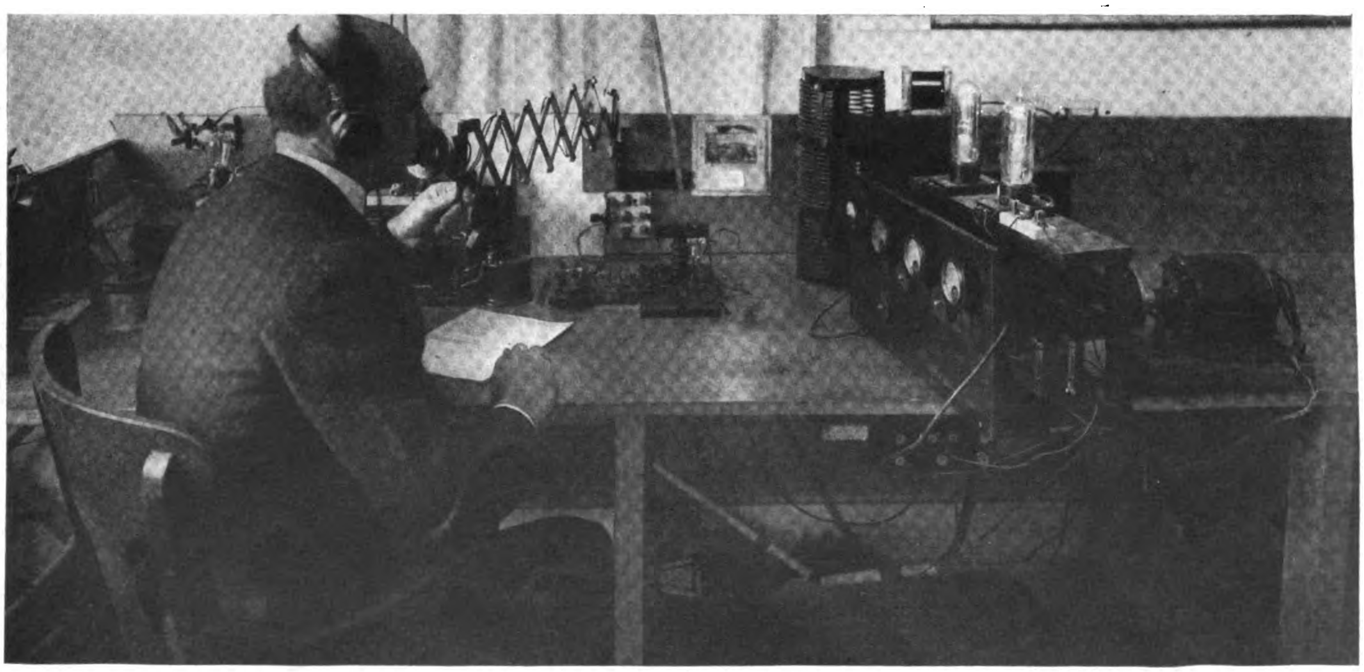
Experiments at 2ZL station, Valley Stream, Long Island, covering several weeks, with transmitting sets employing 5-watt tubes, clearly demonstrated that the signals from such sets are subject to practically the same conditions as damped transmitters, where the distance between the transmitting and the receiving station is more than the regular daylight range of the transmitting station, especially where the C.W. output is modulated in some manner. The foregoing, however, applies only to general conditions.

On nights when the stations of the Eighth District, particularly those in Ohio, were inaudible on Long Island, 2ZL, using straight or modulated C.W., was also inaudible at several Eighth District stations, listening on a pre-arranged schedule. When the signals from Eighth District stations were audible on Long Island, the signals of 2ZL were copied in Ohio. During these tests one point of considerable importance developed. On nights when spark stations in the Eighth District "swung" so badly as to make consecutive reading of their signals impossible with two steps of audio-frequency amplification, the straight C.W. signals from 2ZL were reported as being good and steady, and consecutive reading was entirely possible. Summarized, this established the fact that, while the signals from 2ZL were subject to general conditions over long night distances, when they were heard at all they were much more steady and reliable than spark signals. It should be remembered also, that the input of the tube transmitter at 2ZL was about 160 watts, plate and filament, as compared to 1,000 watts input—without counting the energy used to run the usual non-synchronous rotary spark gap—in the case of the Eighth District spark stations.

After the experiments with the transmitter employing the 5-watt tubes had been carried on for several weeks at 2ZL, and the reports of the listening stations carefully studied, it became evident that the signals of such a small set were entirely satisfactory over distances up to 100 miles, but not practical for regular amateur relay work over long distances, except on a pre-arranged schedule, which, on the part of the receiving stations, becomes about as exciting and interesting as the morning alarm clock. It was quite evident that in order to work any great distance, without pre-arrangement, it would be necessary to use more power, and a distinctive signal would have to be created of such strength that continual calling would be unnecessary. It was not practical, of course, to use more than three or four 5-watt tubes, because the small added output of more tubes does not warrant the additional expense of the tubes or the extra filament and plate power.

As the only obtainable tubes of increased size over 5 watts are not less than 50-watt output capacity, it was decided to install a transmitter employing tubes of that size. Right here is where the writer got into the same predicament as the man who caught a wildcat by the tail—he sure started a fine bunch of trouble for himself. It seemed logical to suppose that to install the 50-watt tubes it would only be necessary to insert the new tubes and sockets, supply proper filament and plate voltage and shoot the moon. But it was somewhat different before a smooth working 150-watt tube set was finally developed.

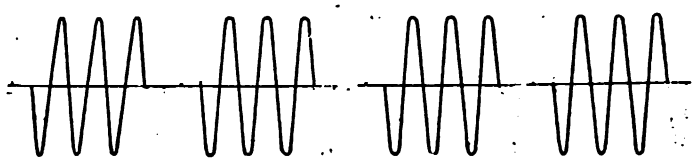
The characteristics of the larger tubes were such that their rated output was 50 watts on 750 volts and 75 watts



Radiophone set at 2ZL in operation. Antenna current normally 3 amperes

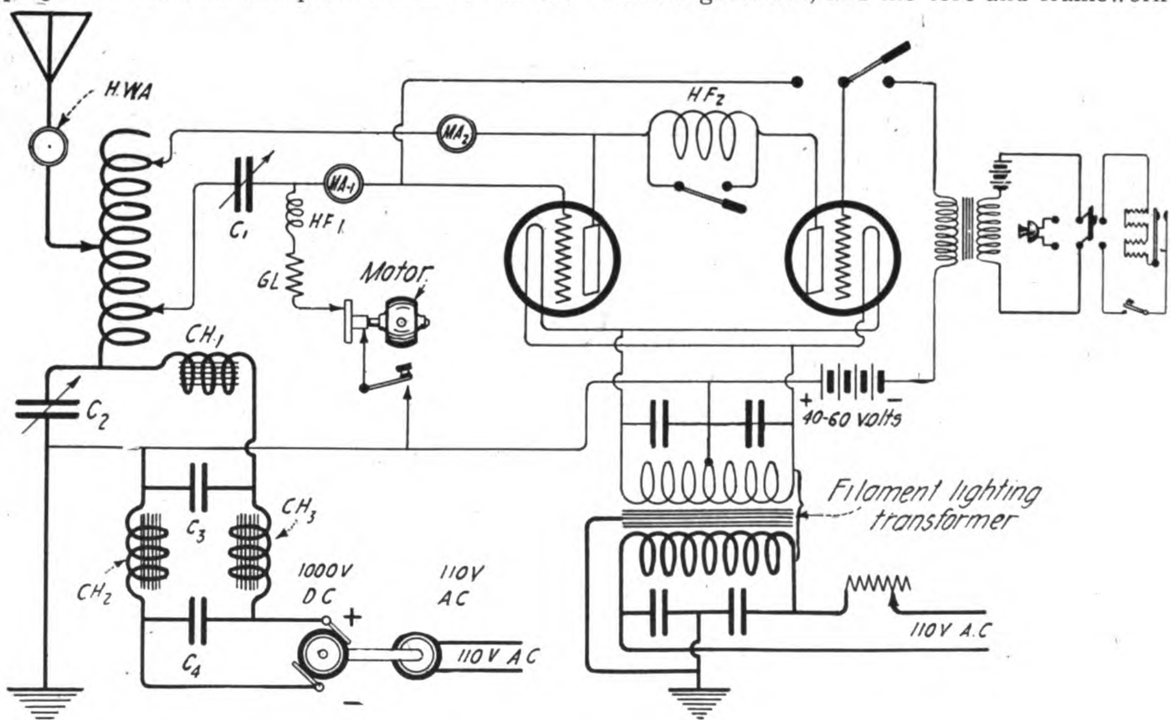
on 1,000 volts plate potential. Of course, it was decided, amateur fashion, to get every single possible, ding-busted watt out of the blooming things, so a motor-generator—110 volts 60 cycle A.C., 1,000 volts D.C., and also a 12-volt 80-100 ampere hour storage battery to heat the 10-volt 6½ ampere filaments were procured and installed. When all was ready the outfit was started and the key pressed. In about 1/1000 of a second two variable condensers, a couple of choke coils, two or three meters and some other odds and ends went to heaven, or wherever such things go when they go up in smoke. The motor-generator was a sturdy cuss or it would probably have gone, too.

As the operating room by this time was full of blue funk—compounded of tobacco smoke, burning rubber and the natural feelings of the writer, experiments were abandoned until such time as the matter could be studied and the proper instruments and parts installed. In the fully for a time; then it also went up in smoke, presumably due to poor insulation. A second one went the same way in short order. It was then decided that the blooming thing was probably full of high-frequency currents, induced directly or indirectly by the set, so a system of protective condensers was installed. Two were used on the primary side of the transformer and the middle point



High frequency oscillations broken up into audible groups by tone wheel, the characteristics of which are 50 per cent. make and 50 per cent. break

grounded. Two were also used across the secondary side, but not grounded, and the core and framework were di-



C-1—.0015 mfd. (Max.); C-2—.003 mfd. (Max.); C-3—1 mfd.; C-4—2 mfd.; HF-1—H.F. Air Core Choke; H.F-2—H.F. Air Core Choke; CH-1—Iron Core Choke (1½ Hys.); CH-2—Iron Core Choke (1 Hy.); CH-3—Iron Core Choke (1 Hy.); GL—Grid leak resistance (variable), 1500 to 5000 ohms; MA-1—Milliammeter, 0-150 M.A.; MA-2—Milliammeter, 0-500 M.A.; Coil—50 Turns 5" Diam. 3/16 Copper Tubing. Circuit diagram and specifications of the 2ZL Station.

course of time, new parts, meters, etc., were installed and the set was started up again. This time trouble broke out in a different place. The tuning, or coupling coil, which had been made up of Litzendraht wire, according to expert advice, got so blooming hot that they ceased doing business and burned up. The new coils were wound with heavy, solid insulated wire, and they also got hot. In order to avoid losses it was decided to wind a coupling coil with 3/16 inch copper tubing. This proved to be a good step and since then no heating has been detected in the set after long stretches of transmission with as much as 5 or 6 amperes in the antenna.

A storage battery would not answer for filament heating purposes on tubes of this size. The alternative was to use either a D.C. generator, or an A.C. transformer. The latter was decided upon. This was a new one on the manufacturers of amateur radio apparatus at that time and one had to be made up specially. The final result was a transformer with secondary voltages of 8 and 10, and a total secondary capacity of 150 watts—more than sufficient to properly heat the filaments of two 50-watt tubes. A tap was provided in the center of the secondary winding to minimize the effect of the A.C. hum on the filaments and for another reason which is covered further on in this article. This transformer was used success-rectly grounded. After that no further trouble was experienced with the transformer.

During the writer's early experience with the 5-watt transmitting tubes the filaments had a habit of burning out after a comparatively short life. Possibly this is not a new idea, the same thing has probably happened to other experimenters. It is caused by excessive filament temperature. The electron current of the plate circuit adds to or subtracts from the filament current according to the way the filament heating circuit and the plate circuit are interconnected. If the negative of the plate circuit is connected to the negative filament terminal, the electron current of the tube will add considerably to the filament current; if the plate circuit negative and the filament circuit positive are connected, the effect will be to subtract from the filament current. The life of a tube is rapidly shortened by overloading, and as this is particularly true of the filament, it is of great importance that proper connection be made between the negative side of the plate potential and the positive lead of the filament heating circuit so that the life of the tube may be conserved.

In order to avoid the fluctuation in filament current just referred to and particularly to get away from the incessant charging of storage batteries for filament heating purposes, it was decided to heat the filaments with A.C., by means of the transformer previoulsy described. A middle tap was provided on the secondary and to this the return from the plate and grid circuits were connected.

The fact that the two tubes have been in almost daily use for five months would seem to indicate that there is very little disturbance of the proper filament conditions with this arrangement. In order to guard against fluctuation in the city supply line voltage, a rheostat of 0-4 amperes was inserted on the primary side of the transformer and this provided a means of keeping the filament heating current at a proper value under the varying conditions inevitable in a small town generating equipment.

The circuit employed at 2ZL includes the well-known Colpitt's oscillator and the Heising modulator. Using one tube as an oscillator and another as a modulator, the antenna current is 3 amperes under ordinary conditions. When the output is modulated by voice or buzzer, an increase in antenna current takes place, due to the fact that the modulator tube releases energy to the oscillator tube as voice or buzzer modulation is impressed across the grid filament circuit of the modulator tube. An increase in antenna current indicates that the C.W. output of the set is being modulated to a fair degree of thoroughness, and proper design and adjustment of the circuits to obtain this increase in antenna current is of the greatest importance. The exact extent to which a C.W. set is being modulated can be determined by the oscillograph, but as this means of determining the extent of modulation is beyond the reach of the average amateur, the desired rise in antenna current will answer as the best substitute method for determining whether or not the set is being efficiently modulated. At 2ZL the increase in antenna current with voice modulation is approximately .3 of an ampere when the normal antenna current is 3 amperes. The voice modulation of the station has been frequently commented upon as being good and the voice clear and distinct. Consequently the proportions of antenna current and increase given will serve as a guide to other experimenters in checking up the approximate degree of modulation obtained in their own sets.

Four points were found to be of great importance in obtaining a proper degree of modulation:

1—Proper value of oscillator grid leak resistance.

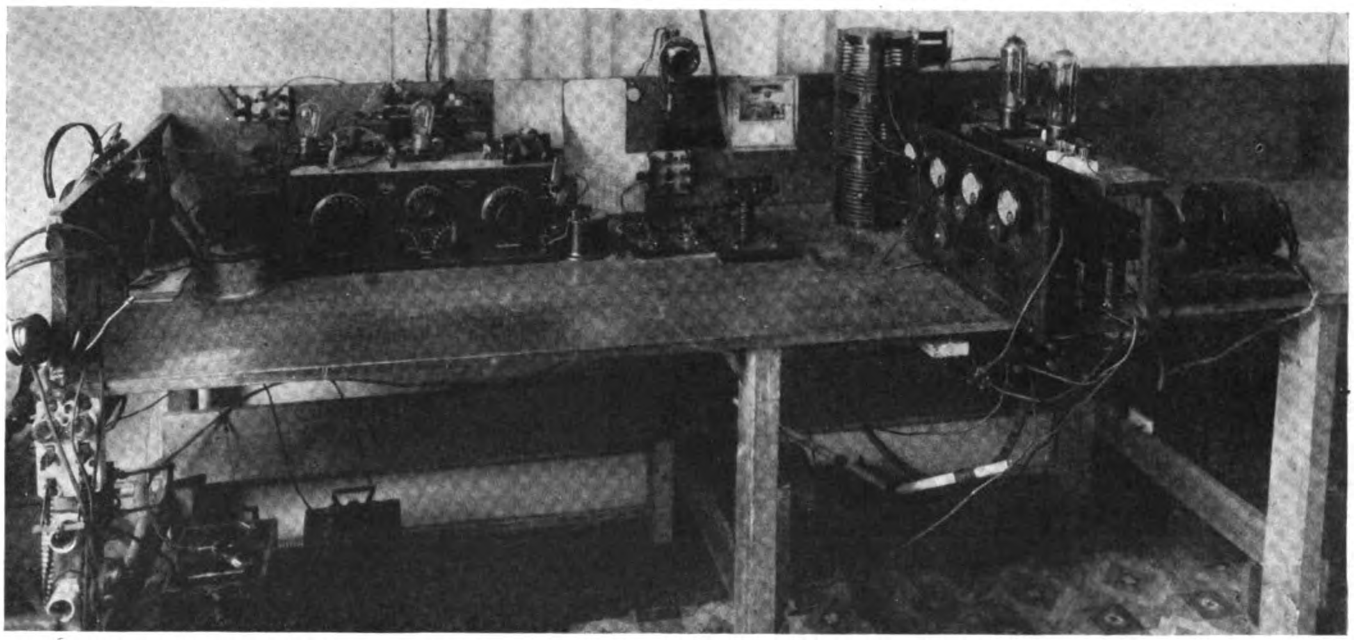
2—Proper polarity of battery on the primary of the modulation transformer must be determined in connection with the buzzer or telephone transmitter.

3—Proper negative potential must be secured on the grid of the modulator tube.

4—Proper value of capacity in grid and feedback condensers.

In the case of 2ZL, the oscillator grid leak is 1,500 ohms, the negative grid battery potential 60 volts, and the proper polarity of the 6-volt battery on the primary of the oscillation transformer was determined, of course, by experiment. It was found desirable at 2ZL to reverse the polarity of the 6-volt battery as between the telephone transmitter and buzzer, in order to obtain the best modulation.

When a potential of 1,000 volts is impressed upon the plate of a 50-watt, or U tube, the space or plate current will be somewhat above the normal 750 volt rating of 150 milliamperes. In the case of the tubes used at 2ZL, the space current of the oscillator tube was about 175 milliamperes with 60 milliamperes negative grid current, when the set was transmitting on 275 meters. Where it is intended to apply 1,000 volts on tubes of this type, allowance should be made for this additional current in the capacity of the generator or transformer to avoid overloading and to insure a sufficient stability of plate potential to get the greatest efficiency out of the tubes. High plate potential and low space current will work a tube at its greatest efficiency without danger of injuring it, but low plate potential and high space current will greatly shorten the life of any tube.



Transmitting and receiving equipment at 2ZL station. Transmitting—Two 50-watt tubes, with indicating instruments, also tone wheel latter shown at extreme right. Receiving—Grebe CR-3, with detector and two-step amplifier, employing UV-200 (Radio Corp) as detector and two UV 201 tubes as amplifiers

The two 50-watt tubes used at 2ZL have been in service since September, 1920, and at this time (February 15, 1921), are still going strong and look good for another five months. During this time the station has been in operation practically every night, but no record has been kept of the actual operating hours.

It was sometimes found difficult to "raise" a distant station when modulating the output by buzzer, because of sharpness of tuning at the receiving station, local interference, etc. It was therefore decided to utilize the two tubes of the set as oscillators, and insert a tone wheel or chopper, in the common grid leak line. A disc of brass 4 inches diameter, ¼ inch thick, was turned off and 20 holes, ¼ inch in diameter, were drilled around the outside edge through the flat surface of the disc and bakelite studs inserted. The face was then turned down and the disc mounted on a 1700 R.P.M. induction motor. Two brushes were brought to bear on this disc, one on the flat surface and one in a position to run over the bakelite studs as the motor revolved. It is this arrangement which has given 2ZL the distinctive 400 cycle note that has been heard from Montreal to Palm Beach and as far west as Little Rock. (Scotland stations please note). It is readily seen, of course, that this chopping arrangement is perfect modulation, in that it breaks up the C.W. output into groups between which no current is flowing in the antenna, because oscillation of the set stops as the brush runs over the studs and is renewed as it comes in contact with the metal of the wheel. With the two tubes as oscillators and chopped in this way the apparent antenna current, as shown by the meter, was 3 amperes, the same as with one oscillator and one modulator. As a matter of fact, however, the full amplitude of the antenna current was considerably in excess of that figure, probably double.

Antenna and counterpoise ground system at 2ZL. The antenna is 120 ft. long between spreaders. The counterpoise ground is used because of the dry sandy soil. It consists of 7 No. 21 copper wires, directly under the antenna, also on 15 ft. spreaders. Both spreaders and wires are insulated from ground

Signals have been reported from stations at the following points and 2ZL has worked with a number of them; including 9XM, at Madison, Wisc:

	Miles—Air Line from 2ZL		Miles—Air Line from 2ZL
Burlington, Iowa	892	Grand Forks, N. Dak.	1,300
Madison, Wis.	809	Newport, Ky.	560
Sheboygan, Wis.	750	Oshkosh, Wisc.	800
New Orleans, La.	1,079	Minneapolis, Minn.	1,025
St. Paul, Minn.	1,025	Palm Beach, Fla.	900
Kansas City, Mo.	1,080	Stanbridge East, Quebec	350
Louisburg, Nova Scotia	550	Ann Arbor, Mich.	520
Montreal, Quebec	350	Battle Creek, Mich.	602
Boston, Mass.	200	Hartford, Conn.	100
Marion, Mass.	220	Little Rock, Ark.	1,025
Birmingham, Mich.	580	Chicago, Ill.	725
Danville, Va.	390	Detroit, Mich.	500
Memphis, Tenn.	925	St. Louis, Mo.	850
Columbus, Ohio	475	Houston, Texas	1,286
Rome, Ga.	725	Port Arthur, Texas	1,265
Washington, D. C.	200	Ellendale, No. Dak.	1,330

It would seem that the signals are heard equally well in all directions and that there is no noticeable directional effect in the case of the antenna of 2ZL station.

Using one tube as an oscillator and one as modulator the voice has been reported from Marion, Mass., Boston, Mass., Memphis, Tenn., Anderson, Ind., Niles, O., Washington, D. C., Rochester, N. Y., Pittsburgh, Pa., Cambridge Springs, Pa., and Montreal, Quebec, and many other points and two-way communication has repeatedly been carried through successfully; 2ZL by voice and the other stations replying by spark. In the case of Washington, communication was carried on by voice both ways with NSF, the naval experimental station located there.

The work done when using straight or unmodulated C. W., has undoubtedly established new records and distances for amateur C.W. transmission, in that daily schedules have been maintained with the following points:—Savannah, Ga. (4XB); Salem, Ohio (8ZG); Canton, Ohio (8ZV); Langley Field, Va. (XF-1). Occasional communication has been established with Madison, Wis. (9XM) and Minneapolis, Minn. (9XI).

It is quite common these days to hear of a small C.W. set covering great distances occasionally, in the nature of freak work, but maintaining daily schedules with stations 400 and 650 miles distant is another matter entirely, especially when it is considered that the total input at 2ZL at no time exceeded 350 watts, for both plate and filament circuits.

As regular work has been done with 8ZV, Canton, Ohio, a few points which developed in regular communication with this station are interesting. The schedule between 2ZL and 8ZV starts at 10.30 P.M. On one or two occasions when communication had been established, it developed that no eastern amateur spark stations had been heard at 8ZV and no western ones at 2ZL. The straight C.W., however, was going through without any trouble. Slight fading was noticeable, but of a longer period and more gradual character than in the case of spark signals. Then 8ZV discovered that the signals of 2ZL were easily audible with the antenna switch in transmitting position and motor-generator running. This condition was immediately put to good use in that it was used as a break-in system, which worked perfectly. The next question seems to be, "Why an antenna?" As a matter of interest, the transmitter at 8ZV employed two 5-watt tubes, and the antenna current was 1.2 amperes. Station 8ZG also employs two 5-watt tubes and the antenna current is approximately the same as in the case of 8ZV.

Insofar as the dependable daylight range of the set is concerned, distances vary with the method of transmission or modulation. Using straight C.W., 2ZL has been copied repeatedly during daylight over varying distances up to 200 miles, that is, at Boston, Mass. Conclusive tests to determine the maximum C.W. daylight range have not been made, but it is believed that with 3 amperes of straight C.W. in the antenna it should be possible to communicate with stations 500 miles distant during fairly favorable conditions. Providing radio-frequency amplification were used at the receiving station, there would seem to be reasonable ground for believing that coast to coast work could be regularly carried on. This assumption is based upon the fact that amateur spark stations in Texas have been heard during mid-afternoon on a clear day in and near New York City by means of this method of reception.

With the output of the set at 2ZL modulated by buzzer, daylight communication has been successfully carried on with stations 150 miles distant, although the reception, of course, called for careful tuning and generally much preliminary transmitting for adjustment of the receiving sets. With voice modulation, during daylight, conversation with stations 150 mles away has also been successfully carried on. When the two tubes were used in multiple, with the tone wheel chopping the grid leak current, the received signals were several times the audibility of buzzer or voice modulation.

As a summary, the dependable daylight ranges of the set with approximately 3 amperes in the antenna, can be reasonably assumed to be as follows:

Straight C.W.	300 miles
Buzzer modulated	100 miles
Voice	100 miles
Tone wheel chopper	150 miles

When these ranges and the flexibility of the set are considered, and also the fact that the total input of the set, plate and filament, under all conditions of transmission, never exceeded 350 watts, the very great advantage of C.W. transmission over the usual spark method are readily apparent. The antenna of 2ZL station is an inverted L of four wires on 15 foot spreaders, 125 feet long and 80 feet high. A counterpoise ground of ten wires is used. The fundamental wave length of the system is approximately 260 meters and the antenna resistance about 7 ohms.

As a side light on the voice transmission tests made at 2ZL, a letter has been received from an amateur in a little town with a population of 160, located 30 miles south of Memphis, Tenn., saying that he frequently heard the phone at 2ZL station. He stated that he used a small aerial and only a single tube as a detector. He said that he and his people liked to listen to the phone and requested that the voice be used often, that music be played occasionally as he and his people enjoyed listening to it.

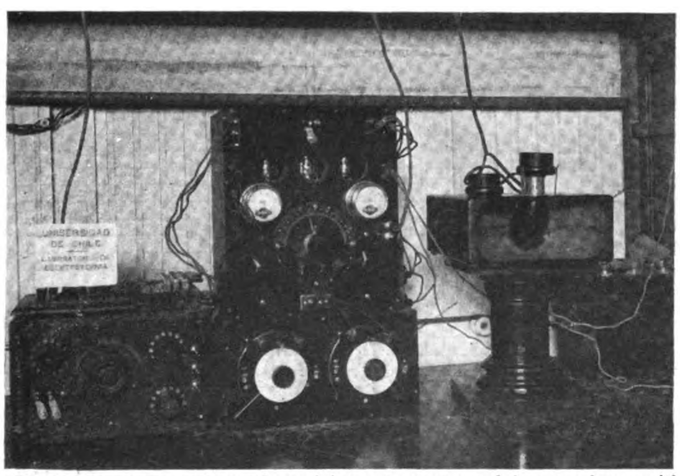
Wonderful and mysterious are the ways of C.W. transmission when an amateur 925 miles distant regards a radiophone concert by another amateur station in the vicinity of New York for his benefit as an ordinary matter.

Just as this issue is going to press we have been informed that all known Amateur C.W. Transmission records have been broken by 2ZL and 5XB stations. The latter is the station of the Agricultural and Mechanical College of Texas, located at College Station, Texas. The transmitter used consists of three 5-watt tubes, the total input plate and filament being approximately 175 watts. The overland air line distance between the two points is 1,500 miles. The two stations were in communication on the nights of February 11th and 12th for approximately 30 minutes on each night and messages were exchanged successfully in both directions.

Reception at Santiago de Chile

By Arturo E. Salazar

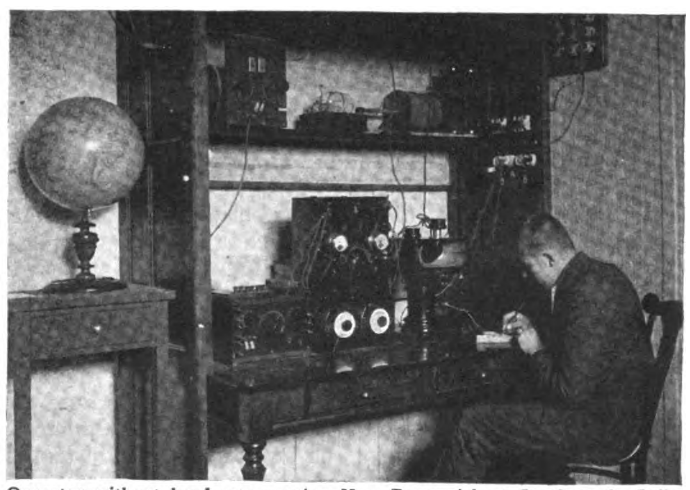
THE Department of Electrical Engineering of the University of Chile is well equipped with an experimental 2.5 kw. sending station of the quenched spark system, partially constructed in the laboratory. This set has proved very useful for teaching purposes and on two occasions has afforded the only means of communication between Santiago and Valparaiso, during temporary breakdown of telegraph and telephone lines caused by snowstorms.



The long wave experimental receiving set constructed in accordance with an article in The Wireless Age and used at the University of Chile

The work performed during the year 1920 produced some interesting results in radio reception. The university was appointed to investigate and determine for official information, which would be the best system to adopt in constructing a high power wireless station, in or near Santiago de Chile.

In carrying out this work comparison was made of the wireless service rendered by the principal stations of North America, including the Mexican one at the hill Chapultepec, near Mexico City. This high power station, 300 kw. or more up to 6000 meter wave length, erected during the war by the German "Telefunken" Company, has demonstrated the possibility of establishing wireless communication between the Northern Continent and Chile in a most effective manner. The same may be said of San Diego, California. However, the conditions existing be-



Operator without head sets copying New Brunswick at Santiago de Chile in daytime—distance 8,200 kilometers

tween these points are favorable for radio work because it is mostly over the sea.

More difficult are the conditions of the stations on the North Atlantic coast of the United States. For this reason two were selected for comparative study over a period of several months during the past year. The tests, based upon facility of reception at Santiago, demonstrated

Distorted L antenna 35 meters high and 60 meters long, running east to west, which is unfavorable for northern reception

that there is a great superiority in the radio communications emanating from the New Brunswick station, using the Alexanderson high frequency alternator, over those using the oscillatory arc.

Perfect and permanent reception of messages of any length and at any hour of the day throughout the year can be made when transmitted from New Brunswick while from arc stations, with conditions normally equal, the strength of signals is at the utmost half as good and the reception is impaired by a very noxious residual sound. This is due no doubt to the permanent state of oscillation of the sending circuit, inherent in the arc system.

There was nothing unusual in the apparatus nor in the antenna employed for these tests. The receiving set though soundly constructed at the laboratory is not supersensitive. In spite of this, with a single phone standing on the acoustic resonator or amplifier, as seen in the photographs, the copying of messages from New Brunswick over a distance of 8200 kilometers is easily made by several operators without head-sets attached.

Development of the Radio Beacon

THE lighthouse may be displaced or its service greatly augmented by the utilization of electric waves common to radio communication. A device for determining the direction of the source from which the electric waves are transmitted has been perfected by F. A. Kolster of the United States Bureau of Standards, and the seemingly visionary theory of yesterday becomes the triumphant scientific achievement of today.

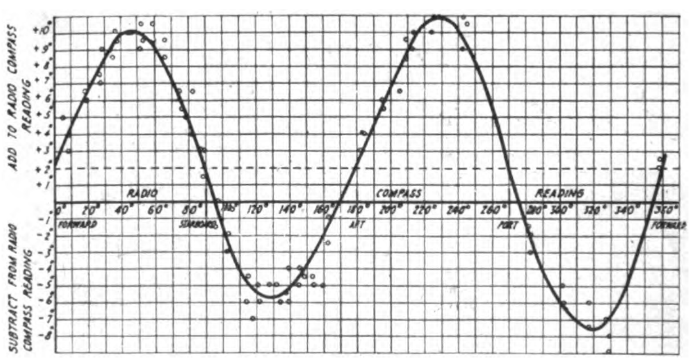
The preliminary experimenting with wireless for the purpose of facilitating sea-going travel was begun in 1916 when the Navesink light station at Atlantic Highlands, New Jersey, was equipped with a one-half kilowatt transmitting equipment designed to automatically send a signal at frequent intervals. A radio compass set was installed on board the lighthouse tender "Tulip," and a series of bearings were taken during the brief experiments which were halted summarily by the world conflict. Recently tests were renewed when three lighthouses in the Chesapeake Bay were equipped with wireless transmitting apparatus and a radio compass was made a fixture on the lighthouse tender "Arbutus."

Smith Point Lighthouse in Chesapeake Bay showing radio beacon

The rigid requirements of the experimental stage were successfully met, and the so-called radio beacon has become permanent equipment on the Ambrose and Fire Island lightships marking the entrance into New York and at the Sea Girt lighthouse on the Jersey coast below Asbury Park. The apparatus is maintained and operated by the keeper of the light station, thus obviating the employment of additional help. The signaling range of these stations is 30 miles on a wave length of 1,000 meters. The practical application of the device was demonstrated when a 45-mile voyage was completed on wireless bearings taken from the Fire Island light vessel by the captain of the "Tulip," who was a novice in the operation of the apparatus. A 30-mile run, course 257°, from the Jones' Inlet buoys to Ambrose Lightship was also made without any information other than that furnished by the use of the radio compass.

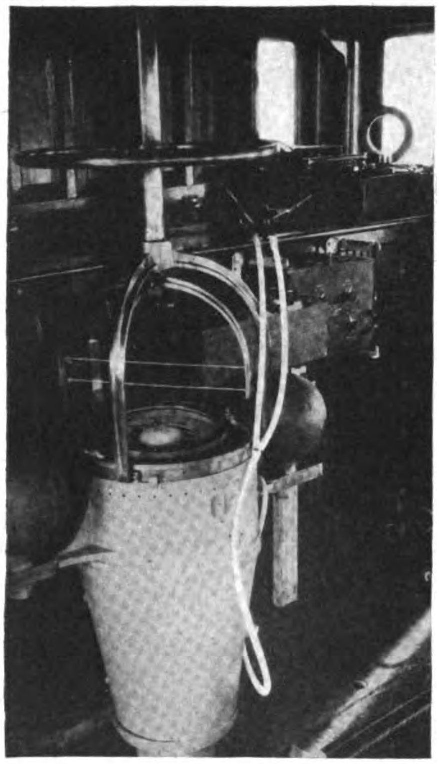
The device for determining the direction of the source from which the electric waves are transmitted comprises a coil of wire wound on a frame about 4 feet square, preferably mounted over the vessel's pilot house and so installed as to be rotatable from within the latter quarters. The receiving set aboard ship and magnetic compass are located within the pilot house, thus facilitating the convenient manipulation of the device by the navigating officer. The shaft upon which the radio compass coil is supported extends into the pilot house, where it is directly connected through a bearing to the binnacle which carries the magnetic compass. Thus the wireless determination of the beacon station is read directly on the magnetic compass and the complete performance necessary in taking a bearing is merely that of rotating the wireless compass coil by means of a wheel to the critical angle of silence and then noting the position directly upon the magnetic compass card.

As a coil is rotated about its vertical axis the

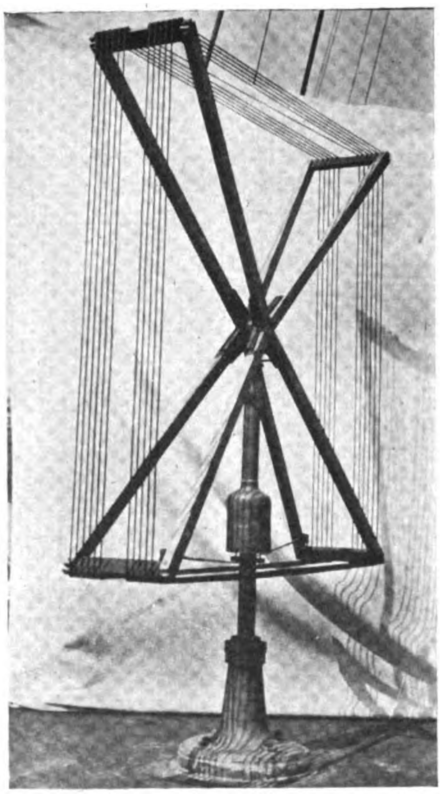


Form of a radio compass correction curve aboard ship

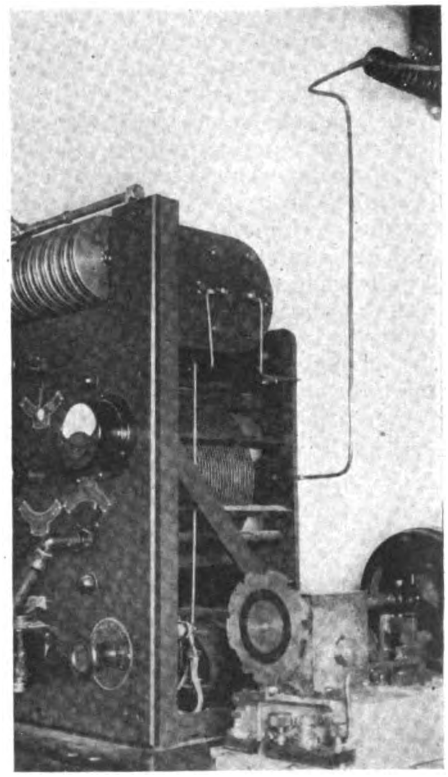
characteristic signals of the radio beacons are received in all positions with gradually varying degrees of intensity until the coil becomes exactly normal or at right angles to the direction in which the radio beacon lies, at which time no signal is audible. The critical position



Shaft supporting the compass coil connected to the binnacle carrying the magnetic compass



The compass coil mounted above the pilot house



Transmitting apparatus connected to the automatic signaling machine

of unyielding silence indicates the direction of the radio beacon. The bearing of two or more radio beacons within range may be taken, thus determining at once the position of the ship. Not infrequently, however, it is only essential to set a direct course towards the radio beacon; in approaching a light ship, for example, the ship's course is held on the radio bearing.

A lighthouse or lightship equipped with a simple automatically operated radio transmitting apparatus simultaneously becomes a radio beacon which is identified by its characteristic signal and the location of which is definitely indicated on the mariner's charts.

The radio compass on shipboard entails calibration as is true in the case of the magnetic compass. The metallic mass of the vessel is responsible for a deviation of the electric waves approaching the ship from its normal course of travel. The degree of deviation is dependent upon the relative position of the vessel. The result of calibration involves a correction of the actual radio compass reading, either added or subtracted, and varying in amount from zero to a maximum depending upon the fore and aft position of the ship with respect to the direction of approach of the electric wave. In the graph illustrated, the horizontal axis represents the position of the radio compass coil with respect to the ship's center line, and the vertical axis shows the positive or negative amount of the correction to be applied for every position of the coil. A scale marked in accordance with this calibration curve is attached to the binnacle in such a fashion as to enable the observer to read the amount of correction to be added or subtracted directly and simultaneously with the radio compass bearing.

Other than obtaining bearings on known stations or near shore, an even superior virtue claimed for the new wireless signaling and compass system is that of lessening the menace of fog—the bugaboo of sea-voyaging expeditions. Ships at sea, perhaps in distress or submerged in fog, can be located and their course determined. In the interest of safety, every vessel at sea in fog could transmit radio fog signals effectively over a distance of ten miles at frequent intervals. Such a practice would enable a companion ship, within range and when equipped with a radio compass, to ascertain the direction of the vessel thus signaling and thereby proceed with safety and without delay. Finally, in a large perspective, it is claimed that a universal adoption of the system as recently evolved would establish more effective safeguards around life and property on the commerce-traveled oceans.

A Coil Aerial Buried in the Ground

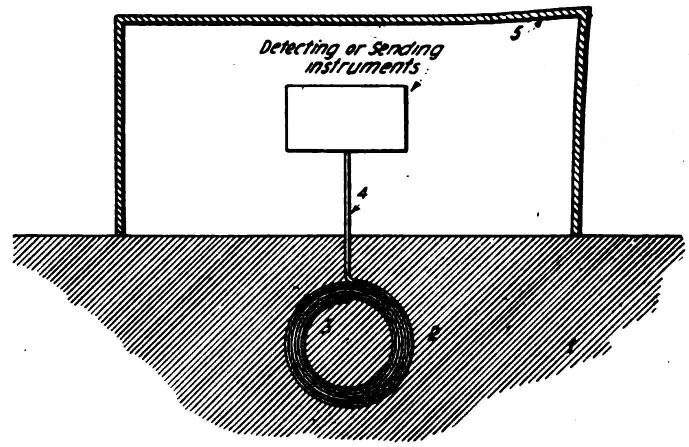
WILLIAM E. BRAKES recently described an aerial for receiving purposes which ought to find favor among the many experimenters who are unable to erect lofty overhead aerials. This aerial is composed of a well insulated and inductively wound coil of wire buried in the ground. Besides being much easier and cheaper to install, it is claimed that the coil-aerial has the advantage of cutting down static interference. Better results will be obtained if the leads and instruments are protected by surrounding them with a metal shield.

The accompanying drawing is an illustration of the aerial in position. The earth is represented by 1 and the coil aerial by 2. The coil is inductively wound with one dead end in the center at 3. The other end of the coil terminates in a lead 4, which is connected into the receiving circuit. The antenna circuit after passing through the receiving system is grounded. The leads are made as short as possible to avoid any losses in transmission of signal current.

A shield or screen of metal is represented at 5, which rests upon the ground and within which are placed the receiving instruments and the portions of the circuit external to the ground. This shield has the function of protecting the receiving instruments and the portions of the circuit external to the ground from the effect of static or other disturbing electrical influences. It is important to avoid, as far as possible, any extended lead from the coil to the receiving instruments.

The amount of wire used in the coil may vary, but it is advisable to use about as much wire as would be used in the ordinary form of antenna.

Instead of embedding the coil (3) in the earth, it may be submerged in a body of water, such as a river or a well, with the advantage of permitting the coil to be turned into different planes according to the direction from which the signals to be received emanate.



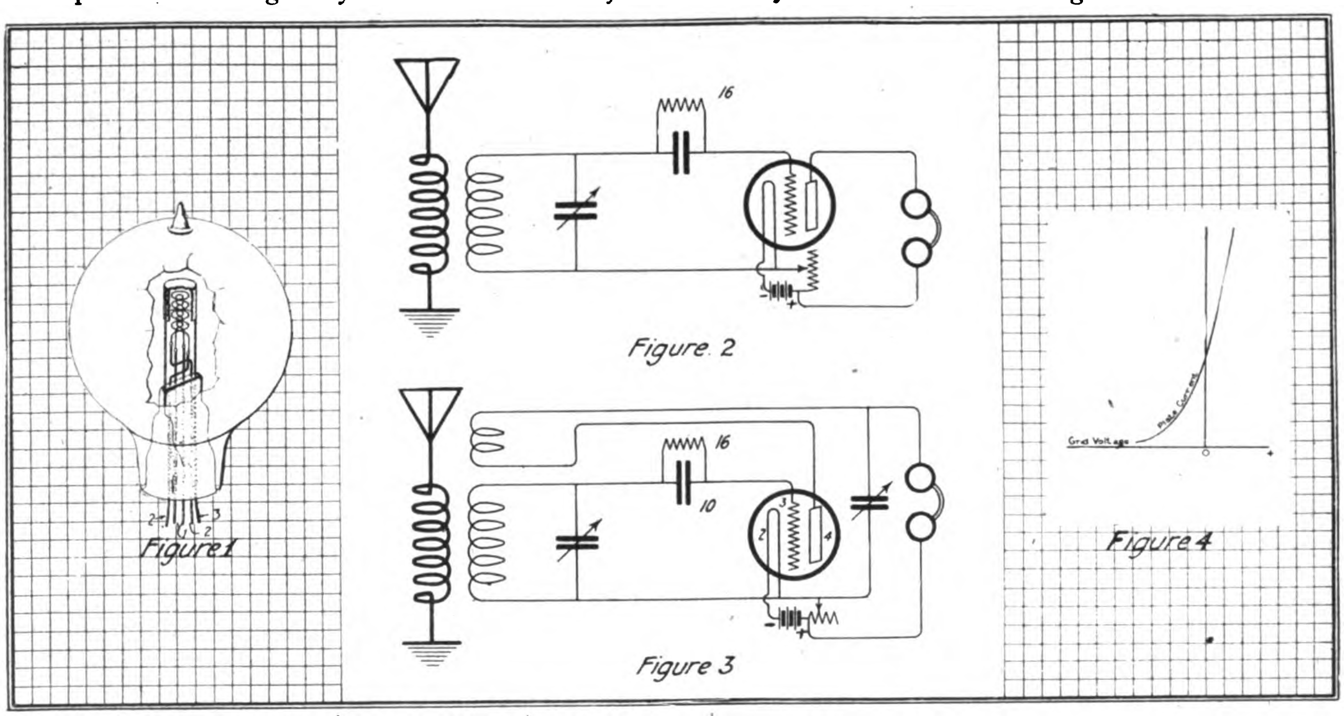
Arrangement of coil aerial, metal screen and receiving apparatus

A Single Battery Vacuum Tube Hook Up

W. C. WHITE has developed an interesting vacuum tube circuit, which requires only a single battery of low potential. This battery is made to fulfill all the functions of the low voltage filament heating battery, high voltage plate battery, and small grid battery.

This is accomplished by constructing the vacuum tube in such a way that the cathode and grid are separated by as small a distance as possible, without actually touching each other during the operation of the tube, and with the anode spaced from the grid by a distance which may be slightly greater than the spacing between cathode and grid, but which will in any case be very small. In using this as a radio detector the anode is connected directly to the positive terminal of the battery which is employed for heating the filament, and included in this circuit is a telephone receiver. Any adjustment of the grid potential which is necessary, may be brought about by connecting the grid to the positive or negative terminal of the filament or to some point of an intermediate potential. In order that the tube shall operate satisfactorily with the connection described, it is preferable that the metal of which the anode is composed shall be electro-positive with respect to the cathode.

The tube illustrated in figure 1 comprises a tungsten filamentary cathode, a grid which is in the form of a coil close to and surrounding the cathode and a nickel cylindrical anode close to and surrounding the grid. Current for heating the filament may be supplied through the lead-in wires 1, and lead-in wires 2 are connected to the ends of the grid coil. Lead-in conductor 3 provides a connection to the anode. The tube requires thorough baking out and exhaustion to a vacuum as good as the ordinary vacuum tubes. During exhaustion current is passed through the tube to heat the anode in order to expel any surface impurities or oxide of special importance because it has been found that in order to obtain the most satisfactory operation the anode surface should be as clean as possible. It is convenient to make the grid of tungsten and to use this as a cathode during exhaustion. By this expedient sufficient current may be passed through the tube to heat the anode to the desired degree without any danger of injury to the cathode.



Tube, circuits and graphic curve of the single battery vacuum tube hook-up

Figure 2 shows a circuit using the tube detector. The battery, which may be of about 6 volts, furnishes heating current for the cathode, a variable resistance being inserted in series with this battery in order to adjust the current through the cathode to the desired amount. The grid circuit comprises the grid condenser, inductance and variable capacity for tuning the circuit. The anode is connected to the positive terminal of the battery through the telephone receiver. The grid connection is brought to the positive terminal of the cathode.

It has been demonstrated that the operation of this tube with the circuit shown depends upon the gradual building up of a negative potential upon the grid by reason of the charging of the grid condenser by successive radio frequency impulses received, and the leakage of this charge during the interval between successive signals. In order for it to operate most efficiently the normal grid potential should be such that a small variation in its potential will produce a large variation in the current between the cathode and anode. Figure 4 shows a curve which represents this relation. It will be seen from an inspection of this curve that when no signals are being received and the grid is therefore at substantially zero potential with respect to the cathode, the circuit will operate upon that portion of the curve which is practically straight and which is also substantially the steepest portion. The maximum degree of amplification will also be obtained when operating upon this portion of the curve. If the normal grid potential is positive, the current taken by the grid will be much greater than when the grid is at zero potential or negative, and as a result the changes in grid potential produced by the signals will not be as great as when the potential of the grid is zero or negative. It is evident that no extra battery is necessary in the grid circuit to adjust the device for most efficient operation. In order that the negative charge upon the grid which is accumulated thereon during the receipt of a signal may leak off after the signal has been received and before the succeeding signal is impressed upon the grid circuit, it is desirable to employ a grid leak shunting the condenser.

There is a tendency for the grid to assume a negative potential with respect to the cathode when no signals are being received, especially if the grid is connected to the negative terminal of the filament. To avoid this the grid is connected to the positive terminal of the filament as indicated in order that there may be at all times a slight leakage current between the grid and cathode.

The use of a cathode of tungsten has the advantage over other cathodes in that the cathode may safely be operated at a high enough temperature to give the electrons emitted an appreciable initial velocity. This initial velocity of the electrons will be great enough to cause a current flow between cathode and anode without any source of potential in the external circuit. By reason also of the fact that the material of the anode is electropositive with respect to that of the cathode there will be a greater flow of current between the two than there would be if both were of the same material. There will also usually be a slight drop of potential through the resistance, and this drop of potential will cause the anode to be slightly positive with respect to the most positive end of the filament and thus assist the action of the tube. The connection shows the anode as positive with respect to the negative end of the cathode by an amount equal to the potential of the battery.

Figure 3 indicates a modification of the circuit which is adapted to receive continuous wave signals by the heterodyne method. The plate circuit of the vacuum tube includes an inductance which is coupled with the secondary coil in such a way that local oscillations will be produced which are of slightly different frequency from the received oscillations and which will combine with the received oscillations to produce beats in the telephone receiver. A variable condenser is employed as a shunt to the telephone receiver in order that the high frequency component of the current in the plate circuit may not be compelled to pass through the receiver. In order that a circuit of this type may be operated as an oscillator it is necessary that it should be adjusted to a point where it will act as an amplifier to such a degree that the energy which may be returned from the plate to the grid circuit is greater than the energy losses of the circuits. Other tubes have required a separate source of potential in the plate circuit to bring them to a point where their energy amplification would be great enough to produce oscillations.

A C. W. Transmitter Using House Lighting Current

A SIMPLE combination of apparatus which converts a single phase alternating current into continuous high frequency oscillations has recently been developed by Mr. D. G. McCaa.

Figure 1 shows a system for producing sustained oscillations in a radiating circuit.

Figure 2 shows the phase relations of the low frequency currents in certain parts of the system and also illustrates the type of primary and secondary high frequency oscillations as well as their relations with reference to power, to the low frequency current.

In figure 1 a source of alternating current is shown—such as an alternator of any definite frequency—ranging for example, from twenty-five to two thousand cycles, or the mains of a commercial lighting system in which a sixty cycle current is supplied at a pressure of one hundred and fifteen volts.

Connected to this source, in parallel with each other, are two circuits A and B, and of these the first includes a key, a condenser (3) and the primary winding (4) of a transformer (5). The secondary winding (6) of this transformer is connected in the circuit with two condensers, 7 and 8. The latter condenser also forms part of a circuit including a quenched spark gap (3) and the primary winding (10) of a high frequency transformer. The secondary winding of this transformer is connected in a circuit which includes the antenna, the secondary winding of a second high frequency transformer, and a ground connection.

The second main circuit (B) includes a key, a reactance coil (17) and the primary winding (18) of a transformer (19). The secondary winding (20) of this transformer is connected in circuit with a second reactance coil (21) and with a condenser (22). The latter has in shunt to it a quenched spark gap (23) and the primary winding (24) of the second high frequency transformer, whose secondary is connected in the antenna circuit.

The circuits 8-9-10 and 22-23-24, are preferably designed to have equal capacities (8 and 22), equal inductances (10 and 24), and the same gap conditions, although this uniformity is not absolutely essential to successful operation. These two circuits constitute the primary high frequency oscillatory systems which supply the secondary or antenna system and maintain it in continuous oscillation under operating conditions. The function of the remainder of the apparatus is to supply to the condensers 8 and 22, low frequency high tension currents which are of equal power and which are properly controlled as to the amount of power and properly spaced as regards their time relation.

In an oscillatory circuit such as that provided by the elements 8-9-10 or 22-23-24, it is possible by properly adjusting the capacity regulating the length and number of the spark gaps, and controlling the supply current, to obtain highly damped discharges at exceedingly high group frequencies. The damping is independent of any reaction by a secondary circuit and the action of the discharges in the secondary circuit assumes a type of impulse excitation. Group frequencies of from twenty to forty thousand impulses a second are obtainable and as the primary discharges occur throughout the major portions of each alternation of the low frequency high tension charging current, continuous oscillations are produced in the secondary circuit when this is coupled to the primary circuit, or system operating as above described, throughout the major portion of the time of each low frequency alternation, provided the decrement of the oscillations in the secondary circuit is not too high.

For efficient operation the supply current must be properly controlled, and this can be accomplished by the introduction of capacity, resistance, or inductance, in either the primary or secondary, or in both the primary and the secondary circuits of the supplying transformer. In this case, capacity operates as a capacity reactance determinable by the formula $\frac{1}{2\pi NJ}$, in which N is the frequency and J is the capacity. Inductance operates as magnetic reactance and is determined by the formula $2\pi NL$. Both the capacity and inductance operate in a manner similar to resistance and limit the current flow.

The condensers 3 and 7 in the circuit A and the reactance coils 17 and 21 of the circuit B are so designed relative to the transformer windings 4 and 6 on the one hand and to the windings 18 and 20 on the other, as to permit the same currents to flow to charge the condensers 8 and 22. With the arrangement of circuits shown in figure 1, the current flowing to the condenser 8 will be out of phase with the current flowing to the condenser 22. This would not be the case if resistance was employed to control or limit the current flow to these condensers, for the capacity provided in circuit A, by the condensers 3 and 7, causes the current in the circuit to lead the impressed electro-motive force, while the inductance provided by the coils 17 and 21 in circuit B, causes the current in the latter to lag behind the impressed electromotive force. In both circuits the inductance of the primary and secondary windings of the transformers 5 and 19, is balanced against the capacity of the condensers 8 and 22.

In order to obtain the proper time relation between the currents supplied to the condensers 8 and 22, it is essential that the sum of the increase of the angle of lead shall be equal to 90 degrees. This phase relation is illustrated in figure 2, in which the line 25, with ordinates above and below the abscissa 26 (denoting time), represents the impressed electro-motive force and current of supply 1, assuming these to be in phase. The curved lined 27 similarly represents the current leading the impressed electro-motive force by an angle of 45 degrees, the distance from the vertical line 28 to the parallel line 29 being equal to one-fourth of one alternation. The curved line 30 represents the current lagging behind the impressed electro-motive force by an angle of 45 degrees, the distance from the line 29 to the line 31 being equal to one-fourth of one alternation. Obviously therefore the currents represented by the lines 27 and 30 are 90 degrees apart, or at right angles or in quadrature to each other and therefore in quarter or two phase relation.

While the impressed electro-motive force of the source and the current supplied are usually not in phase, this condition will not interfere with the operation of the system, since suitably selected capacities and reactances may be employed to advance or retard the current as required, until the desired 90 degrees phase difference is obtained. It is not necessary that the current in one circuit shall be advanced 45 degrees and the other retarded the remaining 45 degrees as indicated in figure 2, since any angle of lead and any angle of lag may be employed provided the sum of the two angles equals 90 degrees.

Since the lead effect of capacity and the lag effect of inductance are decreased by resistance, it is preferable to keep the ohmic resistance of the circuits relatively low.

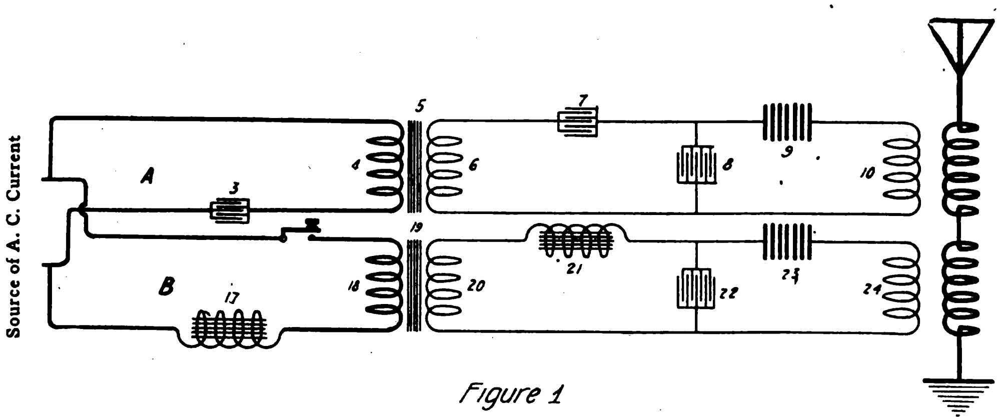


Figure 1—System for producing sustained oscillations in a radiating circuit

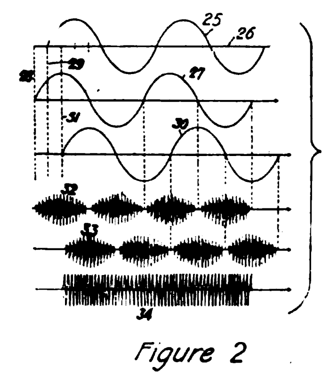


Figure 2—Phase relations of the low frequency currents

As indicated in figure 2, the condenser 8 will discharge as described during the time period of the alternations of its supply current, the highly damped primary discharges induced by the current, indicated by the line 27, being represented at 32 and their power by the varying ordinates of this line. Similarly the variations in the discharges resulting from the current flow indicated by the line 27, are illustrated by 33.

The oscillatory primary impulses excite the secondary or antenna circuit by shock or impulse excitation and permit it to oscillate in its own natural period during the time intervals between the primary discharges. From the relation of the primary discharges as regards the power indicated by the ordinates of the oscillations 32 and 33, it will be seen that power is supplied to the antenna at a uniform rate and that, as indicated at 34, the antenna oscillations are continuous, owing to the overlapping of the primary discharges and the balancing of the power supplied to the two circuits. The line 34 therefore, represents the secondary or antenna oscillations and its ordinates are all equal, by reason of the quarter phase relation and of the above described adjustment of the current flow in the primary oscillatory systems 8-9-10 and 22-23-24.

Radio Telephony Systems Employing Thermionic Vacuum Tubes

By John Scott-Taggart

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

(*Continued from February* WIRELESS AGE)

WE Will now leave the subject of separately excited systems and proceed to deal with the different methods of varying the oscillatory output of a three electrode vacuum tube. There are chiefly two methods of accomplishing this—one is to vary the grid voltage and the other is to cause the microphone to vary the plate potential of the oscillating tube. Varying the grid voltage is one of the very oldest methods, the fundamental arrangement is illustrated in figure 11. The usual oscillating vacuum tube circuit is employed. In

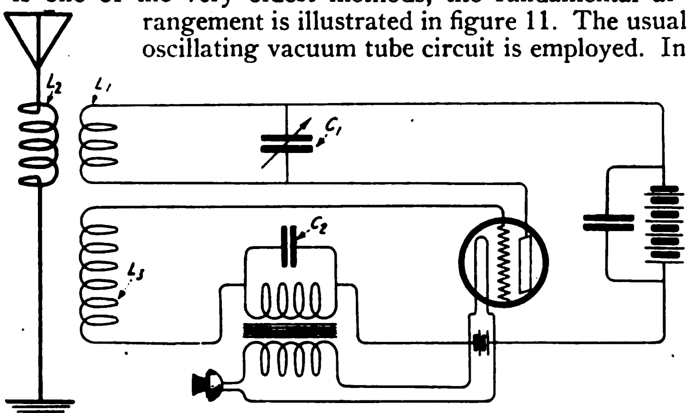


Figure 11—Fundamental arrangement for varying the grid voltage

the grid circuit is connected a secondary of a microphone step-up transformer, a condenser C_3 is connected across T_2. One way of looking at the action of this arrangement is to consider the characteristic curve of a three electrode vacuum tube. When the grid potential is such that the operating point lies half-way along the steep portion of the curve the oscillatory output will be a maximum and will rapidly decrease as the grid potential is varied on either side. When the grid potential is altered so that the operating point or base-line is near a bend in the characteristic curve the oscilla-

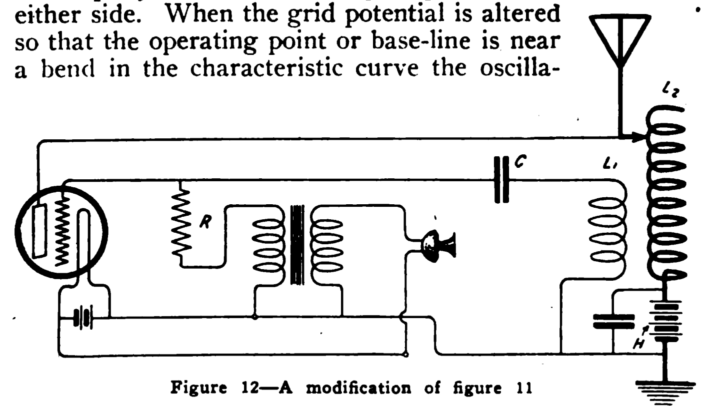


Figure 12—A modification of figure 11

tions will suddenly cease. By connecting the microphone transformer in the position shown in figure 11 the output of the tube V_1 may be modulated by means of the microphone and good speech is obtainable. If desired, a grid battery may be included in the grid circuit of V_1 to give the grid a suitable normal potential. The aerial circuit L_2 is shown loosely coupled to the plate oscillatory circuit L_1 C_1 but, of course, direct coupling could be employed if desired. A modification of the figure 11 circuit is shown in figure 12. The grid condenser C is connected as shown while the grid leak R has in series with it a secondary T of a microphone transformer. The normal grid base-line is thus operated as before, but the two circuits are now connected in parallel instead of in series. A still further modification of the figure 12 circuit is obtained by connecting R directly across the grid and filament of the three electrode vacuum tube and placing the secondary in parallel with this resistance. A still further modification in which the essential grid control feature is still present is illustrated in figure 13. This time, however, a three electrode vacuum tube V_2 is used in place of a grid leak. This arrangement is quite effective but has the disadvantage of requiring a separate accumulator to heat the filament of

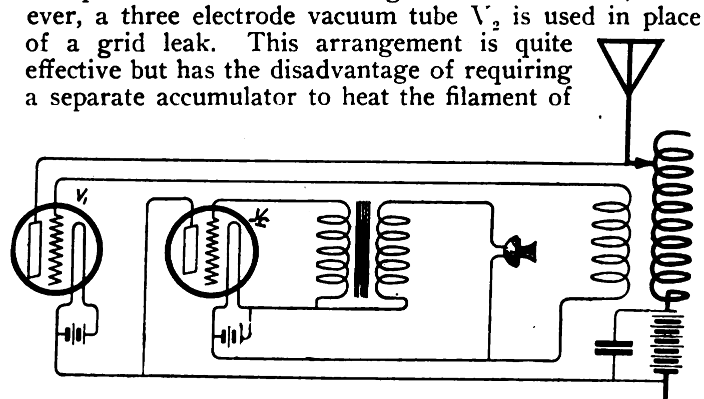


Figure 13—A further modification of figure 11 in which the grid control feature is present

the tube V_2. Although we have shown the microphone transformer connected in the grid circuits, yet it is obviously possible to amplify the microphone potentials by means of a three electrode tube before applying these potentials to the grid of the oscillating tube. Instead of using one grid two may be employed, the microphone potentials being applied to one grid while the high frequency potentials necessary to maintain oscillations are applied to the second grid. The arrangement is shown in figure 14. The grid nearest the filament has impressed upon it the low frequency microphone

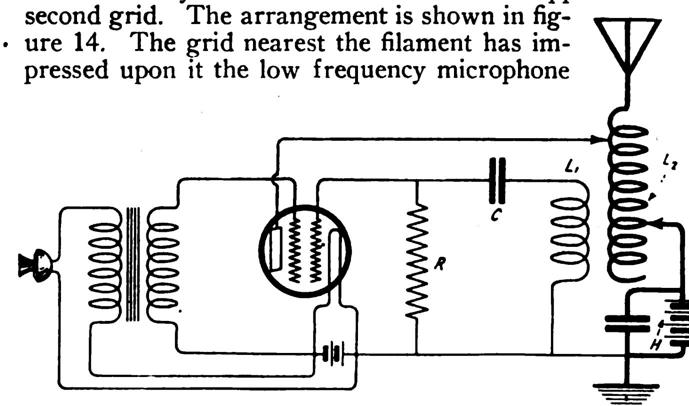


Figure 14—Circuit using a double grid tube to amplify the microphone potential

potentials supplied through the intermediary of the step-up transformer. The other grid is connected in the usual way to the grid oscillatory circuit L_1. As a variation the grid leak R may be connected directly across the grid and the filament instead of across the grid condenser C. It is claimed that this arrangement is more suitable than the usual circuit of figure 11, moreover it is more convenient for high power work, since to obtain effective control it is desirable that the variations of plate current produced by the high frequency potentials and the microphone potentials should be of the same order of magnitude. When working on high powers the high frequency grid potentials are very high, whereas the potentials supplied by the microphone are comparatively low. The arrangement of figure 14 overcomes this difficulty but a tube having two grids is difficult of construction and the circuit is not likely to be of great use for experimental work. The potentials supplied by the transformer control the plate current of the tube and so the oscillatory output.

We now come to another form of modulation which has been very largely employed in commercial and service radio-telephone sets, particularly by the United States Navy. The basic modus operandi of this system of control rests on the well known fact that the output of an oscillating vacuum tube is directly proportional to its plate potential. If, then, we cause the microphone to vary the plate potential we will obtain modulated high frequency currents. The fundamental circuit is shown in figure 15. In the plate circuit of the oscillating tube is connected a secondary of a microphone transformer, and the potentials across the secondary are used to supply the plate voltage of the tube V_1; at least, the positive half cycles of microphone current are utilized, the negative half cycles, of course, being wasted. Under these conditions the tube would only oscillate when the microphone is spoken into, thus nothing would be radiated from the aerial when not speaking. It is found that very poor speech is obtained when such an arrangement is employed. This is due to the fact that the change from the non-oscillating to the oscillating state is very jerky, and, moreover, takes a certain time. Much better results are obtained if a small battery H be included in the plate circuit; it is only necessary that its voltage should be big enough to make the vacuum tube oscillate feebly. When speaking the microphone potentials are impressed on this steady emf. and fairly good speech is obtained. It is preferable, however, to give H a large value approximately equal to half the electromotive force required to produce saturation of the tube. The microphone potentials supplied by the transformer secondary are made of corresponding magnitude so that the plate voltage of the tube is made to vary between approximately zero and twice its normal value; thus the aerial is radiating a main oscillatory current which is varied between almost zero and twice its normal amplitude. It will thus be seen that the microphone supplies part of the energy. Very good speech indeed may be obtained by using this system of control.

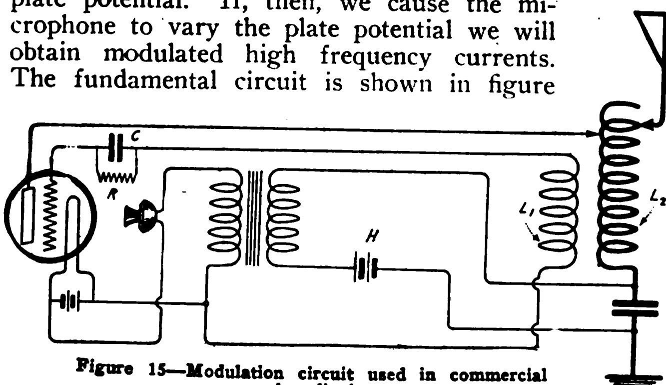


Figure 15—Modulation circuit used in commercial and radiophone sets

An elaboration of figure 15 is shown in figure 16. The power supplied to the plate is derived from the amplifier tubes V_2 and V_3, the original modulating potentials being obtained from the microphone. Although two vacuum tubes have been shown yet one might be used for small powers, or several for high powers. It is desirable to use larger vacuum tubes at the different stages of amplification, thus V_2 may be larger than V_3, or several tubes may be connected in parallel to obtain the same effect. The final tube or tubes V_2 should be rated at about the same powers as a main oscillator tube or tubes V_1. The grids of all the vacuum tubes are given a negative potential which is preferably derived from the potential drop across the grid leak R of the oscillator tube V_1. A battery or dynamo H supplies the normal plate voltage for the tube V_1, and this normal value is increased or decreased by the potentials supplied by T_6. These potentials will have a maximum value about the same as H but will, of course, vary according to the loudness and characteristics of the speech spoken into the microphone. The circuit may be of interest as illustrating how the minimum of batteries may be employed for practical radiotelephone work, thus the same battery H supplies not only the plate current for the first tube V_1 but also the plate current for the two tubes V_2 and V_3. If we desire to make the system quiescent when not speaking, the battery H may be made very small, in fact, just sufficient to maintain oscillations in the aerial. The extra potentials for the amplifying tubes V_2 and V_3 could then be obtained by inserting a battery or dynamo or other source of electromotive force between the positive side of H and the junction point J. This extra electromotive force would act in series with H.

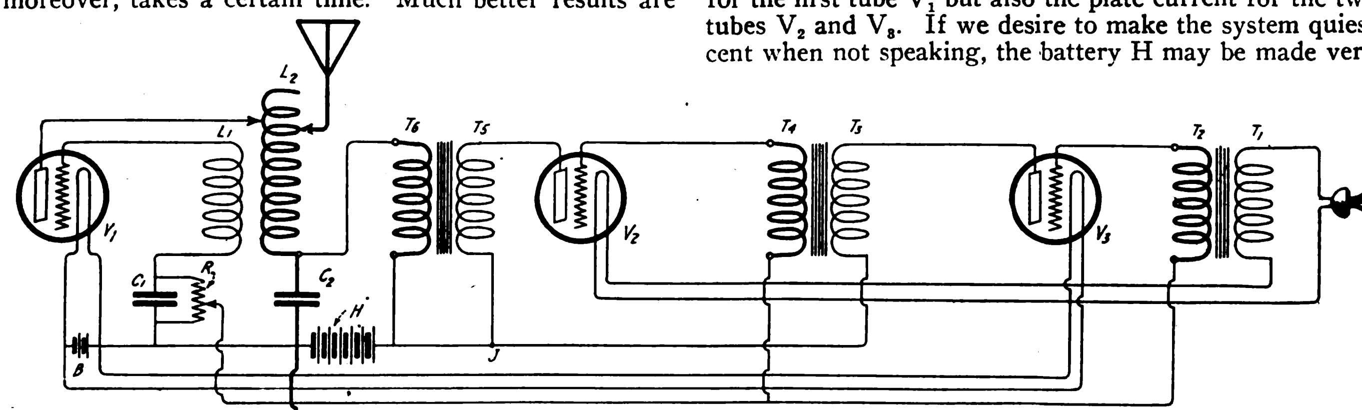


Figure 16—An elaboration of figure 15

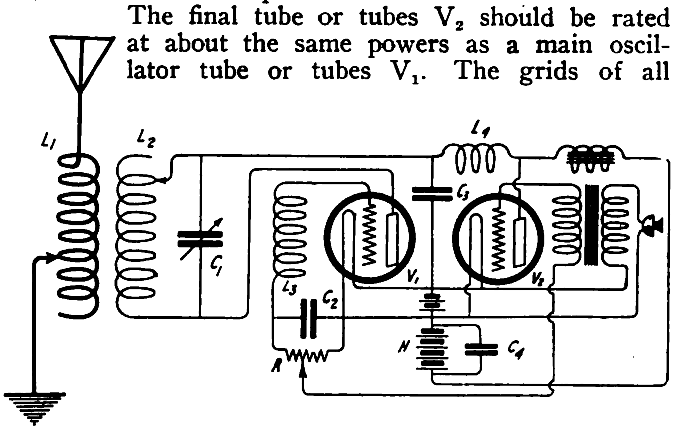


Figure 17—A modulation circuit used extensively in aircraft work

The most popular system of modulation is shown in figure 17. This arrangement has been very largely used in this country and also in Great Britain for aircraft work. Two vacuum tubes V_1 and V_2 are used, the first mentioned acting as a generator of high frequency current, while the latter is used as a modulator tube. It will be seen that the same battery or other source of voltage H is used for both tubes. Instead of using a transformer an iron-core choke coil is employed, the effect, however, being practically the same. If we consider the modulated tube V_2, we will see that variations of grid potential produced by the microphone through the intermediary of the microphone transformer will vary the plate current of this tube, consequently a varying current will flow in the choke and large surges of potential will be established across this coil. These potentials will act in series with the electromotive force supplied by H, surges will add themselves to the voltage of H and will also subtract themselves from it. The plate potential of the main oscillator tube V_1 will consequently be correspondingly varied between practically zero and about twice its normal value. The oscillations produced in the output circuit of V_1 will consequently be modulated in accordance with the microphone potentials, which is what is desired. Instead of a loosely coupled arrangement between L_1 and L_2 a direct coupled circuit may be employed. A condenser C_3 is used to by-pass the high frequency current generated. To prevent this current affecting the tube V_2 and its circuits an inductance L_4 is sometimes included in the position shown. This inductance preferably has a natural frequency equal to that of the oscillations produced by V_1. The grid of V_2 is given a negative potential by taking a tapping from the grid leak R of the oscillator tube V_1. The circuit has been varied in very many ways, but most of these depend upon the practical fundamental circuit of figure 17. The two tubes V_1 and V_2 require to be of the same power.

(To be continued)

A Vacuum Tube Transmitter

AN improved method for modulating the amplitude of a high-frequency wave in accordance with the wave form of a low frequency signal to be transmitted has recently been described by Raymond A. Heising.

The possibility of producing a modulated high-frequency current depends upon the fact that the amplifying power of the vacuum tube increases with the voltage impressed upon its input terminals. If a variable voltage, corresponding to the signals to be sent, is impressed upon one part of the input circuit, and if the high-frequency alternating voltage is impressed upon another part, the high-frequency power appearing in the output circuit will vary in accordance with the low-frequency signal voltage. In applying these two voltages it is essential that the change in amplification be produced by the signal voltage, so the latter should be larger. It has been found that telephonic communication may be maintained even if this condition is violated, but the quality is somewhat impaired.

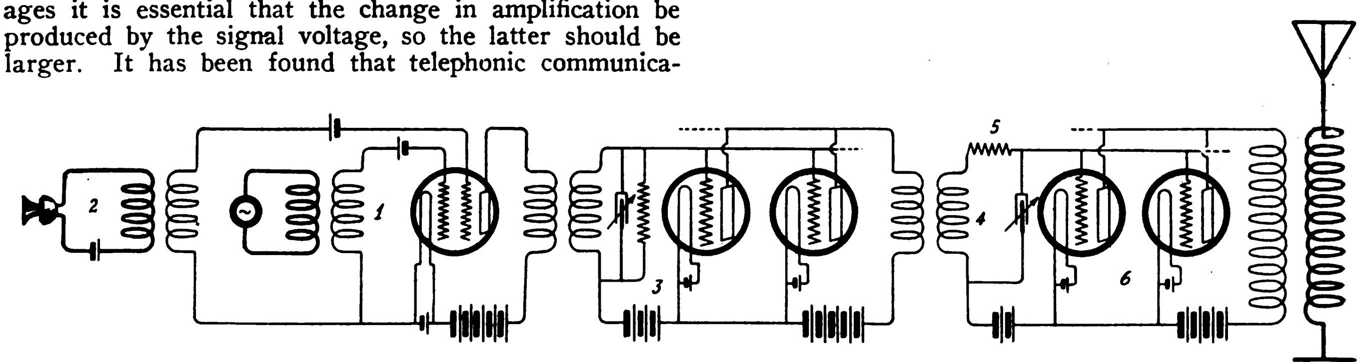


Figure 1—The Heising modulation system

The circuit arrangement which has been found by experiment to be most desirable is shown in figure 1. A generator of high-frequency power is shown which need not have a large power capacity, since it is required to furnish but a small high-frequency voltage. By means of the transformer the electromotive force developed by the generator is impressed upon one grid of the divided input circuit of the amplifier 1.

A microphone is represented at 2. The transformer whose primary circuit contains the microphone, provides that a signal voltage produced in the microphone circuit shall be impressed upon the second input element of the amplifier. Grid batteries are used. Under these circumstances no electrons can pass from the filament to either input electrode, and therefore practically no current is taken by the input circuit. The output circuit of this amplifier contains the coil to which is coupled a tuned circuit whose frequency may be adjusted to that of the wave to be transmitted. A high non-inductive resistance is preferably placed in shunt to the condenser—the object being to adjust the resonant circuit for sharp tuning and also to insure a definite impedance to incoming waves by the input circuits of the amplifiers.

The amplifiers 3 are arranged in parallel and have their input circuits connected across the terminals of the resonant circuit. The object of these amplifiers is to produce in the output circuit a voltage considerably larger than that appearing over their input circuits, and it is not essential that the power output of this set be large. The resonant circuit 4 is also tuned to the frequency to be transmitted. The input circuits of a number of amplifiers 6 arranged in parallel, are connected to the terminals of this second resonant circuit. The resistance 5 is added because it has been found to render more stable the operation of the amplifiers. These amplifiers are especially designed to produce high currents in their output circuits rather than high effective alternating voltages, and therefore the combination of amplifiers 3 with amplifiers 6 serves to increase both the voltage and current components of the power appearing in the output circuit of the modulator element. In practice it has been found possible to employ as many as 500 amplifiers. The common output circuit of amplifiers 6 is finally coupled, by means of a transformer, to the antenna.

The operation is as follows: High-frequency voltages impressed upon the grid from the generator are, in the absence of an electromotive force due to the microphone, simply repeated in enlarged form as variations of current in the output circuit. When an electromotive force of the signal wave form is impressed upon the grid the effect of the signaling voltage is to change the amplifying power of the repeater and consequently to change also the amplitude of the high-frequency current variations in its output circuit. A modulated high-frequency current is therefore produced in the primary windings and its effects are transmitted to the antenna by means of the intermediate apparatus, whose operation has already been described in detail.

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 Resistance Radio Telephone

By R. R. Ramsey

IN radio telephones we have a source of alternating current of high frequency which sends current out into the aerial. The disturbance in the ether which is caused by this current is called the carrier wave. The amplitude of this wave is changed or varied by a device known as the modulator, which is controlled by the voice.

Since the three electrode vacuum tube has come into use tubes are used as generators of the carrier wave and also as modulators. This is usually accomplished by connecting the telephone transmitter to the tubes with tuned or untuned inductance coils. In the case of the tuned coils, each set of coils must be separately tuned for every change of wave length. The untuned inductance method avoids this difficulty with a certain loss of efficiency. In either case one coil is liable to affect the second coil so that disagreeable cross squeals are set up in the set. The cascade amplifying receiving sets have the same defects so that all amplification is produced by audio coils, untuned coils, or by resistance amplification, tuning being in the main circuits alone.

With an idea of securing simplicity and cheapness in radiophone apparatus I have devised a wireless telephone connection in which the modulation is accomplished by means of resistance alone. A diagram of the circuit is shown in figure 1. The oscillating circuit consists of the aerial, the inductance and the variable oil condenser connected to the ground.

All tuning is accomplished by changing the connections to the inductance coil, and by varying the capacity. Two tubes or two sets of tubes are used. I is one or more power tubes or hard tubes connected in parallel. Two power tubes, shown in the figure, are the oscillating tubes by means of which the energy is sent out into the aerial. II is an ordinary receiving or amplifying tube by means of which the current from the telephone transmitter is amplified. The transmitter is connected in series with a resistance R_1, and a battery D, of two or more ordinary dry cells. The resistance R_1 should have a resistance equal to that of the transmitter. The variation of the current through the carbon transmitter causes a variation of the potential difference at the terminals of the resistance R_1. This varies the potential of the grid of tube II, and causes a corresponding variation of the current of the plate circuit of this tube. This current flows through the grid leak resistance R_2 and thus modulates the amplitude of the current sent into the aerial by the tubes I. R_2 should be a resistance comparable to the impedance of tube II. The battery is an ordinary plate battery of 20 or 40 volts. H is a source of high potential, about 300 volts.

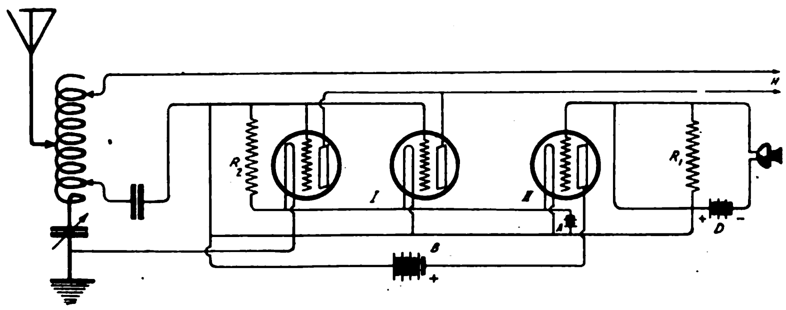


Figure 1—The resistance radio telephone circuit

This circuit has been tried out with good results, using an aerial of poor construction. With an antenna current of 200 milliamperes the voice was transmitted to a portable coil aerial of six turns 2 meters square at a distance of one-half mile, which would lead one to expect a range of five or ten miles with a good receiving aerial. The resistance R_1 is an ordinary resistance box. R_2 is made of card board painted with india ink.

Long Wave Arc Reception Simplified

By Howard S. Pyle

THE reception of the long, undamped wave stations now scattered over the world, is a far simpler matter than one would believe. Although many elaborate arrangements for such reception have been presented, involving three coil tuners and numerous variable condensers, little has been said on the simpler side.

In designing such sets, many amateurs pattern their apparatus after Government instruments with which they have become familiar during their war service, without taking into consideration the fact that the majority of these receivers are designed with selectivity as the prime consideration, and the design includes many steps of amplification rather than a sensitive unit receiver. The average amateur cannot afford many steps of amplification, and should therefore endeavor to obtain sensitiveness in the receiving apparatus, with a fair degree of selectivity. It is with that object in view that the design herewith presented was worked out.

The set described was built and installed aboard a small lighthouse tender here, having an aerial of four wires, 45 feet long and 25 feet high, and no difficulty has been experienced in hearing the German stations, day and night, using but one bulb for reception. Simplicity of construction, low cost and ease of operation, combined with remarkable efficiency, makes it particularly attractive to those whose experience and pocket book are limited.

The whole success or failure of such an outfit lies in the coils used in the tuner. Contrary to general practice, no secondary is used, merely a single coil, with a tickler coil placed in inductive relation thereto. Figure 1 gives a suggested method of mounting to permit variation of coupling. The tuning coil is wound on a form of convenient size, 4 inches being a good diameter, and contains 500 feet of No. 30 single cotton covered wire. It is advisable to tap this winding in five places, mounting a switch on the coil form. Both coils are wound in the same manner, no attention being paid to winding the wire evenly. A groove ¼x¼ inch, forms a very good winding space, although a depth of ⅜ inch will permit of a layer of bookbinders' cloth to be pasted over the finished coil on completion, adding to the appearance.

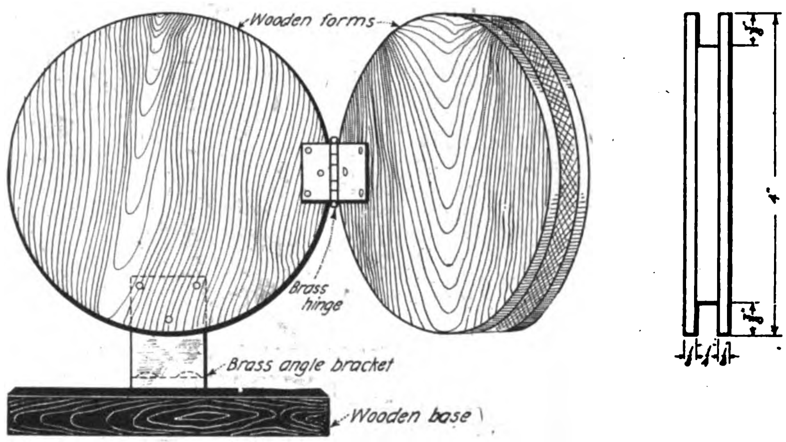


Figure 1—Constructional details of the mounting

The tickler contains approximately one-third the amount of wire used on the tuning coil, and may also be No. 30 single cotton. This should have about three equal taps and the switch mounted on the coil head as in the case of the tuner coil. Binding posts for both coils are mounted near the lower edge of the coil form, and flexible silk leads led to binding posts on the base. If the coil forms are finished in black enamel, and metal parts nickled, the instrument is very attractive.

It will be noted in the accompanying diagram that only one variable condenser placed across the tuning coil is necessary. It is recommended, however, that a small variable of about eleven plates be used in the grid lead, and another of the same size shunted around the telephones and B batteries. The tuning condenser should be of .001 mfd. capacity.

Any ordinary vacuum tube control panel may be used, by merely breaking the plate lead, and leading the broken ends to the terminals of the tickler coil.

The cost of the apparatus, tuner coil, tickler coil and variable, will not exceed five or six dollars, which should make it attractive to many readers.

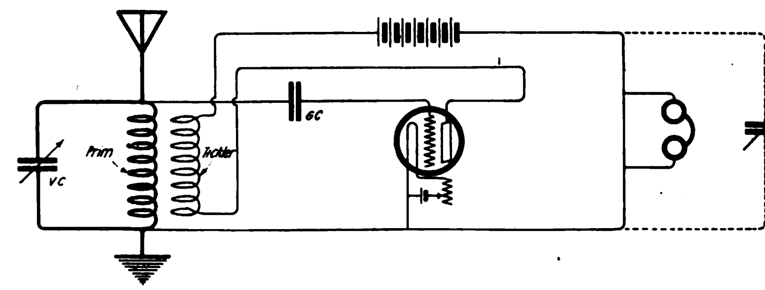


Figure 2—Circuit diagram for long wave arc receiving

With careful attention paid to construction as described, and connections properly made with stranded wire and securely soldered surprising results will be obtained, and the time and money involved will be well spent.

Transmitting Music by Radiophone

LITERALLY music is in the air. It is being transmitted by wireless, and whereas formerly young and old congregated at the music store to hear their favorite selections on the phonograph it is now possible to corral musical vibrations from out of space. The Government radio laboratory is periodically conducting experimental concerts by wireless which can be heard for over 200 miles and the music is distinctly audible 30 miles away.

The usual method of transmitting music by wireless utilizes a microphone placed in a receiving horn on the phonograph. Another method undergoing experiment includes the adaptation of the microphone directly to the needle instead of using the reproducer on the phonograph. With this latter method some of the distortion attributed to sound waves is eliminated. The vibrations from the reproducing needle are conveyed directly to the microphone instead of assuming the form of sound waves in the horn of the phonograph, and then being converted into mechanical vibrations in the diaphragm of the microphone.

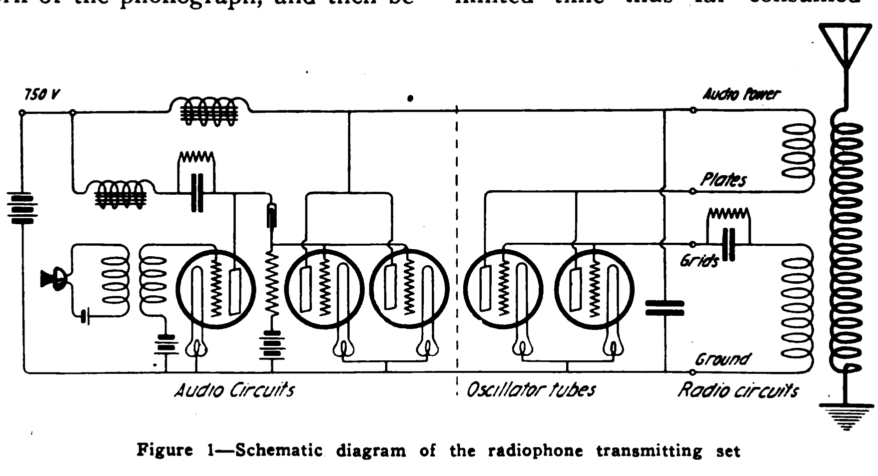


Figure 1—Schematic diagram of the radiophone transmitting set

Of the two methods, there is no preference at present, owing to the limited time thus far consumed in drawing comparisons. To obtain the correct modulation for different kinds of music, it would seem that varying positions of the microphone for different sorts of phonograph records would be advisable. It has been observed that certain notes, usually the higher ones, are not as readily distinguished at the receiving station as other notes lower down in the scale.

The radio laboratory of the Government has hitherto allotted one day in the week—usually Friday evening from 8:30 to 11 o'clock—for experimental concerts. A wave length of 500 meters is used. The radio operators have substituted a carbon microphone—as used in the mouthpiece of an ordinary telephone—for the vibrating diaphragm ordinarily used on the phonograph. Consequently, the phonograph sound record produces direct variations of electric current in the telephone apparatus instead of creating sound. While no sound is heard where the phonograph record is being played, the music is easily heard by individuals at distant receiving stations.

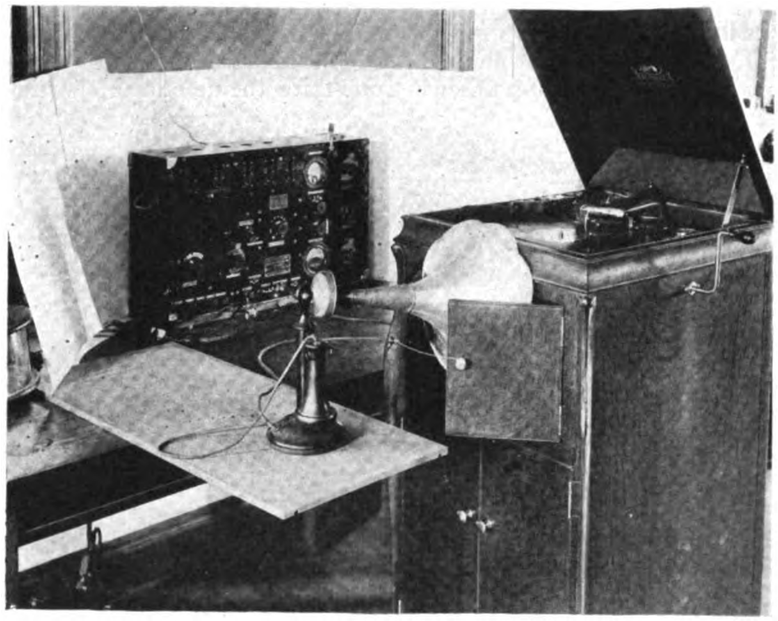


Figure 2—Radiophone transmission of music created by phonograph

A Two-Step Audio Frequency Amplifier

By C. F. Smith

THERE seems to be a distinct change in the methods and aims of the radio experimenters during the last year and a half. They are no longer satisfied with a collection of instruments which will bring in signals. They want to make their own apparatus, and they want it to look like the commercial product. This tendency suggests the co-ordination of commercial practice with the facilities and abilities of the average worker. The amplifier described in this article was designed with this in mind, as well as a consideration of economy in time and money.

The diagram of connections shown in figure 1 is of the conventional sort, composed of two transformers, two tubes and rheostats, binding posts for the input—6 volts for the filaments—and the telephones. An amplifier of this type can be depended upon to operate consistently at all times, where complicated circuits have a habit of going wrong when it is necessary for them to work properly.

Although the usual practice is to mount all the instruments behind the panel on this set a base is employed which carries some of the apparatus and acts as a support for the panel. It measures 7⅜ x 5 x ½ inches, while the panel is 10 x 5 inches. The panel may be ⅛ inch thick, but 3/16 inch will be better.

Figure 4 illustrates the method of fastening the panel to the base. Three ½-inch holes are bored along the front edge of the base, with their centers ½ inch from the edge. Then holes to

(*Continued on page* 36)

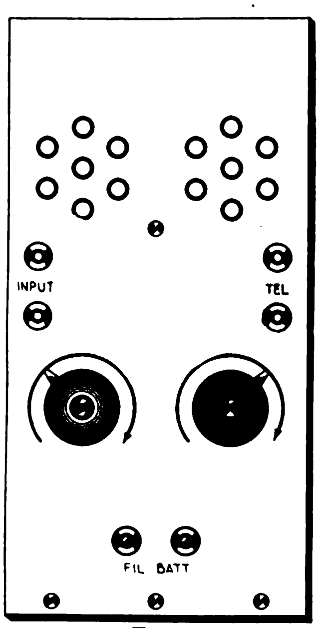


Figure 2

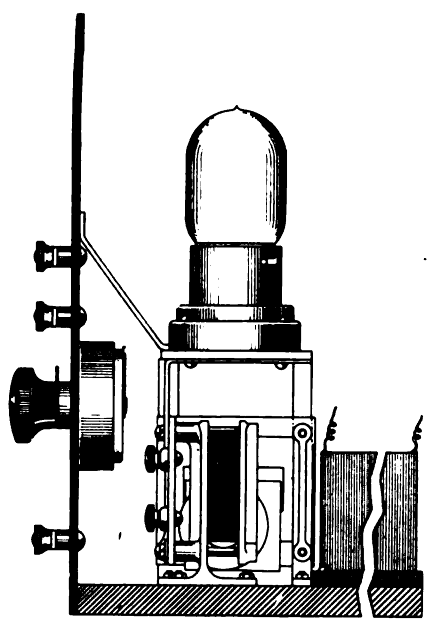


Figure 3

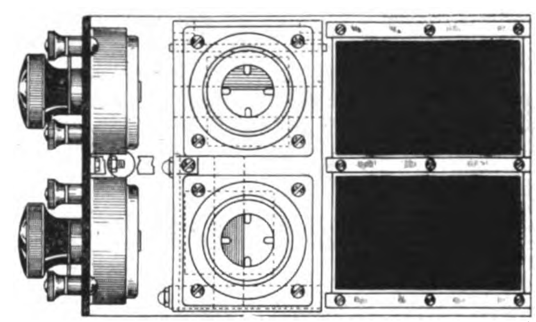


Figure 4

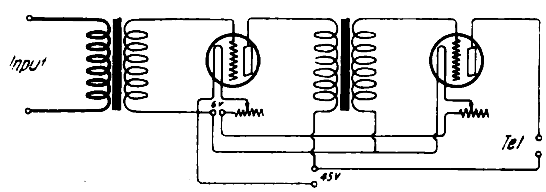


Figure 1

Circuit and constructional details of the two-step audio-frequency amplifier

A One-Operation Control of Honeycomb Coil Units

By R. R. Batcher

FIRST PRIZE, $10.00

THE following type of coil mounting makes provision for holding four sets of coils, any pair of which may be connected in the circuit when desired, thus controlling the coupling by one operation. While this mounting and control may seem a little large in size compared with ordinary mountings, the advantage of having all coils mounted permanently in one case and the absence of capacity effects, due to freedom from handling the coils in changing wavelength range, have considerable weight.

Many amateurs have found that the continual removal and replacing of coils in the ordinary adapter soon weakens and cracks the moulded base. Very often also the wire is loosened by knocks received while the coils are lying around when not in use. For ordinary use four sets of coils will provide any desirable range with the necessary overlap. However, no recommendation is made as to the size of coils. Each amateur can select the ones required from available catalogue data.

This mounting has four rotating coils mounted on a movable or rotatable plate with the plate so mounted that the coils swing past four stationary coils similarly placed in a parallel plane on a fixed panel. Both the movable and fixed plates holding the coils carry commutators upon which brushes rest to connect in one of the coils at a time. On the movable plate the brushes are stationary and the commutator rotates with the coils, but on the stationary coils the brushes, fastened to the end of the shaft, rotate and the commutator is stationary.

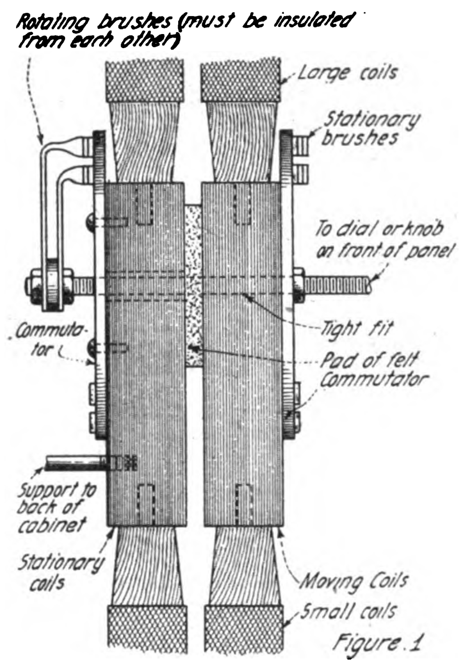
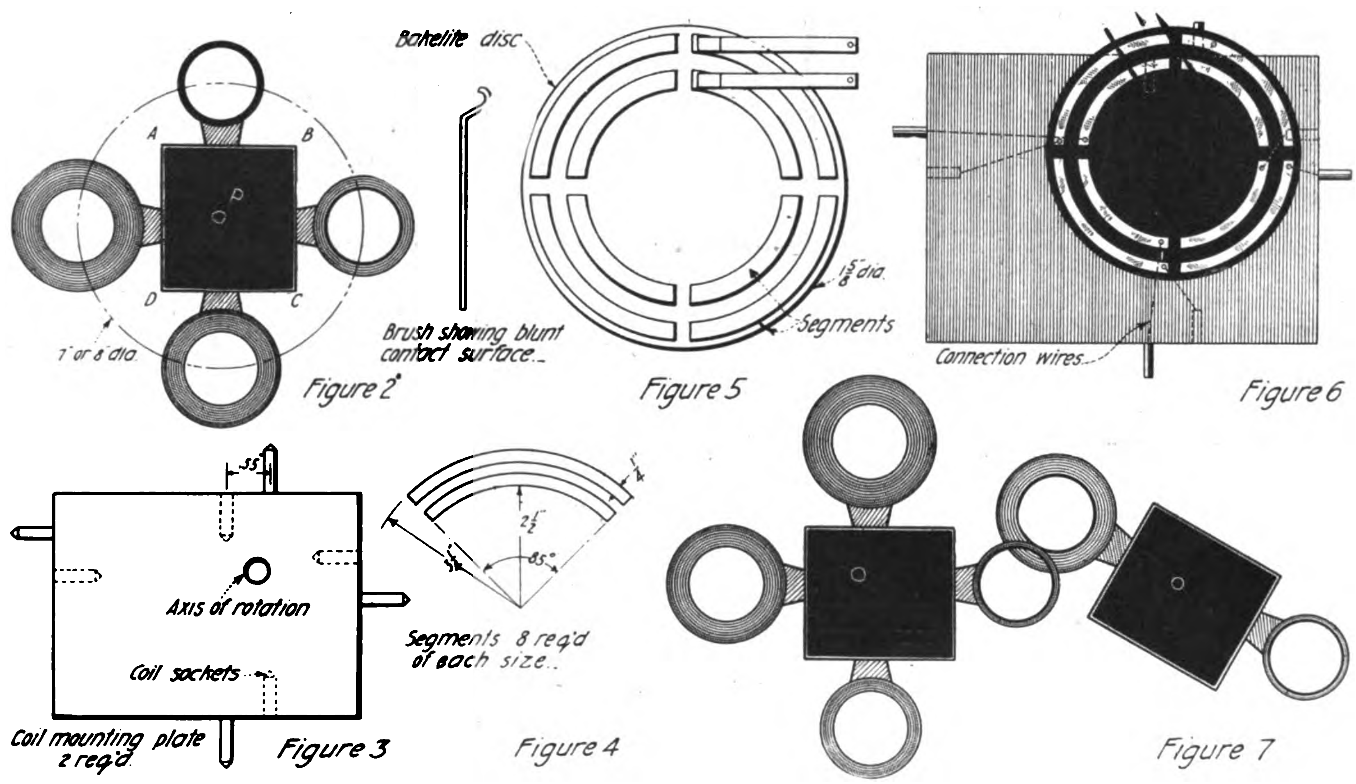


Figure 1—Assembly of the honeycomb coils control

With this arrangement the coupling between any two coils may be varied up to about 90 degrees by moving the disc through that angle and turning the disc a few degrees beyond that point connects the next set of coils, on which the coupling may again be varied through 90 degrees before the third set of coils are connected in, and so on through the four sets of coils. It will thus be seen that both the size of coils used and the coupling between them is under the control of one dial or knob.

As various sizes of coils have different diameters and weights though possessing the same thickness, it is necessary to drill the hole for the shaft off center on the rotating plate, in order that the weight may be equally distributed. This plate is rectangular in shape, and is about one inch longer than the width.

The plate should be made of bakelite 7/8 inch thick. As the size of the plate will vary according to the selection of coils to be used no other dimensions are given, but the following method can be used to advantage in determining exact dimensions. On paper lay out an eight-inch circle and mark its center (P). Equally spaced on the circumference of this circle lay the four secondary coils with the axis of the winding coinciding with the edge of the circle and with their bases extending inward. This is shown in figure 2. A rectangle (shown as A B C D) is inscribed in the center. The



Details showing bakelite plate, commutator segments, brushes, tickler coil in position and various construction plans and dimensions center of the circle (P) will coincide with the point where the plate is to be drilled for the shaft. The shaft should be at least ¼ inch in diameter. On the edge of the plate pins and holes are made to fit the standard honeycomb coil bases. Figure 3 shows a specimen plate made according to this plan.

The commutator segments may be cut from thin copper or brass sheet as shown in figure 4. Two sizes are necessary and eight are required of each size. They are fastened by small brass pins to a 3¼-inch bakelite disc 3/16 inch thick, as shown in figure 5. Two of the discs shown in figure 5 will be required, one being affixed to the rectangular plate as shown in figure 6. A side view of the completed rotor is shown as part of the assembly diagram, figure 1.

The stationary coils are mounted rigidly on the second rectangular plate as shown in figure 3. The two sets of coils should pass each other with as little clearance as possible. A felt pad placed between the rotating and stationary plates will act as a friction brake to prevent the heavier coils on the rotor from whirling around to the lowest point. The brushes should not touch two segments of the commutator at the same time and the surface of contact should not be too large. A type of brush shown in figure 5 is suitable for this work. The two brushes mounted on the end of the shaft must be well insulated from each other and from the shaft as well. Flexible copper ribbon or stranded cable can be used to bring out the connections from the moving elements.

In order to use tickler coil connections a second rotating set of coils may be mounted alongside the first set controlled by a second dial or knob so that the coils come within the field of the first system, as shown in figure 7. It is not necessary, however, to use four coils on this rotor, as two sizes are ordinarily sufficient. The dial markings should bear four scales each going from 0 to 90 or 0 to 100 covering the whole 360 degrees of rotation.

With this system a neat and entirely enclosed honeycomb coil mounting is provided by means of which adjustment of the coils is positively and readily controlled.

Honeycomb Coil Mounting

By Warren Wood

SECOND PRIZE, $5.00

THIS mounting is adapted to only one set of coils, the wavelength range of which can be extended by using tapped coils. The entire device is inclosed in a cabinet 12 inches long, 6 inches high and 6 inches wide, and condensers for tuning may be mounted in the same cabinet by making it higher. I mounted my condensers at each end and made the cabinet the same size as my short wave regenerative set cabinet, fixing it so that I can use the honeycomb coil cabinet on top of my detector and amplifier in place of the short wave set. Having the cabinets the same size so that they are interchangeable makes the set more practical.

Wooden centers with two holes bored in them are put in the honeycomb coils through which brass rods run for the coils to slide on. The coils are made to slide along the rod by turning a knob at the front of the cabinet. Either a dial or a pointer and scale are connected to the rod to indicate the position of the coils. The rod from the knob runs for an inch into the cabinet and an angle of brass is fastened as shown in figure 1 to hold it steady. At the end of the rod an arm of brass about 2 inches long is fastened securely. A second arm is fastened to the end of the first so that it can move back and forth. This arm is bent so that the end comes in line with the center of the coils where it is fastened to another arm an inch long which is screwed securely to the wooden center of the coil. By turning the knobs the coils are moved back and forth for inductive coupling.

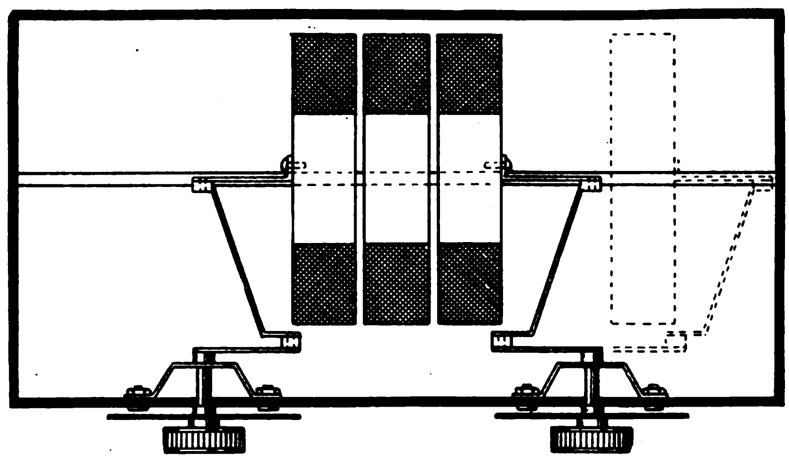


Figure 1—Top view showing operation of shifting coil

The dimensions given may be changed to suit the needs of the builder and if tapped coils are used there is enough room between or above and below the dials and knobs for the switches. A simple and very effective long wave set is secured through this method of mounting the coils and it is cheaply made as the coils may be bought unmounted.

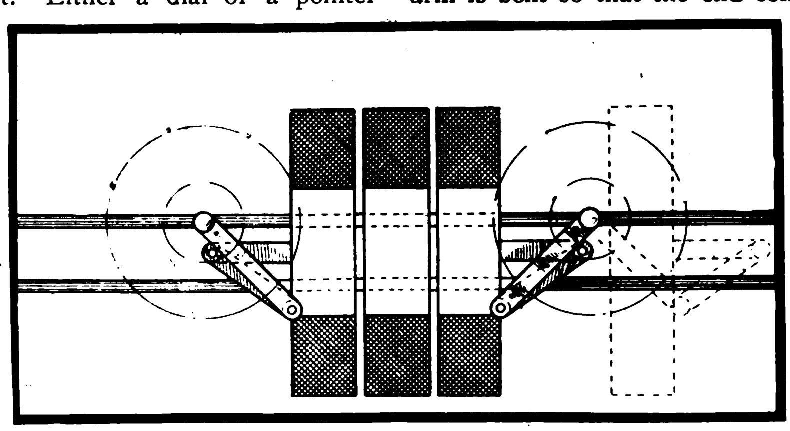


Figure 2—Front view showing arrangement of the arms

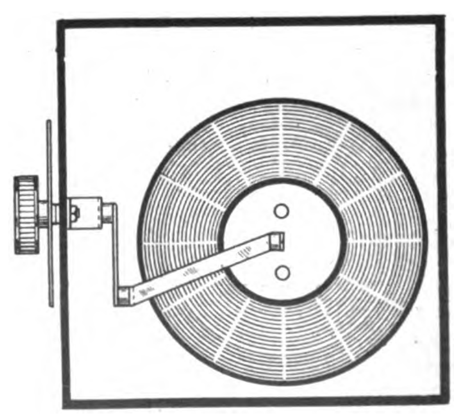


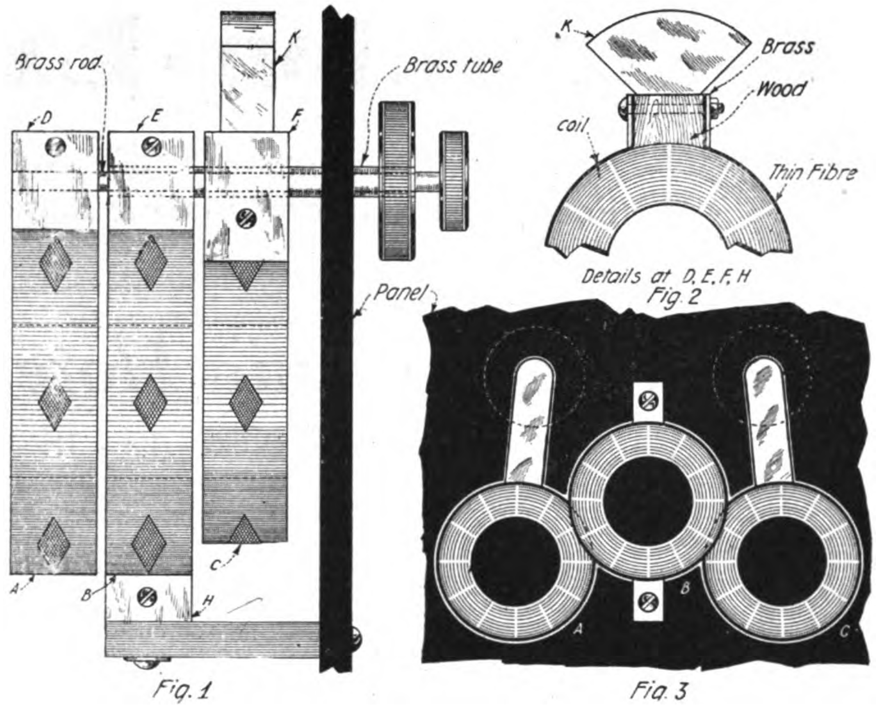
Figure 3—End view showing arm connected to coil

An Inductance Mounting

By D. R. DeTar

THIRD PRIZE $3.00

A MOUNTING for inductances of the lattice type should be simple, rugged, smooth in operation, and of good appearance. These features have been considered in the design of mounting here described. The detailed and constructional diagrams are almost self-explanatory. In figure 1 are shown three inductances, using concentric knobs. The coils, A, B, C, are mounted as shown in figure 2. Strips of thin fibre are wrapped around the periphery of the coils and clamped tightly between wooden blocks; the brass strips are held by means of bolts. The brass rod is fixed firmly in the smaller knob and in the block D, and is an easy, moving fit in the tube. The tube is fastened securely to the larger knob and to the block F, but is free to rotate in E. K. is a counterweight to balance the coil C. No weight is shown on coil A, but of course, one is necessary. In order that the coils may hold their adjustment, friction devices of some sort are necessary. Springs between D and E, and E and F, serve this purpose very well. In figure 3 is shown a variation of this method, wherein the concentric knobs are replaced by separate ones. The



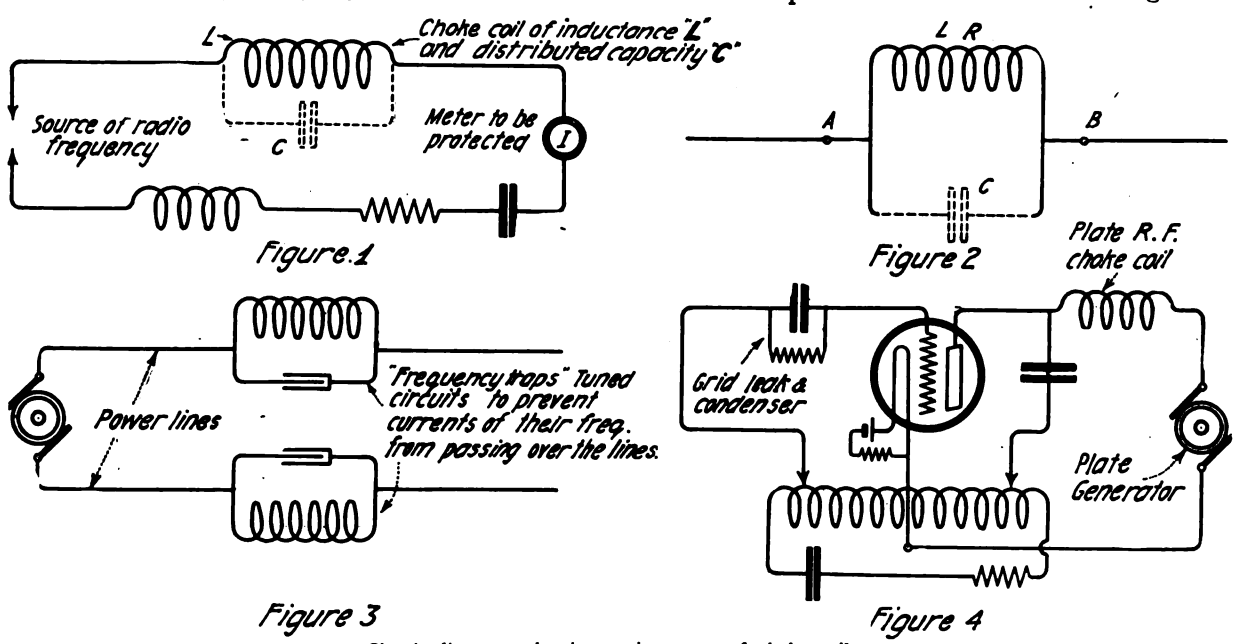
Front and side views of the mounting and detail of construction

mounting, etc., is virtually the same as shown in figure 1. No dimensions are given because they are optional with the builder.

The Use of Choke Coils in Radio

By A. Machson

THE primary and most important elements of a radio circuit are the inductance and condenser. It may therefore be instructive to consider the use of choke coils in radio circuits as a phase of inductance.



Circuit diagrams showing various uses of choke coils

The main function of an inductance coil when used as a choke is to protect apparatus behind it from high voltages or to limit the current flowing in an inductive circuit. When it is desired to limit the current, a current choke coil is used; when protection is desired from high voltages, a voltage choke coil is used. The current choke is more common in low frequency alternating current work, as in the primary circuit of resonance trans-

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formers, whereas the voltage choke is more frequent in radio. In low frequency work the choke consists practically always of an inductance, whereas in high frequency work the choke may be an inductance coil or a radio frequency circuit. In low frequency work the action of the choke depends essentially on the inductive reactance presented by the coil, whereas in high frequency the action of the choke, whether coil or circuit, depends both on the inductance of the coil and the distributed or concentrated capacity of the choke.

That the use of choke coils or circuits is a very important factor in radio will be evident from an examination of modern radio circuits. Choke coils and circuits are sprinkled all over, in one place to protect apparatus from high voltage, in other places to build up high voltages, and still other places to stop the flow of leakage or capacity currents. Diagrams of such circuits showing the special uses of the chokes will be shown and discussed.

The necessity for using chokes arises very frequently in experimental and research work until the circuits or designs are so perfected that the chokes may be dispensed with. It is therefore important to understand exactly how a choke coil functions and why it does so.

To the average amateur an inductance coil acts as a choke coil because it has a high inductance and offers a high reactance to the current at the given frequency, but in actual practice it is found that in some cases high inductances are very poor choke coils, and that frequently a small inductance properly built is an extremely good and efficient choke. That the amateur's idea does not explain the choking action of an inductance is also evidenced by the fact that a coil which may be a good choke at 1300 meters is a poor one at 300 meters.

The most effective choking circuit, if it could be built, is a capacity-free, high inductance. For in this case the inductance would indeed have a high pure inductive reactance, and this could always be made large enough for any choking purpose. But although considerable progress is being made in the design and construction of coils they still have distributed capacity.

Consider a choke coil of inductance "L," which has a distributed capacity "C" and assume it to be connected in a circuit as in figure 1. "I" is an instrument let us say which is to be protected, and which may not be shunted by a condenser for protection. The choke coil cannot be considered a pure inductive reactance, because there is a capacity reactance due to "C" in parallel with it, neutralizing the inductance. Now it is not difficult to conceive that many cases may arise, where, in spite of the fact that the inductance is high, the distributed capacity may be so high that it by-passes the current to be choked, and thus ruins the instrument which was to be protected. On the other hand the choke coil may be so designed that the distributed capacity assists and makes the coil an efficient choke.

An inductance, therefore, when used as a choke, must be considered in conjunction with its distributed capacity. Every turn has a capacity to every other turn. These small distributed capacities add up to an equivalent total capacity "C." This capacity is generally considered to be in parallel with the inductance, as in figure 2. Consequently the coil has a natural period of its own which is, according to the usual formula

$$T = 2\pi\sqrt{LC}$$

The simple analysis which follows will show when this choke coil acts as an efficient choke. Consider the coil as in figure 2, where "L" is the inductance, "C" the distributed capacity, and "R" the ohmic resistance. The impedance of the coil between the terminals AB at frequency "f," where w equals $2\pi f$, is as follows:

$$Z_{A\text{-}B} = \frac{1}{\dfrac{1}{R + jwL} + jwC}$$

$$= \frac{R + jwL}{1 + RCwj - w^2LC} = \frac{R + jwL}{(1 - w^2LC) + jwRC}$$

$$= \sqrt{\frac{R^2 + w^2L^2}{(1 - w^2LC) + R^2C^2w^2}}$$

If the coil is so designed that L and C tune to the frequency of the applied voltage, namely if $W = \dfrac{1}{\sqrt{LC}}$ and the resistance of the coil is negligible, that is R equals zero, then

$$Z_{A\text{-}B} = \sqrt{\frac{o + w^2L^2}{(1-1) + R^2C^2w^2}} = \sqrt{\frac{w^2L^2}{R^2C^2w^2}} = \frac{wL}{RCw}$$

$$= \frac{L}{RC}$$

Since R is assumed to be zero, then Z the impedance is infinite. However R is never zero but the coil can be designed so that it is very small, in which case Z, the impedance, is very great.

This result shows that if "R," the resistance of the coil is negligible the impedance of the choke to currents of its natural period, is infinite. If "R" is small, then the impedance is very large. Consequently to have an inductance coil act properly and efficiently as a choke, it must be designed so that its natural frequency will be equal or nearly equal to the frequency at which it is to be used. This shows that a coil acts as a choke, not so much because it has a high inductance, but because it acts as a tuned circuit whose impedance is very great at the frequency to which it is tuned.

(*Continued on page* 35)

Prize Contest Announcement

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

RELAY KEYS FOR SETS UP TO 1 K.W.

Closing date, April 1, 1921.

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

Prize Winning Articles Will Appear in the June Issue.

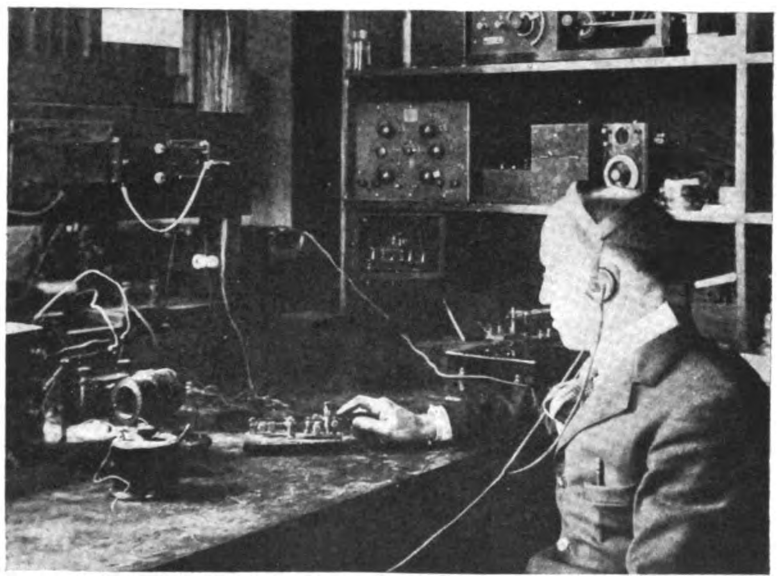
Experienced operators sometimes find it desirable to use small telegraph keys, cootie keys, or vibroplex keys (bugs), on their transmitters and it then becomes necessary to include a relay key in the circuit to handle the large current. The small contacts, on speed keys of the types mentioned, will not safely handle anything but battery current. The design and construction of a relay key should make provision for snappy action and an overload of 100 per cent.

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

Farmers' Market News by Radio

THE wireless telegraph as a means of dispatching a weather and market news service to farmers is being given a trial by the United States Department of Agriculture in the belief that market reports brought up to the minute would save the farming community thousands of dollars. The service embraces half a dozen counties in Virginia and Maryland, adjacent to Washington, D. C.



Wireless outfit at Kansas Agricultural College

Radio communication as a serviceable agency for farmers was introduced in the Kansas Agricultural College by E. A. Stewart, who was then a professor in rural engineering; the accompanying photograph shows the wireless outfit used at that time. While the system inaugurated by the Department of Agriculture contemplates the dissemination of news relating to market fluctuations, the modest effort of the Kansas Agriculture College confines itself to the distribution of weather forecasts. "Tune in and get the weather," was the invitation isued by the college authorities to thousands of farmers whose names and addresses are recorded on the mailing lists of the institution. Forecasts as to the conditions of the weather are sent out daily at 9.55 o'clock in the morning on a wave length of 375 meters. The rate of sending is 18 words a minute and from 8 to 10 words a minute where the message is repeated.

Profesor Stewart is planning the installation of a state-wide wireless service to farmers in Minnesota. The injunction, "Tune in and get the weather, John," may soon be as common on farms as the reminder, "Feed the calf, John." Why shouldn't the farmer use this method to help decide when to cut hay or alfalfa? The saving of one crop from the rain would pay the cost of a wireless set. A ready and efficient weather service would prevent losses from storms running into thousands of dollars in a single community. Warning of a winter storm of great severity generally gives the farmer and stockman ample time to house their cattle and sheep and make everything snug and tight for the impending blast, and a sending station could be used in times of distress, such as snow blockades, fires or tornadoes, to communicate with the outside world.

The wireless receiving set may also be used as a reliable indicator of weather conditions. Static electricity which is always present in the air increases when clouds are near and indicates storm conditions. The static will be heard 12 to 24 hours ahead of a clouded area, and for an hour or two preceding a heavy thunderstorm sparks may be seen to pass between the aerial and the ground, if the ground switch is opened a small distance. A receiving set put to this use would have considerable value on the farm in addition to getting the weather and market news.

The Use of Choke Coils in Radio

(*Continued from page* 33)

This analysis is the basis of the so-called "frequency trap," which is nothing but a closed circuit of inductance and capacity tuned to the frequency of the current which is to be choked out of a line (see figure 3). This arrangement of capacity and inductance to tune to the given frequency is satisfactory for power lines, telephone lines, etc., but in radio sets it becomes a little unwieldy, especially where experimental work is done and in small sets where the number of elements and space is reduced to a minimum. Hence, it is far more desirable to build small choke coils which, in themselves without the aid of concentrated capacity, will act as efficient chokes. The analysis shows that if coils can be designed to have sufficient distributed capacity to tune with the inductance the object will be attained.

The most satisfactory kind of coil for this purpose is the multi-layer square section coil. These have been designed and built for a large number of frequencies and have proved very efficient. It is not necessary to build a coil for each frequency, but it will be found by experimenters that a coil tuned to a given frequency acts as a very efficient choke coil over a fairly wide range of frequencies. Thus a 3-millihenry coil was found to give very good choking action over a 400 to 600 meters range of wave lengths, while a 15-millihenry choke tuned to about 1700 meters was found to give efficient choking action between 1500 and 2000 meters. These coils may be wound with various sized wires to accommodate different currents, but for average small power radio sets No. 22 wire is quite sufficient.

A set of coils consisting of say 1 mh, 3 mh, 6 mh, 12mh, 15 mh, and 20 mh will give enough range to cover the wave length band from 200 meters to 3000 meters. The construction of these coils is quite simple and has been described in numerous places, for example the article by Frank Bremer, May, 1920, issue of THE WIRELESS AGE.

As a practical illustration of the use of choke coils consider the oscillatory circuit shown in figure 4. This is a well known and widely used tube circuit for the generation of continuous waves, called the Shunt Feed Circuit. The condenser across the generator is for the purpose of eliminating the commutator hum. In this circuit it is absolutely essential that an efficient choke be placed in the plate circuit of the tube; for the generator is practically shunted across the plate circuit, forming a short circuit to the radio frequency voltage across the tube unless there is an efficient choke in series. The plate circuit choke prevents this and the most efficient coil found for this purpose is the multilayer choke mentioned.

It is to be hoped that this added knowledge as to the manner in which chokes operate will assist amateurs in designing coils according to their needs.

A Two-Step Audio Frequency Amplifier

(*Continued from page* 26)

take 8-32 machine screws are drilled through the panel into the base. Finally, flat head screws are inserted from the front, and nuts put on the screws inside the ½-inch holes. This makes a stronger mounting than if wood screws were employed..

The rheostats, of the Paragon type, are mounted 3½ inches from the bot-

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Amplifying Transformers

No. 166A General Radio unmounted....$4.50
No. 166A General Radio mounted...... 7.00
No. Z7392 Clapp Eastham unmounted... 4.00
No. Z7392A Clapp Eastham mounted... 6.50

Antenna Change-Over Switches

No. P-1 Kilbourne and Clark, bakelite base, good value..................$ 5.60
No. Y-658 Clapp Eastham 1 K.W. size. 12.50

Audion Control Panels

No. P-400 De Forest without cabinet..$10.90
No. P-401 De Forest with cabinet...... 13.25
No. P-500 De Forest with cabinet and 45 volts "B" battery 24.00

"B" Batteries

No. 7623 Standard 22.5V small $1.50
No. 7625 Standard 22.5V large 2.65
No. 7650 Standard 22.5V variable....... 3.50

Coils (Litz)

LL- 300 Mounted $2.10
LL- 750 Mounted 2.80
LL-1000 Mounted 3.00

Coil Mountings

No. LC-101 with gears and base......$12.00
No. LC-201 with gears and base and primary switch 14.00
No. LC-100 with gears but no base.... 9.00

De Forest Panel Units

No. US-100 Primary switch $2.40
No. US-200 Anti-cap switch 3.95
No. US-400 Two point tickler switch... 1.90
No. U-800 "A" bat. switch and tel. binding posts 2.00

De Forest Vernier Condensers

No. CV-1010 .001 without vernier in glass case $17.50
No. CV-1013 .001 with vernier in glass case 19.50
No. CV-1500 .0015 unmounted without vernier attachment 13.95
No. CV-1503 .0015 unmounted with vernier attachment 15.60
No. CV-1510 .0015 without vernier in glass case 18.95
No. CV-1513 .0015 with vernier in glass case 20.60

Note—Any of the above condensers are admirably adapted for radio telephone work.

Condensers (Variable)

No. F-800 .0006 Clapp Eastham Bal...$ 7.50
No. F-800A .001 Clapp Eastham Bal.. 9.50
No. F-800B .0015 Clapp Eastham Bal.. 11.50

Condensers (Low Voltage)

No. ES-355 1 MF 500 volts $1.25
No. ES-356 2 MF 500 volts 1.25
No. 21AA Western Elec. 1000 volts A. C. 2.50

Weston Meters (Model 301)

0-100 Milli-amps flush $8.50
0-200 Milli-amps flush 8.50
0-300 Milli-amps flush 8.50
0-500 Milli-amps flush 8.50
0-1 Ampere flush 8.50
0-2 Ampere flush 8.50
0-3 Ampere flush 8.50

Omnigraphs

No. 2 15 dial machine $30.00
No. 2A 5 dial machine 22.00

Regenerative Receivers

No. CR-1 Grebe 175-680 Meters $90.00
No. CR-2 Grebe 175-680 Meters 51.00
No. CR-3 Grebe "Relay Special" 175-680 Meters 65.00
No. CR-3A Grebe With tube control, 175-375 Meters 45.50
No. CR-5 Grebe's "Super-Special" 175-3,000 meters, tube control, self-contained. Complete receiving set. Just out $80.00
No. CR-6 Grebe 175-680 M. Det. and 2 step amplifier 200.00
No. CR-7 Grebe 500-20000 Meters "Long Wave Special" 210.00

Telephones

Baldwins Type C, Navy standard.....$16.50
Baldwins Type E, "Super-sensitive".. 20.00
Baldwins Type F, very small, light.... 21.00
No. CW-834 Western Electric......... 13.50
No. P-1 Brown 4000 ohms, extremely sensitive and light 20.00

Vacuum Tubes

No. UV-200 Radiotron, detector........$5.00
No. UV-201 Radiotron, amplifier 6.50
(These are the Radio Corp's new tubes)

Lead-in Insulators

No. 1 4½"x2" with ¼" wire hole.......$1.50
No. 2 Same as above but with ¼" rod.. 2.00
No. 3 6"x2" with ⅜" wire hole......... 2.50
No. 4 Same as above but with ⅜" rod.. 3.00

Condensers Transmitting (Dubilier)

No. D-100 250 W. 10,000 V. .007 MF..$19.00
No. D-101 500 W. 14,000 V. .007 MF.. 30.00
No. D-102 1000 W. 21,000 V. .007 MF. 45.00

Line Protectors

No. AM-888 Dubilier 1 K. W. size.......$4.00
No. 452 Murdock, with condenser...... 9.00
No. 453 Murdock, with rods 7.50
No. P-1 Clapp Eastham 1 K. W. size... 6.00

Spark Gaps (Plain)

No. 440 Murdock, zinc points $0.90
No. 7750 Beeko, porcelain base........ 1.40
No. P-1 Clapp Eastham, heavy zinc points with marble base.......... 3.95

Rotors

No. 443 Murdock, 3/16, ¼ or 5/16" shaft $3.00
No. T-1 Thordarson, 8 or 16 pt......... 6.00
No. B-1 Benwood, 8, 10 or 14 pt...... 8.00
No. H-1 Hyrad, 10 pt., 9ZN type......10.50

Rotary Gaps

No. 443 Murdock 4000 RPM..........$18.50
No. 124 Kiltzen, Improved model..... 26.00
No. B-1 Benwood, Noiseless 30.00

Quenched Gaps

No. G-1 Amrad 1 K. W. size $41.50
No. G-2 Amrad ½ K. W. size......... 24.50
No. G-3 Amrad ¼ K. W. size......... 12.00

Oscillation Transformers

No. T-1 Thordarson "Special" $12.00
No. TXL-100A International 14.95
No. Z-652 Clapp Eastham 1 K. W...... 20.00

Transformers (Transmitting)

No. F-1 Acme 500 Watt with bakelite panel, completely mounted $30.00
No. H-1 Acme 1000 Watt with bakelite panel, completely mounted 45.00
No. P-1 Thordarson 250 Watt Type "R" old model 15.00
No. P-2 Thordarson 500 Watt Type "R" 24.00

Note—These Thordarson transformers are splendid values at above prices.

Wireless Telephones

Type "O" De Forest A. C. type.......$260.00
Type "OT-10" De Forest D. C. type... 325.00
Type "O" Buzzerphone 135.00

C. W. Inductances

Type 181 Tuska $7.50
Type 181A Tuska, K. D. type......... 5.00
Type 182 Tuska (Magnetic type) 10.00
Type 183 Tuska (Tickler type)..........12.50
Type 170 Tuska Filter 16.00

C. W. Transformers. (Phone Work)

Acme 200 Watt mounted $20.00
Acme 200 Watt unmounted 16.00
Acme 50 Watt mounted 15.00
Acme 50 Watt unmounted 12.00

Choke Coils. (Phone Work)

Acme 1½ Henry 500 MA double coil...$8.00
Acme 1½ Henry 500 MA single coil... 6.00
Acme 1½ Henry 150 MA double coil... 6.00
Acme 1½ Henry 150 MA single coil... 4.00

Resistances. (Phone Work)

No. 1 Ward Leonard 5000 ohms........$1.75
No. 2 Ward Leonard 10000 ohms........ 2.95

Telephone Transmitters

No. 329-W Western Electric $3.95
No. 5175A Connecticut 3.90
No. 5176A Connecticut with short arm.. 4.25

Jacks and Plugs

No. WE-1 Western Elec. 2 circuit......$0.90
No. WE-2 Western Elec. open circuit... .55
No. WE-3 Western Elec. plug.......... 1.10

Books

Vacuum Tubes, by Bucher $2.25
How to Pass U. S. Exams............ 0.75
How to Conduct a Radio Club......... .75
Practical Amateur Wireless Station.... .75
Robinsons Manual of Wireless Telegraphy 2.50

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tom of the panel and 1¼ inches from the side. The center holes of the two groups for observing the filaments, are 2½ inches from the top and 1¼ inches from the side. Countersinking these holes slightly improves their appearance.

Engraved scales on the panel can be made with a sharply pointed scriber, and a pair of dividers can be used to make the arcs on the rheostat. The scratches should be made lightly at first, then gradually deeper. After the burrs have been sanded off and the scratches cleaned out again, they can be filled with a mixture of whiting and oil. A scratch finish on the panel, done with No. 1 sandpaper and oil, makes an attractive finish that is more permanent and easier to obtain than the polished finish.

In order to fit the transformers, which are of the general radio type, on a 5-inch base, it is necessary to have one in line with and the other at right angles to the base. Their position is shown in figure 3 and by dotted lines in figure 4. From the corner nuts on the transformers two brackets of ⅜ x 1/16-inch brass strip, 1 inch high, are erected. These support a bakelite panel 5 x 2½ x ⅛ inch, to which two Murdock sockets are secured. A bracket of ⅜ x 1/16-inch brass strip runs from the small panel between the sockets to the main panel.

Mounting the two 22½-volt B batteries on the rear of the base and securing them by small strips of wood screwed to the base preserves order and prevents damage resulting from constant shifting.

To secure a symmetrical appearance of the tube controls, it is advisable to make up a detector and one-step amplifier first, and later add a two-step amplifier. There is little advantage in having more than three steps of audio frequency amplification.

To operate this amplifier, it is only necessary to join the input terminals in place of the telephones in the plate circuit of a single-stage amplifier, and to connect the 6-volt filament battery and telephones. It will be found that the filament rheostat will give a control—for gas tubes—practically equivalent to that obtained by a variable plate voltage.

The Monthly Service Bulletin of the

National Amateur Wireless Association

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

New York Amateur Convention

A CONVENTION of amateurs that promises to excel anything yet accomplished in this line is scheduled to take place in New York City, on March 16th, 17th, 18th, 19th. The project is sponsered by all of the radio clubs of the Second District, and is to be managed by a committee appointed by the Executive Radio Council, with J. O. Smith as Chairman.

The beautifully decorated roof of the New Pennsylvania Hotel has been reserved for the Convention, and an exhibition of the latest apparatus manufactured for amateurs will be held within the glass enclosed structure. A lecture hall will be established in the adjoining room and prominent amateurs, engineers and manufacturers will appear in person to deliver papers of special interest to those who like to keep in touch with the latest developments in the field.

More than 10,000 invitations have already been issued and a record attendance is expected during the first three days, which will be devoted to the exhibition and lectures, with a smashing wind-up in the form of a banquet on the evening of the fourth day. There will be ample accommodation for all those who care to attend the daily sessions, but so great is the demand for seats at the banquet that those who wish to attend are urged to immediately make application, accompanied by $3.00 remittance, to Ferd. C. W. Thiede, 486 Decatur Street, Brooklyn.

Philadephia Repeats

FEBRUAIRY 26th and 27th are the dates set for the Second Annual Convention of the Third Amateur Radio District, to be held in Turngemeinde Hall, Philadelphia. Facilities to accommodate 1,000 amateurs have been arranged and reservations for board during the two days of the Convention can be secured through Dr.

Gordon M. Christine, 2043 N. 12th Street, Philadelphia, or H. Paul Holz, 1902 N. 11th Street, Philadelphia. Tickets for the banquet on the evening of February 26th, are being issued at a cost of $2.00 each.

One of the questions to be discussed at this important assembly of amateurs is the elimination of QRM, and it is planned also to visit radio stations in the vicinity on both days of the convention.

Amateur Cross Continent Reception

AMATEUR wireless records are said to have been broken by Howard D. Selvage of 45 Durand Place, Irvington, N. J., who claims to have heard messages sent January 4 by H. C. Seefred of Los Angeles to Gordon Bennett of Oakland, Cal., In reply to a letter of inquiry to verify the call, Mr. Selvage received word from both Seefred and Bennett stating that his hearing of such messages was correct and that the feat breaks all known records. Mr. Selvage, who is a member of the Irvington Radio Club, picked up the messages on apparatus in his home. Mr. Selvage heard the call at 2:55 A. M., Eastern time, or 11:55 P. M., Western time.

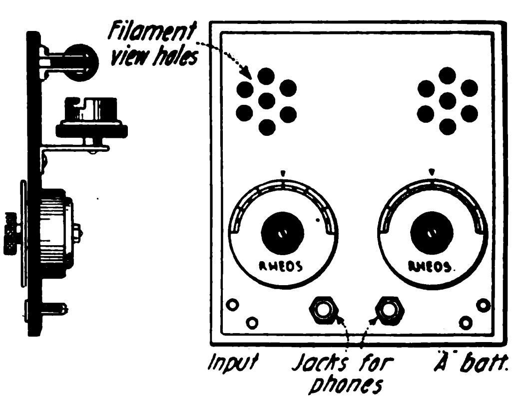
Some years ago a claim was made that stations in New York and Roanoke, Va., heard calls in Piedmont, Cal., and in Pasadena, Cal., but letters of inquiry failed to show that such calls had been made.

The Irvington Radio Club, which has a large number of young men as members, with headquarters at 53 Linden Avenue, is affiliated with the Second District Council. The club has been a pioneer organization in radio work in this vicinity.

An Efficient Detector-Amplifier

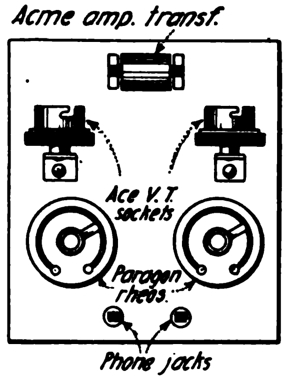
By Howard S. Pyle

IN the December number of The Wireless Age the writer described the construction of a "Sensitive and Compact Portable Receiver." A detector-amplifier unit for use in connection with such a receiver has since



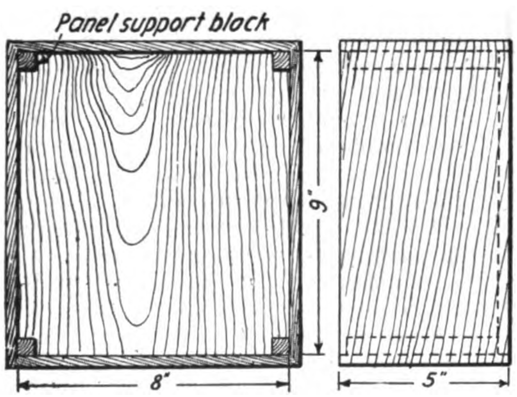
Side and front view of the detector-amplifier been built, and is giving excellent satisfaction. The unit idea is carried out by using the over-all dimensions of the receiver unit. This gives a symmetrical appearance when used in combination with other units and permits hook-up in various circuits.

The cabinet is constructed and finished exactly as the receiver unit, using ½ or 3/16 inch stock. Small blocks of wood are mounted in the four inside corners, 3/16 of an inch from the face of the cabinet to support the panel, which is 8x9 inches of 3/16 inch bakelite. The panel is secured in place by nickel plated round head wood screws in the four corners, located so as to strike the center of the supporting blocks.



Rear view showing table sockets and rheostats

The two tube sockets are mounted on the rear of the panel by means of brass angle brackets. The ACE type of socket was selected because of the suitable grid leak built into it. A small mica fixed condenser was inserted in the grid circuit. Paragon rheostats were used to vary filament current. An Acme semi-mounted amplifying transformer was placed between the tube sockets. Seven symmetrical holes were drilled on each of the upper sides of the panel, slightly countersunk from the front to permit observation of the filaments.



Constructional dimensions of cabinet

The plug and jack system was used for the telephones to permit the use of the detector alone or in combination with the amplifier by inserting the plug in the proper jack. The binding posts, knobs, etc., should be of a type to match those of the receiver unit. Scales and pointers or dials, if they are used on the receiving unit, may be used on the rheostats. The connections are the standard amplifier type, both filaments being lighted from one A battery, and a single plate battery of 45 volts, supplying both tubes. The class two, or hard type of tube should be used in the amplifier side.

If the builder has not yet finished constructing the receiver unit, it would be well to place the binding posts along the right hand side of the panel, and those of the amplifier unit on the left hand side, to facilitate strap connection. However, with the posts along the bottom of each panel, only short leads are necessary and can be made with stranded wire or black enameled copper, No. 14, in the rigid bus type.

The accompanying drawings illustrate the panel layout and general arrangement.

Amateur Wireless Outfits Increase

A large increase among amateurs in wireless telegraphy since the lifting of the ban against amateur radio activity a year ago is shown by records at the office of S. W. Edwards, inspector for the eighth radio district. The district comprises all of the states of Michigan, Ohio and West Virginia and that part of Pennsylvania as far south as Scranton and New York state as far east as Schenectady.

A total of 1,111 licensed amateur stations now are located in the district, in addition to 800 and 900 stations that are not licensed. The licensed amateur operators in the district numbered 1,297 at the close of 1920. There are 13 commercial wireless stations in the district.

A total of 141 lake vessels now are equipped with radio apparatus. Of the number, 58 are passenger vessels and 17 of these passenger vessels are required by law to have wireless. The Department of Commerce is encouraging the amateurs in the belief that the older ones will develop new ideas and inventions. About 250 of the amateur wireless men in the district are experimenting in wireless telephony.

Seneca Radio Association Hears Church Music

Amateur radio men, members of the Seneca N. Y. Radio Association report that church services in Pittsburgh were heard by radio phone. Beginning at 7:45 o'clock, the church service or musical service was heard distinctly.

Atlantic City Radio Association

The radio association composed of boys in and around Atlantic City, N. J., is still campaigning for more members.

More than they expected—

EVERY month since the Corwin Mail Order Service was started, hundreds of amateurs have ordered apparatus, expecting prompt shipments and fair prices. And invariably, the carefulness with which their orders were filled, and the perfect condition in which the goods arrived, have even exceeded their expectations.

If *you* think that *no* mail order service can be thoroughly satisfactory, perhaps a trial of Corwin Service will surprise you, also. See if you need any apparatus in this list.

Universal Coil-Mounting Plugs
Anyone can easily make smooth-running mountings with these plugs. Exceedingly accurate! Made to fit Radisco and all hand wound coils.
Price, 80 cents, postpaid.

VACUUM TUBES
Electron Relay $6.00
VT Amplifier, 1 lb. 7.00
VT Extra Hard 7.50

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A. R. Co. .001 .... $6.25
A. R. Co. .0005 .... 5.00
With No. 67 Dial add $1.00
Murdock 366 .... $4.75
Murdock 367 .... 4.75
Murdock 368 .... 3.75
Clapp-Eastham 800 .... 7.50
Clapp-Eastham 800A 9.50
Clapp-Eastham 800B 11.50
Complete with dial
Shipping weight One Pound.

GRID CONDENSERS
Radisco, Postage 3 cents 35c

ANTENNA SWITCHES
Murdock, 3 lbs. $4.50
Clapp-Eastham, 10 lbs. 12.50

OSCILLATION TRANSFORMERS
Radisco No. 5 .... $15.00
Via Express collect only.

RADIO CRAFT PRODUCTS
Detector $15.00
Two step Amplifier 50.00
Detector and 1 step 45.00
Detector and 2 step 70.00
Postage paid.

"B" BATTERIES
Radisco No. 1, 2 lbs. $1.50
Radisco No. 5, 5 lbs. 2.65
Everready Storage battery prices on application.

TUSKA C. W. APPARATUS
181 Coil, 2 lbs. .... $ 7.50
182 Coil, 2 lbs. 10.00
183 Coil, 3 lbs. 12.50
170 Filt., 8 lbs. 16.00

AERIAL WIRE
7 x 22 tinned copper
100 feet, 2 lbs. $1.25
200 feet, 4 lbs. 2.40
500 feet, 8 lbs. 6.00

AMPLIFYING TRANSFORMERS
A.R. Co., 1 lb. $5.00
Federal, 1 lb. 7.50

JACKS AND PLUGS
Federal Closed Circuit 85c
Federal Open Circuit 70c
Federal Double Circuit $1.00
Federal Plug 2.00
Postpaid

ALL RADISCO COILS and Wireless Press Books.

ROTARY SWITCHES
Clapp-Eastham, No. 19 .... $1.00
Clapp-Eastham, No. 19A .... .85
Our Own, No. 1 .... .40
Our Own, No. 2 .... .55
Postage .... .05

CORWIN DIALS
No. 66, 3" .... $ .75
No. 67, 3" with knob 1.30
No. 68, 3¾" 1.00
No. 69, 3¾" with knob 1.70
Postpaid.

RECEIVERS
Murdock No. 55, 2000 ohm $4.50
Murdock, No. 55, 3000 ohm 5.50
Brandes Superior 7.00
Baldwin C 16.50
Baldwin E. improved 20.00
Brownlie, New 12.50
Shipping weight 2 Pounds

CONTACT POINTS
CP-No. 1 Brass, dozen 25c
CP-4 Brass, dozen 35c
CP-5, Nickel Plated, dozen 45c
Postpaid.

VARIOMETERS
Radisco No. 1 .... $7.00
Radisco No. 1D 8.50
3 pounds.

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

A. H. CORWIN & COMPANY
Dept. C3. 4 West Park St., Newark, N. J.

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DETECTOR TUBE
TYPE C-300
WITH STANDARD FOUR PRONG BASE

TYPE C 300 invites comparison. Amateur requirements decided its design. Many years' research of vacuum tube properties have made Type C 300 the Ideal Amateur Receiving Tube. Detector sensitiveness at low plate voltages requires that gas action be combined with the electron emission and by a **wonderful new process of manufacture** this gas action is so controlled that the plate voltage for maximum signal audibility is always within the limits 18-22½ volts. Only a single block cell is needed in the plate circuit—a big saving in battery investment. Type C 300 is completely silent in operation—a decided advantage in receiving weak signals.

Any three member vacuum tube is necessarily an amplifier but the results obtained from Type C 300 as a tone frequency amplifier with only 22½ volt plate battery proved a surprise. Again Type C 300 invites comparison. Competitive tests show this tube to excell any tone frequency amplifier previously developed. For power amplification in operating loud speaking telephones and in complex and multistage circuits use the special Pliotron amplifier Type C 301 for freedom from distortion. Write for special Bulletin C 301.

Type C 300 is a free and persistent oscillator for regenerative amplification and CW reception.

The pleasure and satisfaction from operating Type C 300 cannot be described. See your dealer today — or write for his name and copy of Bulletin C 300.

TYPE C-300
$5.00

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ARLINGTON TESTED CRYSTALS

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New 1920 Red Head Phones

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The Newman-Stern Co., Distributors for DeForest, Murdock, Signal, Bunnell and other famous lines.

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Bridgeport Radio Club

Interest in wireless among Bridgeport people is evident from the fact that there are now 87 fully equipped wireless stations in the city. Frank M. Hamm a member of the local high school faculty, is responsible for this increase in radio study and operation by amateurs of the city.

Back in October, 1919, Mr. Hamm came to Bridgeport. He was a wireless enthusiast, and was disappointed when he found but three wireless stations in Bridgeport.

However, he did not allow his disappointment to go unremedied, but set about the task of interesting Bridgeport folk in the fascination of wireless. He chose as a basis for this work the High School Annex, the home of the Freshman class, and organized the Bridgeport High School Radio Club. Interest in the club increased by leaps and bounds until the name of the club had to be changed. Interest on the outside became so evident that others than high school students were admitted to the club and the name was changed to the Bridgeport Radio Club. Today there are 87 wireless stations in Bridgeport, and with one exception, the owners of the stations are members of the Bridgeport Radio Club originated at the High School Annex in October, 1919.

The original members of the club continued their work during the summer vacation and when they returned to school in the fall they found requests coming from every side for admittance to the club The enrollment became so large that it was necessary to divide the club into two sections, the junior section for those who had no previous experience in wireless, and the senior section for those who were further advanced in the work.

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.

W. O., Covington, La.

The trouble seems to be in your receiving coils, which may be open in some way. Suggest that you test them carefully with phones and battery for continuity of circuits.

* * *

A. F., N. Y. C.

The formulæ you require are not available at this writing.

J. F., Jr., Danville, Illinois.

There is practically no difference in results, although when all wires are connected the voltage distribution is more even, and the mechanical strength is improved in case an insulator should break.

* * *

F. A. F., U. S. S. Acushnit.

The wave length of your aerial is approximately 225 meters. We cannot state just what the capacity would be. Why not measure it?

* * *

F. C. G., Detroit, Mich.

Operators generally write down each letter as received; with practice one can copy a few letters behind. Your difficulty in copying will correct itself with practice. "The Wireless Experimenter's Manual," by Bucher will no doubt clear up apparatus trouble.

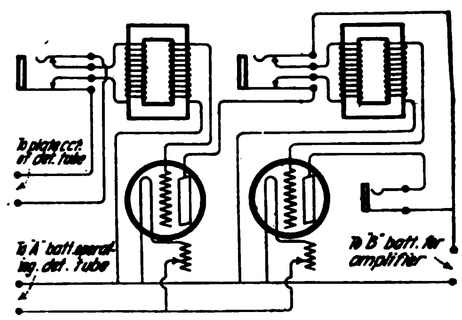
* * *

H. C. H., Westtown, Pa.

We do not know of any college giving a four-year course in Radio Engineering and issuing a degree.

* * *

H. J. S., Owego, N. Y.



The amount of high voltage needed is a matter for trial and depends on the individual tube you are using.

* * *

D. R., Calty, Wis.

A number of ships are equipped with arc transmitters, although in general ships and land stations operate with arc sets on about 2,000 meters or above.

Both filaments burn with practically the same brilliancy, although this is a matter of trial. For various hook-ups see Bucher's "Wireless Experimenter's Manual." Without knowing the exact hook-ups of the Mignon set referred to, we cannot give an answer to your question. Honeycomb coils, two in series, can be used as a variometer.

* * *

F. A. K., Osborn, Ohio.

In figure 215, page 269. "Wireless Experimenter's Manual," condenser C2 can be a variable one up to .001 mfd. The upper side of the generator connected to the plate is positive. Tungar bulbs will not handle much more than 100 volts without arcing. In regard to a wireless transmitter using a 30-mile steel wire line we fail to see why such a system is needed. Let us have more exact data on the subject.

* * *

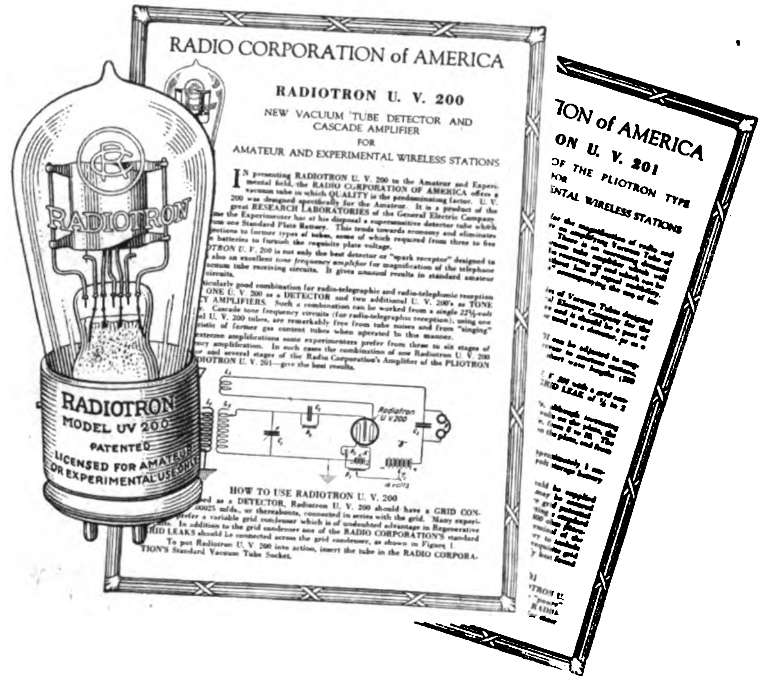
T. A. F., Wilkes-Barre, Pa.

We do not think the coils you speak of would operate successfully on a radiophone set. They were designed for reception.

* * *

G. W. R., Bayonne, N. J.

The radio frequency amplifier you speak of should operate successfully under the various conditions, although the tickler feedback system is not as good as a separate heterodyne, for in order to obtain a beat note, the apparatus must be tuned slightly off resonance.



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HAVE you received your copies of these two descriptive bulletins devoted to the operation and practical use of Radiotrons? They should be read by every amateur and experimenter in the United States.

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These highly instructive papers were prepared by well known authorities on vacuum tubes and contain practical circuit diagrams and detailed instructions which will enable the experimenter to obtain the most effective results from Radiotrons.

If you have not received copies, call upon your local radio dealer and ask for them or write to us direct—they are free for the asking.

DEPENDABLE PRODUCTS

Radiotron U. V. 200	$5.00
Radiotron U. V. 201	6.50
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