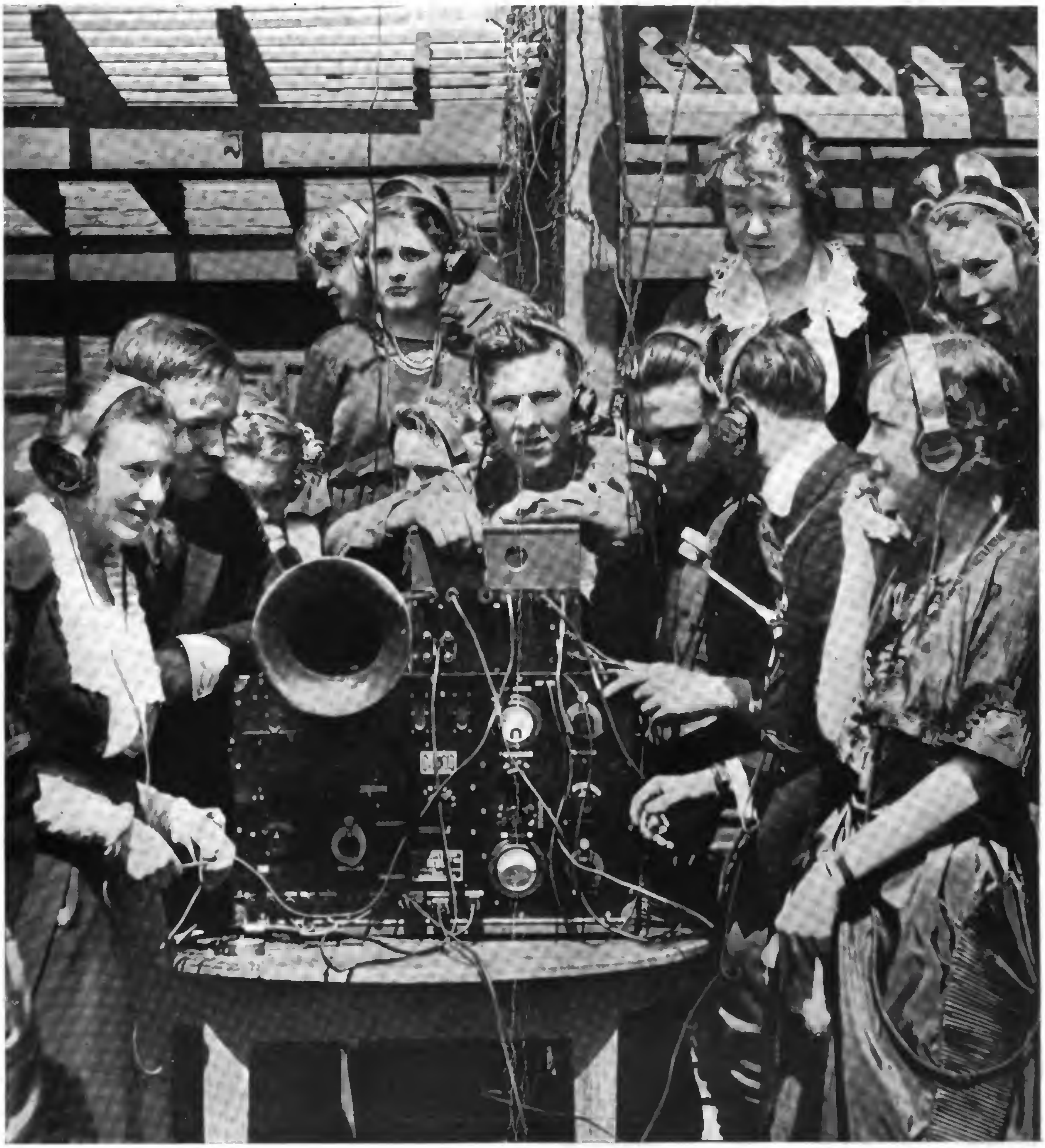
June, 1920 20 Cents

The WIRELESS AGE

Volume 7 Number 9



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"Casey" Free Radio Schools
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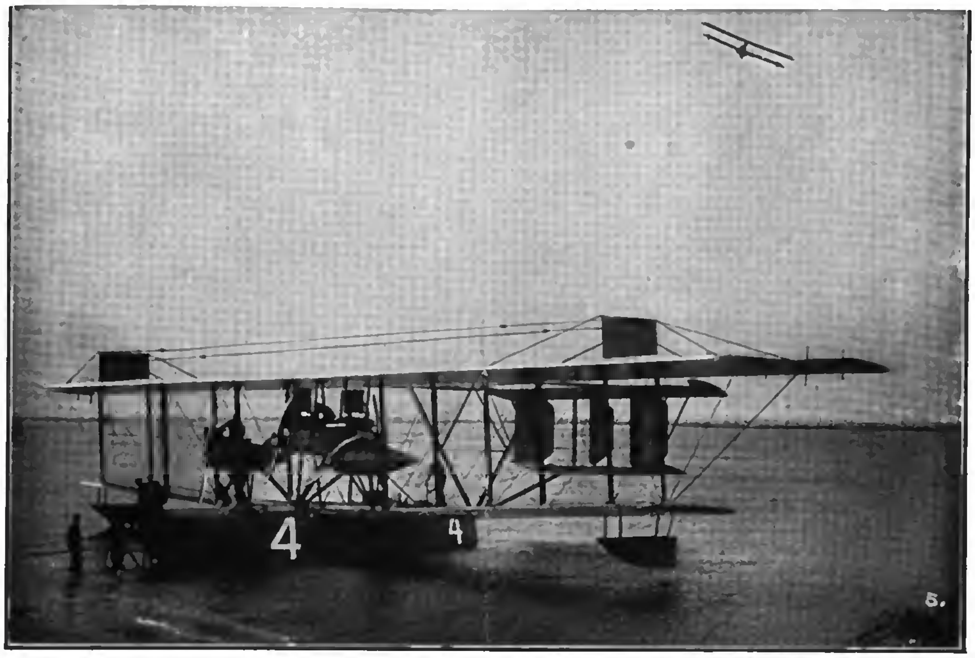
Extract from New York World, June 3, 1919.



NC-4—ELECTROSE Equipped.

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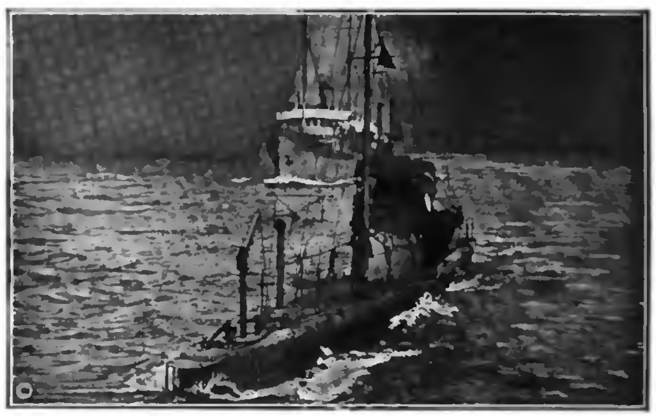

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Vol. 7 Contents of The Wireless Age for June, 1920 No. 9

Edited by J. ANDREW WHITE

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Edward J. Nally, Pres. Lee Lemon, Vice-Pres. David Sarnoff, Secy. George S. De Sousa, Treas. J. D. Conmee, Business Mgr.

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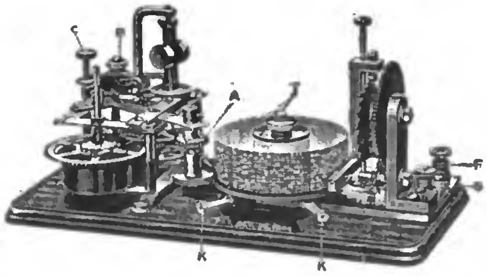

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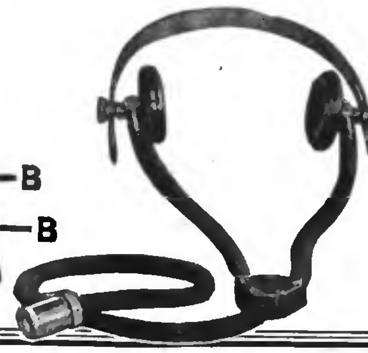

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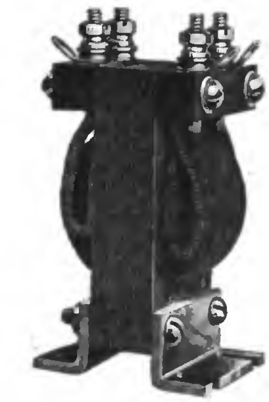

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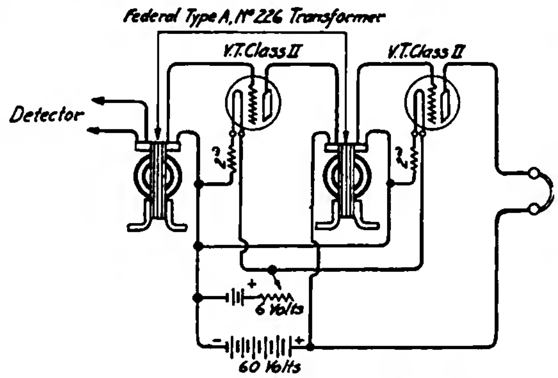

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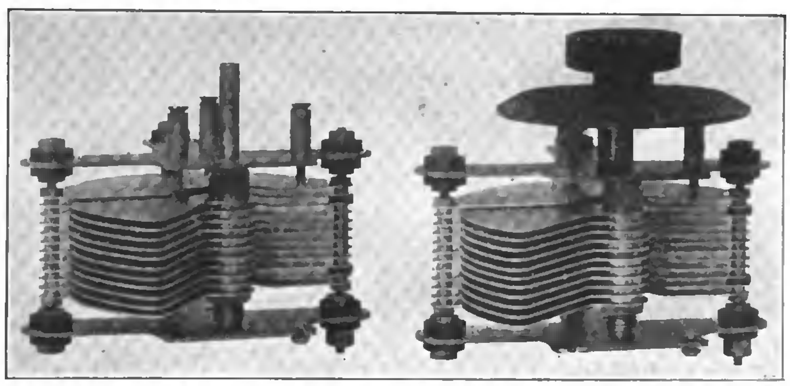
Federal Telegraph and Telephone Co.

Buffalo, New York

The Atlantic Radio Company Variable Condenser



THE ATLANTIC RADIO COMPANY VARIABLE CONDENSER, illustrated above, is made in two capacities—.0005 Mfd, and .001 Mfd. The rotary plates are rounded on one end, affording a straight-line capacity—a valuable feature in wave meter work. The condenser is furnished unmounted only, but with the addition of Dial and Knob, if desired. Dial is moulded composition, scale in white—0-100 reading. Bakelite Knob. We can guarantee this condenser in every way as to quality, reliability and satisfaction. The low price is decidedly an innovation.

Capacity	Unmounted	With Dial and Knob
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conceded by several well known Radio Men to be far superior to any similar type of Inductances. Made in seventeen sizes, tapped and plain. Wave length range from 200 to 20,000 meters, priced from 70c. to $4.85. Plentiful supply in stock at all Radisco Agencies.

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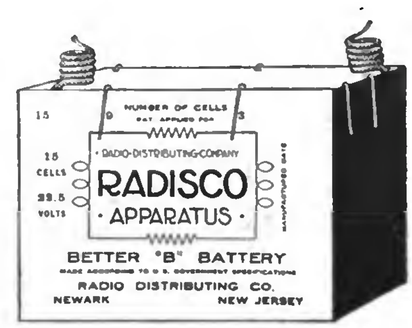

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Atlantic Radio Co.,
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BROOKLYN, N. Y.
Kelly & Phillips Electric Co.,
312 Flatbush Ave.

BRONX, NEW YORK
Amateur Wireless Equipment Co.,
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CHICAGO, ILL.
Chicago Radio Laboratories,
1316 Carmen Ave.

EUREKA, PEORIA, ILLINOIS
Klaus Radio Co.

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K. & L. Electric Co.,
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NEWCASTLE, PA.
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PHILADELPHIA, PA.
Philadelphia School of Wireless Telegraphy,
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PROVIDENCE, R. I.
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If none of the above agencies are in your vicinity, communicate with

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Two Stage Amplifier,
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Price: $75.00

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Versus

Ordinary Apparatus

Did it ever occur to you that when you install that new amplifier, audion control box, receiver, or whatever it is you have in mind, you will want to call in some of your friends and acquaintances and show them your new apparatus? Do you realize that among others, there will be radio men who know *REAL* apparatus when they see it? Do you want them to remark, probably outside your hearing, that "your equipment may be all right for the amateur and experimenter, but of course the Navy and other concerns who *KNOW*, use a better grade?".

If these thoughts should ever run thru your mind you can avoid any chance of being dissatisfied by purchasing WICONY apparatus, the standard Navy type of equipment.

We do not build a line especially for the amateur and experimenter because we believe the amateur and experimenter should use regular apparatus. We do, however, sell our standard Navy type apparatus to the amateur at a price so low that we often hear the remark "How can you do it?" The answer is that the bulk of our business is with the United States and foreign governments —who buy in quantities—and in selling the same apparatus to the amateur, he gets the benefit of prices due to quantity production.

Observe from the following, picked at random, how little more it costs to get apparatus you *KNOW* you will never regret having bought, and which you will always be proud to show to *ANYBODY.*

		Price
Type WI-106A	Audion Control Box (without filter system)	$60.00
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Type WI-129A	Audion Control Box (including 110 V. filter system)	75.00
Type WI-149A	Marconson Plate Battery	12.00
Type WI-163A	Western Electric Type Head Telephones	14.50

We can make immediate shipment of the above apparatus

Audion Control Box,
Type WI-129A
Price: $75.00

WIRELESS IMPROVEMENT COMPANY

RADIO ENGINEERS, MANUFACTURERS AND DISTRIBUTORS

47 WEST STREET, NEW YORK, U. S. A.

If this page is cut out and appended to the same page cut from the editions to follow, a complete file of very interesting information will soon be available. (No. 6)

Vol. 7. No. 9. JUNE, 1920

THE WIRELESS AGE

WORLD WIDE WIRELESS

Radio Corporation Holds First Meeting

IMPORTANT developments in long distance wireless communication were announced at the annual meeting of the Radio Corporation of America held in the Woolworth Building, New York, on May 4th, the first meeting to be held since the merger was effected between the General Electric Company and the Marconi Wireless Telegraph Company of America.

Edward J. Nally, in his address to the stockholders, stated in connection with the agreement with the General Electric Company: "It brings to our commercial department the co-operation of that company's world-wide organization, and, what is probably the most valuable asset of all under the agreement—exclusive control of the Alexanderson Alternator. This device bids fair to practically revolutionize the art of long distance communication by wireless. The report comes to us that the signal transmitted from our American stations equipped with the Alexanderson Alternators has attracted the attention of the wireless experts of Continental Europe. It is said they wonder what manner of device it is that sends a signal so noticeably superior to that to which they are accustomed. Already, the British Marconi Company has adopted the Alexanderson Alternator to be purchased from the Radio Corporation as its standard high frequency apparatus for communicating for distances exceeding 2,000 miles. Commissions or representatives of the Governments of Poland, Denmark, Sweden and other foreign countries, have been sent here to investigate and examine it, with a view to procuring sets for their stations. It is safe to predict that as a result of these investigations it will soon be conceded your company controls the world's foremost device for long distance wireless communication. The resultant advantages to the company, both financially and in the way of prestige, are readily apparent."

Mr. Nally also stated that "a representative of the United States Government in the person of Admiral Bullard of the U. S. Navy has been designated by the President and Secretary of the Navy to attend the meetings of our stockholders and Board of Directors, with view to a close co-operation between the Government and the company. This interest on the part of the Government and its full accord with our program has already proved helpful through gaining the assistance of the State and Navy Departments in connection with certain of our dealings in European and South American countries."

It was also announced that the Board of Directors has approved a large program of construction for the near future. It is proposed to immediately purchase a site near New York City for a group station of five units, the station when completed to be devoted to the following purposes: one unit to work with Buenos Aires, Argentina; one to work with France; one to work with Germany; one to work with Scandinavia; and one with Italy and Poland.

The following were elected to the Board of Directors: Edwin W. Rice, Jr., Albert G. Davis, Owen D. Young, Gordon Abbott, James R. Sheffield, John W. Griggs, Edward W. Harden and Edward J. Nally.

Officers were elected at the Board meeting on the following day: Owen D. Young, Chairman of the Board; Edward J. Nally, President; Charles J. Ross, Secretary; George S. DeSousa, Treasurer; Hon. John W. Griggs, General Counsel.

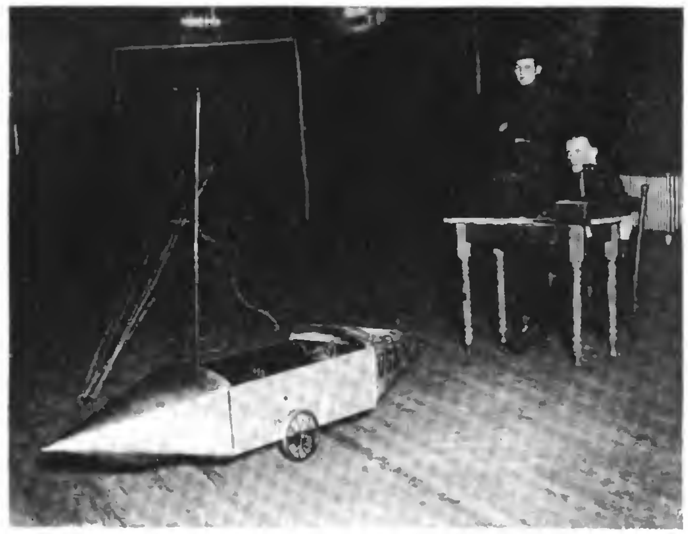


Photo Int'l

Wireless controlled torpedo demonstrated at the 12th Regiment Armory, New York

Radio Message From Amundsen Breaks 19 Months' Silence

CAPTAIN Roald Amundsen, discoverer of the South Pole, has arrived at Anadir, a trading post on the Bering Sea, in Eastern Siberia, according to a wireless message from Anadir, received at Nome, Alaska. The dispatch gave no details other than suggesting that the explorer had reached the village in a ship.

For more than nineteen months the silences of polar seas have shrouded the vessel that bore Amundsen and his shipmates in their unusual endeavor to reach the North Pole.

Wireless Service Between England and Egypt

THE British Post Office is hurrying the construction of two new high power wireless stations to supplement cable service between England and Egypt. Cable companies have also laid new lines between England and Gibraltar and between Malta and Alexandria. Another new line between Aden and Bombay is to be laid this year.

Cable congestion in the Near East, India, the Far East, South Africa and Australia was recently made the subject of inquiry by the Federation of British Industries.

Chess Played by Wireless

A GAME of chess played by wireless between Edward Lasker, of Chicago, and A. F. Whittaker, of Washington, awaits decision by J. R. Capablanca, Pan-American chess champion; as to the victor.

The moves by the Washington man were telephoned from the Capital City Chess Club to the naval operator at the Arlington wireless station. Messages were received at an amateur's station in Evanston, and relayed to the Illinois Athletic Club.

It is said the game proved to be much faster than those played by telegraph and chess play by radio may be the means of reviving the cable-matches that formerly were played between English and American teams.

Photo Int'l

Dancing to music transmitted by radiophone. Illustration shows headsets being adjusted

Radio a Practical Aid to Fishing Industry

WIRELESS communication in conjunction with the airplane has become a valuable stabilizer for the fish packing industry of Southern California, following a program of co-operation which has just been outlined with officials of the North Island aviation school by members of the state fish and game commission.

Airplanes have become "spotters" for the fishing fleets of canneries and as a result reliable information is being obtained which has tended to stabilize the industry.

The planes, flying over the sea are in constant lookout for fish schools which can be easily sighted from an airplane, says Fish and Game Commissioner M. J. Connell. By wireless information is then flashed to the headquarters of the commission in Los Angeles and this information is immediately distributed to all fish packing plants of the location of fish schools.

Radio Service Aboard Trans-Atlantic Ships

SUCH striking results have been obtained by the new long distance Marconi wireless sets on board the Cunarders Imperator, Mauretania and Carmania that a rapid extension of these instruments to other great liners may be expected. The White Star vessels Olympic, Adriatic, Baltic, Celtic, Cedric and Megantic are being similarly equipped. All these ships will now have direct intercommunication with land over a distance of 1,400 miles. Radio-telegrams intended for passengers may be handed in at any post office in England. The word "Aberdeen" must be included in the address after the name of the ship. The charge for such radio-telegrams is 10½d per word.

Marconi Welcomed in Spain

NEWS of the arrival in Spain of Guglielmo Marconi and of the enthusiastic popular reception accorded to the distinguished inventor in that country serves to draw attention to a voyage which has been pronounced comparable in a way to the venture of Columbus. The voyage of the Electra has excited great interest in scientific circles.

Marconi expects upon his voyaging, which may be extended, to make a special study of atmospheric and meteorological conditions as these may affect wireless communication and to chart his findings, it being expected that these will prove of importance in respect particularly to the problem of standardizing communication through the air in all parts of the world.

The Passing of Theodore Newton Vail

THEODORE NEWTON VAIL, chairman of the board of directors of the American Telephone & Telegraph Company, died April 15, in the Johns Hopkins Hospital, Baltimore, Md.

Mr. Vail came from Jekyl Island recently for a slight operation. He had been in a rather serious state of health. He was born in Carroll county, Ohio, July 16, 1845.

Theodore N. Vail was among the many successful Americans who got their start in life by learning telegraphy. This list of former telegraphers includes such men as Andrew Carnegie and Thomas A. Edison, and Mr. Vail, in his chosen field, was as successful as they were in theirs. So successful, in fact, that in 1907 he became the head of the largest telephone company in the world, the American Telephone and Telegraph Company.

When Alexander Graham Bell invented the telephone, Mr. Vail was just 31 years old, but he quickly saw the possibilities of conversations by wire.

His first line was from Boston to Providence, and he was ridiculed for the attempt. It was called "Vail's side show" by the scoffers, but it really was the start of one of the greatest developments in modern life. Thirty-five years later, in 1915, it was possible to talk from New York to San Francisco, and in the same year it was possible to talk by wireless telephone from Arlington, Va., to the Eiffel Tower in Paris and to Honolulu simultaneously.

It was his frequently expressed belief that the next few years would produce wireless telephone communication of practically unlimited distance and effectiveness.

Newsy's Interest in Radio Results in Robbery

THE burglar who appropriated a complete wireless receiving apparatus from a supply house in New Haven, Conn., has been captured. LeRoy B. Dortche, age 15 years, is the name the accused gave at police headquarters. He said he was a student of radio and intended setting the apparatus up in his home and "listening in" on distant radio stations of the world. He said he delivered morning papers about the city, and while out early in the morning he took advantage of the opportunity to secure the instruments, which he had yearned for ever since he became interested in radio-telegraphy.

American Freighter Mystic Rescued by Radio

RADIO advices received by the Naval Communication Service announced that the coast guard cutter Ossipee had found the disabled American freighter Mystic 400 miles east of Sandy Hook and was standing by. The Mystic sent a call for help saying that she was disabled and was out of fuel and fresh water. The disabled vessel was bound from Avonmouth for New York.

The 3,000-Mile Iowa Radio Relay Test

THE Iowa Aerial Daylight Relay test with neighboring states, covering a territory of about 500,000 square miles, was successfully carried out, according to Clifford W. Patch, district superintendent of Iowa. The message, sent around to a number of stations, was planned to discover how rapidly the various stations could receive and transmit messages. Many cities in Iowa, Illinois, Wisconsin, Minnesota and North Dakota participated in the test.

The message, which was started from Patch's station in Dubuque, read: "Progress today depends more and more upon speed and snap. Radio furnishes the speed. You furnish the snap."

The message was sent on three routes. Route number one, beginning at Dubuque and ending at Minneapolis, was the longest, and the message, starting at 8 o'clock, closed at 10 o'clock. There were twenty-six stations on this route, through which the message had to be relayed.

Radio Compass Guides Airplanes

A RADIO compass for airplanes which will enable them to locate other planes accurately regardless of weather conditions has been successfully tested by navy flyers. On a recent trip of the NC-3 from Philadelphia to Pensacola that machine and another from Anacostia, D. C., field were equipped with the new compass.

Officials at Anacostia kept in communication with the NC-3 constantly by wireless and took bearings at stated intervals on both planes by means of the compass.

The two planes were directed toward each other from the field until, when sixty-five miles apart, the compass of each came into operation, confirming their positions and establishing communication.

S O S Radio Service

DISTRESS calls from two vessels, each outbound from New York, were received by radio recently stating both ships were fast filling with water. Assistance was rushed to them.

The first S O S was received from the freighter E. A. Morse, which was steaming for Genoa. It said: "We have no steam; are filling rapidly." She was then 280 miles southeast of New York.

"We may be able to keep afloat for two or three hours," ran a later radio from the Morse. The Acushnet, a coast guard cutter, and the San Mateo, bound from Boston to the West Indies, headed for the disabled craft.

The wooden steamer William O'Brien, three days from New York bound for Rotterdam, wirelessed from a position about 500 miles east of Philadelphia:

"Hatch covers off; taking water rapidly. Please stand by."

The coast guard cutter Acushnet, which has been searching for the disabled steamer William O'Brien, reported by wireless that she found the sea covered with fuel oil and a name board of the steamer drifting about 500 miles east of New York. An empty life boat was picked up in the same locality.

It is feared the steamer went down not long after she had asked for assistance during a gale. She left New York for Rotterdam.

Radio Brings Aid to Ship off Fire Island

THE Naval Communication Service recently received a wireless announcing that the Coast Guard cutter Seminole had taken the Shipping Board freighter Ipswich in tow about eighty-five miles east of Fire Island. The message failed to disclose the nature of the freighter's trouble, but stated the craft was not in danger. The Ipswich, of 3,700 tons, was bound for New York from London.

Uncle Sam Has 135 Wireless Stations

THE government shore wireless stations number 135, of which eighty-eight are in continental United States, twenty in Alaska, nineteen in the Philippines, three in the canal zone, two in Hawaii and one each in Porto Rico, Guam and Samoa. The government ship stations total 470.

Photo Int'l.

Band rendering dance music that was transmitted by radiophone

Pacific Coast Radio Compass Stations

FOG will soon be robbed of its dangers to Pacific Coast shipping by means of radio. The opening of the naval radio compass stations on the Pacific Coast is but a few weeks off. The first will be four stations at the entrance of San Francisco Bay, at Point Montara; Bird Island, near Point Benita; Point Reyes, north of Point Reyes lighthouse, and Farallon Islands.

The method of operation is based on determining the direction of radio waves. The vessel, concealed in fog, sends out radio signals. Each of the radio stations intercept these signals, and by compass radio determines from which direction they come. Each station notifies a central station, which in turn notifies the vessel the precise direction it is from the station, and these directions charted show by intersection of the lines the vessel's precise location.

Due to shortage of enlisted personnel, the opening of all stations cannot be expected at present, but it is the intention to open at the earliest possible date one station, probably Bird Island, at the northern enrance of the Golden Gate, as soon as personnel can be trained.

Radio Realizes the Horse Marines

ENGLISH sea captains are betting on the races—by wireless. The first week of the opening of flat racing brought a number of turf transactions flashed from the high seas, passengers as well as ship masters and officers ordering their bookmakers to place bets on "live ones."

A system of flashing racing "tips" by radio is being fast developed.

Radio Telephony Across Oceans and Continents

By Dr. Alfred N. Goldsmith

Director of the Radio Laboratory, The College of the City of New York

THE recent announcement by Senatore Marconi that we may shortly expect to telephone by radio across the Atlantic and that regular service will be available, is both startling and encouraging. It is clear, for example, that in the comparatively near future the president of any large corporation will be able, from his desk in any town in the United States, to telephone to the managers of his branch offices in distant countries. In effect, London, Rome, Paris, Tokio, Cape Town and Buenos Aires will be as much within his immediate reach as his next-door neighbor.

Dr. Goldsmith, who looks forward to a not far distant date when every telephone subscriber will have direct access to the radio telephone

This revolutionary step forward in communication marks the beginning of a new era. From the days when fast runners laboriously carried messages over moderate distances to fall exhausted at the end of their trying trip, communication has never been quite capable of meeting all the demands on it. The loss of time in getting word to the other man is more of a brake on efficient business than almost any other single factor; but there has been tremendous progress made, and more is expected for the near future. Already it is possible to send radio messages from the United States to Hawaii and Japan on the one hand and to England, France, Italy and Norway on the other.

The great stations now in existence in the United States, or planned for the immediate future, will extend this range of communication until telegraph messages can be sent speedily to any corner of the world.

A very natural question which the individual user of the radio telephone of the future will desire to have answered is: "How shall I send a radiophone message to Mr. William Brown in London? Just what will I have to do to get the connection and to talk to him? How will it sound? And what will it cost?" It is fortunately possible to answer some of these questions fairly definitely today.

All that Mr. Smith will have to do in New York to talk to Mr. Brown in London, is to take his telephone receiver off the hook and ask either for "Radio Long Distance" or for the number of the special high power radio telephone transmitting station which will carry his voice across the Atlantic. As soon as he gets the long distance radio station, he will be asked by the operator to whom he wishes to speak. On giving the name and address of the desired man in London, he will be told to "Hang up the receiver, please. We will call you when your party is ready." In a few minutes his telephone bell will ring, and he will be told "Your party is ready; go ahead, please"; and he will be in touch with his correspondent in London.

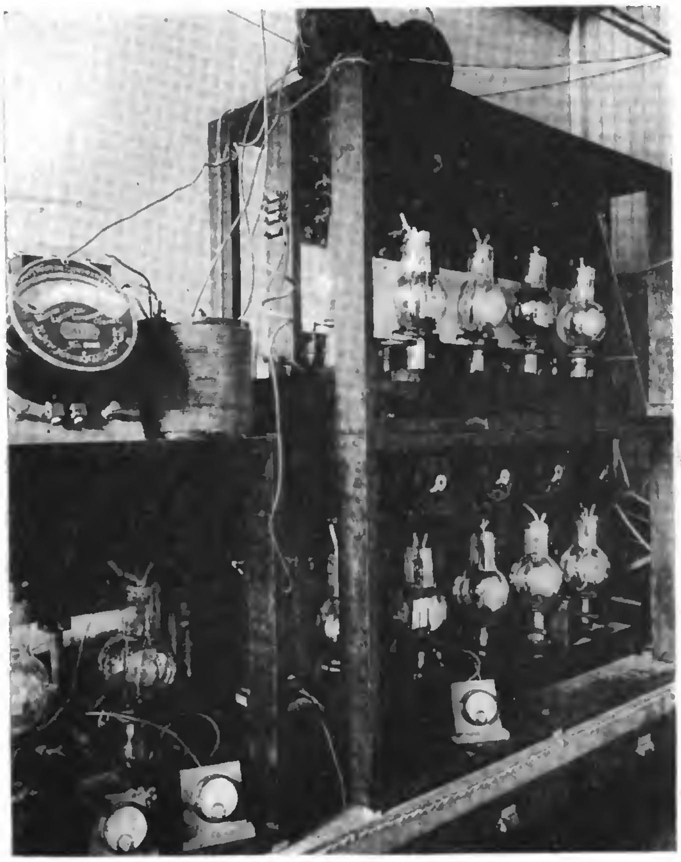
It will not be necessary for him to leave his office or his home, or wherever he happens to be, to telephone to any point that he desires. Every telephone subscriber will become automatically a subscriber to the radio telephone without further expense or trouble on his part.

As regards the connection itself, it is certain that the speech will be clear and easily understood. There may be a little difficulty about the language when a subscriber in Rio de Janeiro talks with a subscriber in Vladivostok, Russia, but this cannot be blamed on the radio telephone. We shall all have to become accomplished linguists to utilize to the full the immense possibilities of this new means of long distance communication. Or else the long deferred hope of the adoption of Esperanto, or some such universal language, will have to be realized.

As regards the cost of a radiophone message to far distant cities, this will naturally depend on a number of things which cannot be accurately measured today. Of course, the further the message must be carried by wire lines to the radiophone stations, the more expensive it will be. And the further the radiophone stations send it over ocean or continent, the higher the cost. And the time of day and speed with which the connection is demanded will probably have to be considered also. If a man is willing to telephone during the slack period late in the evening or early in the morning, he will probably get reduced rates.

In any case, it is clear that the radiophone should not be used for casual gossip between Chicago and Melbourne, Australia. On the other hand, it is likely that the rates for a three-minutes talk to London, Paris, Rome, or any other of the greater European capitals from the chief American cities, will be well within reason and entirely worth while if important matters are to be handled. During the slack hours the rates will probably be such as to permit the use of the radiophone on special family occasions, such as weddings, births and so on, even by most of us.

Of course, the chief users of the long distance radiophone will be the larger commercial interests and the banking houses. Their business is handled best at high speed, on short notice, and by competent men in effect speaking face to face. There are, however, many other uses of the radio telephone, which, while less spectacular and over shorter distances, will nevertheless be very valuable to society. Ships at sea will be in telephone



Dr. Goldsmith's radiophone set, showing the dozen vacuum tubes which were used to generate several horsepower for wireless telephony regularly conducted over a distance of 160 miles

touch with land. Any traveler who is immune from seasickness should have no difficulty in calling up his office from mid-ocean and making sure, by direct question and answer, that all is going well. Or he can call up the other side of the ocean, personally arrange for accommodations, and even make his business appointments and outline the matters he wishes to talk over when he arrives. If, as now seems likely, the radio telephone is used to a considerable extent on the better through-trains, the railroad trip will be much less of a loss of time than it is at present. The traveler on the future Pullman, equipped with its radio telephone set, will be in personal contact with any point in the country which he desires to reach. In fact, if a passenger on the "20th Century Limited" desires to speak by telephone direct to a passenger on the "Mauretania," in mid-ocean, or to a business associate in Madrid, it is quite within the bounds of possibility that he will be able to do so.

The man who does not want to be reached by those who want to speak to him him will not have much chance in the future. As soon as he approaches any telephone booth or enters his office or home, he is at one end of a wire, the other end of which reaches practically to any important point in the habitable globe.

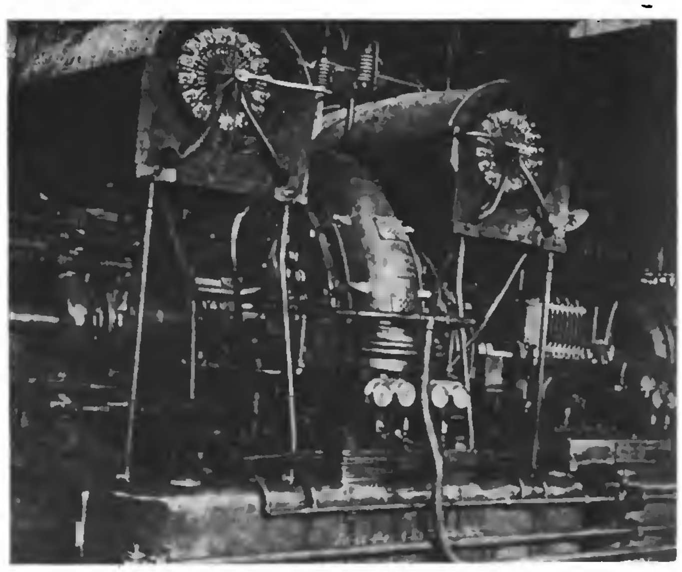
To carry out the plans mentioned, will require the erection of a number of high power radiophone stations here and abroad. These sending and receiving stations will be connected to the ordinary telephone lines of the country in which they are situated. That is all that is necessary to enable them to be fully used by the telephone subscribers of that country. Every radiophone message will go by the wire lines from the subscriber to the radiophone transmitting stations, then by radio across ocean or continent to be received at the radiophone receiving station and automatically transferred to the wire lines in the distant country leading to the called party. The reverse holds for everyhing the called party says. It will be noticed that the spoken words are automatically transferred twice, once at the radio transmitting station and once at the radio receiving station. This will be done instantaneously and accurately without human intervention, by the remarkable "amplifiers" which have recently come into extensive use. So that, long-distance telephone communication will have in it two short wire links, on each side of the ocean and a long stretch of air, which will be bridged entirely by radio.

There are two important ways of transmitting wireless telephone messages successfully; the bulb and the alternator.

The bulb method uses vacuum tubes, which look like large lamps but have remarkable possibilities in the way of producing and controlling the highly special currents required to carry a radiophone message. These bulbs are made of special glass which will not melt when subjected to a high temperature and other difficult conditions of operation. Inside the bulb, from which practically all the air must be carefully removed, are placed appropriate metal parts. One of these is the brightly glowing filament, somewhat as in an ordinary tungsten lamp. Another is a plate of some special metal, usually tungsten or nickel. A third metal part known as the grid may be placed in the tube. Or else, to accomplish similar results in a different way, a third metal part may be fastened outside the tube. These lamps, which in their way are as wonderful as the one used by Aladdin to evoke the genii, are capable of taking the faintest electric currents and "amplifying" or increasing their effect until hundreds or thousands of horse power are controlled by the voice of the speaker! These bulbs are also capable of producing currents that alternate or reverse millions of times in a second! In a smaller form, they are used for receiving the signals as well.

The original effect on which these bulbs are based was discovered by Edison, but they were first successfully applied in a basic and fundamental way to radio telegraphy by Professor Fleming, the eminent English electrical engineer. Substantial improvements have been made in these bulbs by Dr. de Forest, the American inventor, Dr. Langmuir of the Research Laboratory of the General Electric Company, and Mr. Roy A. Weagant of the Radio Corporation of America. America can well be proud of the share her scientists and engineers have played in the development of this remarkable device, the vacuum tube amplifier, oscillator and modulator.

When one of these bulbs does not supply sufficient power to telephone by radio the desired distance, a number of them may be connected up to work together successfully.



The New Brunswick high power station of the Radio Corporation of America, equipped to enable wireless to carry the spoken word over land and sea; the photo shows the giant 200-kw. high frequency alternator with dynamo at the right and the transformers on top

Nearly five years ago the writer used a radiophone set employing these bulbs as shown in the illustration. It will be seen that a dozen of these large "radio lamps" were used to generate several horsepower which was then sent out from the aerial wire system stretched over the buildings of the College of the City of New York, also shown in an accompanying illustration. This set enabled the writer to telephone by radio to Schenectady, 160 miles distant, at almost any time. This was by no means the greatest distance over which the words could be heard when conditions were favorable. In fact, words spoken at the Laboratory in New York were clearly heard in North Dakota, 1,300 miles distant, on numerous occasions! At the time this work (which was carried on in conjunction with the General Electric Company) was done, it was close to being the world's long-distance record for radio telephone communication.

Interesting work along these lines has been carried on by the United States Navy and the Western Electric Company. Not only were long distance tests carried out, but excellent radio telephone communication with airplanes and over short distances for military purposes were achieved.

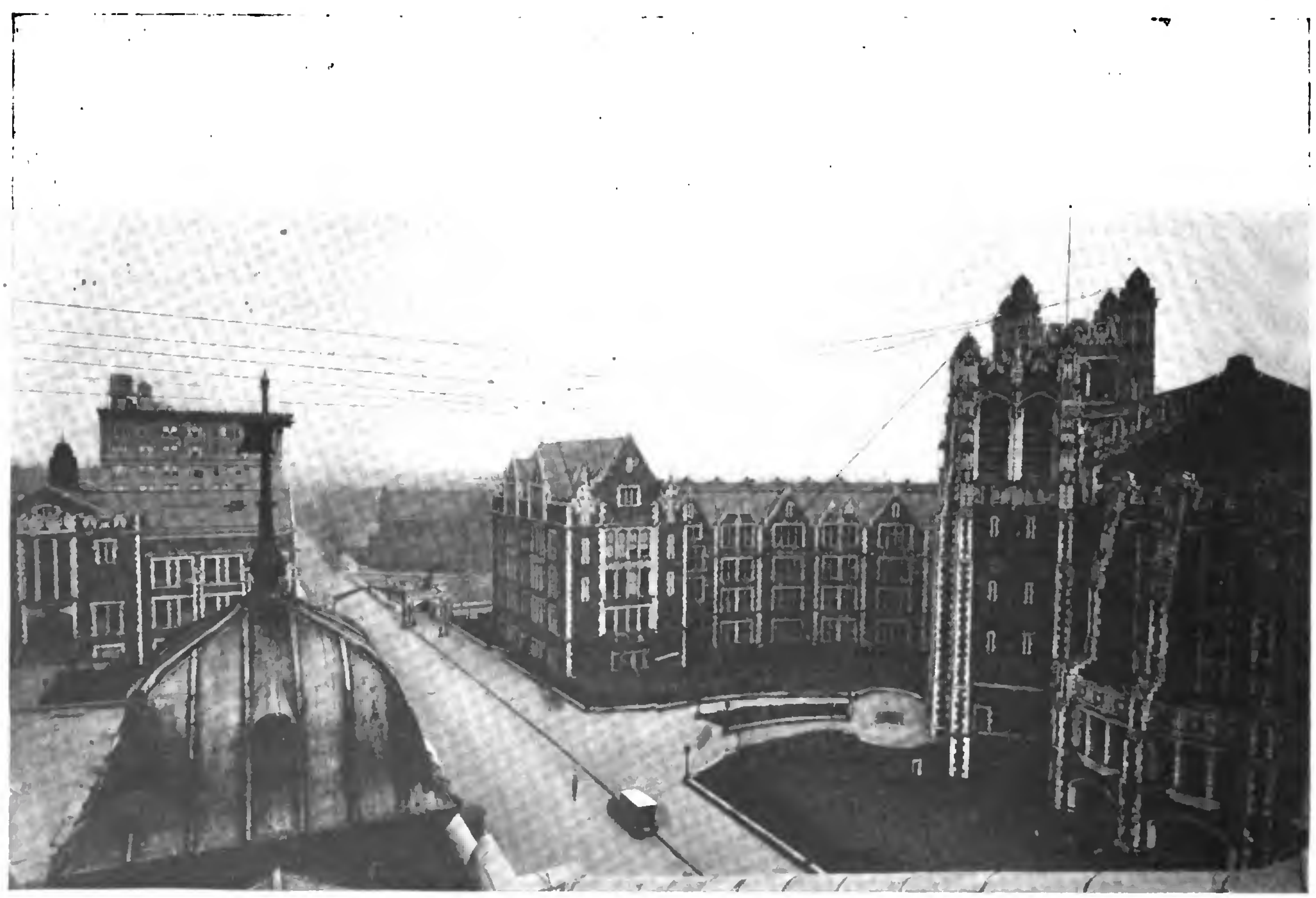
The equipment used by the English Marconi Company to telephone across the Atlantic recently was very similar in nature and operation to that used by the writer and mentioned above. It also consists of a number of appropriate bulbs, acting together, and producing the "modulated aerial current" needed for this purpose. In the writer's earlier experiments it was found possible to talk by radio telephone from points quite distant from the laboratory. For example, speaking from a residence seven miles away from the laboratory, it was possible to transfer every word spoken automatically to the radio telephone and send it out to the desired destination. This was quite along the lines mentioned above.

There is a second way of sending radio telephone messages, using an alternator. The form found most desirable in America and giving excellent results is known as the "Alexanderson Alternator" after its inventor, Mr. E. F. W. Alexanderson, Chief Engineer of the Radio Corporation of America. These machines were developed by the General Electric Company over a long period of years and are powerful and sturdy generators of the currents required to send over long distances. It is likely that the alternator will compete successfully or even supersede the bulb radio telephone transmitter when very long distances are to be covered. These machines are triumphs of careful engineering. Their rotating parts, made of the finest steel with most accurate machining, spin at an unusually high speed and require careful balancing and centering. They have proven themselves capable of handling heavy radio telegraph traffic from the United States to our Allies through the war.

When President Wilson sailed to Europe on the "George Washington," radio telephone messages from Secretary Daniels of the Navy in Washington were sent to the President all the way to France. The equipment used was the Alexanderson alternator with its bulb and magnetic amplifier controls. More recently, radio telephone messages have been repeatedly sent from the New Brunswick, N. J., station of the Radio Corporation of America, to France, using this equipment.

Efficient radio telephone service in America requires two things: mastery of the art in America, and proper working arrangements with competent foreign radio companies. Fortunately, both of these conditions have been met.

Quite recently, the General Electric Company and



The aerial wire system at the College of the City of New York, connected to the wireless 'phone apparatus installed in the building at the right; words spoken here were clearly heard in North Dakota, 1,300 miles distant, on numerous occasions the Marconi Wireless Telegraph Company of America concluded arrangements whereby their radio interests in the future will be handled by a great all-American company, the Radio Corporation of America. Suitable working arrangements have also been made between the Radio Corporation and the English Marconi Company and its associated companies. Controlling, as it does, practically all the high power stations in the United States (with the exception of those belonging to the United States Navy), with American engineers and capital back of it, and strongly fortified by suitable arrangements with its foreign correspondents, the Radio Corporation will unquestionably maintain the present high standing of radio in the United States and insure our future prestige and standing.

One of the powerful Alexanderson alternators used for radio telephony at the New Brunswick station of the Radio Corporation is shown herewith. Controlled by the delicate voice currents, such machines as this will carry the spoken word over land and sea. The beneficial influence of this triumph of science will be felt in many different ways. The speeding up of business and production, the ready correspondence with our friends in times of emergency, the simplification of foreign affairs in diplomacy and the safety of life at sea will be but a few of the great results of radio telephony in the future. As communication advances, the world shrinks and dwellers in far distant lands become our next-door neighbors.

Marconi as he is today; this picture shows the distinguished inventor on board his yacht shortly after he announced that there will soon be regular radiophone service across the Atlantic

What the Amateur Can Learn from the Navy

By Robert J. McAusland, Jr.

MR. LAWRENCE C. F. HORLE, formerly United States Navy expert radio aide, in a talk before the Radio Club of America recently, made it clear to anyone familiar with the development of amateur receivers, that history can and did repeat itself in the case of the navy receiver design.

Although Mr. Horle's talk thoroughly covered the trend of development for the period of the last three years, we shall not attempt to explain in detail all of the designs. The problem that confronted the navy consisted of the following elements: Facing war, it became necessary to produce large numbers of receivers for use on naval boats, which would live up to the severe service required. The specifications laid down for these receivers were five in number. First, they must have a wide range of wavelengths; second, they must have a high selectivity and sensibility over the range covered; third, ease of operation must be secured, so that inexperienced operators could be used; fourth, the design must be light and compact and yet capable of giving service during heavy gunfire; and, fifth, ease and economy in manufacture were of paramount importance.

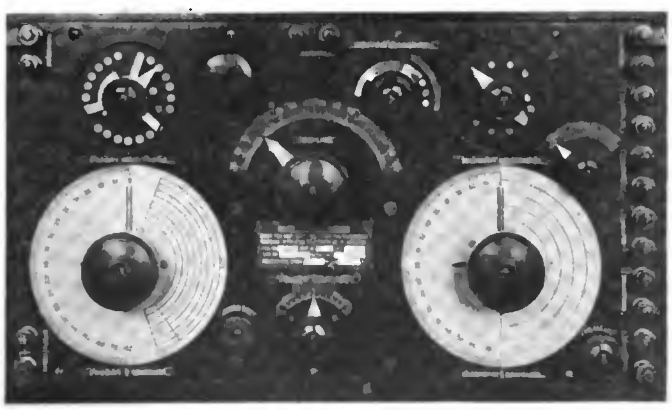


Figure 1—Front view of CM 294C receiver

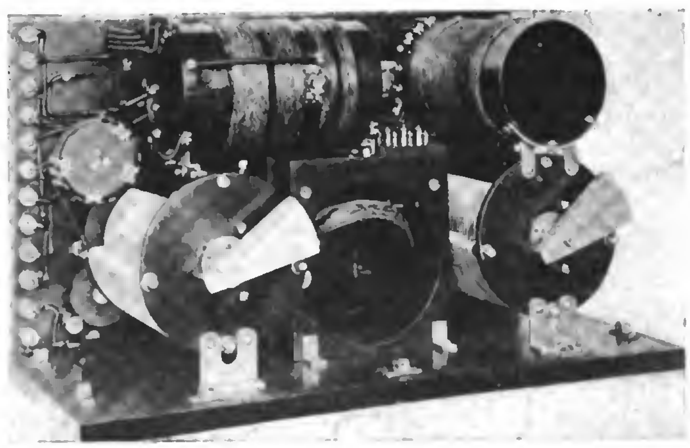


Figure 2—Rear view of receiver built by Marconi Co. for the U. S. Navy

The method by which the navy found solutions to these problems led to the development of apparatus of standardized design incorporating the features just outlined.

The reader may find some points of interest in the navy design and by utilizing them he may find a solution of his problems along the lines of the above mentioned five specifications. For example, many an amateur may use to advantage such standard parts as condenser plates, knobs, binding posts, etc., which he can buy cheaply in the open market, and by assembling some of his own apparatus save a few dollars.

Figures 1 and 2 show respectively the front and rear views of a CM 294C receiver, designed for the navy by the Marconi Wireless Telegraph Company, having a range of 250 to 3100 meters on an antenna of .0008 mfd. and 55 microhenries inductance—the ordinary navy antenna. In figure 3 is given the wiring diagram of the device, clearly showing each of the parts and their function in the circuit.

A study of the front view, which is practically the standard layout, will show that the parts have been very logically arranged. Primary and secondary condensers are at the two sides and near the bottom, at just the right height for ease of manipulation by the operator, while the two and three point inductance switches for the secondary and primary coils are placed above their respective condensers, at a place demanded by their lesser usage. A neat feature of the design is that as the inductance switches are turned from point to point, the pointer shown above the condenser knob is automatically operated by a cam movement to the proper wavelength scale on the condenser dial. Further, these inductance switches are so arranged as to put the primary condenser either in series or in parallel with the primary loading coil as required by the setting. Coupling and tickler coupling in the center, and the other controls such as detector test, stopping condenser, etc., offer a logically useful layout and an extremely neat appearance. One more characteristic is the secondary fine adjustment device for tuning the secondary circuit accurately. This is really only a train of three gears driving the secondary condenser through an idler, the reduction being ten to one. The principal use of this device is to take care of small changes of condenser setting when tuning.

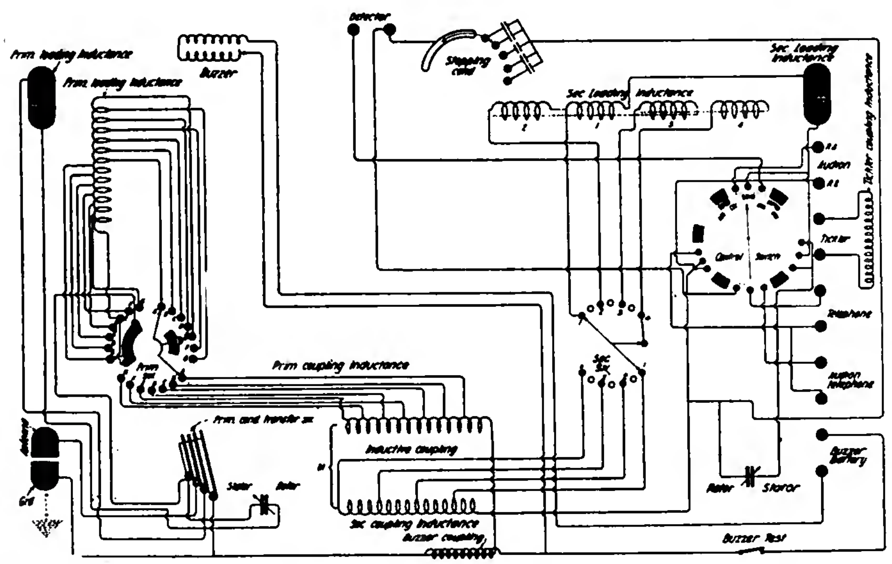
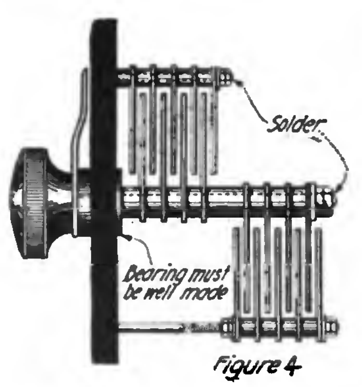


Figure 3—Wiring diagram of CM 294C receiver showing connections and function of each unit

Figure 2 shows the details of the design. The fine adjustment gear and idler are clearly shown. The condenser, whose values are .0045 primary and .0032 secondary in the usual Class I design, are made of 5-inch diameter aluminum plates, 32 mils thick. The balanced plate type condenser, in which one-half the rotor plates are located on one side of the shaft and the other half on the other side, as shown in figure 4, was adopted as standard practice later. This idea by eliminating the heavy counter weight of the usual design, will reduce the cost of the amateur condenser.

Details of the inductance coils are noteworthy. The navy coils were invariably wound with Litzendraht on natural dilecto tubing 4 inches inside diameter and 4⅛ inches outside diameter, a saving in efficiency for the longer wave stations, say above 1000 meters. Below this value the litz is of little use. Primary and secondary tubes were nearly always located at right angles to prevent direct coupling from primary to secondary load. In some of the later sets it was found necessary to provide additional protection against this by placing a shielding partition between the two circuits. The secondary coil is wound in four distinct sections to cut down the distributed capacity of the coils.

There were two distinct classes of navy receivers. These were based on two different researches to obtain the best inductance resistance ratio for the coil. The first type was based on the idea that a high capacity and a small inductance would be the best. Hence all the first group of receivers had the characteristics outlined above. This assumption was found incorrect, as will be seen by a study of the decrement of a receiver circuit. It can be shown that for a given wave length, the decrement varies inversely as the cube root of the inductance. Hence the greater the inductance the less the decrement the receiver introduces. The second group of receivers were almost identical with the first group except the condensers, which were about one-quarter as large, and the inductance correspondingly larger. Coils were now made of No. 20-38 litz rather than the No. 3-16-38, which had been the previous practice. The amateur will find the former litz better than the latter. A great improvement was also made by building the detector valve directly into the receiver. When you consider that a foot of lead introduces disturbing capacities of the order of .000003 mfd, the advantage of this arrangement is clear. Careful shielding also was done. Best practice shows that complete shielding inside the receiver box with 1/16 inch soft copper, and shielding of the telephone cords with flexible copper braiding will give best results and prevent electrostatic couplings.



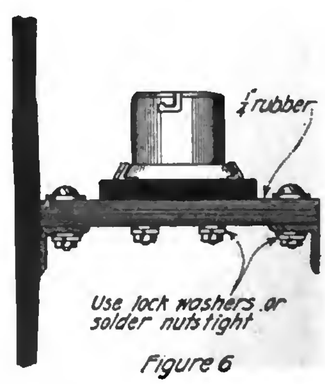


Figure 4—Balance plate type condenser
Figure 6—Shock-proof mounting for audio frequency tube

Let us now turn to the amplifiers the navy built, which in all cases were manufactured as units separate from the receiver. The type of circuit used—the ordinary transformer coupled—is shown in figure 5. At first air core transformers were used, but later, iron cored came into practice, and that is the best present day design. Two-mil carbon steel was found the best but three-mil silicon steel, which is a little less expensive, will give the amateur almost as good results for the radio frequency transformers. In the diagram shown, three radio frequency and three audio frequency amplifiers are assembled in one unit, each amplifier being shielded from the other. This makes expensive construction and should be avoided by the amateur, as the advantage over the method outlined above is very small. Another point for the amateur to remember who has a noisy and vibrating room to work in

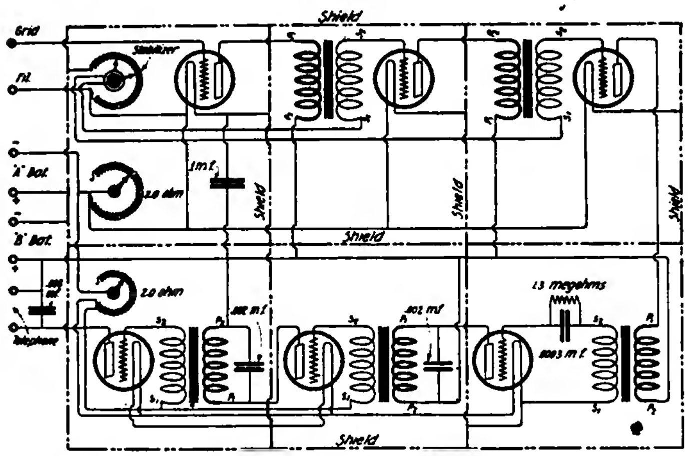


Figure 5—The ordinary transformer coupled type of circuit used

is that shockproof mountings are not needed for the radio frequency amplifier tubes. A good cheap shockproof mounting for the audio frequency tube is shown in figure 6. It consists of a sheet or several strips of rubber ¼ inch thick, mounted as shown. For a noisy place it will be found that an inductance of 100 microhenries inserted in series with the grid of the first tube will filter out extraneous noises. This was invented particularly for weeding out induction from the magneto on aeroplanes.

The navy added to the knowledge about transformers, particularly that each transformer gives best results at a given wave length. Below is a list of possible designs for you to try out. All coils are wound with No. 36 single silk enameled wire, on closed iron core transformers, sections of which are not exactly known, but which probably fill up the inside hole of the coil.

Primary or Sec.	Dimensions in inches Outside	Inside	Thick	Induc. (μhy)	Turns	Working Range (meters)	Best Point (meters)
Both	1.75	1.25	.22	19.5	800	2000-8000	5500
Both	1.75	1.25	.11	8.7	400	800-3200	1800
Both	1.05	.825	.11	.80	100	200-800	450
Prim.	1.75	1.25	.12	...	468	6000-24000	14000
Sec.	1.75	1.25	.24	...	830		
Prim.	Core	⅝" sq.	Gap .72"	...	170	300-1100	700
Sec.		.11" thick		...	190		

It is earnestly hoped that in the above outline, the reader may find sufficient information to try out some new apparatus for himself, and profit by the navy's experience.

The "Casey" Free Radio Schools

By William M. Bolger

Wanted—Any number of industrious ex-service men and women for a free scholarship in either elementary or vocational training by the Knights of Columbus. Must not object to sacrificing two hours each alternate evening; must be regular and consistent in attendance. To qualify must have served in army, navy or marine corps, army nurse service, or have an honorable discharge from War or Navy department. Apply to any Knights of Columbus council near your town or city. Courses free: wireless telegraphy, auto mechanics, acetylene welding, commercial law, English, arithmetic, stenography and typewriting, salesmanship, advertising, journalism, etc.

THE above invitation extended to former service men and women has been responded to by some 100,000 students who are now attending the chain of free evening schools under the auspices of "Casey" from the Canadian border to the cactus plains of Texas and from the bustling Atlantic seaboard across the continent to the Golden Gate and picturesque northwest. More than six and one-half millions of dollars have been laid aside to give the ex-service men and women an opportunity to make up for the time they lost in serving Uncle Sam in the World War.

The Knights have gone into the education business with a vim. William J. McGinley, the Supreme Secretary, and himself a "wireless fan," has decided to so develop this particular course that before next winter arrives the K. of C. will be able to transmit by relay wireless messages from New York to the Golden Gate, from Kansas to Texas, from Washington to Oregon and other far distant points.

The students of the San Francisco school recently sent out a message which was to be picked up along the route to New York City. Every station "listening in" reported afterwards the time and contents of the message, but on account of the low voltage they were not able to transmit any considerable distance. With the establishment of

Ex-service men attending the wireless class of the K. of C. school at Portland, Ore., one of twenty schools for free instruction of those who served with the colors several more radio schools where there is a distance of several hundred miles intervening, the K. of C. will be able to skip across the transcontinental aerial route and keep the schools testing the ability and progress of its individual student body.

J. F. Maher, radio instructor in the K. of C. school at Savannah, Ga., reports establishing direct communication with another experimental station in Washington, D. C., located at 1744 Corcoran street, and adds: "Every night we hear amateur stations as far north as Massachusetts, and west to Kansas."

The K. of C. schools will shortly be allowed, according to Mr. McGinley, to send a postal card to every amateur station whose call letter they pick up. In this way they will be able to render invaluable data to the amateurs throughout the country regarding the sending power of their apparatus.

The supplementary chain of evening schools were conceived at the Peace Convention of the K. of C. last August and within three months time had become a reality. A group of educators from various parts of the country constituted the committee which planned the nation-wide supplementary evening schools. In New York City the wireless school at 240 West 51st Street is never lacking in steady attendance. It has been in communication with the Boston school, another in Delaware, and has communicated with the steamships off Fire Island and other points adjacent to the harbor.

There are approximately twenty radio schools now located in different cities under the auspices of the Knights. An interesting sidelight on the attendance is the fact that many army nurses are taking the course. In a survey made of the radio schools it was found that they maintain a high record for attendance and that the students are deeply interested in their work which makes it less hard for the faculty.

Several of the teachers in the schools are men who formerly served with the signal corps of the Army and radio service of the Navy. In many of the schools the students spend the first hour with the wireless and second period with the class in electricity. With the resumption of the fall term of the K. of C. schools this autumn it is planned to have several more radio classes established and a complete relay service that will take in a radius of at least 2,500 miles.

A New Three - Electrode Vacuum Tube

A NOVEL type of three-electrode vacuum tube has been evolved by John Scott-Taggart. This tube differs from the usual pattern in that the grid takes the form of a metal plate close to the filament, while the anode, also in the form of a metal plate, is placed diametrically opposite and on the other side of the filament. The tube is

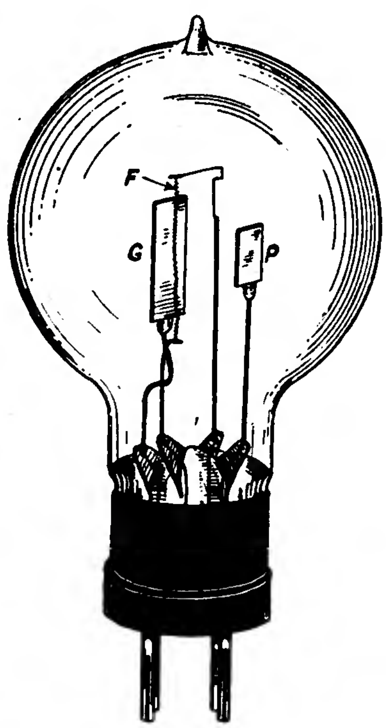


Figure 1—The new type of three-electrode tube

illustrated in figure 1. The filament F is arranged vertically, the tube support being a nickel-iron spring which keeps the filament taut. The anode P is a small metal plate placed at a considerable distance from the filament. The control electrode which takes the place of a grid is in the form of a large metal plate G, situated within a few millimetres of the filament F. The curves in figure 2 were obtained with a vacuum tube which possesses the following dimensions:

P plate 10 m/m x 10 m/m x 0.008" nickel sheet.
G plate 22 m/m x 10 m/m x 0.008" nickel sheet.
Filament F crimped 25 m/m x 2/3 mils tungsten wire.
Distance F to P, 9 m/m.
Distance F to G, 2 m/m.

It will be seen from the curves that varying voltages on

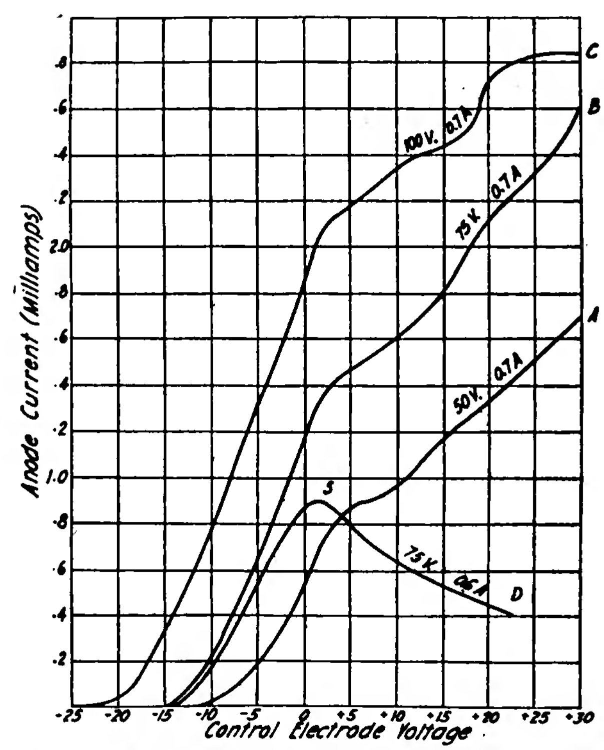


Figure 2—Graphic curves showing the operating characteristics of the tube

G will cause variations in the anode current to P, causing the tube to operate in a very similar manner to an ordinary three-electrode tube with the grid placed between the filament and plate. An increase of control potential causes an increase of anode current, and vice versa. It will be seen that parts of the curves lying to the left of the ordinate through zero potential on the control electrode are very regular and similar to those obtained with an ordinary vacuum tube. When, however, the control electrode is made positive with respect to the filament, it will be seen that the curves commence to lean over rapidly to the right. The electrode G is now drawing to itself an appreciable portion of the electrons emitted from the filament. The effect is far more marked than in the case of an ordinary vacuum tube, since the plate is a more suitable electrode for absorbing the electrons than a fine wire grid. To the right of the zero ordinate the curves become less regular when the control potentials reach higher positive values than those shown in curves A, B and C. The anode currents reach a saturation value and then begin to decrease. This effect is shown in figure 2 by the D curve, which corresponds to 75 volts on the anode and 0.6 amp. through the filament. The anode saturation current is reached at S. An increase of control potential now causes the anode current to drop, electrons which formerly went to the anode are now being drawn to the control electrode.

The same effect is obtainable with an ordinary vacuum tube, but the comparatively sharp bend at S is far more marked in the case of this special tube. This is explained by the fact that the control electrode is of such a nature as to absorb electrons very rapidly. From the curves it will be seen that the amplification obtainable is not as high as in the case of the more usual types of vacuum tubes, in which the grid is placed between the filament and anode. When tested on an actual amplifier, the results, however, are almost as good. The representative point should preferably move only along the negative portion of the curve.

The tube operates efficiently as a detector, the point S being specially suitable for strong signals, both half-oscillations producing decreases of anode current. The vacuum tube also operates excellently as an oscillator or self-heterodyne receiver with 100 volts on the anode and 6 volts across the filament.

No doubt the characteristics and general properties of the tube could be greatly improved by further research.

An Oscillating Current Generator

LEE DE FOREST has devised a high frequency generator which he claims is simple and efficient. With reference to the figures, 1 designates an evacuated vessel provided with two chambers which are united by a narrow passage 4. In these two chambers a mercury electrode or a mercury amalgam electrode is placed. A source of electromotive force, indicated at 7, supplies the current to the electrodes to heat them and causes a vapor trodes. A high resistance, 19, is also connected between the grid and the vapor arc column in the vertical passage to form a "leak" path between these electrodes, the purpose of this leak being to carry off the excess charge which may accumulate on the grid and thereby reduce the efficient operation of the oscillator.

DeForest finds that if a second oscillating circuit is established, which includes the electrode 9 and the vapor

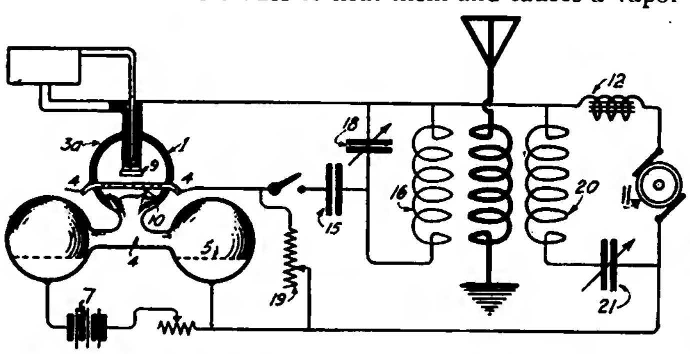
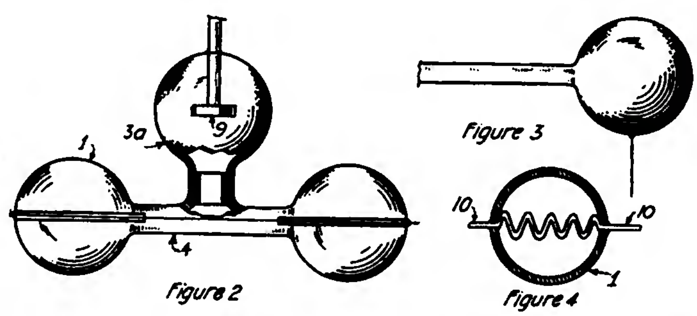


Figure 1—Circuit showing hook-up of the oscillating current generator



Figures 2, 3, 4—Details of the evacuated chambers, showing electrodes, passage for vapor arc column and hollow grid

arc column to form in passage 4. In chamber 3A, forming part of the evacuated vessel and communicating with the mercury arc passage, are located two cold electrodes, 9 and 10, arranged at different distances from the vapor arc column maintained in the vertical passage. The electrode 9 is electrically connected to one terminal of a source of emf. 11. Direct current is used for this purpose. The other terminal of this same source is connected to one of the cathode electrodes, for example, 5. The circuit connection between these two last mentioned electrodes also contains an "inertia" coil, as indicated at 12. The electrodes 9 and 10 must be kept cool. This may be accomplished in several ways. In the case of the electrode 9, a simple arrangement is shown wherein a reservoir which is provided with pipes opening upon the electrode 9 and adapted to allow a cooling medium such as air, water, etc., to circulate through it. The electrode 10 may be of any shape; in the illustration it is in the form of a bent hollow grid with extensions projecting out through the walls of the tube to allow the circulation of air or oil through it. The cooling medium may be supplied from the one reservoir, but for the sake of avoiding confusion in the drawing, this connection is not shown.

An oscillating circuit is connected to the electrodes 9 and 10, the circuit consisting of a condenser and an inductance. A switch, or make-and-break device. is also placed in series with this oscillating circuit and its elec- arc in the vertical passage, and an inductance and a condenser 20 and 21, all in series with each other, the oscillations set up in the original oscillating circuit are increased in intensity provided the period of the second circuit is made equal to that of the first. It is not essential, however, to use this second circuit, but when the two circuits are employed, they should be inductively coupled as shown.

An output circuit may also be associated, either inductively or conductively, with one or both of the circuits. In the arrangement shown, the output circuit is made up of a variable inductance connected between the radiating antenna and the earth in the usual way. The natural period of this output circuit should be equal to that of the first oscillating circuit.

DeForest states that he has as yet been unable to fully and completely understand the operation involved in a generator of the type described. He has found, however. that such an arrangement does operate as a generator of high frequency oscillations suitable for radio work, and whether correct or not, explains the phenomena involved as follows:

If the generator 11 is a direct current source, a negative current is set up across the oscillator by means of the thermions passing from the hot electrode (vapor arc in passage 4) to the cold electrode 9. A negative charge impressed upon the grid will greatly reduce the electron flow from the vapor arc to the cold electrode 9, or in other words, will increase the potential drop between the cold electrode and the hot electrode. Therefore, if the electrical connection between the grid and the plate, 9, be suddenly established by closing the make-and-break switch, the positive potential of the plate and of the positive terminal of condenser 18, will be suddenly increased. Further, any positive charge on the grid will be rapidly carried away by action of the negatively charged electrons from the hot electrode attached thereto, inasmuch as the capacity of the stopping condenser, 15, is small. Thus a difference in potential is quickly established between the two terminals of the condenser. The inductance coil, 16, prevents this difference of potential across the condenser from immediately equalizing, and in consequence, an oscillatory discharge is set up through the inductance. At the end of a half period of this discharge the potential of one terminal of the condenser is therefore reduced or made negative, while that on the other side is made positive relative thereto. The reduction of the positive potential at one terminal of the condenser and on the plate causes a sudden increase of positive current from the generator, which again charges one terminal of the condenser positively and again sets up a negative current across the coil to the other terminal of the condenser and to the grid. This inrush of negative charge to the grid will again reduce the electron flow from the hot electrode to the cold electrode, that is, will still further increase the positive potential of the plate and the corresponding terminal of the condenser with respect to the other terminal of the condenser. Thus the condenser will once more begin to discharge a positive current through the coil and the entire action as above described will be repeated, growing in intensity as it proceeds, due to the magnetic inertia of the coil, up to the point where the loses in the circuits and in the oscillator itself are equal to any further increase in the energy representing the oscillation.

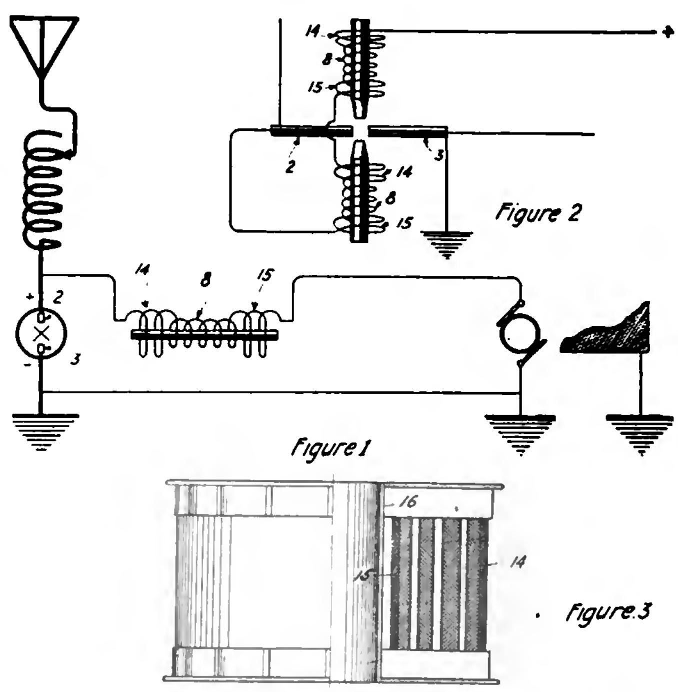
Improvements in Arc Generators

A PATENT recently issued to L. F. Fuller, covers the reduction in size, cost, and weight of an arc radio transmitter, and also provides a transmitter which has a D.C. generator which is safer to handle than the generators formerly used in arc transmitters. The Poulsen arc radio generator comprises a closed chamber containing an atmosphere of hydrogen in which are arranged electrodes between which the arc is formed. The arc gap is subject to a strong transverse magnetic field produced by field windings arranged in the D.C. circuit which supplies the arc. A choke coil is arranged in each arm of the circuit between the D.C. generator and the arc to prevent the high frequency oscillations produced by the arc from reaching the generator.

For purposes of coil insulation, it has always been considered essential to place the magnetic windings in the lead between the generator and the arc electrode, which is grounded. In this prior construction, it is inadvisable to ground the frame of the D.C. generator on account of the large inductive kick of the arc magnet winding which produces dangerous potential surges which, if the frame were grounded, would be impressed on the D.C. generator insulation, causing burn-outs. The generator frame has, therefore, always been insulated from the earth with the result that it frequently became highly charged, and therefore, a source of danger. Also, in the tropics, the material used for insulating the frame from earth, sometimes warps and shrinks, throwing the generator out of alignment with the prime mover. Fuller has found that by combining the choke and magnet coils and placing them in the lead which is connected to the antenna side of the arc and by grounding the generator side of the armature to the generator frame, that a better and cheaper construction is produced than was possible with the prior arrangement. Usually, but not necessarily, the negative lead is connected to the grounded side of the arc.

Figures 1, 2 and 3 are respectively a diagrammatic representation of Fuller's invention, a diagrammatic representation of a modified form of arc generator, and an elevation, half in section, of the combined magnetic and choke coils.

The oscillation generator of the invention comprises two electrodes, 2 and 3, between which the arc is formed, the electrode 2 being connected preferably to the positive side of the electric generation and to the antenna and the electrode 3 being connected preferably to the negative side of the generator and to the ground. The magnetizing winding, 8, is arranged in the lead between the generator and the electrode 2. This winding may be concentrated on one pole or may be placed on both poles, and when so placed, the winding may be in series as shown in figure 2, or they may be in parallel. The other lead connects the ground electrode directly with the armature of the generator and this side of the armature and the generator are grounded. Fuller has found it advantageous to combine the magnetic winding and the choke coil in one winding. That end of the combined winding which is connected to the electrode 2 is constructed so as to serve as the choke coil and since it is often impossible to determine in advance which end of the coil will be



Figures 1, 2, 3—Wiring circuit, arc generator and the combined magnetic and choke coils respectively

connected to the electrode on account of various features of installation, he prefers to form choke coils 14 and 15, at each end of the combined coil. The turns of the winding nearest the electrode are subject to higher duty than the inner turns of the coil and outer turns 14 and 15 are more heavily insulated than the inner turns. The end turns of both ends of the coil are covered with increased insulation for the reason stated before, but when it its definitely known which end of the coil is to be connected to the electrode, the turns on that end only, will be provided with heavier insulation.

The combined coil is built up on a spool, 16, within which the magnet pole is arranged.

A New Variable Condenser

A NEW method of condenser construction is disclosed in a patent recently issued to Robert J. Fitzgerald. The main object of his invention is to provide more efficient and more easily applied insulation for the condenser plates and as an important feature of the invention, he coats the various conducting elements with a non-conducting film, permanently deposited thereon and enveloping the conductor. This non-conducting film or jacket is of such a character that it is not affected by the temperature, chemical or electric conditions with which the condenser is subjected. As an example of such a film, an enamel composition of such character that it may be backed onto the plates may be employed.

In the accompanying drawings, one embodiment of the invention is illustrated on a large scale so far as the thickness of certain parts is concerned, in order to facilitate illustration. Figure 1 is an inverted plan view. Figure 2 is a section of the line 2-2 of figure 1. Figure 3 is an enlarged view of one of the elements.

In the form shown, the condenser is mounted on a slab of any suitable non-conducting material. Several stationary condenser plates of semi-circular form are rigidly secured to this slab by connecting bolts or other suitable means and the plates are held in spaced relationship by spacers. The single rod 15 extends through the plates approximately at the center of the curvature and is positioned at the center of the curvature of the stationary plates, which are shown as cut away midway of the straight line, to form a recess receiving the shaft as is the usual apparatus.

By means of this invention, the use of separate insulation plates is avoided. Each plate carries its own insulation and in case of the breakage of insulation of any plate, the plate may be readily removed and replaced by a new one.

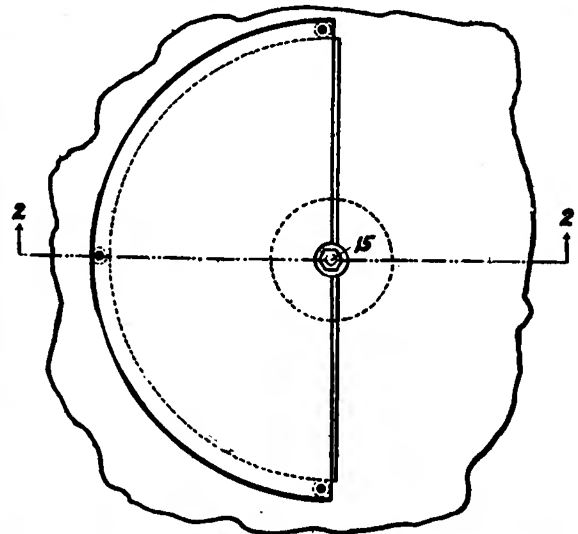


Figure 3

Figure 1

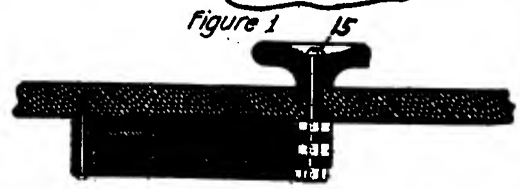


Figure 2

Figures 1, 2, 3—Details of the variable condensers

Condenser Construction

IN THE construction of condensers where solid dielectric is used, intimate contact between the surfaces of the conducting plates and the insulating sheets is highly desirable. If there are spaces present between the conducting sheets and the dielectric, the capacity of the condenser is cut down owing to the larger distances between the plates and the capacity of different elements varies because of the irregularity of such spaces. Furthermore, the dielectric medium lacks uniformity since it consists at some points solely of mica and at other points of mica and air, or impregnating compound, if the latter be employed.

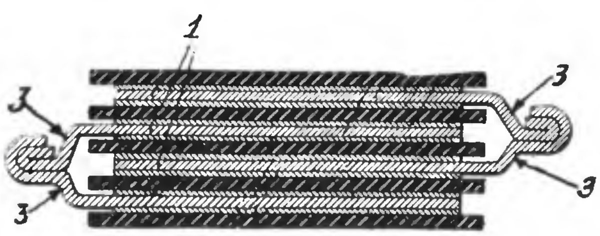


Figure 1—Assembly of the conducting and dielectric plates

In figure 1, William Dubilier shows a method whereby the inconvenience above mentioned may be avoided. Between the hard conducting plates 3, and the dielectric plates 1, are interposed conducting plates made of soft foil. The assembly is then subjected to an extremely high pressure of the order of several thousand pounds, with the result that the faces of the conducting plates and insulating sheets are intimately connected and brought into absolute union, with each other; for instance, if mica be employed as a dielectric, its hairy and minutely irregular surface will be imbedded into absolute union with the conducting plates so as to eliminate any small voids or spaces between the same; that is, the soft foil works itself into the depressions of the mica sheet at the same time maintaining perfect connection with the hard copper conducting sheet, 3.

Dubilier also shows his method of adjusting fixed condensers in order that they may have a predetermined capacity value. Figure 2 shows condenser sections set up and connected in series in order to form a condenser which will withstand high electromotive forces. Heretofore, condensers made of a large number of conducting plates and insulating sheets have been tested after being completed, and the capacity adjusted, by tearing off or adding the required number of insulating sheets and conducting plates to bring the capacity within the necessary limits. After adjusting the capacity in this way, there is a certain amount of "patch work" on each condenser, which is obviously undesirable, and it is necessary to change the terminal connections of the conducting plates in order to accommodate a greater or smaller number, as may be required. In some instances, condensers made up of several condenser sections have been employed, each of such sections consisting of a number of conducting plates and insulating sheets bound together and the terminals of the sections connected in series or in parallel to make up the complete condenser. The capacity of condensers of this latter type has been brought within desired limits by tearing off or building on the necessary number of conducting plates and insulating sheets to the last section. This practice is open to the same objections as above mentioned and also to the further disadvantage that the removal of conducting plates from the last or end section may reduce the area or effective surface of the latter to such an extent as to give a breakdown in that section. In condensers where high potentials are to be withstood, it is desirable to distribute the potential over a large number of condenser sections in order that no single section may be subjected to undue stress. Figure 2 shows a condenser of the last mentioned type in which the disadvantages heretofore encountered in making capacity adjustment are avoided. In making up a condenser of any desired capacity, several sections are built up and the individual capacity of each section is made of such value that when approximately the number of sections necessary to provide a complete condenser of approximately the desired capacity, are connected, the addition or withdrawal of a section from the complete condenser will produce a change in the capacity of the condenser less than the permissible error. In other words, when about the proper number of sections have been connected, the capacity of the complete condenser is tested and one or more sections added on or removed, as may be necessary.

Since the capacity of the sections has been so chosen that when the approximate desired capacity has been reached, the addition or removal of a section will produce a change in capacity well within the permissible variation from standard. It is also possible to bring the capacity of the condenser to a value within the prescribed limits in the above manner.

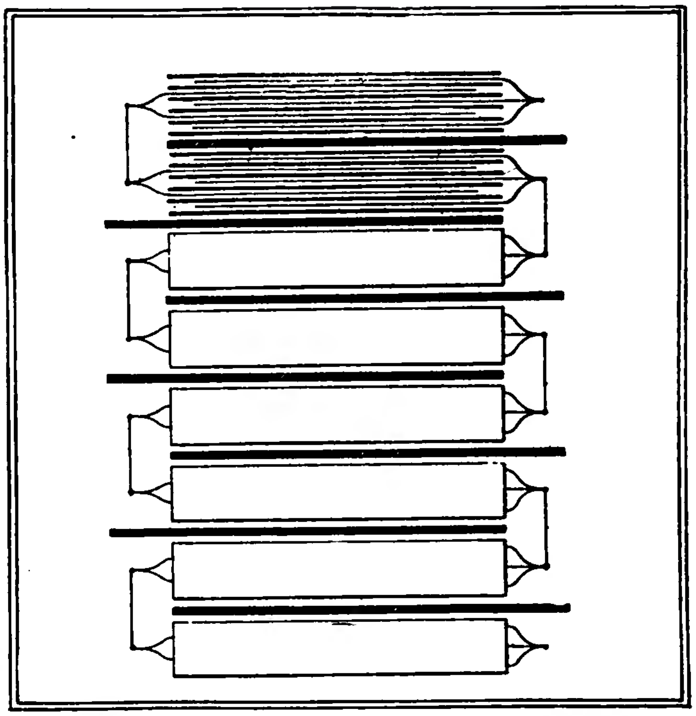


Figure 2—Condenser sections set up and connected in series

Controlling the Amplitude of Radio Frequency Continuous Oscillations

IT has been found that an electron discharge device comprising an incandescent cathode, a co-operating anode, and a discharge controlling member of the grid inclosed in an evacuated envelop may be employed for producing radio frequency oscillations. In order to secure this result a source of energy is placed in the plate circuit of the device, which includes the cathode, the anode, and an inductance, and this circuit is coupled with the grid circuit, which includes the cathode and grid, and a second inductance. If a suitable degree of coupling is provided between the two circuits enough energy is transferred from the plate circuit to the grid circuit to impress upon the grid the potential necessary to control the flow of current in the plate circuit in the desired manner. In some cases the electrostatic coupling betwen the two circuits, which is always present by reason of the capacity between the electrodes, is sufficient to bring about the desired result. In other cases this is supplemented in various ways, as, for example, by a coupling between the inductances in the two circuits, or by an additional electrostatic coupling consisting of a condenser between the grid and anode, or by a combination of the two forms of coupling. Because of the unidirectional conductivity of the electron discharge device, the current in the plate circuit will usually be pulsating in character. For practical purposes, however, it may be considered as being made up of two components, one a constant direct current, and the second an alternating current superimposed upon the direct current. In order to utilize this alternating component in a radiating system it has been customary to couple a coil in the antenna with the plate circuit inductance. It has also been customary to employ variable condensers in the plate or grid circuits, or in both circuits, for tuning the system to produce the desired frequency of oscillations. With the systems heretofore employed, in order to secure maximum efficiency of output, it has also been necessary that the antenna should be tuned to the same frequency as the system which produces the oscillations.

Dr. A. N. Goldsmith provides a system in which the entire tuning may be accomplished by varying one of the constants of the antenna, and in which the necessity of an inductive coupling between the antenna and the system producing oscillations is avoided. In accomplishing this object the grid and plate circuit inductances are included directly in the antenna, and the capacity of the antenna is made use of in place of the condensers previously employed for tuning the grid or plate circuits.

In case it is desired to utilize the radio frequency oscillations produced by the electron discharge device for the transmission of sound waves, it has been proposed to superimpose upon the grid circuit of the device a variable current produced by means of the sound waves which it is desired to transmit. With this arrangement the degree of control which can be secured is limited to some extent by the amount of energy which can be controlled by an ordinary telephone transmitter. Hence it will be apparent that if means are provided for amplifying the current variations produced by the telephone transmitter a larger degree of control may be secured. A further object of this arrangement is to provide simple and efficient means for amplifying the audio frequency current produced by the telephone transmitter. In accomplishing this an audio frequency coupling is used between the grid and plate circuits. When the telephone current is superimposed upon the grid circuit corresponding but amplified variations are produced in the current in the plate circuit. These amplified current variations are, by means of the audio frequency coupling fed back into the grid circuit, and as a result of the audio frequency potential variations upon the grid are made much greater than it is possible to secure by means of the original telephone current alone.

As indicated in the drawing, an electron discharge device is used which comprises an electron emitting cathode of filamentary form, a plate-shaped anode, and a grid interposed between the cathode and the anode, all inclosed in an evacuated envelop. The plate circuit of this device includes the cathode, anode and inductance and a direct current generator. Current for heating the cathode to cause it to omit electrons is supplied by a battery, the means for regulating the heating current which is customarily used being omitted in order to simplify the drawing. The grid circuit comprises the cathode, grid, an inductance and coils 9 and 10 of transformers adapted to the transformation of audio frequency currents, for

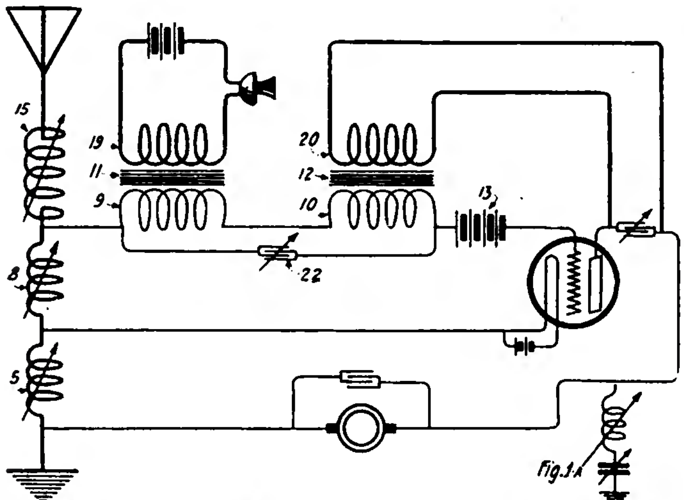


Figure 1—Circuit diagram of the improved tuning system

example, the iron core transformers 11 and 12. The antenna may be connected to the top of the inductance through a tuning coil or directly connected to the top of coil, depending upon the antenna characteristics, and the radiating system is grounded through inductances 8 and 5. With the connection thus far described the grid and plate circuits are coupled electrostatically by reason of the capacity between the electrodes and this coupling is supplemented by the capacity of the antenna which is in effect connected between the grid and anode. The relative positions of coils 5 and 8 may also be made such as to furnish any desired degree of inductive coupling between the two circuits.

It is desirable to have the effective impedance in the output circuit of an oscillation discharge device, or several such devices in parallel or series, equivalent to the net internal impedance, which is mostly resistance, of such device or devices. This requires the introduction of the antenna reactance and resistance into the oscillating circuit with a transformer ratio which is, in general different from unity so as to obtain the most efficient operation. The coil 15 provides such a means of varying the ratio of transformation whereby the antenna reactance and resistance are introduced into the oscillating circuit, and a condenser in the antenna circuit, usually in the ground lead, would provide a similar means of adjustment though in the opposite sense.

The arrangement thus described is adapted to produce radio frequency continuous oscillations, the frequency of which may be varied by varying the tuning of the system by means of the tuning coil. The tuning of the system may also be varied by varying the inductance of coil 8 or coil 5, or, if desired, a variable condenser may be connected between the bottom of coil 5 and ground as shown in figure 1A. It will also be apparent that the desired result may be obtained by varying any two or more of the above-mentioned elements. In order to control the amplitude of the oscillations thus produced in accordance with the amplitude of the current produced by sound waves, current from the telephone transmitter supplied by a local battery is caused to flow through the primary of the transformer 11. When the transmitter is acted upon by sound waves, a variable telephone current will flow through the primary of the transformer. The potential of the grid is thus caused to vary in accordance with variations in the telephone current and the amplitude of the oscillations produced in the antenna will thereby be varied in accordance with the variations in the current through the transmitter. The current in the plate circuit will vary in the same way. This current will now have in addition to the radio frequency component an audio frequency component which varies in accordance with the variations in the telephone current, and this component is caused to flow through the primary of transformer 12, and is thus superimposed upon the grid circuit causing a further increase in the amplitude of the audio frequency potential variations upon the grid, provided the coils 19, 9, 20 and 10, are connected in such a way as to give the proper polarity to secure the reinforcing action. The condenser in the plate circuit which shunts the primary 20 is given such a value that it offers a low impedance to the radio frequency component of the plate circuit by a high impedance to the audio frequency component. The condenser which shunts secondaries of transformers 11 and 12 is also given such a value that it offers a low impedance path to the radio frequency component of the current in the grid circuit. The condenser may be employed for shunting the source of current in order that the radio frequency component of current in the plate circuit will not be compelled to pass through this source.

In the arrangement shown in figure 2, a plurality of electron discharge devices connected in parallel are employed for producing oscillations, the cathodes of all of these devices being supplied with heating current by common battery. In this case the source of current instead of being connected in series in the plate circuit is connected in the parallel branch, and an inductance is employed to prevent the radio frequency component of the plate current from flowing through the source and to insure efficient production of radio frequency energy. The coil 25 acts as a maintaining inductance in that it gives rise to radio frequency potential differences at its terminals. The result is that the plate circuit voltage of the electron

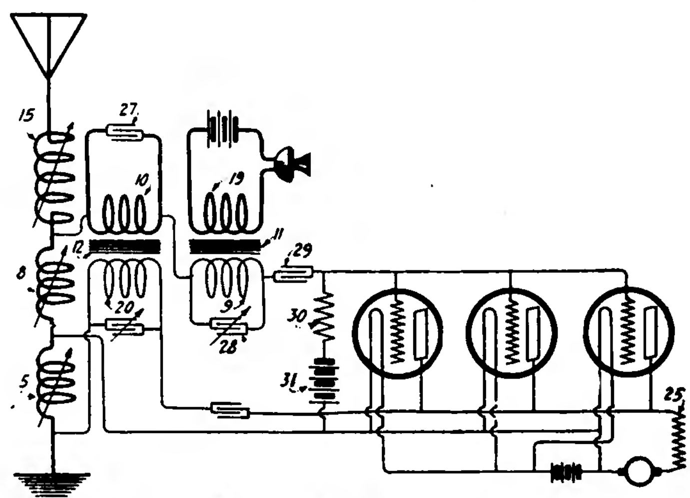


Figure 2—Modified form using three tubes

discharge device, that is, the voltage between filament and plate, is variable with a radio frequency component. Because of the phase of the grid potential control, the voltage is highest when the internal resistance in the bulb is highest between plate and filament, and the external voltage is least when the energy is absorbed per cycle in the discharge device, and increased efficiency results. The condenser in the second branch of the plate circuit serves to prevent the direct current component of the plate current from flowing through this branch. In this case separate condensers 27 and 28 are employed for shunting the coils 9 and 10 instead of the single condenser 22.

EXPERIMENTERS' WORLD

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

Construction of a Simple Wavemeter, Range 150-500 Meters

By A. H. Rice Jr.

THE construction of a wavemeter of efficient design is so simple and the benefits to be derived from its use so numerous, that the writer feels that the small expense involved in making one is more than justified.

There are probably two reasons why a wavemeter is not a part of every experimenter's equipment; first, the bugbear of having it calibrated; and, second, the extravagance of possessing an idle condenser. Both of these objections have here been eliminated and if directions are followed carefully, an accuracy within 5% may be obtained without calibration, which is sufficient for practical work, and the condenser, when not being used for measurements, may be placed in any part of the receiving circuit.

A wavemeter consists essentially of an inductance of known value and a variable capacity. A Murdock No. A366 condenser, having 43 plates and a maximum of .001 mfd. capacity was selected, as they have been found to be uniform in construction and are very reasonable in price. The corresponding wavelengths for the various settings of the condenser may be calibrated directly on a celluloid scale and this, in turn, may be fastened to the condenser or they may be plotted in curve form. In order to simplify construction, the latter method has been chosen, see figure 5.

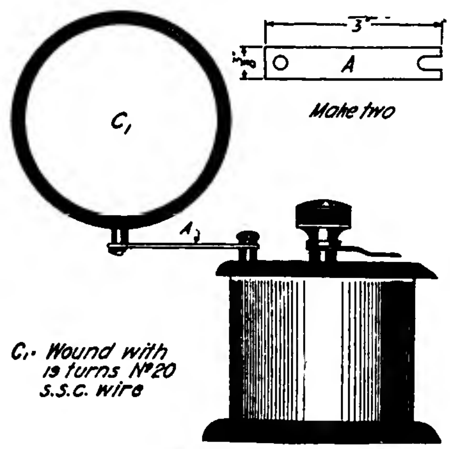
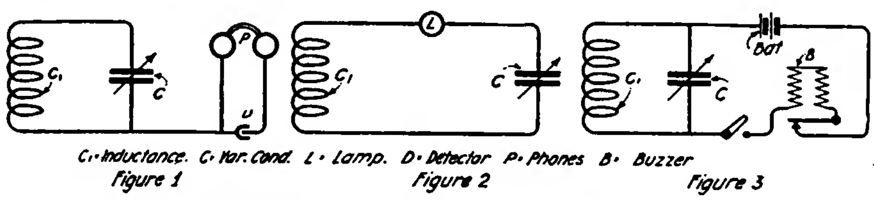


Figure 4—Showing the coil connected to condenser



Figures 1, 2, 3—Connections required for various measurements

The inductance may be wound on a mailing tube having an outside diameter of 5 inches and about 2 inches long, although, if there is a lathe handy a wooden ring of these dimensions will result in a much better looking coil. Nineteen turns of No. 20 SSC wire are necessary, the winding covering a space of about ¾ inches. Small binding posts should be mounted at each end of the coil, as indicated in the diagram, to which the terminals should be carefully soldered. The tube should be dipped in shellac and dried out to prevent shrinkage, but no shellac should be placed over the winding.

In addition to the inductance and capacity, a buzzer, small flash light bulb and mineral detector are necessary; the bulb and detector are used for ascertaining the maximum efficiency of the transmitter or the wavelength of an incoming signal and the buzzer is used as a transmitter to generate oscillations of known wavelength.

In connecting up the meter, the experimenter is advised to make all connections as short and direct as possible with No. 16 bare copper wire, excepting those from the coil to the condenser, which should be made of strip brass 1/16 inch thick, see figure 4.

Figures 1, 2 and 3 show the connections required for various measurements and particular attention is called to the fact that in figure 1, the phones are not connected across the condenser, for if this were the case, their additional capacity would require a re-calibration of the meter.

No effort will be made to burden the reader with instructions on the various methods of using the wavemeter, as this has been fully covered in several complete works on the subject and in many of the current magazines.

Reference to the diagram will disclose any details which may have been omitted in this description. All of the apparatus may be mounted on a panel and placed in a cabinet for convenience if desired, but unless the reader is an expert at woodworking, he is urgently advised to turn this job over to his cabinetmaker, as careful workmanship here will make the wavemeter a "thing of beauty and a joy forever."

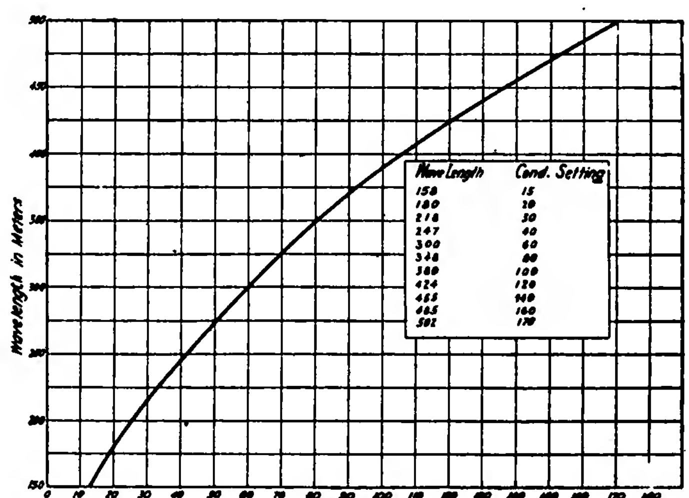


Figure 5—Graphic curve and chart showing various calibrations

Wind Your Own Honeycomb Coils

By C. J. Fitch

THERE is no doubt that honeycomb coils are the most practical inductance coils that the amateur can find. The price of a complete set of coils including the coil mounting is, however, beyond the reach of many experimenters. The obvious remedy is to wind your own honeycomb coils.

The experimenter who tries to wind these coils by hand usually fails, because each turn being wound diagonally around a cylinder is oval shaped and tends to straighten out to a circle, taking the shortest path around the cylinder. As a result the winding collapses. To prevent this, the wire must be wound on a form so shaped that each turn is already around the shortest path of the form. The form, therefore, must be spherical in shape; then each turn, no matter which direction it is wound, will not shrink to a smaller size and loosen the whole winding. This not only facilitates the winding, but makes a better coil mechanically and electrically. Mechanically, the coil is self-supporting and will stay as wound when removed from the form. If given a coat of shellac, the coil is very strong, and can be used for many purposes, as for variometers, wavemeters, etc. Electrically, the coils have a greater inductance than those wound on a cylinder with the same amount of wire.

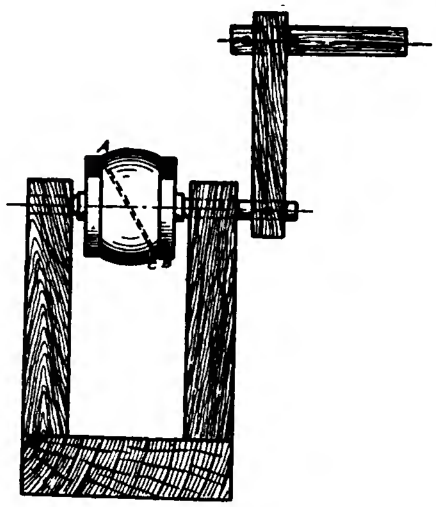


Figure 1—Machine for winding honeycomb coils

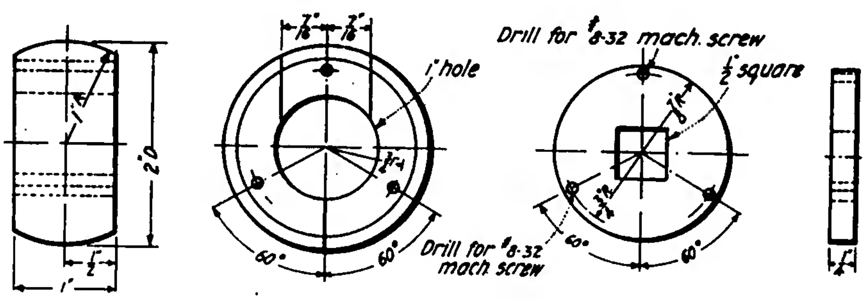


Figure 2—Constructional details of the arbor

Figure 1 shows a machine for winding honeycomb coils which anyone can build. The entire machine is made of wood.

Figure 2 shows the details of the arbor. It can be cut out of a piece of soft wood with a knife and sandpapered smooth or turned out on a lathe.

To wind a coil, first fasten the machine securely to a bench or table. Clamp the end of the wire under the end plate at A, figure 1, and wind diagonally across the arbor to B, as shown by the dotted line. From B, wind around to A, cross over the first turn at A and wind onto C. Continue in this way, spacing the turns about 1/16" apart, till the winding is complete. Then remove the coil and apply a coat of white shellac.

The writer has wound several coils in this way as easily as a single layer cylindrical coil could be wound, and they have an appearance equal to machine wound coils.

Figure 3 shows the method of mounting the coils on a panel so that they can be swung back and forth on hinges to vary the coupling. Two coils should be hinged to the panel and a third coil fastened stationary to the panel between the hinged coils. One hinged coil is the primary, the middle coil the secondary, and the third coil the tickler coil, for the regenerative circuit.

As shown on the drawing, the clips are arranged so that a coil can easily be removed, and another coil inserted in its place.

The following gives winding data for a set of coils suitable for the average amateur station:

No. of Coils	No. of Layers of Wire	Size of Wire
2	2	24
2	4	24
2	6	24
2	10	26
2	14	26
1	18	26
1	22	28
1	26	28
1	30	28

Tuning is accomplished with variometers or variable condensers. With a primary condenser of .001 mfd. and a secondary condenser of .0005 mfd., a wide range of wavelengths can be covered.

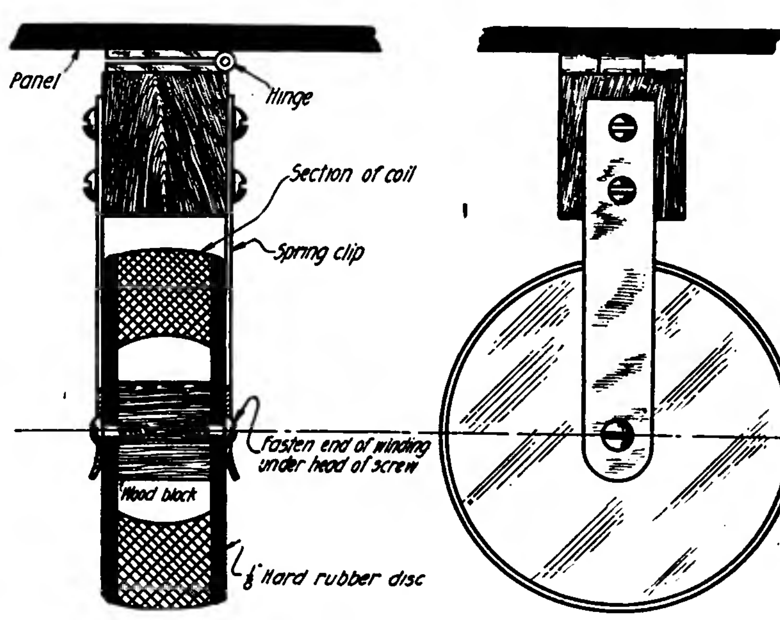


Figure 3—Method of mounting the coils

Second District Call Letters of Amateur Stations

Letters.	Power.	Name and address.
2AA	18	Vincent J. Fritch, 939 College Ave., New York City.
2AB	1000	M. W. Sterns, 129 Wadsworth Ave., New York City.
2AC	50	Chester R. Gernert, 41 Bridge St., Somerville, N. J.
2AD	45	Theo. N. Whildin, Oakdale, Long Island, N. Y.
2AE	80	Wm. H. Hoppi, 365 Quincy St., Brooklyn.
2AF	500	Benj. Berlin, 1252 Flatbush Ave., Brooklyn, N. Y.
2AG	25	Howard Terry, 25 Myrtle Ave, Keyport, N. J.
2AH	500	A. Edelman, 956 Leggett Ave., New York City.
2AI	50	John G. Eber, 5505 Third Ave., Brooklyn.
2AJ	40	Edwin T. Buttner, 1376 Third Ave., New York City.
2AK	500	Carl J. Hunkins, Johnson Ave., Newark, New Jersey.
2AL	36	Walter N. Stanley, 451 Hancock St., Brooklyn.
2AM	250	Henry L. Bantelman, Jr., Tuckahoe Rd., Yonkers, N. Y.
2AN	250	Conrad J. Sedlak, 633 Main St., North Bergen, N. J.
2AO	1000	Robert J. Freeman, Aloah Rdo. Sta., Soutbampton, N. Y.
2AP	500	C. F. Unger, Franklin Ave., Harrison, N. Y.
2AQ	25	Harry Blutstein, 723 Stone Ave., Brooklyn.
2AR	500	G. H. Underhill, 78 S. Hamilton St., Poughkeepsie, N. Y.
2AS	220	Harvey Kennedy, 1965 Vyse Ave., New York City.
2AT	15	Herman Fischer, Jr., 146 Myrtle Ave., Irvington, N. J.
2AU	220	Chas. J. Huff, 1972 Honeywell Ave., New York City.
2AV	250	Frank S. LeRoy, 103 So. Maple Ave., Ridgewood, N. J.
2AW	14	Arthur A. Heberlein, 768 Melrose Ave., New York City.
2AX	500	Howard Blower, 664 E. 18th St., Brooklyn.
2AY	100	Burton Greenburg, 332 E. 67th St., New York City.
2AZ	500	Eugene S. Pearl, 307 Gregory Ave., Passaic, New Jersey.
2BA	550	H. M. Ash, Oakland, N. J.
2BB	990	I. R. Lounsberry, Jr., 15 Ann St., Ossining, New York.
2BC	50	Charles Mulligan, Washington Ave., Bergenfield, N. J.
2BD	24	Elmer G. Baier, 253 Ninth St., Brooklyn.
2BE	50	George S. Yerbury, 331 Lafayette Ave., Passaic, N. J.
2BF	500	B. H. Mills, U. S. Gen. Hospital No. 41, Fox Hills, S. I.
2BG	250	George F. Gaede, Pompton Rd., Paterson, N. J.
2BH	22	Henry G. Muller, 2900 Eighth Ave., New York City.
2BI	50	James Wood, 1420 Putnam Ave., Brooklyn.
2BJ	550	H. H. Dahms, 21 Manitou Ave., Poughkeepsie, N. Y.
2BK	700	Carl E. Trube, 6 Livingston Ave., Yonkers, N. Y.
2BL	25	Reed Cline, Main St., Millerton, N. Y.
2BM	770	E. Heermance, 523 State St., Hudson, New York.
2BN	800	E. G. Sisson, Jr., 57 Union St., Montclair, N. J.
2BO	500	M. A. McIntire, 1127 Ave. G, Brooklyn, N. Y.
2BP	500	John Pollock, 230 W. 99th St., New York City.
2BQ	236	Baldwin Guild, 636 Mt. Prospect Ave., Newark, N. J
2BR	75	Leroy S Callan, 1087 New York Ave., Brooklyn, N. Y.
2BS	500	Frdk. E. Garlick, 23 Occident Ave., Tompkinsville, N. Y.
2BT	12	Earl F. Adams, 1048 Julia St., Elizabeth, N. J.
2BU	50	Harold T. Sniffin, 730 E. 178th St., New York City.
2BV	12	Reginald K. Woodward, 84 Amherst St., East Orange, N. J.
2BW	500	E. T. Hynes, 2429 Valentine Ave., New York City.
2BX	18	Brownea Business College, Brooklyn, N. Y.
2BY	220	Erwin Oeller, 511 Mumford St., Schenectady, N. Y.
2BZ	250	Will T. Weatherbee, 609 W. 186th St., New York City.
2CA	50	Harry G. Lichtenstein, 1245 Madison Ave., New York City.
2CB	30	John D. Schram, 283 E. 32nd St., Brooklyn.
2CC	500	Clarence Collignon, Montvale, New Jersey.
2CD	980	Roger D. Prosser, Chestnut St., Englewood, N. J.
2CE	1000	J. W. Dain, 1100 Orchard St., Peekskill, New York.
2CF	75	Arthur E. Prince, 30 South Eldert Ave., Rockaway Beach.
2CG	550	Frederic K. Shield, Coxsackie, N. Y.
2CH	500	S. Isaacson, 900 Riverside Drive, N. Y. C.
2CI	25	Clarence H. Osborn, 97 Watkins Ave., Middletown, N. Y.
2CJ	500	Walter E. Bathgate, 102 High St., Passaic, N. J.
2CK	880	T. F. O'Brien, 19 Nassau Ave., Freeport, N. Y.
2CL	500	George L Storm, 742 Highland Ave., Newark, N. J.
2CM	220	H. Zimmerman, Jr., 2590 Third Ave., New York City.
2CN	220	Edward T. Dickey, 1649 Amsterdam Ave., New York City.
2CO	50	Peter Cooper, 512 Sewal Ave., Asbury Park, N. J.
2CP	600	Jas. P. Devine, 1068 University Ave., New York City.
2CQ	660	E. M. Washburn, 111 Miln St, Cranford, N. J.
2CR	75	Morris Lieberman, 524 Barbey St., Brooklyn.
2CS	1000	Charles M. Schaefer, 201 Park Ave., Port Richmond, N. Y
2CT	750	Matthias Thury, 878 Macy Place, New York.
2CU	24	H. B. Von Thun, 271 Decatur St., Brooklyn.
2CV	50	Herbert G. Rowley, 107 Clifton Ave., Newark, N. J.
2CW	995	F. M. Ham. 403 Prospect St., Westfield, New Jersey.
2CX	50	Ernest K. Seyd, 531 Washington Ave., Brooklyn.
2CY	50	Herbert G. Rowley, 107 Clifton Ave., Newark, N. J.
2CZ	440	Frank V. Becker, 12 Callister St., New York City.
2DA	1000	A. H. Winn, 325 Church St., Poughkeepsie, New York.
2DB	220	R. D. Zucker, 46 Clinton Place, Mt. Vernon, N. Y.
2DC	25	John Stofan, 95 Grand St, Garfield, New Jersey.
2DE	25	Arthur Mahn, 539 E. 145th St., New York City.
2DF	500	Harry G. Silversdorff, 641 Pavonia Ave., Jersey City, N. J.
2DG	108	Harry Y. Higgs, 30 Irving Place, Brooklyn, N. Y.
2DH	72	Samuel W. Knapp, 75 Cooper St., Brooklyn.
2DI	250	Ernest A. Cyriax, 219 E. 71st St., New York.
2DJ	1000	E. B. Lant, Scarsdale, N. Y.
2DK	50	Wm. R. Chinn, 25 Westchester Ave, White Plains, N. Y.
2DL	990	V. F Bangert, 34 Orchard St. Jamaica, N. Y.
2DM	880	H. C. Nightingale, 349 18th Ave., Paterson, N. J.
2DN	25	Arnold Brilhart, 10 Cornell Ave., Yonkers, N. Y.
2DO	30	Louis J. Wadsworth, 1494 Bushwick Ave., Brooklyn.
2DP	500	Charles Fucci, 606 Henderson St., Jersey City, N. J.
2DQ	12	R. W. Porter, 166 78th St., New York City.
2DR	500	T. C. Cooper, 269 Garfield Ave., Jersey City, N. J.
2DS	880	LeRoy Clark, Chestnut St., Englewood, N. J.
2DT	500	F. T. Hermann, 131 Main St., Hempstead, L. I.
2DU	100	J. E. Engstrom, 100 St. Marks Place, Brooklyn.
2DV	500	E. D. Hallett, 86 Prospect Pl., Rutherford, N. J.
2DW	18	J. J. Hallahan, 180 Market St., Perth Amboy, N. J.
2DX	100	I. R. Greves, 34 Hobart Ave., Summit, N. J.
2DY	500	A. J. Haynes, 128 W. 80th St., New York City.
2DZ	50	Daniel D. Hancock, Newman Springs Ave., Red Bank, N. J.
2EA	500	Edwin S. Crane, 47 Sinclair Ave., Flushing, N. Y.
2EB	50	Edward V. Neuser, Ridge St., Pearl River, N. Y.
2EC	24	F. C. W. Thiede, 486 Decatur St., Brooklyn.
2ED	400	Graham V. Lowe, 262 W. 77th St., New York City.
2EE	250	E. W. Maurer, 65 Osborn St., Keyport, New Jersey.
2EF	50	Theo. Hurd, 7 Tilton Ave., Red Bank, New Jersey.
2EG	1000	Egmont Arany, 62 W. 124th St., New York.
2EH	1000	E. M. Williams, 1627 Seventh Ave., Troy, New York.
2EI	500	Henry C. Quick, 471-75th St., Brooklyn.
2EJ	200	Russel Davis, 601 Page Ave., Allenhurst, N. J.
2EK	50	M. Ferris Roberts, 17 Heights Terrace, Ridgewood, N. J.
2EL	990	H. H. Carman, 217 Bedell St., Freeport, L. I., N. Y.
2EM	50	Chas. F. Jacobs, 279 Park Place, Brooklyn.
2EN	18	George B. Huss, 30 Clifton Ave., Lakewood, N. J.
2EO	50	Samuel Levelle, 255 So. Manning Blvd., Albany, N. Y.
2EP	25	Chas. P. Baulser, No. Main St., Pearl River, N. Y.
2EQ	990	J. J. Nightingale, 741 Market St., Paterson, N. J.
2ES	50	Frank M. Ende, MacFarland Ave., Arrochar Park, S. I.
2ET	500	G. B. England, 917 St. Nicholas Ave., N. Y. C.
2EU	50	Harry Davis, 520 Clinton Ave., Newark, N. J.
2EV	500	Edwin Lentz, 5 Mertz Ave., Hillside, N. J.
2EF	500	John C. H. Steinkamp, 89 Hyatt Ave., Yonkers, N. Y.
2EX	550	B. B. Jackson, 34 E. Newell Ave., Rutherford, N. J.
2EY	475	F. J. McKinney, 300 Glenwood Ave., Bloomfield, N. J.
2EZ	50	Jas McAnley, 311 W. 54th St., New York City.
2FA	24	Wm A. LeMay, 1117 Hutton St., Troy, N. Y.
2FB	24	Harold Cohn, 546 W. 146th St., N. Y.
2FC	50	Fred Clayton, 607 Emory St., Asbury Pk., N. J.
2FD	30	John DiBlaisi, 227 E. 75th St., New York City.
2FE	1000	M. G. Pawley, Blair Academy, Blairstown, N. J.
2FF	90	Harold S. Brower, 19 So. Clinton St., Poughkeepsie, N. Y.
2FG	1000	F. H. Myers, 540 Providence St., Albany, N. Y.
2FI	750	Geo. E. Cole, 36 Watsessing Ave., Bloomfield, N. J.
2FJ	50	Frdk. A. Girard, Magnolia St., Montvale, N. J.
2FK	440	Richard W. Freure, 439a McDonough St., Brooklyn, N. Y.
2FL	1000	K. R. Woodruff, 616 Clifton Ave., Clifton, N. J.
2FM	880	Francis McCartin, Jr., 524 Paige St., Schenectady, N. Y.
2FO	50	W. S. Blanchard, 401 Westervelt Ave., New Brighton, N. Y.
2FP	60	Harold Peiler, 321 E. 90th St., New York City.
2FQ	50	Joseph Pignone, 2065 Anthony Ave., New York City.
2FR	75	J. R. Richardson, 16 Culver St., Yonkers, N. Y.
2FS	500	Howard L. Stanley, Prospect St., Babylon, N. Y.
2FT	1000	Wm. E. Murray, 521 N. James St., Peekskill, N. Y.
2FU	180	Chas. I. Hertz, 510 W. 144th St., New York City.
2FW	990	C. V. Macpherson, 590 W. 172nd St., New York City.
2FX	880	Ray V. D. Gedney, Center Ave., Little Falls, N. J.
2FY	500	Dan Voepel, Jr., 1140 Clay Ave., New York City.
2FZ	500	F. Frimerman, 334 E. 100th St., New York City.
2GA	32	F. W. Miller, 4 Hicks Ave., Winfield, L. I.
2GB	50	Frank H. Giefer, Ravenhurst, West New Brighton, N. Y.
2GC	50	A. E. Sonn, 282 Parker St., Newark, N. J.
2GD	750	R. G. Kaufman, 20 Llewellyn Ave., Bloomfield, N. J.
2GE	990	George C. Otten, 58 Chichester Ave., Jamaica, N. Y.
2GF	48	J. C. Ruckelsbaus, 566 Ridge St., Newark, N. J.
2GG	9	Chas. P. E. Gruetzke, Jr., 1237 Brook Ave., New York City.
2GH	500	M. Hardy, 373 W. 126th St., New York City.
2GI	50	Henry J. McCue, 76th St. and Shore Road, Brooklyn.
2GJ	440	E. G. Cronenmeyer, 1269 Theriot St., New York City.
2GM	50	W. Grumbacker, 514 W. 170th St., New York City.
2GN	50	John H. Peitler, 45 53rd St., Corona, N. Y.
2GO	50	H. G. Mulligan, 356 Madison Ave., Albany, N. Y.
2GP	50	Thos. Martin, 15 Troy Road, Menondo, N. Y.
2GQ	18	Chas. T. Manning, 81 Maple Ave., East Orange, N. J.
2GR	1000	John M. High, Jr., 254th St. and Independence Ave., N. Y.
2GS	75	Geo. D. Stewart, 90 N. Bway, Yonkers, N. Y.
2GT	600	J. V. N. Bergen, Port Jefferson, L. I.
2GU	36	N. Y. Catholic Protectory, Walker Ave., Van Nest, N. Y.
2GV	550	C. J. Ripperger, 147 Wisner Ave., Middletown, N. Y.
2GW	440	C. L. Homan, Sayville, L. I., N. Y.
2GX	500	Y. M. H. A., 92nd St. and Lexington Ave., N. Y. C.
2GY	50	Frank X. Hayes, 162 E. 82nd St., New York City.
2GZ	220	Robt. C. Barnes, 916 E. 179th St., New York City.
2HA	275	W. H. Sands, 80 Forster Ave., Mt. Vernon, N. Y.
2HB	22	H. L. Brown, 152 S. Broadway, Yonkers, N. Y.
2HC	250	Gordon Peck, 68 Woodruff Ave., Brooklyn.
2HD	12	K. C. Underwood, 54 N. 11th St., Newark, N. J.
2HE	50	Leroy Wm. Rock, 201 Beach St., Red Bank, N. J.
2HF	250	Chas. W. Coote, 725 W. 172nd St., New York City.
2HG	500	G. W. Krueger, 73 Lincoln Park, Newark, N. J.
2HH	500	P. H. Betts, 238 Valley Road, Montclair, N. J.
2HI	80	Howard I. Becker, 185 Division St., Schenectady, N. Y.
2HJ	15	H. J. Hasbrouck, Jr., 71 Elmont Ave., Port Chester, N. Y.
2HK	500	H. Geitz, 1926 Bleecker St., Ridgewood, L. I., N. Y.
2HL	25	M. Freyfus, 154 Fairmount Ave., Newark, N. J.
2HM	50	Clarence A. McKee, 821 E. 216th St., New York City.
2HN	440	Chas. H. Burch, 72 Third St., Long Island City, N. Y.
2HO	850	Wm. B. Lyons, Broad St., Bloomfield, N. J.
2HP	50	Thos. Martin, 15 Troy Road, Menondo, N. Y.
2HQ	50	Frdk. Doscher, 246 Morris Ave., Rockville Centre, N. Y.
2HS	25	Donald Van Brakle, 83 Maple Pl., Keyport, N. J.
2HT	50	Howard W. Ticknor, 316 Mt. Prospect Ave., Newark, N. J.
2HU	472	Grosvenor Hotchkiss, 146 Halsey St., Brooklyn.
2HV	50	Edw. D. Blodgett, 335 Rugby Road, Brooklyn.
2HW	16	Frank M. Hanna, 1211 Hutton St., Troy, N. Y.
2HX	100	Harry Alexander, 838 Riverside Drive, New York.
2HY	1000	Nelson M. Smith, 143 Norton Ave., Port Chester, N. Y.
2HZ	585	Arthur F. Clough, 96 Hamilton Ave., Yonkers, N. Y.
2IA	500	F. V. Bremer, 3613 Boulevard, Jersey City, N. J.
2IB	25	T. V. Geohegan, Pleasant Ave., Athenia, N. J.
2IC	990	Raymond I. Gratzner, City College of N. Y., New York.
2ID	50	Frank H. Schubert, Thatcher Ave., Harrison, N. Y.
2IE	24	H. A. Benzing, 802 E. Jersey St., Elizabeth, N. J.
2IF	500	John H. Bates, 513 Tinton Ave., New York City.
2IG	36	Wm. K. Caughey, 25 Mada Ave., W. New Brighton, N. Y.
2IH	25	Leo Samuels, 43 Treacy Ave., Newark, New Jersey.
2II	30	W. J. Howell, 135 Edgecombe Ave., New York City.
2IJ	50	Wm. Weller, 2156 Webster Ave., New York City.
2IK	550	O. L. Davis, 1337 S. Boulevard, New York City.
2IL	250	G. C. McClintock, 319 Dudley Ave., Westfield, N. J.
2IM	11	E. C. Williams, Jr., 120 Greenway North, Forest Hills, N. Y.
2IN	750	Geo. T. Droste, 203 E. 202nd St., New York City.

(To be Continued.)

A Small Radiophone Transmitter

By Clinton R. White

LITTLE has been said about radiophone transmitters in the past, yet many amateurs would have a wireless telephone transmitter were it not for the very high cost of the sets made up by dealers. This article is intended to make clear just what is necessary, and how to construct a complete short distance wireless telephone transmitter at a small cost.

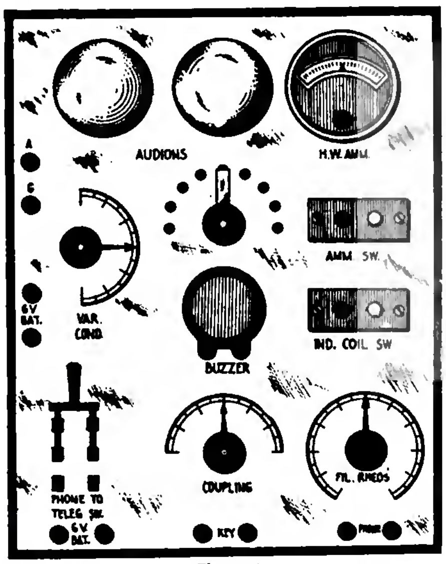


Figure 1

Figure 1—Front view of the panel showing position of instruments

First, a list of the material necessary: 2 Marconi VT transmitting tubes; 2 sockets; a hot wire ammeter (0 to 1 ampere); a telephone transmitter; a filament rheostat; a 43-plate variable condenser; a telephone induction coil; a double-pole-double-throw knife switch; 2 single-pole-single-throw switches; a wireless key; 10 binding posts (small size); a piece of good insulating material, such as bakelite, rubber, or even wood, size about 12 x 14", 3/8" thick; a fuse block with two 3-ampere fuses; a half-pound of No. 20 D.C.C. magnet wire; a bakelite or cardboard tube, 4" in diameter and 3" high, another 3" in diameter and 2" high; and a good high-pitch buzzer.

Many amateurs will have some of the listed apparatus around the work shop. The average amateur knows how to mount the various instruments on the rear of panel, as this subject has been gone over many times in previous articles in THE WIRELESS AGE. By studying the diagram, one can readily see how the instruments are placed.

The small vario-coupler can be made and mounted in the following manner: Wind 40 turns of the magnet wire on the larger tube, taking taps off at every 10 turns. Then wind 30 turns on the small tube, taking taps off at each end and one long flexible lead from the center. Mount the large coil on the back of panel, as shown in diagram, then mount small coin as shown. After the large coil is mounted, solder leads from the large coil to ten taps.

If house current is used, it is very important that the positive side of the lighting circuit be found. This can be determined by a glass of water with a little salt in it; when the ends of the wires are dipped in the water the negative will bubble.

Additional bulbs may be connected in parallel, which will add to the output. The variable condenser serves to tune the closed circuit while the tapped large coil varies the open circuit. It will be noted that there is a switch to open the circuit of the secondary of the telephone induction coil. This is done so that the transmitter may be put in series with the ground lead for experiment leaving the closed circuit free.

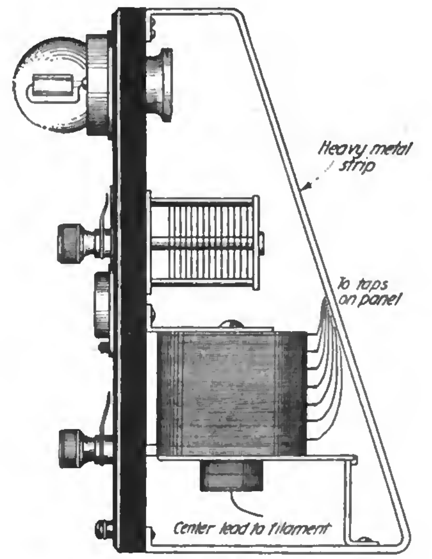


Figure 2

Figure 2—Side view of the radiophone transmitter

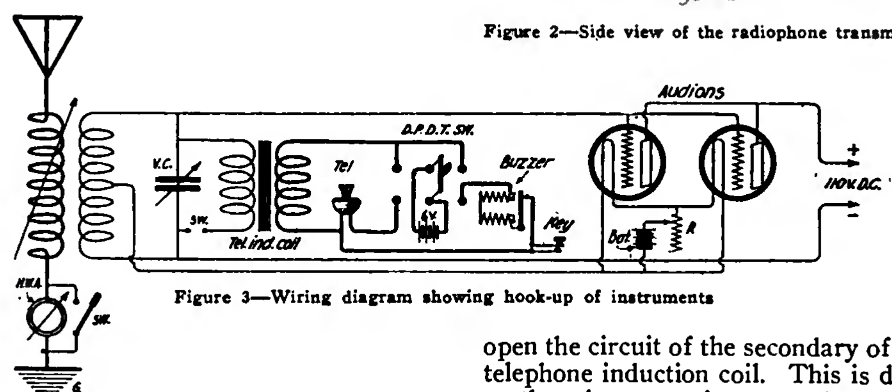


Figure 3—Wiring diagram showing hook-up of instruments

Design and Construction of a Short-Range Wavemeter

By A. Rosander

A VERY essential but seldom used piece of apparatus in amateur stations is a wavemeter. A wavemeter consists of, in essence, a calibrated receiving circuit, by means of which transmitter circuits are tuned to a desired wavelength. In an ordinary wavemeter—the one described—the inductance of the exploring coil is fixed with the variable condenser calibrated so that each degree setting will correspond to a given wavelength. The wavelengths due to these changes in capacity are usually shown by a graph curve accompanying the wavemeter. This can be explained from the fundamental fact that every circuit containing fixed inductance and capacity has a distinct wavelength at which it will oscillate more freely than all others. By varying the capacity a complete set of waves (wavelengths) can be obtained for a given fixed inductance and variable condenser.

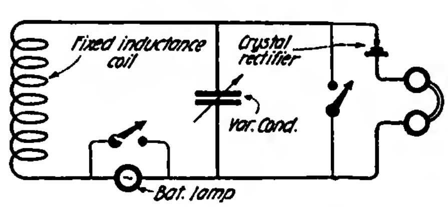


Figure 1—Circuit diagram of the short-range wavemeter

This wavemeter is inexpensive and accurate enough to comply with the law. It is similar to the low range wavemeter described on page 46 in "How to Conduct a Radio Club." It consists of the following pieces of apparatus: a fixed inductance; a variable condenser; crystal detector or lamp, or both; and an ordinary 2000-ohm head set. The inductance consists of 22 turns of No. 16 S.C.C. copper wire wound on a shellacked cardboard tube 6½ inches in diameter. This tube is mounted on standards somewhat like primaries of receiving transformers. Flexible connections, one foot long are made from each end of the coil to the variable condenser. The variable condenser is an ordinary Murdock variable condenser having a maximum capacity of .0005 mfd.

The detector and condenser are mounted on a base with room for holding the inductance coil when it is not in use. These pieces of apparatus are so fixed that they can be incorporated into the ordinary receiving set without any inconvenience, thus reducing the cost to a minimum and comprising a very compact wavemeter. In preference to using a crystal detector and phones for tuning the primary circuit, a small 2 or 4-volt battery lamp may be used, provided it has a proper short-circuiting switch.

In conjunction with this, using a current indicator such as a milli-ammeter or hot wire wattmeter, a resonant curve may be plotted from which an accurate idea of the purity and sharpness of the emitted wave may be obtained. Nothing is of more importance than knowing these two conditions. The manipulator will then know whether or not he is complying with the law, and furthermore, can quickly ascertain whether the radiated energy appears in a single sharp wave or in two or more broad waves.

With this necessary adjunct and a hot wire ammeter in every station, the efficiency of amateur stations will rise to an unprecedented height.

WAVEMETER DATA

Degrees of Condenser Scale	Corresponding Values of Wavelength
0	140
10	160
20	195
30	235
30	260
40	300
60	300
80	340
100	365
120	400
140	440
160	470
180	500

Indoor Antenna

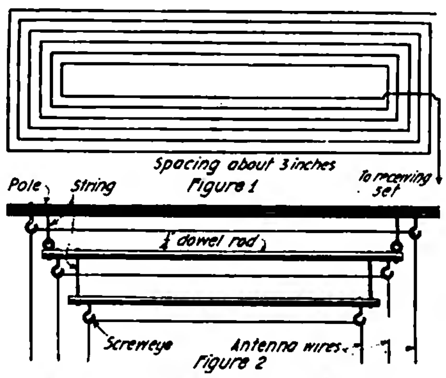
By C. Chandler Pidgeon

THE article in The Wireless Age for March, 1920, beginning near the bottom of page 40, entitled "Apartment House Antenna," attracted my attention. Since I live in an apartment house, I have had to solve the same problem, and I submit the following for your consideration.

Being desirous of operating a receiving set, and being unable to have a regular aerial, I tried several things, principally the bed springs, the gas fixtures, and a loop, such as is used in direction finders. None of these proved very satisfactory.

One evening I measured the length of the small hallway in our apartment. This I found to be nearly 30 feet. By placing bamboo poles across between the tops of door frames at opposite ends of the hall, I had a space 3 feet wide and 25 feet long for my antenna. In that space I have hung eleven turns of wire, arranged as in figure 1. I suppose any wire would do, but I happened to have No. 22 cotton covered enameled wire and used that.

With this antenna and a 200 to 3000 meter receiving set, I receive the time signals from Arlington and hear some of the radio telegraph and telephone work that is being carried on at about 200 meters in the city and surrounding neighborhoods.



Figures 1, 2—Constructional details of the indoor antenna

My receiver is very small and quite young yet, so I don't get much in the way of results. I am using a "crystaloi" detector now and am sure the results I get are as good as can be expected. The batteries for my audion set are out of order, but when working I could hear NAA 20 feet from the phones, using a single "audiotron" bulb. As soon as I get my two-step amplifier to work and with sufficient inductances, I hope to have all of the large stations on the Eastern coast and probably some European stations.

The antenna I use is one which any apartment dweller may put up with little expense and I feel sure the results will be better than those which can be attained by the scheme given on page 40 of the March Wireless Age.

Figure 2 shows a detail of the manner of supporting the wires. I have too many turns for 200 meters, but I use a series condenser and have not bothered to take down a few turns of wire.

A Two Stage Amplifier Cabinet

By Arno A. Kluge

IN THE average amateur receiving set, no provision has been made for the use of a number of vacuum tubes such as are required for multi-stage amplifiers, but this difficulty may be overcome by the construction of an amplifier cabinet, and the original receiving equipment thus retained intact. A two stage amplifier will be found the most suitable for all-around amateur purposes, as the investment required for tubes, coupling transformers, and batteries will often be found prohibitive in the more elaborate equipment.

In figure 1 such a cabinet is shown. It consists of an oak or mahogany box about 12 inches square and 6 inches deep, having hard rubber or bakelite panel for the front. The top of the

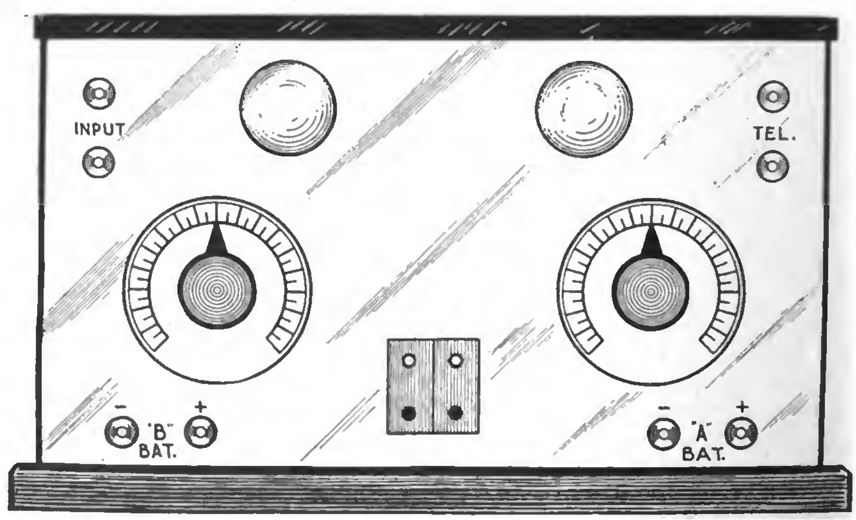


Figure 1—Front view of the amplifier cabinet

box is hinged, to give ready access to the vacuum tubes, which are mounted inside the box for greater protection. Two circular celluloid windows are provided for observance of the filaments during operation. Directly below these are two "back-mounted" rheostats for controlling filament current. In the center of the panel near the bottom are two miniature flush switches for turning the supply current on and off.

Sockets for the tubes are fastened to the back of the box inside. Their type will depend upon the style of tube used. No design is shown therefore. In case that the tubular style with wire leads is used, binding posts will of course have to be provided.

The tubes are coupled to each other and to the input circuit either by the use of impedances, as in figure 2, or by the use of coupling transformers, as in figure 3. The circuits shown are used in Signal Corps receivers, type SCR-59 and SCR-72, and require only one "A" battery and one "B" battery. Other circuits, such as that furnished with the Marconi V. T. tube, may of course be used, depending largely upon the style of tube employed.

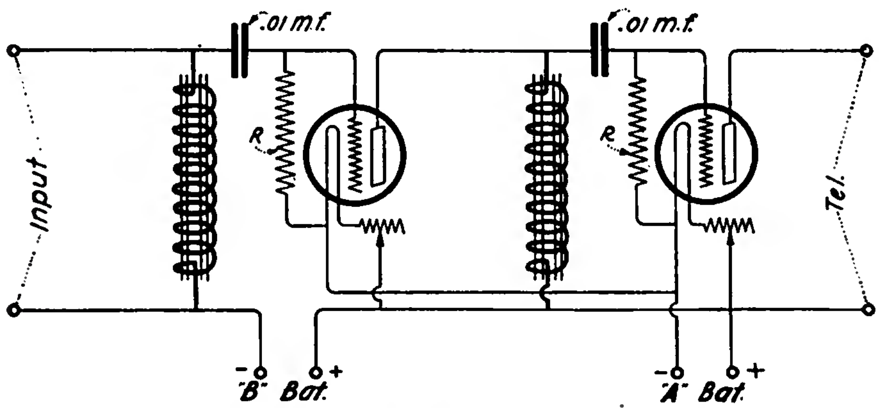


Figure 2—Circuit showing tubes coupled to each other and to the input circuit by use of impedances

Of the two circuits shown above, the one employing coupling transformers is the simplest and the best, no grid condensers or grid leak resistances being required. In figure 2, the resistances R are 2 megohms each, and give the grid a slight negative potential. The impedances consist of 25,000 turns of No. 38 enameled wire, wound on an iron core 2 inches long and ½ inch in diameter. The completed coil will be about 1 inch in diameter, and should be enclosed in a soft iron case.

For the circuit of figure 3, the coupling transformers should consist of 4,000 and 12,000 turns of No. 44 enameled wire on the primary and secondary respectively. Owing to difficulty attending the winding, these are best purchased complete.

The last mentioned is a closed core transformer. Core pieces may be cut from thin annealed iron to form an "L" 2½" high and 1½" broad, the body of the "L" being ½" wide. These are then built up after coil is wound and so placed that the coil is on one leg of a hollow rectangle formed by the "L" shaped pieces. A core of 8 inches long and ⅞ inch in diameter is used for the open core type, with 15,000 turns of No. 34 on the primary, and 25,000 turns of No. 38 on the secondary.

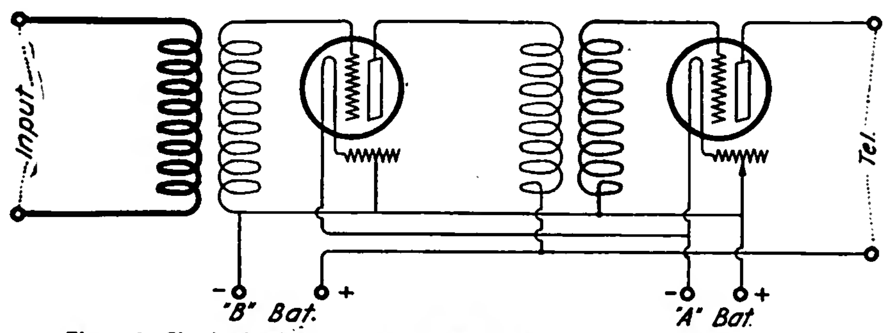


Figure 3—Circuit showing coupling secured by means of coupling transformers

These dimensions should enable the amateur to construct a suitable amplifier for any style of bulb, and such an instrument will shortly find a place in every up-to-date station.

The Design and Construction of a Simple Wavemeter—Range 150 to 300 Meters

By F. C. Brockman

First Prize—$10.00

THIS wavemeter is designed so that the average amateur with few tools can make it. Some of the construction is intended to provide substitutes for parts which require the use of machine tools in their manufacture. I have made most of the apparatus with very few exceptions without the use of machine tools. Most amateurs have a large stock of odds and ends on hand which they will want to use and for them the design is intended as a guide.

The essentials of a wavemeter are, of course, an inductance and a capacity—that is, a coil and a condenser, in series. This circuit will oscillate at a wavelength determined by the relation between the inductance and the capacity according to the expression:

$$\lambda = 1884\sqrt{LC} \qquad (1)$$

where L is the inductance in microhenries and C the capacity in microfarads. The condenser selected for this instrument is made by the General Radio Company. By ordering their No. 124C, the condenser, handle, and scale can be obtained without the case, cover, or binding posts. The plates are made of hard aluminum and are rugged enough to withstand ordinary usage without bending. The ten rotary plates are cut away to give approximately geometric variation of capacity, allowing closer adjustment at the lower end of the scale. The support of the condenser itself is a ribbed aluminum casting to which is riveted a dilecto disc riveted in turn to an accurately machined brass bearing about 1 inch long. The shaft is accurately machined with a flange which locates the plates and acts as a thrust bearing. The contact for the rotary plates is made through a bronze spring washer. The brass scale rotates opposite a line indicator so that readings are always made at the same point. A knob is used for ordinary adjustments while an extension handle is very useful for fine adjustments. The minimum capacity is about 0.00002 mfd., the maximum is 0.00065 mfd. Curve

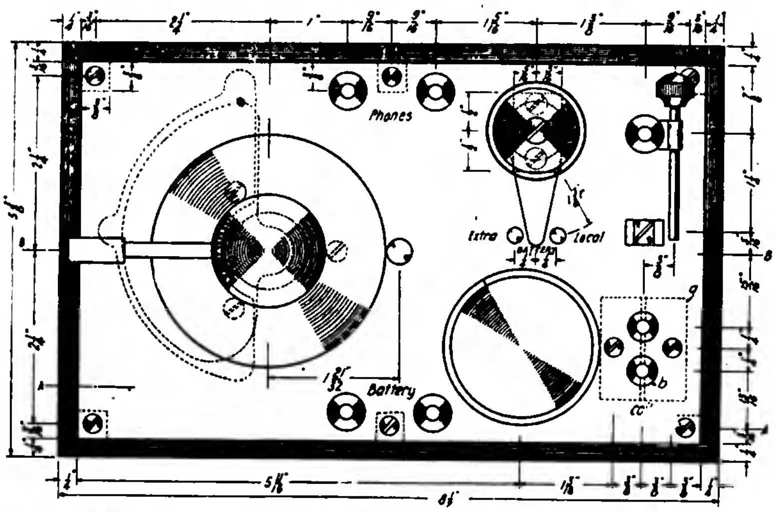


Figure 1—Top view of the wavemeter itself with constructional details

A, figure 11, is the calibration curve of the condenser used.

Figure 1 is a top view of the wavemeter itself. Figure 2 is a side view in sections. Figure 3 is an inside view of the cover. Sufficient dimensions are given for construction. The corners of the box and cover are lock-jointed and finished afterwards. This joint makes a strong box of neat appearance. The cover and bottom are glued and nailed or screwed on after the sides and ends have been glued together. Mahogany of the softer grades is easy to work and can be given a neat wax finish. A small suit-case handle can be fastened to the cover, or a strip of leather can be secured to it as desired.

The panel is preferably of 3/16 inch XX black dilecto, although hard rubber may be used. The dilecto can be given a neat grained finish by rubbing lengthwise with a piece of emery cloth fastened to a block of wood until all the high spots are taken off and the surface presents a uniform appearance. The panel is fastened to six supports by number 6-32 round head screws. The supports may be ⅜ inch square brass drilled as shown in the section at A, figure 2, or they may be of wood, glued in the corners of the box. In this case wood screws are used for securing the panel.

Mount the condenser as shown dotted in figure 1. The condenser is held on by three No. 6-32 flat head screws. The dial and knob are held to the shaft by a set screw under the end of the extension handle.

No drilling dimensions are given for the buzzer because they are easily determined from the base of the buzzer to be used. It may be either a "Century" high frequency buzzer, made by the Century Telephone Construction Company, or a Mesco No. 55 radio buzzer, advertised in various issues of this magazine.

The plug receptacle is made of two ⅜ inch brass bushings B, figures 1 and 5, forced into a dilecto block shown at A, figures 1 and 5, and pinned. It is best to make the block first, secure it to the front of the panel at the proper place and use it as a templet for drilling the panel holes. Be sure to drill carefully so that the dilecto will not splinter as the drill breaks through. Instead of dilecto, hard rubber or hard wood may be used, but in the latter case, it is held to the panel by No. 6 wood screws. The block serves as a reinforcement for the thin panel and makes a sturdy receptacle. The bushings are shown at B, figures 1 and 5, and are long enough to project 1/16 inch above the panel. If it is found inconvenient to use screws for securing the wiring to them, drill the 3/16 inch holes through and cut slots across the ends or drill holes just large enough to hold the wire used.

The battery switch is shown in section in figure 4. The blade is made from phosphor bronze or coe bronze 1/32 inch thick, although spring brass may be used. The width of the blade, as well as the length of the shaft (a No. 10-32 screw) depends on the style of knob used. The blade is held to the knob by a nut and washer. The bushing is a ⅜ inch diameter brass rod with a 3/16 inch hole through the center. The switch is secured to the panel in the same way in which the plug receptacle is secured, using the same precautions in drilling and allowing the bushing to project 1/16 inch. Connection is made to it by soldering a flexible lead to the nuts on the end of the shaft, or by soldering the wire into a hole in the side of the bushing. The switch points are made of 3/16 inch brass rod forced into the panel. The lower end of each has a saw slot into which the connections are to be soldered.

The detector is of the "cat-whisker" type and is shown in figure 1 and 2 with details in figures 6 and 7. Figure 7 shows the crystal clip which is made of 1/32 inch phosphor or coe bronze held to the panel by an 8-32 round head screw. Figure 6 shows the arm holder made of the same material. The arm itself is 1⅞ inch long by ⅛ inch diameter, threaded 6-32 on one end and fitted with a wire cat-whisker on the other. It is clamped in the holder by tightening the nut on the binding post. The knob may be of any convenient shape, a simple one being like that on the condenser arm.

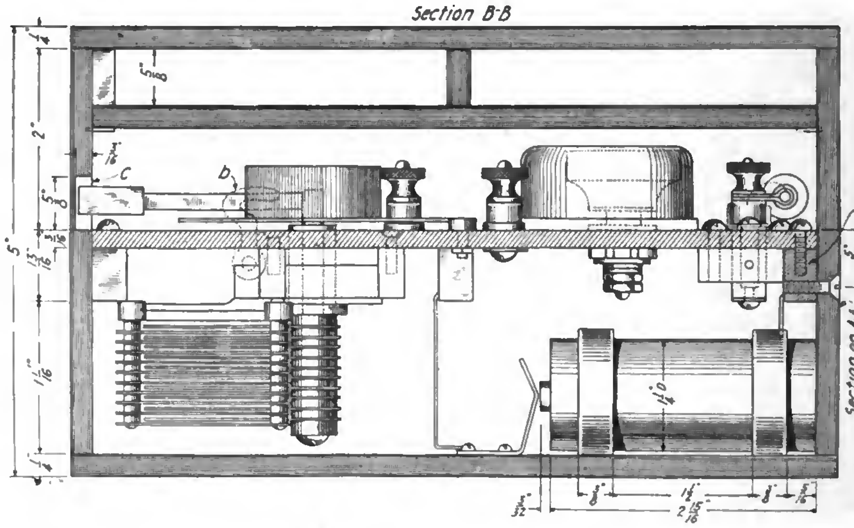


Figure 2—Side view in sections

Two pairs of binding posts are provided, one for the phones, the other for an external battery.

Figure 2 shows a battery mounted in clips in the bottom of the box. The battery shown is an Eveready as made for the U. S. Signal Corps. However, any small flashlight battery is suitable and for that reason the dimensions of the clips are not given. A convenient way for wiring it is to solder leads to the proper clips and to two of the panel supports, if they are of metal. Connection is taken from them by leaf copper held between the panel and the supports and clamped by the panel screws.

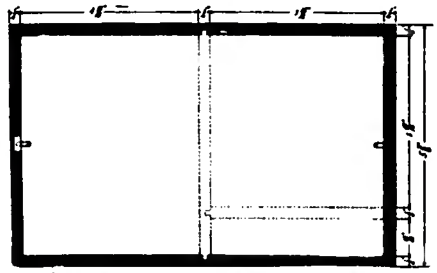


Figure 3—Inside view of cover with constructional details

Figures 2 and 3 show the inside of the cover. It provides a place for the coil, the cord, and crystals. There is no place for telephones, as they are generally in the receiving circuit and never packed away. If desired, the internal battery may be eliminated and a compartment with a door in the end of the box made for the phones. The calibration curve may be pasted to either side of the lid inside the cover. The cover is held to the box by four hooks shown dotted at B, in figure 2. The slot in the edge of the cover shown at C, figure 2, and A, figure 3, fits over the condenser handle and keeps it from swinging when carrying the meter.

The inductance used is shown in figure 8. The spool used by the writer was turned from 5/8 inch XX black dilecto sheet. The amateur who has no lathe may make his spool of the 1/8 inch mahogany used in cigar boxes. glued in. Finish neatly when dry and apply two coats of Ajax or Sterling varnish. These are the best to use. Shellac may be used if the others cannot be obtained, but the spool must be thoroughly dried before and after applying it. Drill two 3/8 inch holes for the brass bushings, which also serve as coil terminals. The bushings are made of 3/8 inch brass rod and have a saw slot on one side as at A, figure 8. Tin the slots before assembling the bushings so that a good electrical connection can be made.

For the coil, wind 20½ turns of No. 20 DCC copper wire, banked by layers (figure 8a). Push the ends through the lead holes, B, and let about 3/8 inch project into the 3/8 inch holes. Tin the ends of the wires. Force the brass bushings into the holes in the spool, being careful to get them tight and see that the coil ends fall in the slots. Apply heat to the bushings, also a little solder to secure a good connection. Treat the winding with varnish and cover with book binder's cloth to give a neat appearance.

The plug connection is shown in figure 9. The block is preferably made of hard rubber as dilecto or wood splits if the plugs fit very tight. However, with reasonable care, dilecto may be used and makes a better finish. In order to secure good alignment it is best to use the receptacle in the panel on a templet for one and that in the coil as a templet for the other when drilling the 3/16 inch holes through the blocks. The plugs are of 3/16 inch brass rod—though coe bronze has more spring—worked down with emery cloth till they fit the receptacle bushings snugly without forcing. Then slot one end of itself. A better way is to take two individual wires and make a flat cable by sewing them with their centers 9/16 inch apart to a flat strip of leather or heavy canvas doubled around them. The capacity of this length

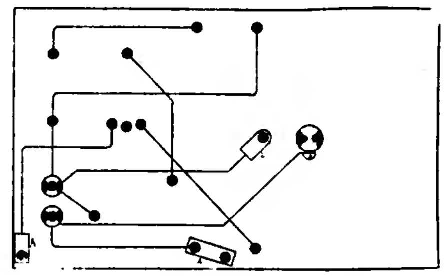
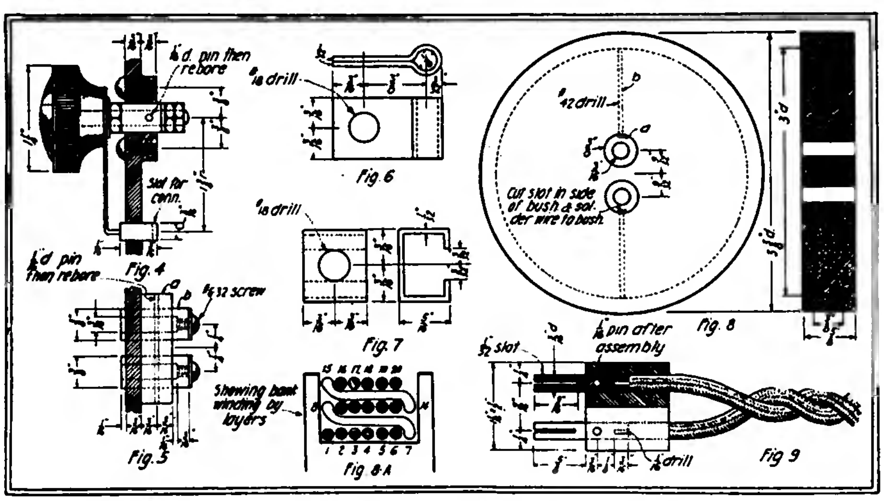


Figure 10—Wiring diagram under the panel

of lamp cord having thin insulation, is about 0.000039 mfd., which is the capacity of the condenser at about 16.8 divisions. A high capacity cord will raise the minimum wavelength considerably more than the maximum, thus reducing the ratio of maximum to minimum, or the range of the instrument.

Thread the wires through the holes in the blocks and solder the ends into the holes in the plugs. Draw the wires back through the blocks and force the plugs in after them. Drill two small holes and pin the plugs as indicated in the figure.

Figure 10 shows the wiring under the panel. It should be made with No. 16 bare solid wire, though other



Figures 4, 5, 6, 7, 8, 8A, 9—Details giving constructional dimensions

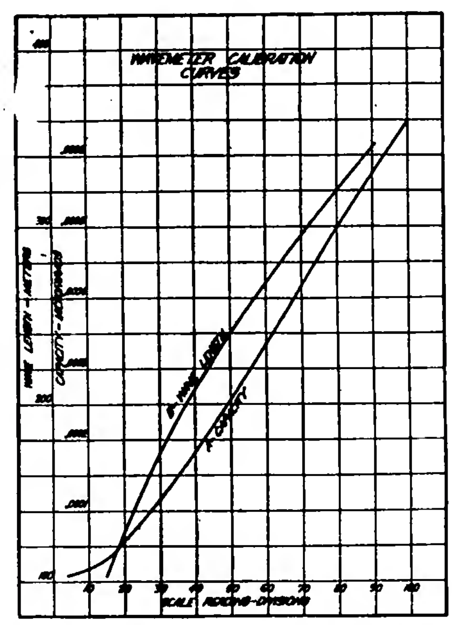


Figure 11—Graphs showing the capacity and wavelength calibration of the meter

To do this, but three discs 3 inches in diameter and two discs 3 3/8 inches in diameter are needed. Glue them all together to form a spool with a hub 3/8 inch long by 3 inches in diameter as in figure 8. Clamp while gluing and when dry reinforce with three 1/4 inch wood dowels forced and each and drill a small hole about 3/16 inch deep in the other end.

For the cord use 20 inch of No. 16 or 18 twisted lamp cord with extra heavy insulation. This is not for protection against high voltage, but for obtaining greater spacing of the wires and hence lower capacity in the cord sizes not smaller than No. 20 will do. Where wires cross, bend the outer one to clear that next to the panel to prevent short circuits. All joints should be securely soldered. Connection is made to the condenser stationary plates as well as to the panel supports carrying the internal battery connections by strips of leaf copper as shown in figure 10.

Figure 11 shows the capacity and wavelength calibration of the meter, and table I gives the values for replotting them if desired.

The instrument can be used as a receiver for measuring the wavelength of a transmitter, or as a transmitter for measuring the wavelength of a receiver or other circuit. Coupling it in the antenna circuit of a receiver, tuning in a signal on the receiver, and then tuning the wavemeter till the signal in the receiver phones is a minimum will give the wavelength of the received signal. Another method is to tune in a signal and then operate the wavemeter as a transmitter in proximity to the receiver secondary circuit and tuning it till the two are in resonance. The wavemeter then shows the wavelength of the received signal. Coupling between the two must be fairly loose so that coupling waves are not generated, as these waves are of different frequencies from the desired wave.

The wavemeter may also be used to measure inductance or capacity, when one or the other is known, by the use of formula (1).

TABLE I

Condenser Divisions	Wavelength	Capacity
10	...	.000018
15	102	.000033
20	126	.000055
30	171	.000116
40	207	.000183
50	239	.000257
60	268	.000335
70	296	.000417
80	321	.000498
90	344	.000576
100	...	.000650

Simple Wavemeter

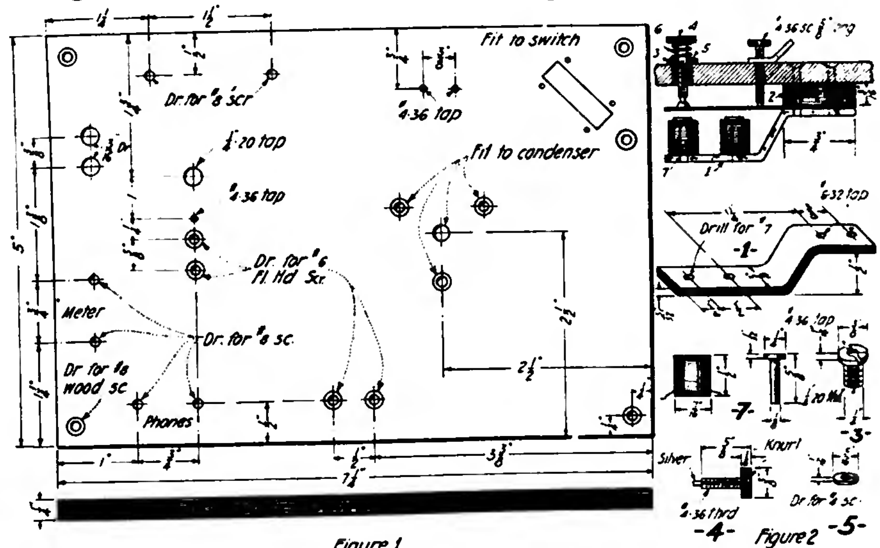
By O. E. Cote
Second Prize—$5.00

HEREWITH are the drawings and photos of a simple wavemeter. This meter, while being simple, is at the same time very rugged and of reliable construction throughout. Complete drawings will be omitted, as the average experimenter can suit himself as to the design of the containing case as well as detector and buzzer switch. Figure 1 shows the general layout of the panel, which is made of bakelite and finished in the usual way.

Figure 2 shows the construction of the buzzer and although many amateurs will undoubtedly use other types of ready-made buzzer, this construction will be of some help to many.

Part No. 1 is the yoke and is made of soft iron. Part No. 2 can be either brass or fibre, as this only serves the purpose of holding the yoke away from the panel. Part 3 is a brass bushing and holds the adjusting screw 4, which is also made of brass. Part 5 is a small brass washer which fits under spring 6. This spring is for the purpose of keeping a tension on the adjusting screw. 7 are the magnet cores, which are made of soft iron. After the magnet coils are assembled on these cores, the latter are driven lightly into part 1.

The magnets each contain about 420 turns of No. 32 enameled wire. I have used a piece of silicon steel about .01 inch thick for the vibrator and it gives very good results.



Figures 1, 2—General layout of the panel and construction of the buzzer

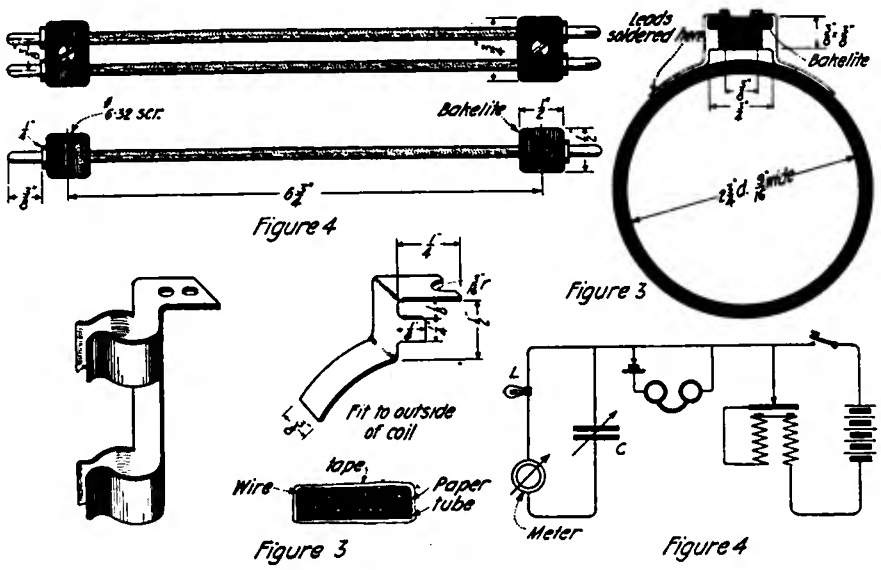
Figure 3 shows the holder for the battery. No dimensions are given, as the maker can use his own judgment, but it will be found that a flashlight battery (round) will do very nicely.

The coils and clips are shown in figure 3. The holders are of brass with a piece of bakelite in between, which holds the small bushing into which the connecting plug fits. The coils are made in the following manner.

Coil No. 1, which is the small one, contains 20 turns of 48/38 double silk covered litzendraht.

A tube is made by wrapping around an arbor 2¾ inch diameter about 5 or 6 wraps of brown wrapping paper having glue on one side in order to hold the tube together after it is removed from arbor. This tube is 9/16 inch wide, and takes just ten turns of wire for one layer. Two layers are put on and leads soldered to brass pieces as shown in sketch figure 3. Several thicknesses of paper or varnished linen must be put between these holders and winding for insulation. After this, the coil is taped with ordinary cotton tape 3/8 in. or 1/2 inch wide. The taping is carried over the ends of the holders which fasten to the cord. The bakelite end pieces are split and by bringing them together with the flat head screws they hold the brass plugs securely in place.

The condenser used is the General Radio type 182C. This condenser is



Figures 3, 4—Coils, clips, connectors and hook-up

coil. The outside of the coil is then shellacked. The second or large coil is made in the same manner and contains 70 turns. One thickness of ordinary manila paper is put between each layer of wire to cut down distributed very rugged and is ideal for this type of instrument. A chart is also enclosed giving the wavelengths and if the amateur would prefer, he can make it direct reading by fastening a piece of white paper on the dial and

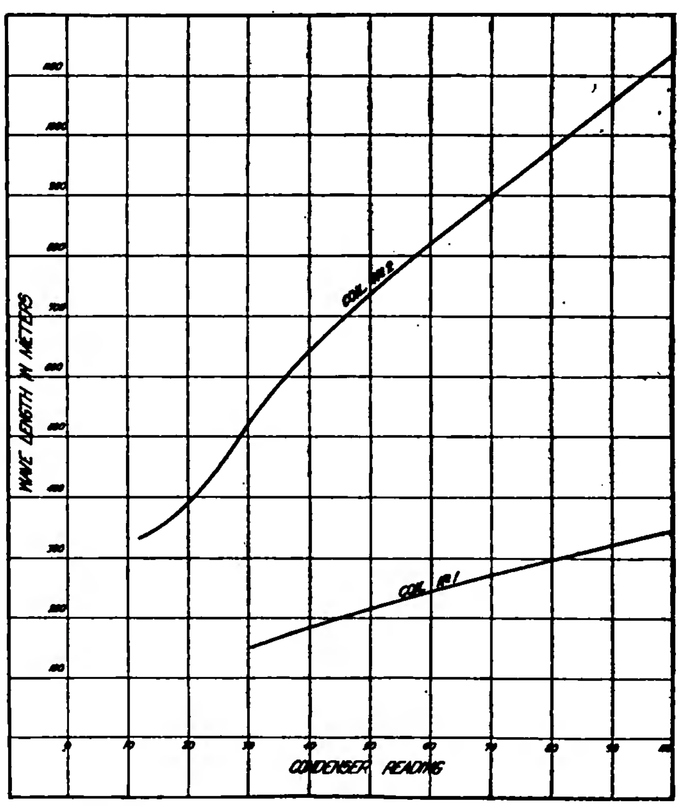
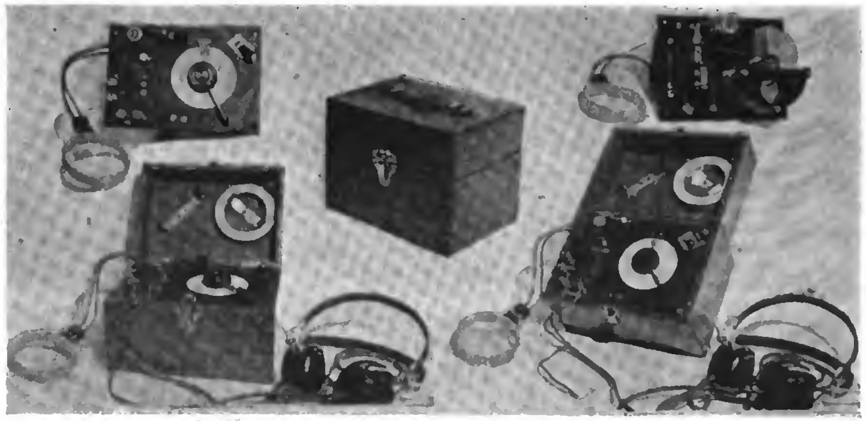


Figure 5—Graphic chart showing calibration of meter

capacity. The inside diameter of the big coil is 2¼ inches.

Figure 4 shows the connectors. The wires are rubber covered silk lamp marking down the wavelength direct. I would advise the maker to calibrate his meter from some other standard, as it will be found that the condenser values vary slightly and it is also very hard to duplicate a set of coils unless they are all made at one time. Two binding posts are brought out and marked "meter" so as to be able to connect a milliammeter for quantitative measurements. These binding posts are short circuited when no meter is used in order to complete the circuit through the coil.



Photos giving various views of the meter

A Wavemeter for $3.50

The Design and Construction of a Simple Wavemeter

By E. S. Herrick

Third Prize—$3.00

THE wavemeter described in this article was built to fill a long felt want. It not only has proven itself satisfactory in every way in my own station, but it has been used by several friends in the vicinity, who do not possess such an instrument.

The meter was personally calibrated to a U. S. standard wavemeter at a Government radio laboratory. The condenser was also calibrated to a standard condenser. Both curves are given (figure 1), and with these, one may determine the inductance of most any circuit from the formula $\lambda = 1884\sqrt{LC}$.

It is, of course, known that another condenser may not have exactly the same capacity as the one here described, neither may two inductances built to measure, have identical values in microhenries. However, the curves and values of this instrument and another built as near as possible to these specifications, will not differ to such a degree as to make an appreciable difference.

My own little meter has paid for itself many times over. It has been put to many uses, such as tuning the transmitter, calibrating my receivers, measuring inductances, and last, but not least, it has been used as a secondary of a loose coupler. It makes an excellent secondary receiving circuit and if slid along the table, to and from a primary coil, any degree of coupling may be obtained.

The condenser used is a Murdock 17-plate variable air condenser. This makes a light, durable, little unit and costs but two or three dollars. The inductance is wound on a tube, figure 2, 2½ inches outside diameter and 1 inch in width. Two holes are drilled in the tube ⅛ inch from the edge and

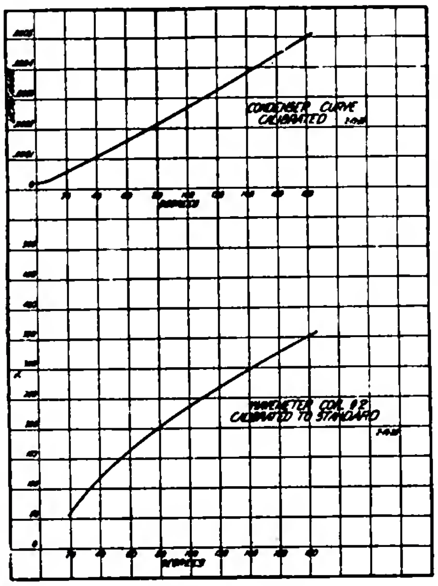


Figure 1—Graphs showing calibration of meter

exactly on the diameter line of the tube. These holes should be made to take a 4-32 machine screw. The winding space is ½ inch and should be wound with rubber tape or some adhesive substance in order that the windings will not slip. The coil is wound with No. 20 B&S DCC wire. There are 33 turns banked 3 layers. This bank winding may be found described in a copy of THE WIRELESS AGE. Figure 4 shows the relative position of the turns on the coil. A hole is drilled at each end of the winding to pass the ends of the coil through the tube. The wire is then soldered to the brass bolts which hold the coil to the condenser leads.

The leads, figure 3, are made from 1/32 inch brass strip, ½ inch wide and 2½ inches long. One end is rounded, and drilled, for clearance of the 4/32

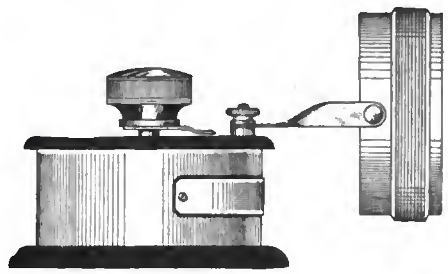
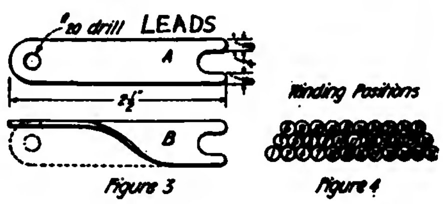


Figure 2—The inductance connected to condenser

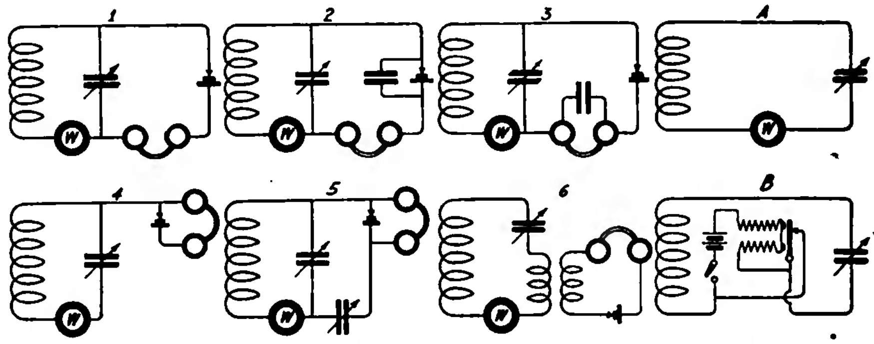


Figures 3, 4—Constructional details of leads and method of winding the coil

machine screws in the coil. The other end is slotted so that it may be easily removed from the condenser binding posts. After the leads are drilled and shaped they should be put into a vise and with a pair of pliers twisted 90 degrees, as shown in the drawing. Two leads are needed and each should be twisted in the opposite direction.

Figure 5 gives several different hook-ups for connecting the detector and phones to the wavemeter. The wattmeter or other sensitive thermometer is not used when the phones and detector are in circuit. Neither are the phones and detector in circuit when the wattmeter is used. The table of audibilities, together with the several hook-ups, as given in the Bureau of Standards Circular No. 74, is are made as short as possible, no appreciable difference in wavelength indicated, will result.

When using the wavemeter as a driver, for calibrating received signals, the circuit shown in B, figure 5, should be used. Care must be exercised, however, that the coils of the buzzer are not connected in the wavemeter circuit. This would throw the calibration of the meter to the winds.



Ckt. N°2—85, Ckt. N°1—55, Ckt. N°3—45, Ckt. N°5—40, Ckt. N°6—15, Ckt. N°4—10, Relative Audibility

Figure 5—Several hook-ups for connecting the detector and phones to the wavemeter

worthy of a place in any amateur's book of hook-ups.

If the experimenter owns a current squared meter or thermo-galvanometer, much finer and more accurate adjustments of the transmitter may be made. It is true that an instrument of this type is easy to read and obviates listening for the maximum note in the telephone receiver. If the lengths of leads to and from the meter The contacts must make and break the circuit only, using the spark discharge across the contact points, to start the oscillations in the circuit. Larger coils have been made for this wavemeter, by the author, and if the reader desires data on coils of longer wavelengths, a letter will bring it.

The writer has had considerable experience in the use of wavemeters, but has failed to find one as good as this one.

Which Way?

Franklin Studied Electricity via The Kite String

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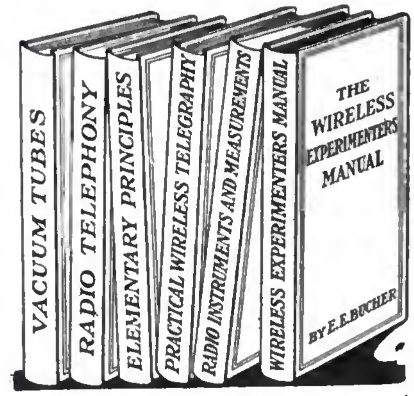

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More than 60,000 copies of this book have been sold to date. It is used in practically every school, college, and library in this country.

PRACTICAL WIRELESS TELEGRAPHY is the recognized standard wireless text book. It furnishes much information of utmost value in regard to the very latest styles of wireless sets now in use.

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A Sectional Receiving Set

By L. B. Salt

EVERY one realizes now that the logical receiving set to have is one to which additional units can be added at any time, as well as one that can be readily disconnected and reconnected within a short time, thus making it possible to keep up with the newest connections and the "last word" in the radio art.

The unit set, such as the DeForest, has the advantage of permitting operation with a few units which can be added to at any time. I believe, however, that the sectional set has all the good features of the above and a few more, such as being able to use a condenser or other instrument separately. It keeps each instrument free from dust. It is not necessary to cut out a new board each time a unit is added, and when the entire set is assembled, it looks more like a panel set, as the small panels fit very well if the edges are true.

The best size to make the small panels is 5 inches square. The boxes

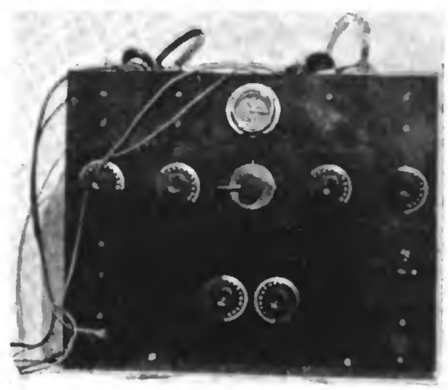


Figure 1—Complete Set

Top row (left to right)—Grid leaks with condensers. Fixed condensers. Clock. Small coil. Grid leaks without condensers.

Second row—Five variable condensers. Two .005. Two .008. One .00175.

On left of tuning coils—22.5-45 volt batteries. Two jacks for phones.

On right of tuning coils—Rheostat. Vacuum tube.

Prize Contest Announcement

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

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

Closing date, July 1, 1920.

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

Prize Winning Articles Will Appear in the September Issue.

Wireless is not wholly an indoor sport; those who have tried out portable sets know a lot of interesting things that develop in sending and receiving in the open. Hiking, canoe trips and camping are not complete these days unless a radio outfit is taken along. Here's a chance for the fellows who have worked out something special to tip their fellow amateurs off on how to make the "only" portable aerial.

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

are made of ¼ inch wood, which leaves only four and a half inches for the instrument. The cabinet for the coils can be made any size desired provided it is a multiple of five, otherwise the small sections will not fit around it. In this set, the coil cabinet was made 10 x 15 inches in order to take the largest size honeycomb coil. The gear wheels have a ratio of one to four, as the ratio of the gears on the DeForest coil holder is two to one. Thus, when the knob is turned through a half circle, the small bevel gear makes two complete revolutions and the coil swings through ninety de-

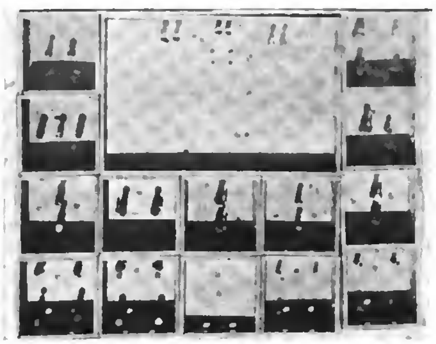


Figure 2—Rear view of the sections

grees. These gears are made by the Boston Gear Works at Quincy, Mass., and are their number G-486, costing about $1.50 per pair. The boxes were bought from a pattern maker, but could easily be made at home if one has the tools, in which case all the side pieces should be held together and the holes drilled all at one time, before the boxes are assembled. Aluminum was used to hold the panels to the piece of wood to which the binding posts are fastened, but any other metal could be used. When the set was first designed, four strips of aluminum were to be used, one on the top, one on the bottom, and one on each side, but by using 1/8 inch hard aluminum only two strips were necessary. They were made to fit the box tightly, so that it would not be necessary to put screws or nails into the board on which the binding posts were mounted, in order to hold the instrument in the box. By using large knobs the screws holding the strips and instruments were covered up, making a very neat looking set. By setting the binding posts in an inch or so and having the holes in the sides of the boxes, it is possible to push the set up flush with the wall and have all the wiring concealed, or one condenser may be placed on end on the table and the wires brought through the holes. The boxes in this set were made 9 inches deep, but they should have been made 10 inches, as it is necessary to have 8 inches between the panel and binding post board if the set is to accommodate

Figure 4—Two of the condensers

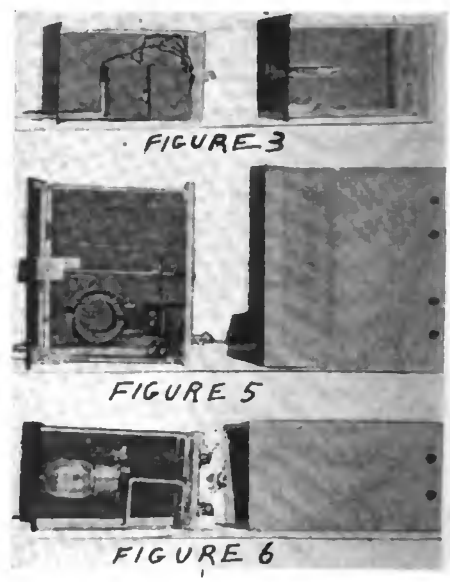


Figure 3—Batteries and phone jacks
Figure 5—Construction of tuning cabinet
Figure 6—Vacuum tube mounting

the largest size DeForest coil. However, if the coils are mounted on the outside or any other tuning arrangement is used, the boxes need not be as deep. The accompanying pictures show better than words or diagrams how the set looks.

In order to make the set most complete, all the diagrams in the various radio magazines for the last two or three years were cut out and pasted on pages of a loose leaf book, and indexed according to Crystal Receivers; V. T. Receivers; One, Two and Three Step Amplifiers; Misc. Connections; etc. By using a loose leaf book, new diagrams can be added as they appear in the latest magazines. By so doing, a hundred or more different connections can be collected in a very short time, thus giving the amateur an unlimited field for experimental work.

A Low Power Set

By Jos. PIGNONE

FOR local use, there are two sets which may be used. One is the telephone and the other the spark coil set. Each of these have their respective merits and demerits. For speed and

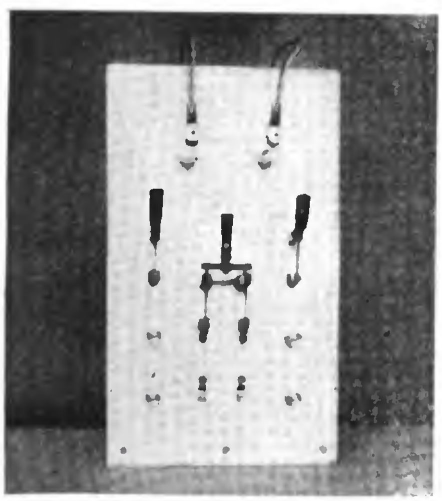


Figure 1—Front view of panel

accuracy of transmission, the wireless telephone excels. However, for original outlay and succeeding cost of upkeep, the wireless telephone equipment is out of reach of many. In addition, the operation of the telephone may also be too intricate for some amateurs. The spark coil set may seem to be a thing of the past to advanced amateurs. This is not so. If the spark coil set is properly designed, it will often do the work of a ¼ kw. set.

In this case, for compactness and efficiency, the panel type was selected. The result is that the leads from the condenser are shortened considerably. The lead from the condenser to the gap is 2 inches and from the gap to the transformer 4 inches. Also the lead from the condenser to the transformer is 6 inches.

The make of the apparatus used will be mentioned to facilitate the procuring of them. The spark coil employed in this set is a "Ford" ignition coil. Amateurs in and about New York have been getting very satisfactory

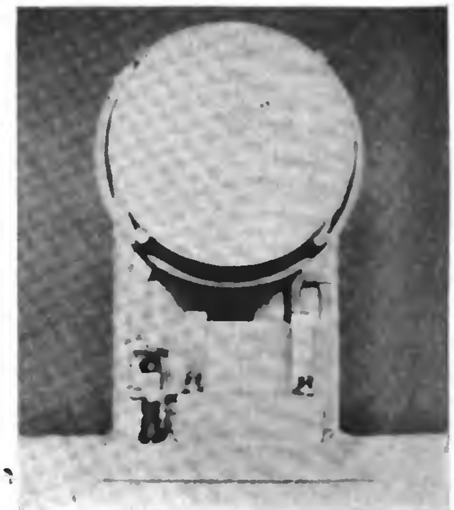


Figure 2—Rear view

results with these coils. They give a fat spark, and a pleasing note if properly adjusted. The condenser used is a small "Dubilier" .004 mfd mica. This was chosen because of its compactness. However, a small oil condenser slightly larger can be constructed to replace this. The spark gap can easily be made. It may be of any design, but the one shown, with ¾ inch electrodes

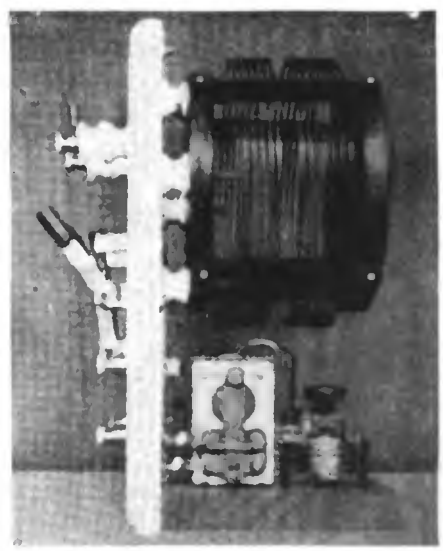


Figure 3—Side view

works best with this coil. Lastly, the transformer — having an oscillation transformer with variable coupling would be of no advantage, as the energy involved is so small. A pancake or a cylindrical coil may be used, and in the set illustrated the cylindrical type was selected only because the bakelite strips for such a coil were handy. This unit is 7 inches in diameter wound with edgewise strip. Eight turns comprise the primary and the same number the secondary. The turns are spaced 1/8 inch apart. The primary and secondary are spaced 1/2 inch apart.

The panel is 7 x 12 inches and the base attached to it is 7 x 6 inches. On the face of the panel are mounted the proper control switches. The double-pole switch is for the power supply, which is 6 volts; the single-pole switch on the left is to short the key and the one on the right is to short the vibrator. The reason for having the single-pole switch is that the builder might wish to experiment with synchronous interrupters. Also, for tests, the set might be used continuously. The aerial and ground leads are brought to the front of the panel.

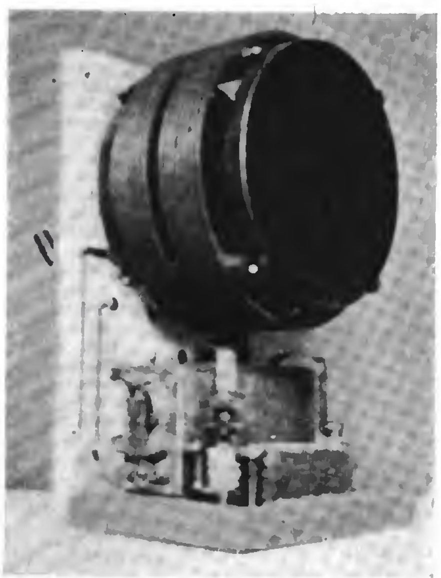


Figure 4—View of the oscillation transformer

It is useless to state the transmitting radius of such an equipment, as local conditions vary too greatly. However, with the author's set, 25 miles have been accomplished.

Correction March "Age"

In the diagram printed on page 37 of the March issue, a grid condenser should have been shown between the crystal detector connection and the grid.

Winner of Wireless Contest

James Collins, of Cleveland, was awarded the special prize—a $150 wireless receiving outfit—in the wireless contest conducted by The Press, in co-operation with associated newspapers throughout the country.

Collins was awarded the prize for his essay on "The Wireless Amateur." He is 18 years of age and is about to enter college.

Backing Up Geagan

P. F. GEAGAN'S article in the April issue on "Getting Results" was sure interesting; it has undoubtedly been read and digested by everybody, regardless of whatever else they may have passed up.

While it might seem to a casual peruser that Mr. Geagan is inclined to wax sarcastic at times, none can deny that the things he brings to our attention are appropos, and if put into practice, will, without doubt, result in a vast increase in efficiency and in the satisfaction we obtain from listening to what the "Wild Waves" are saying (a la ACE).

My first wireless set, constructed back in the medieval times when the art was new, consisted of a coherer, with its attendant bell and tapper; a dishpan, hung out of the window for an antenna; and three dry cells, salvaged from a neighbor's auto for a source of power for the de-coherer. The station which I had hopes of hearing was New York, about 150 miles away, and when after an hour nothing came in, in spite of all possible adjustments, I decided that they were not sending. Possibly they weren't. I don't know.

Of course, I now have a really excellent audion panel, with which I can get un-damped "stuff" without either heating the tube with a match or using three or four 3-foot tubes of No. 36. But in spite of the things I can get on it, there is lacking the thrill that I experienced while waiting with the old coherer for the message that never came. Familiarity breeds contempt, we are told, and nowhere does it apply more than in the wireless game. My best regards to Geagan for a long life, and may his bump of humor never grow less.

Whoever wrote "Clean English in Wireless," too, should know that the large majority of bugs are with him, and will back him up in anything he tries to do to eliminate the objectionable conversations to which we have most of us listened at times.

Good luck an' everything.

B. R. Wedemann.

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.

J. F. T., Kingsbridge, N. Y. C.:

In order to get the 25-mile radius with the radiophone outfit which you mention, it would be necessary for you to use a 400-volt generator. A 60-volt B battery would probably reduce your radius to something like 3 or 4 miles.

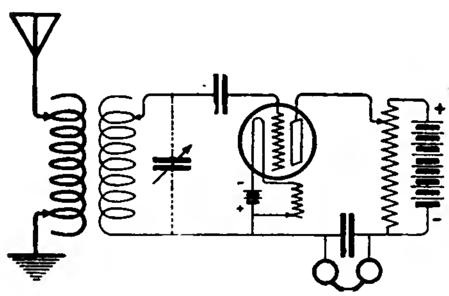
H. K., N. Y. C.:
In reply to your query requesting information which will enable you to construct a radiophone having a radius of 4 miles using 75 volts in the plate, we refer you to a recent article published in this magazine covering the construction of a 25-mile radiophone set.
With the hook-up which you show, you should be able to cover this distance providing everything is working properly. You do not show in your hook-up any meters for determining the radiation which you are getting. Using a rectified 350 volts, the distance which your outfit will cover should be in the neighborhood of 15 to 20 miles. In order for you to know what results you are getting, however, you should provide yourself with a radiation meter having a maximum range of about one ampere.

* * *

A. W. S., Billings, Mont.:
The Adams Morgan Co. is located at Montclair, N. J.
It will be impossible to tell you what size to make the primary loading inductance for your receiving transformer, unless we know what wavelength you wish to load up to, as well as the size of your receiving transformer. Neither can we advise you as to the construction of a tickler coil without some information as to the wavelength range of your receiving transformer, as well as the size and form of the secondary coil.

* * *

G. W. H., Chicago, Ill.:
We print herewith a diagram showing a hook-up for your loose coupler and auxiliary apparatus.



M. J. S., N. Y. C.
You should be able to obtain a copy of The Phillips Code through J. H. Bunnell & Co., New York City, or through the Telegraph Age. It will cost you about $1.50.

* * *

H. F. K.:
Figure 1 of the article by C. R. Leutz, which was printed in the April number, should be corrected so that the left hand filament connection of tube No. 1 and the right hand filament connection of tube No. 4 come to the negative terminal of B-1.

* * *

C. R., Valdosta, Ga.:
We are unable to tell you where it will be possible for you to obtain a ½-kw. open core Marconi transformer. We suggest that you advertise in some of the radio magazines. It may be that some amateur now has one which he would be willing to dispose of.
The efficiency of Leyden jars as condensers is usually somewhat greater than the efficiency of a plate glass condenser, due to the fact that a better grade of glass is used in the Leyden jar.
We regret that we are unable to advise you as to the power input of the new station at Savannah, Ga.
We have insufficient data at hand at the present time to enable you to construct a magnetic detector.

JOIN NOW

H. L. WELKER, Secy., Date....................
National Amateur Wireless Assn.,
68 Broad St., New York.

As I desire to receive full recognition as an amateur wireless worker of the United States, I ask the privilege of enrollment as a Member in the National Amateur Wireless Association and request that you send me the complete Member's Equipment, for which I enclose herewith remittance of $1.50 Initiation Fee, covering Initial Equipment, and $2.00 for First Annual Dues, or $3.50 in all.

I understand that I will receive membership certificate pin, pennant and a copy each of "How to Conduct a Radio Club" and "How to Pass U. S. Govt. Wireless License Examinations," and that the yearly dues entitle me to a year's subscription to THE WIRELESS AGE.

I am / am not now a subscriber to the AGE.

Name ....Age ......
St. Add. ....
City ....State ....

FILL IN ANSWERS TO THESE QUESTIONS

1. Have you a Government License (give number......) or do you propose applying for one?..
2. If you are under 21 years of age, give names of 2 adults for reference as to character:
   Reference ....Address................
   Reference ....
3. If you are a member of any Local, State or Interstate wireless club or association give its name and name of Secretary with address ....
4. Are you now a subscriber to THE WIRELESS AGE?..................
5. Describe briefly your equipment.......................................
   ....
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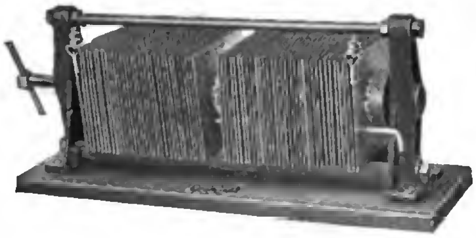
AMRAD RADIO PRODUCTS



Amrad Quenched Gaps

"They report me painfully QSA," writes one user. "I am surprised at the radiation obtained on extreme low power consumption," says another. "Your sigs so loud it seemed almost unbelieveable," said one postal from a station 500 miles distant.

Instances like these, many times repeated, prove our claims for greater radiated energy, low decrement, reliability and economy—all on 60 cycles.

Type G-1	(Illustrated above) 20,000 volts up, 1 K.W.	**$29.75**
Type G-2	10,000 volts up, ½ K.W.	**$18.75**
Type G-3	5,000 volts up, ¼ K.W.	**$13.50**

Adjustable Resistances, necessary for obtaining highest efficiency and double frequency note, now available. Gaps and Resistances described in Bulletin Q.

Amrad Induction Coil

The one and only coil on the market especially designed for radio work. Rating 100 watts. Output 100% greater than the average 2" coil. Puts the "punch" into the antenna.

Type C	6 volt primary	**$35.75**
Type C-1	32 volt primary	**$38.50**

Range 130-230 Meters

Price $7.50

Amrad Wavemeter, Type D

Shows your wavelength directly in meters. No calculations. Accurate. Set plumb on 200 meter mark when calibrated. All other readings within 2% accuracy. A great aid when tuning up Quenched Gap sets. Useful also for determining antenna wavelength and calibrating receiving sets. Ask for Bulletin W.

Type C

Price $6.50

Amrad Detector Stand

Improved construction. Moulded Electrose base. Compact, rugged, neat. Sensitive adjustment, remarkably proof against shock. Tested and approved by Navy Department. Single model, Type C-1, $3.50. Bulletin T describes.

Type B

Price $13.75

Amrad Lightning Switch

A standard 100 ampere switch mounted on three 40,000 volt insulators. Leakage common to ordinary slate base switches totally eliminated. Insure the safety of your home and station and increase your transmitting efficiency by installing this switch. Meets Fire Underwriters' specifications.

SPECIAL NOTICE: Above prices are effective June 15, 1920. Prior to that date Amrad Radio Products may be obtained from your dealer at prices published last month.

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