PART FOUR

Information

A SCIENTIFICALLY CONSTRUCTED AMATEUR STATION

Too little attention has been paid by amateurs to the ground wire system of their radio stations. Amateurs whose stations are located appropriately should give attention to the interesting series of experiments described below, conducted by a Special Engineer of the Radio Corporation's High Power Receiving Research Staff, who has found time to apply the principles utilized in high-power commercial radio stations to amateur stations. By following his advice any amateur can duplicate the results he has obtained. He has analyzed and placed before amateurs the "crux" of a successful tube transmitting station.

MANY amateurs have considerable difficulty in getting a low antenna resistance, particularly in locations where the soil is sandy. Under these conditions, a counterpoise must generally be used to get the antenna resistance down to a reasonable figure. In many cases, however, it is possible to combine a ground connection with a counterpoise, in such a manner as to still further reduce the antenna resistance by a large amount.

An article in the "General Electric Review" for October, 1920, describes the Alexanderson system for Radio communication. It shows how Mr. Alexanderson has combined a buried wire ground with a capacity ground for more uniformly distributing the earth currents. In Figure 1, the inductance of the helix below the ground tap tunes the capacity ground, while the inductance between the ground tap and the antenna tunes the antenna circuit. The section of the helix above the ground connection may be considered positive with respect to ground, and the section of the helix below the ground connection may be considered negative with respect to ground. By suitable tuning, the total antenna current may be distributed between the capacity ground and the buried wire ground in any desired ratio.

In the case of Station "2BML," at Riverhead, L. I., the soil consists mainly of dry sand under the antenna. There is a small pond near the antenna, but not under it. A good ground was obtained in this pond by running several hundred feet of wire into it. The antenna resistance using this ground was very high, between sixty and seventy ohms at 200 to 300 meters. The writer decided that since the soil under the antenna was sandy, the high antenna resistance was due to the fact that the antenna flux was forced to travel through very high resistance soil for a considerable distance before reaching the low resistance ground wires.

A counterpoise of four No. 14 B. & S. copper wires running parallel with the antenna flat top and directly beneath the antenna was put up, the parallel wires being four feet apart and carefully insulated. The counterpoise extended several feet beyond the antenna at both ends. When the counterpoise was substituted for the ground, the antenna resistance was lowered from about sixty ohms to ten ohms. By combining the ground with the counterpoise as shown in Figure 2, the antenna resistance was still further reduced to about four ohms. The resistance of the helix used to tune this antenna was about three ohms, making a total antenna resistance of seven ohms. The above resistance values were taken at 280 meters wave length.

When the circuits are properly adjusted, removing either the ground connection or the counterpoise connection will not change the antenna wave length, but will change the antenna resistance only. The easiest way to tune up the counterpoise and ground is to first tune to the desired wave length, using the counterpoise alone, the try the ground clip on different turns until the point is found where the wave length is the same as with the counterpoise alone. The ground clip should be adjusted to within a half turn on a large diameter helix. When the ground clip is at the neutral point, the inductive impedance of the helix below the ground point tunes with the capacity impedance of the counterpoise, forming a series-tuned circuit of comparatively low resistance. The total antenna current divides between the ground and the counterpoise inversely proportional to the effective resistances of the ground and counterpoise circuits.

With the counterpoise on the bottom of the helix and no ground connection, the wave length is 336 meters and the effective resistance is about nine ohms. When the ground clip is put on turn No. 1, the total current divides in inverse proportion to the ground resistance and the counterpoise reactance, and, obviously, most of the current will flow in the ground lead. Since the counterpoise has little effect, the wave length is practically determined by the antenna capacity and the helix inductance between the ground clip and the antenna clip. As the ground clip is moved up nearer the neutral point, the wave length becomes shorter, due to the decrease in inductance between the ground and antenna clips, and the counterpoise reactance is partly tuned out by inductance of the helix between the ground and counterpoise clips. The effective resistance decreases as the ground clip is moved up, because the counterpoise is taking a greater and greater portion of the antenna current. When the neutral point is reached, the counterpoise reactance is entirely tuned out, and the counterpoise takes most of the antenna current.

In the case of Station "2BML," the counterpoise capacity was .0007 M.F.D., and the antenna capacity was .0005 M.F.D. When the ground clip was properly adjusted, about 75 per cent. of the total antenna current flowed in the counterpoise lead and the other 25 per cent. in the ground lead. With this combination the antenna resistance was only about 40 per cent. of the value obtained with the counterpoise alone.

Many amateurs already have a counterpoise, and the writer believes if these amateurs will combine their counterpoise with a ground connection as described, their radiation will, in many cases, be doubled, especially in cases where a good ground connection is available. Very good results should be obtained even if the ground system is not directly under the antenna, as for example a water-main ground.

Figure 1 is a diagram of connections of the apparatus used at the above station. There are no special features excepting the combination of counterpoise and ground described above. A master oscillator is used to keep the frequency as constant as possible. It is essential to make the condensers in the ground and counterpoise leads large in comparison with the counterpoise and antenna capacities. The condenser in the counterpoise lead is simply a stopping condenser to keep the plate voltage off the counterpoise. Two 250-watt, type UV-204 RADIOTRONS are used. One tube is used as the oscillator and the other as the modulator.

The antenna current is six to eight amperes, depending upon the voltage of the local 60-cycle supply. The plate voltage is 2,000, using full wave rectification with two KENOTRONS. The smoothing condenser is 1 1/3 M.F.D., but is not large enough to smooth out the 60-cycle ripple, so the modulation is not particularly good and is seldom used, although it has been heard over distances of 300 to 400 miles several times. The RADIOTRONS draw 600 watts or more from the condensers, so a very large condenser would be required to smooth out the 60-cycle hum completely. The maximum input in the antenna with a single tube varies from 250 to 450 watts without overheating the tube, and doubtless more energy could be put in by using a higher plate voltage.

The helix consists of a power line lightning arrester choke coil made of 21 turns of ⅜-inch aluminum rod wound in cylindrical form, 15 inches in diameter. Two old 2,000-volt transformers are used for supplying voltage to the KENOTRON rectifiers. One is a five K. W. 133-cycle power transformer, while the other is a 250-watt potential transformer, both having a 20 to 1 ratio and both delivering the same watts to the rectifiers.

The antenna is also a make-shift affair consisting of a small horizontal cage of three No. 14 wires about forty feet high and eighty feet long.

The station has now been in operation for a number of months, and like many other C. W. stations, the radiation was about one-half ampere at first, but was gradually increased by experimentation until eight amperes was finally reached. Half-wave self-rectification was also tried with both 60 and 300 cycles. The

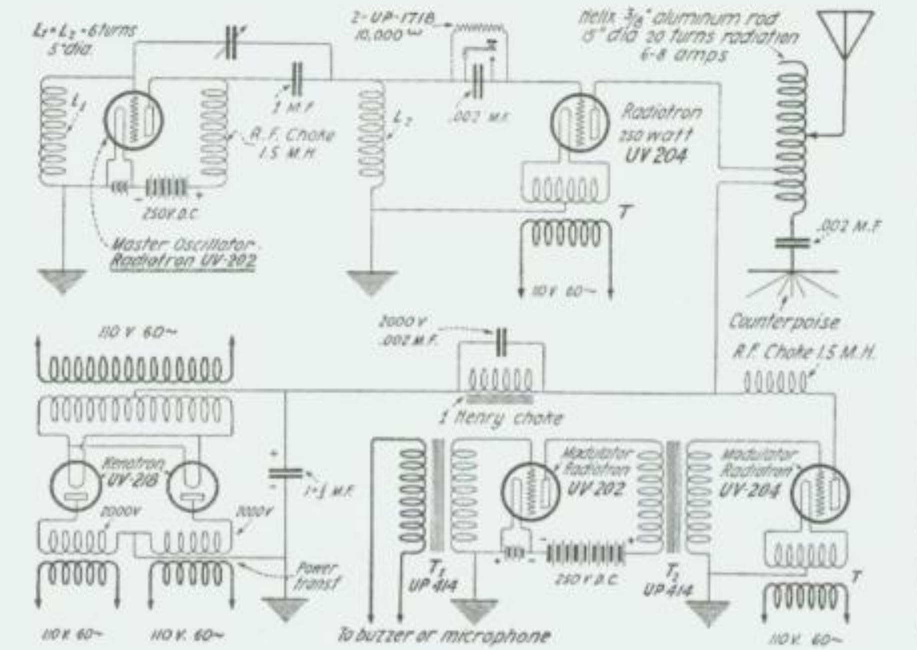

FIGURE 1

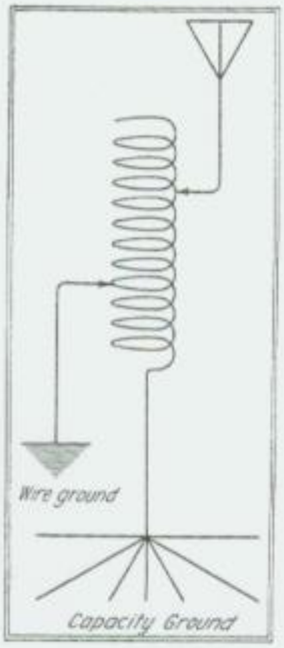

FIGURE 2

300-cycle source gave an exceedingly pure, musical note and was very successful, but the available generator was small and the antenna current was only about three amperes with full load on the 300-cycle generator. The C. W. signals from "2BML" have been reported QSA on many occasions from stations within a 1,000 mile radius.

GENERAL INFORMATION FOR THE AMATEUR

THERE are at the present time approximately 35,000 amateur radio transmitting stations in the United States, and probably twenty-five receiving stations to every transmitting station, making a total of 875,000 amateur stations. The large majority of these stations use only a small amount of power for transmitting; consequently, their range is small. There are organizations of amateurs which include primarily those who are interested in the relaying of messages from one station to another, and during the cooler months of the year, when the air is clear of static, it is frequently possible to relay messages through such stations across the continent within a few hours. As a general rule such messages are relayed over fairly well established lines of communication, including the most efficient stations operated by the best amateur operators of the country. The "National Amateur Wireless Association," which includes in its membership most of the leading amateurs of the country, is one of the organizations which maintains a national traffic organization and relays messages to all points of the country without charge. The stations which are a part of this relay system of the "National Amateur Wireless Association" include many of the leading amateur stations which employ tube transmitters, and, because they use C. W. transmitters, exceptional results are obtained, the range of these tube stations frequently exceeding 1,000 miles. During the warm months of the year, when there is considerable disturbance from atmospheric electricity due to thunderstorms, repeated tests have proved that tube transmitters can work successfully through heavy static caused by thunder showers, while spark stations of the same power could not be heard.

One of the problems of amateur activities is that of interference between stations. This is largely the result of the use of spark transmitters which radiate their energy over a wide band of wave lengths. In the case of continuous wave transmission the energy is radiated on substantially one wave length, thereby eliminating to a great degree the objectionable interference caused by spark stations. The character of transmitted energy is such that the effect at the distant receiver is much greater, power for power, than a spark set, principally for the reason that the undamped wave transmitter permits the use of highly refined and efficient methods of reception.

RADIO LAWS AND REGULATIONS OF THE UNITED STATES

THE owner of an amateur radio transmitting station must obtain a station license before it can be operated if the signals radiated therefrom can be heard in another state; and also if such a station is of sufficient power to cause interference with neighboring licensed stations in the receipt of signals from transmitting stations outside the state. These regulations cover the operation of radio-telephone stations as well as radio-telegraph stations.

Station licenses can be issued only to citizens of the United States, its territories and dependencies.

Transmitting stations must be operated under the supervision of a person holding an Operator's License and the party in whose name the station is licensed is responsible for its activities.

The Government licenses granted for amateur stations are divided into three classes as follows:

Special Amateur Stations known as the "Z" class of stations are usually permitted to transmit on wave lengths up to approximately 375 meters.

General Amateur Stations which are not within five miles of a Government Radio Station and are permitted to use a power input of 1 kilowatt and which cannot use a wave length in excess of 200 meters.

Restricted Amateur Stations are those located within five nautical miles of Government radio stations, and are restricted to ½ kilowatt input. These stations also cannot transmit on wave lengths in excess of 200 meters.

Experimental stations, known as the "X" class, and school and university radio stations, known as the "Y" class, are usually allowed greater power and also allowed the use of longer wave lengths at the discretion of the Department of Commerce.

All stations are required to use the minimum amount of power necessary to carry on successful communication. This means that while an amateur station is permitted to use, when the circumstances require, an input of 1 kilowatt, this input should be reduced or other means provided for lowering the antenna energy when communicating with near-by stations in which case full power is not required.

Malicious or wilful interference on the part of any radio station, or the transmission of any false or fraudulent distress signal or call is prohibited. Severe penalties are provided for violation of these provisions.

Special amateur stations may be licensed at the discretion of the Secretary of Commerce to use a longer wave length and higher power than general amateur stations. Applicants for special amateur station licenses must have had two years' experience in actual radio communication. A special license will then be granted by the Secretary of Commerce only if some substantial benefit to the science of radio communication or to commerce seems probable. Special amateur station licenses are not issued where individual amusement is the chief reason for which the application is made. Special amateur stations located on or near the sea coast must be operated by a person holding a commercial license. Amateur station licenses are issued to clubs if they are incorporated, or if any member holding an amateur operator's license will accept the responsibility for the operation of the apparatus.

Applications for operator's and station licenses of all classes should be addressed to the Radio Inspector of the district in which the applicant or station is located. Radio Inspectors' offices are located in the following places:

First District	Boston, Mass.
Second District	New York City
Third District	Baltimore, Md.
Fourth District	Norfolk, Va.
Fifth District	New Orleans, La.
Sixth District	San Francisco, Cal.
Seventh District	Seattle, Wash.
Eighth District	Detroit, Mich.
Ninth District	Chicago, Ill.

No license is required for the operation of a receiving station, but all persons are required by law to maintain secrecy in regard to any messages which may be overheard.

There is no fee or charge for either an operator's license or a station license.

C. W. TRANSMISSION AT AMATEUR WAVE LENGTHS

A GREAT many amateur operators have applied to the Radio Inspectors of the different districts for special amateur licenses, giving as a reason that they wish to use tube transmitters which would not operate properly on 200 meters, the regular amateur wave length. This belief is entirely wrong. Tube sets will generate power on 200 meters, as well as on any other wave length, providing the antenna is of proper size for 200-meter work.

Some experiments with tube sets on wave lengths below 200 meters were made at "2ZL" Station, Valley Stream, L. I., where a separate antenna, considerably smaller than the main antenna regularly used, was employed for this short wave work. This smaller antenna was about 60 feet long over all, and consisted of four wires. It was found possible to do successful work on this antenna using wave lengths between 140 and 200 meters. Considerable work was done on 175 meters, the antenna current on this wave length being two amperes with two RADIOTRONS UV-203. One hundred miles in daylight could be covered readily on this wave length and with the current mentioned.

When the transmitter was adjusted to a wave length of 175 meters it was found, in at least three instances, that the receiving operators had to adjust their secondary circuit variometers at zero in order to hear the signals. This indicates that many amateur receiving sets will not operate efficiently on wave lengths below 200 meters. After the communication had been carried on for some time on 175 meters, considerable comment was made by other amateur stations on the desirability of working on that wave length in that there was no interference at that wave length. Atmospheric disturbances gave little or no trouble, whereas on wave lengths above 200 meters the interference from this source was very pronounced.

It is entirely possible to work on 175 meters with tube transmitters or on any lower wave length, without trouble, provided the antenna system is of the proper size of that wave length. The belief that tubes will not operate and generate power on 200 meters or below, has evidently arisen through lack of experience. Tubes will oscillate on short wave lengths just as well as on long wave lengths. At "2ZL" Station a 50-watt RADIOTRON UV-203 was made to oscillate and generate power in a small antenna circuit with a period of only 50 meters.

RADIO RULES—NATIONAL ELECTRIC CODE

The following requirements governing the installation of radio receiving and transmitting apparatus were placed in effect on April 29, 1922.

The rules are given out by the Electrical Committee of the National Fire Protection Association, and will appear in the next issue of the National Electric Code, 1923 edition, as Rule No. 86, Radio Equipment.

FOR RECEIVING STATIONS ONLY

Antenna:—

a. Antennas outside of buildings shall not cross over or under electric light or power wires of any circuit of more than six hundred (600) volts or railway trolley or feeder wires nor shall it be so located that a failure of either antenna or of the above mentioned electric light or power wires can result in a contact between the antenna and such electric light or power wires.

Antennas shall be constructed and installed in a strong and durable manner and shall be so located as to prevent accidental contact with light and power wires by sagging or swinging.

Splices and joints in the antenna span, unless made with approved clamps or splicing devices, shall be soldered.

Antennas installed inside of buildings are not covered by the above specifications.

Lead-in Wires:—

b. Lead-in wires shall be of copper, approved copper-clad steel or other approved metal which will not corrode excessively and in no case shall they be smaller than No. 14 B. & S. gage except that approved copper-clad steel not less than No. 17 B. & S. gage may be used.

Lead-in wires on the outside of buildings shall not come nearer than four (4) inches to electric light and power wires unless separated therefrom by a continuous and firmly fixed non-conductor that will maintain permanent separation. The non-conductor shall be in addition to any insulation on the wire.

Lead-in wires shall enter buildings through a non-combustible, non-absorptive insulating bushing.

Protective Device:—

c. Each lead-in wire shall be provided with an approved protective device properly connected and located (inside or outside the building) as near as practicable to the point where the wire enters the building. The protector shall not be placed in the immediate vicinity of easily ignitable stuff, or where exposed to inflammable gases or dust or flyings of combustible materials.

The protective device shall be an approved lightning arrester which will operate at a potential of five hundred (500) volts or less.

The use of an antenna grounding switch is desirable, but does not obviate the necessity for the approved protective device required in this section. The antenna grounding switch if installed shall, in its closed position, form a shunt around the protective device.

Protective Ground Wire:—

d. The ground wire may be bare or insulated and shall be of copper or approved copper-clad steel. If of copper the ground wire shall not be smaller than No. 14 B. & S. gage, and if of approved copper-clad steel, it shall not be smaller than No. 17 B. & S. gage. The ground wire shall be run in as straight a line as possible to a good permanent ground. Preference shall be given to water piping. Gas piping shall not be used for grounding protective devices. Other permissible grounds are grounded steel frames of buildings or other grounded metallic work in the building and artificial grounds such as driven pipes, plates, cones, etc.

The ground wire shall be protected against mechanical injury. An approved ground clamp shall be used wherever the ground wire is connected to pipes or piping.

Wires Inside Buildings:—

e. Wires inside buildings shall be securely fastened in a workmanlike manner and shall not come nearer than two (2) inches to any electric light or power wire unless separated therefrom by some continuous and firmly fixed non-conductor making a permanent separation. This non-conductor shall be in addition to any regular insulation on the wire. Porcelain tubing or approved flexible tubing may be used for encasing wires to comply with this rule.

Receiving Equipment Ground Wire:—

f. The ground conductor may be bare or insulated and shall be of copper, approved copper-clad steel or other approved metal which will not corrode excessively under existing conditions and in no case shall the ground wire be less than No. 14 B. & S. gage except that approved copper-clad steel not less than No. 17 B. & S. gage may be used.

The ground wire may be run inside or outside of building. When receiving equipment ground wire is run in full compliance with rules for Protective Ground Wire, in Section d, it may be used as the ground conductor for the protective device.

FOR TRANSMITTING STATIONS

Antenna:—

g. Antennas outside of buildings shall not cross over or under electric light or power wires of any circuit of more than six hundred (600) volts or railway trolley, or feeder wires, nor shall it be so located that a failure of either the antenna or of the above mentioned electric light or power wires can result in a contact between the antenna and such electric light or power wires.

Antennas shall be constructed and installed in a strong and durable manner and shall be so located as to prevent accidental contact with light and power wires by sagging or swinging.

Splices and joints in the antenna span shall, unless made with approved clamps or splicing devices, be soldered.

Lead-in Wires:—

h. Lead-in wires shall be of copper, approved copper-clad steel or other metal which will not corrode excessively and in no case shall they be smaller than No. 14 B. & S. gage.

Antenna and counterpoise conductors and wires leading therefrom to ground switch, where attached to buildings, must be firmly mounted five (5) inches clear of the surface of the building, on non-absorptive insulating supports such as treated wood pins or brackets equipped with insulators having not less than five (5) inch creepage and air-gap distance to inflammable or conducting material. Where desired approved suspension type insulators may be used.

i. In passing the antenna or counterpoise lead-in into the building a tube or bushing of non-absorptive insulating material shall be installed so as to have a creepage and air-gap distance of at least five (5) inches to any extraneous body. If porcelain or other fragile material is used it shall be installed so as to be protected from mechanical injury. A drilled window pane may be used in place of bushing provided five (5) inch creepage and air-gap distance is maintained.

Protective Grounding Switch:—

j. A double-throw knife switch having a break distance of four (4) inches and a blade not less than one-eighth (1/8) inch by one-half (1/2) inch shall be used to join the antenna and counterpoise lead-ins to the ground conductor. The switch may be located inside or outside the building. The base of the switch shall be of non-absorptive insulating material. Slate base switches are not recommended. This switch must be so mounted that its current-carrying parts will be at least five (5) inches clear of the building wall or other conductors and located preferably in the most direct line between the lead-in conductors and the point where ground connection is made. The conductor from grounding switch to ground connection must be securely supported.

Protective Ground Wire:—

k. Antenna and counterpoise conductors must be effectively and permanently grounded at all times when station is not in actual operation (unattended) by a conductor at least as large as the lead-in and in no case shall it be smaller than No. 14 B. & S. gage copper or approved copper-clad steel. This ground wire need not be insulated or mounted on insulating supports. The ground wire shall be run in as straight a line as possible to a good permanent ground. Preference shall be given to water piping. Gas piping shall not be used for the ground connection. Other permissible grounds are the grounded steel frames of buildings and other grounded metal work in buildings and artificial grounding devices such as driven pipes, plates, cones, etc. The ground wire shall be protected against mechanical injury. An approved ground clamp shall be used wherever the ground wire is connected to pipes or piping.

Operating Ground Wire:—

l. The radio operating ground conductor shall be of copper strip not less than three-eighths (3/8) inch wide by one sixty-fourth (1/64) inch thick, or of copper or approved copper-clad steel having a periphery, or girth (around the outside) of at least three-quarters (3/4) inch (for example a No. 2 B. & S. gage wire) and shall be firmly secured in place throughout its length. The radio operating ground conductor shall be protected and supported similar to the lead-in conductors.

Operating Ground:—

m. The operating ground conductor shall be connected to a good permanent ground. Preference shall be given to water piping. Gas piping shall not be used for ground connections. Other permissible grounds are grounded steel frames of buildings or other grounded metal work in the building and artificial grounding devices such as driven pipes, plates, cones, etc.

Power from Street Mains:—

n. When the current supply is obtained directly from the street mains, the circuit shall be installed in approved metal conduit, armored cable or metal raceways.

If lead covered wire is used it shall be protected throughout its length in approved metal conduit or metal raceways.

FOR TRANSMITTING STATIONS (*Continued*)

Protection from Surges, etc:—

o. In order to protect the supply system from high-potential surges and kick-backs there must be installed in the supply line as near as possible to each radio-transformer, rotary spark gap, motor in generator sets and other auxiliary apparatus, one of the following:

1. Two condensers (each of not less than one-half (½) microfarad capacity and capable of withstanding six hundred (600) volt test) in series across the line and mid-point between condensers grounded; across (in parallel with) each of these condensers shall be connected a shunting fixed spark-gap capable of not more than one-thirty-second (1/32) inch separation.
2. Two vacuum tube type protectors in series across the line with the mid-point grounded.
3. Non-inductively wound resistors connected across the line with mid-point grounded.
4. Electrolytic lightning arresters such as the aluminum coil type.

In no case shall the ground wire of surge and kick-back protective devices be run in parallel with the operating ground wire when within a distance of thirty (30) feet.

The ground wire of the surge and kick-back protective devices shall not be connected to the operating ground or ground wire.

Suitable Devices:—

p. Transformers, voltage reducers, keys, and other devices employed shall be of types suitable for radio operation.

NOTE ON THE CARE OF MINERALS

In receiving outfits employing crystal detectors, the effective range depends a great deal upon the sensitivity of the crystal. Some crystals are naturally more sensitive than others, but even a sensitive crystal may be ruined by improper care. The action of the air on these crystals sometimes oxidizes their surface and prevents them from functioning properly, but a more serious trouble is caused by touching the surface of the crystal with the fingers. Where this has been done and the surface of the crystal is found to be less sensitive after continued use, it should be scraped lightly with a pen-knife.

A Radio Dance in your home made possible by the application of the Victrola or Graphanola attachment to any of the receiver-amplifier units described in this book.

VACUUM TUBE PRECAUTIONS

DON'T handle vacuum tubes roughly or elements may be injured.

DON'T burn vacuum tube filaments above rated amperage and voltage.

DON'T rely solely on an ammeter for proper current consumption—filaments should be burned at constant voltage rather than constant amperage.

DON'T insert vacuum tubes in sockets unless absolutely certain rheostats are turned off or at the proper setting for normal operation.

DON'T make the drastic error of connecting the plate battery to the filament terminals —watch all battery connections.

DON'T use more than one standard block plate battery (22.5 volts) on the plate of Radiotron detector tube UV-200.

DON'T use more than from 60 to 80 volts on the plates of Radiotron amplifier tubes UV-201—60 volts will be found quite sufficient.

DON'T underestimate the value of "A" battery potentiometer PR-536 in connection with Radiotron detector tube UV-200 if you wish to secure maximum signal strength.

DON'T burn out a vacuum tube through carelessness and expect your dealer to exchange it for another.

DON'T use excessive plate voltage on power tubes if you want long life.

DON'T energize the filaments of all the tubes in a cascade circuit at once, unless the circuit has been used before.

DON'T take one tube out of a cascade circuit in which the filaments are in parallel—it causes a rise in current in the remaining filaments and may burn them out. Cut off all the power first.

DON'T make any alterations in your wiring while vacuum tubes are in their sockets. It is quite a common thing for 40 or 60 volts to become twisted up in the filament circuit as a result of this practice. High voltage for the filament spells disaster for your tube.

DON'T expect a continued increase in signal strength as your filament temperature increases beyond normal. You will only reduce the life of your tube. Tubes function best at one particular point—when you increase their filament current beyond this point you do the signal no good and the tube great harm.

DON'T forget that necessary filament current may frequently be greatly reduced by proper manipulation of the tuner circuits, especially the tickler or regenerative circuit.

DON'T expect to have a loud speaker operate from a detector tube—you'll be disappointed. At least one stage of audio-frequency amplification is generally necessary.

DON'T forget that vacuum tubes cost from twenty to thirty times as much as ordinary incandescent lamps—they deserve a little respect.

DON'T expect to get the best results if you use an amplifier tube for a detector, or vice versa.

DON'T be anxious to produce sound with very great volume—it isn't necessary.

DON'T expect your loud speaker to work properly if you have a pair of phones connected to your detector circuit.

DON'T try to use Radio Corporation radio frequency intervalve transformers with other tubes than Radiotrons—you may not be able to make them function properly.

NOTE ON CONTROL OF REGENERATION

In vacuum tube receiving circuits employing regeneration, some means is generally provided for controlling this action. If the circuit is adjusted to a point where its action is too great, telephone signals will be distorted by oscillations set up in the detector tube itself. When this happens, it is merely necessary to alter the position of the regeneration control member.

Regeneration, when properly employed, has the effect of amplifying incoming signals many times and the best results may be obtained by bringing the regenerator control up to a point just before oscillation starts, or by bringing it to an oscillating point and then reducing it slightly. The point of oscillation may be recognized by a peculiar continuous mushy sound in the telephone receivers and a sharp click may be heard when oscillation starts or stops. Too great a degree of regeneration also has the effect of producing whistling noises.

The regenerative feature in receiving sets when properly employed is of great value, but improperly employed it is not conducive to the best operation. Great care should therefore be taken in employing regeneration, otherwise radio telephone speech and music may become distorted.

TECHNICAL TERMS USED IN RADIO

Aerial—One or more wires insulated from, and suspended at a certain height above the ground, and used to radiate energy in the form of ether waves produced by a transmitter. When used for receiving purposes the correct name is antenna though both terms are used for either reception or transmission.

Alternating Current, (Abbreviated A. C.)—An electrical current flowing through a wire which has the direction of its flow periodically changed. Thus when we speak of a 60-cycle alternating current, we mean one that completely reverses its direction of flow sixty times per second. Alternating current plays a prominent part in practically every part of the radio circuit.

Ammeter—An instrument used for measuring the flow of current in amperes through a given circuit. An ammeter is invariably connected in series with a given circuit.

Ampere—The standard electrical unit of current flow.

Amplifier—This term is used in referring to either an amplifier tube or an amplifier receiving unit. See vacuum tube.

Amplitude—In radio work, this refers to the highest point reached by a wave or oscillation, i. e., the crest of each wave. A wave may, therefore, have a high or low amplitude according to the initial energy which created it.

Antenna—See aerial.

Armstrong Circuit—See Regeneration Circuit.

Atmospherics—Also known as static, strays, X's. "The noises of space." Natural electrical discharges occurring in the ether and in reality miniature lightning storms. Since these discharges travel through the same medium as radio waves, they are readily picked up by receivers and prove very troublesome at times. It is comparatively difficult to tune out these disturbances, for they have no definite wave length.

Audio Frequencies—Frequencies corresponding to vibrations which are normally audible to the human ear. All frequencies below 10,000 cycles per second are termed audio frequencies. See radio frequencies.

Broadcasting—As applied to radio work, the sending of intelligence either by radio telegraphy or telephony from a given central point for the benefit of a great number of receiving stations located within the broadcasting station's range.

Capacity, (Abbreviated C.)—Capacity is the property of a device to store energy in electro-static form. Capacity, as well as inductance, governs the frequency and wave-length of a circuit. The unit is the Farad, but on account of its size, the micro-farad (M. F.) is used. A micro-farad is one millionth part of a farad.

Cascade Amplification—This refers to high amplification of received radio signals where several vacuum tubes are employed in cascade fashion. Thus, we may speak of a three-step (cascade) amplifier.

Choke Coil—A coil wound so as to have great self-induction. This choking action introduced in a radio circuit is called impedance.

Circuit—In radio and electrical work the path in which an electric current flows from the source, and returns to it, is called a circuit. A circuit may be either open, closed or oscillating.

Close Coupling—A tuning coil, or coils, or transformer are said to be close coupled when the primary and the secondary are very close together, thereby causing large values of mutual inductance.

Condenser—Two or more sheets of metal separated by an insulator called the dielectric. A condenser is used in radio work for storing electrical energy and for bringing circuits into resonance or tuning them.

Counterpoise—One or more wires stretched immediately above the earth, but insulated from it, usually directly beneath the regular aerial and employed in transmission and reception instead of, or in connection with, a "ground."

Continuous Wave, (Abbreviated C.W.)—A form of electro magnetic wave used extensively in radio work having a constant amplitude and no damping, as distinguished from the older form of discontinuous, highly damped wave. C. W. makes possible long distance amateur radio telegraphy and telephony.

Crystal Detector—Certain metallic crystals when introduced in a radio receiving circuit have the property of rectifying the incoming signal oscillations so that the resultant intermittent direct current will operate a sensitive telephone receiver.

Detector—Any apparatus which transforms the oscillations received by the antenna into a form of current which will operate a telephone or other recording device.

Direct Current, (Abbreviated D. C.)—An electric current flowing continuously in one direction. In a two-wire circuit, for example, direct current always flows from the positive source to the negative return. Therefore, direct current always has a readily determinable polarity, while alternating current (A. C.), which is periodically reversing its polarity while flowing through a circuit, and has no apparent polarity.

TECHNICAL TERMS USED IN RADIO *(Continued)*

Electron—The final sign of negative electricity. An Atom combined with an Electron is a negative Ion; an Atom minus an Electron is a positive Ion.

E. M. F.—Electromotive force, the unit of which is the volt.

Ether—A medium of great elasticity and extreme minuteness, supposed to pervade all space as well as the interior of solid bodies and is the medium through which light, heat and radio waves are transmitted.

Flat-Top Aerial—One whose suspended wires are stretched in a plane parallel to the surface of the earth.

Frequency—In alternating currents, the number of complete cycles of reversal of current through a circuit per second. Thus, we speak of a 60-cycle current as one which has sixty complete reversals per second. See Alternating Current and Audio and Radio Frequencies.

Grid Leak—A very high, non-inductive, resistance connected across the grid condenser or between the grid and the filament of a vacuum tube to permit excessive electrical charges to leak off to an external source, thus furnishing stable control under all operating conditions, and governing the action of the grid.

Ground, or Earth—In radio work the ground is the low potential end of the circuit and functions in connection with the aerial or antenna of most sending and receiving systems. The term "ground" is used in any connection to earth, river or sea. See Counterpoise.

Harmonics—In radio, harmonics refer to the incidental waves mostly noticeable in undamped wave operation. These harmonics differ in length and frequency from the true and original operative wave of such transmitters. At times, amateurs will hear the harmonics of high power long wave stations while their tuners are set for much shorter waves.

Henry—The unit of inductance.

Hertzian Waves—Electro-magnetic waves named after their discovery by Prof. Heinrich Hertz, in 1887.

Hot Wire Ammeter—An instrument used in radio transmission work which measures current in amperes by means of a wire expanding in proportion to the heat generated by the passing current.

Impedance—The combination of resistance and retarding action offered by a coil of wire to a varying current on account of the back e.m.f. produced by the varying lines of force, see also Reactance.

Inductance, (Abbreviated L) — Inductance, like capacity, plays a very prominent part in radio circuits. It is the property of a coil of wire which tends to prevent any change in the value of current following through it. It governs the frequency and therefore the wavelength of a circuit. The unit of inductance is the Henry. In radio work the milihenry and the microhenry are the more practical terms used.

Induction—The transference of energy from one circuit to another by means of electromagnetic phenomena.

Insulator—A non-conductive material and one through which electricity will not pass.

Kilowatt, (Abbreviated K. W.), meaning one thousand watts.

Loop Antenna—A small frame antenna used for indoor reception thus eliminating both outdoor aerials and ground connections. It gives very marked directional effects.

Loudspeaker—Any receiving device designed to reproduce signals or speech loud enough to be heard without individual use of the conventional telephone receivers.

Megohm—One million ohms.

Microfarad, (Abbreviated M. F.)—One millionth part of a Farad and the practical unit of capacity.

Microphone—A sound magnifier or an instrument used in both wire and radio telephony to vary the current in circuit by means of speech.

Miliampere, (Abbreviated M. A.)—The thousandth part of one ampere.

Ohm—The unit of electrical resistance.

Ohm's Law—The fundamental law of electricity. It is that the current in amperes flowing through a circuit is equal to the pressure in volts divided by the resistance in Ohms.

Oscillations—Alternating currents of very high frequencies are called electrical oscillations. If the amplitude of a series of oscillations is constant, they are called continuous or undamped waves, but if the amplitude is not constant, as in the spark method, they are called damped waves.

Potential—Referring to electrical pressure. See E.M.F and Volt.

Radiation—The transmission of energy through space in the form of electromagnetic waves.

Radio Frequencies—Frequencies corresponding to vibrations not normally audible to the human ear. All frequencies above 10,000 cycles per second are termed radio frequencies. See Audio Frequencies.

Reactance—Opposition offered to the flow of a varying current by a condenser (capacity reactance), or an inductance (inductive reactance).

Rectifier—An apparatus which converts alternating current (A. C.) into pulses of direct current (D. C.). Tungar, Rectigon and Kenotron apparatus are employed for rectifying purposes. Certain metallic crystals also have rectifying action when used as detectors in radio reception.

TECHNICAL TERMS USED IN RADIO *(Concluded)*

Regenerative Circuit, (also known as the Armstrong circuit)—A radio circuit comprising a vacuum tube so connected that after detection, the signal introduced in the plate circuit is led back to or caused to react upon the grid circuit, thereby increasing the original energy of the signal received by the grid and greatly amplifying the response to weak signals. In reception, the leading back of plate energy to the grid for further strengthening is usually accomplished by means of a small coil placed close to the secondary of the receiving tuner. This small coil is frequently called the "tickler."

Resistance—Opposition to the flow of an electric current through a conducting medium. All metals have more or less electrical resistance. Copper is used universally for both electrical and radio work on account of minimum resistance, comparative low cost and ready availability. The unit of resistance is the Ohm.

Resonance—A very important function of radio circuits. Resonance in a given circuit is said to exist when its natural frequency has the same value as the frequency of the alternating electromotive force introduced in it. The current is then in tune with the natural period of vibration of the circuit. The theory of electrical resonance is the same as that of acoustics, readily demonstrated by the tuning forks, when one tuning fork will not respond to another unless it is of the same key or pitch.

Rheostat—A variable resistance usually employed to control or regulate current flow.

Selectivity—In radio work, the power of being able to select any particular wave length to the exclusion of others.

Sharp Tuning—Where a very slight change of a tuner or tuning system will produce a marked effect in the strength of signals.

Static—See Atmospherics.

Transformer—Any device used in electrical and radio work for the transference of energy from one state to another. Thus we have Power Transformers, Amplifying Transformers, Telephone Transformers, Oscillation Transformers, Tuning Transformers.

Tuning—The act of altering capacity or inductive values in a radio circuit so as to bring the circuit into resonance with an external source of similar character. In radio receiving, the greatest signal strength is possible only when the product of the inductance —— capacity value of the receiver matches that of the transmitter.

Undamped—A train of high frequency oscillations of constant amplitude such as continuous waves or C. W.

Vacuum Tube, (Abbreviated V. T.)—In radio work applies to a glass tube exhausted of air and containing essentially a filament for the creation of electrons, a plate positively charged and to which the electrons are attracted, and a grid, inserted between the filament and the plate, for controlling the amount of electronic flow. This action of the vacuum tube plays three leading functions in radio work, i. e., detection, amplification and generation of high frequency electro-magnetic waves.

Velocity of Waves—Radio, electric and light waves travel through space at the speed of 186,000 miles per second, or 300,000 kilometers per second.

Volt, (Abbreviated V)—The unit of electric pressure.

Voltmeter—An instrument for measuring the voltage across an electric circuit.

Watt, (Abbreviated W.)—The unit of electric power. To find power in Watts multiply voltage by amperage. 746 Watts equal one horsepower. 1,000 Watts equal one kilowatt (K. W.).

Wave Length—Radio waves in their passage through the ether, travel in undulating wave form similar to the waves at a seashore. When the wind is blowing hard and steady the distance between each wave crest is comparatively long, while if the wind is blowing more mildly and in short spurts, the distance between wave crests is accordingly shorter and we have short waves. In radio substitute the wind for the transmitter and you have the same action so to speak. Wave length is therefore, closely allied with frequency, i. e., long wave lengths have low natural frequencies while short wave lengths have greater natural frequencies. In general, short wave lengths are used for short distance low power work, while long wave lengths are employed for long distance high power work, although there is no relation between wave—length and transmitting range.

NOTE ON FILAMENT REGULATION

As a general rule most experimenters are tempted to have the filaments of vacuum tubes burn too brightly. The proper brilliancy is the lowest one at which signals are good. Increasing the filament current beyond this point does not increase the signal strength, but does lessen the life of the tubes considerably. A good general rule to follow is that of keeping the filament as low as possible, consistent with good reception.

Moreover, certain types of vacuum tubes operate at very low filament temperatures. It is therefore best for the novice to follow closely the directions furnished with each vacuum tube receiver.

PRICE LIST OF RADIO APPARATUS

EFFECTIVE JUNE 1st, 1922

Supersedes all Previous Lists

RECEIVERS AND AMPLIFIERS FOR RADIO BROADCASTING RECEPTION

Item No.	Type	Description	List Price
1	AR-1300	G. E. Combined Crystal Radiophone Receiver and Regenerative Tuner 175-700 meters	$50.00
2	AA-1400	G. E. Detector-2-stage Amplifier for use with AR-1300 Tuner; less tubes	75.00
3	ER-753	G. E. Crystal Radiophone Receiver, 175-700 meters, with Telephones	18.00
4	RG	Westinghouse Aeriola Grand Receiver, 150-550 meters, comprising one Aeriotron Detector, three Aeriotron Amplifiers, four Ballast Vacuum Tubes and four "B" Batteries	325.00
5	RF	Westinghouse Aeriola Sr., 190-500 meters, with Brandes Telephones and one WD-11-D Aeriola Sr. Dry Battery Detector Tube	65.00
6	RE	Westinghouse Aeriola Jr., 190-500 meters, with Brandes Telephones and Spare Crystals	25.00
7	RC	Westinghouse Short Wave Regenerative Receiver, 180-700 meters, less tubes	132.50
8	RA	Westinghouse Short Wave Regenerative Tuner, 180-700 meters	68.00
9	DA	Westinghouse Detector-2-stage Amplifier, for use with RA Tuner, less tubes	70.00
10	AR-1375	Wireless Specialty Crystal Receiver, 170-2650 meters, with Telephones	40.00

BROADCASTING RECEIVER SPECIALTIES AND ACCESSORIES

11	DB	Crystal Detector, complete	6.50
12	DE	Spare Crystals (Pressure Type)	1.00
13	DD	Spare Crystals (Cat Whisker)	1.00
14	CB	Load Coil for Type RC Receiver	6.00
15	LS	Victrola Reproducing Loud Speaker Attachment	18.00
16	LS	Grafanola Reproducing Loud Speaker Attachment	18.00
17	LV	Vocarola (Loud Speaker)	30.00
18	AD	Receiving Antenna Equipment (W)	7.50
18-a	AG-788	Receiving Antenna Equipment (G. E.)	7.50
19	PA	Receiving Antenna Protector (W)	2.00
19-a	UQ-1310	Receiving Antenna Protector (G. E.)	2.50
20	IA	Receiving Antenna Insulator	.50
21	IA	Transmitting Antenna Insulator	2.00
22	SA	Transmitting Antenna Ground Switch	5.00

VACUUM TUBES FOR DETECTION, AMPLIFICATION AND AMATEUR OR EXPERIMENTAL TRANSMISSION

23	UV-200	Radiotron Detector Tube	5.00
24	UV-201	Radiotron Amplifier Tube	6.50
25	UV-202	Radiotron 5-watt Transmitter Tube	8.00
26	UV-203	Radiotron 50-watt Transmitter Tube	30.00
27	UV-204	Radiotron 250-watt Transmitter Tube	110.00
28	WD-11	Aeriotron Detector Renewal Tube, for Aeriola Sr. Receiver	8.00
29	WR-21-D	Aeriotron Detector Renewal Tube, for Aeriola Grand Receiver	7.50
30	WR-21-A	Aeriotron Amplifier Renewal Tube, for Aeriola Grand Receiver	7.50
31	WB-800	Aeriotron Ballast Renewal Tube, for Aeriola Grand Filament Circuit	3.50
32	UV-216	Kenotron 20-watt Rectifier Tube, for 5-watt Radiotrons	7.50
33	UV-217	Kenotron 150-watt Rectifier Tube, for 50-watt Radiotrons	26.50

VACUUM TUBE SOCKETS AND MOUNTINGS

34	UR-542	Porcelain Socket, for Detector, Amplifier, 5-watt Radiotron and 20-watt Kenotron	1.00
35	UT-541	Porcelain Socket, for 50-watt Radiotron and 150-watt Kenotron	2.50
36	UP-552	Bakelite Socket, for Detector, Amplifier, 5-watt Radiotron and 20-watt Kenotron	1.50
37	UT-501 / UT-502	End Mountings, for 250-watt Radiotron, per pair	2.00

VACUUM TUBE DETECTOR AND AMPLIFIER ACCESSORIES

Item No.	Type	Description	List Price
38	UV-712	Audio Frequency Intervalve Amplifying Transformer	7.00
39	UV-1714	Radio Frequency Intervalve Amplifying Transformer, 200-5000 meters	6.50
40	UV-1716	Radio Frequency Intervalve Amplifying Transformer, 5000-25000 meters	8.50
41	PQ-1743	Wave-changing Switch for Radio Frequency Transformer UV-1714	.45
42	PR-536	"A" Battery Potentiometer	2.00
43	UD-486	Four-Point special Telephone Jack	7.25
44	UD-824	Single Telephone Plug	1.75
45	UD-825	Double Telephone Plug	2.60
46	UC-567	Tubular Grid and Plate Condenser, .00025 mfd	1.20
47	UC-568	Tubular Grid and Plate Condenser, .0005 mfd	1.35
48	UC-569	Tubular Grid and Plate Condenser, .001 mfd	1.50
49	UC-570	Tubular Grid and Plate Condenser, .0025 mfd	2.00
50	UX-543	Tubular Condenser Mounting	.50
51	UP-509 to UP-527	Grid Leaks for Receiving Units, 50,000 Ohms to 5 Megohms	.75
52	UX-543	Grid Leak Mounting	.50

VARIABLE CONDENSERS FOR RECEIVING CIRCUITS

53	UC-1819	Faradon Variable Mica Condenser, .0001-.005 mfd	8.75
54	UC-1820	Faradon Precision Variable Air Condenser, .00004-.0006 mfd	7.50

SPECIAL AMPLIFIER UNIT

55	AA-484	Wireless Specialty 2-Stage Component Part Audio Frequency Amplifier, mounted, less tubes	45.00

STORAGE BATTERIES

56-a	3LXL-5	Exide, 6 volts 40 ampere hours	17.50
56-b	3LXL-9	Exide, 6 volts, 80 ampere hours	23.00
56-c	3LXL-13	Exide, 6 volts, 120 ampere hours	30.00
56-d	6HR-5	Westinghouse-Union, 6 volts, 50 ampere hours	18.00
56-e	6HR-9	Westinghouse-Union, 6 volts, 100 ampere hours	24.00
56-f	6HR-13	Westinghouse-Union, 6 volts, 150 ampere hours	33.50

BATTERY CHARGERS

57	195529	Tungar Charger, 2-ampere size	18.00
58	219865	Tungar Charger, 5-ampere size	28.00
59	195528	Tungar Renewal Bulb, 2-ampere size	4.00
60	189048	Tungar Renewal Bulb, 5-ampere size	8.00
61	282395	Rectigon Charger, 2½-ampere size	18.00
62	285168	Rectigon Charger, 6-ampere size	28.00
63	277681	Rectigon Renewal Bulb, 2½-ampere size	4.00
64	289414	Rectigon Renewal Bulb, 6-ampere size	8.00

COMPLETE AMATEUR RADIO TELEPHONE TRANSMITTING SETS

65	TF	Westinghouse Radio Telephone and Telegraph Transmitter, 20-watts, including four 5-watt Radiotrons, Desk Microphone 284-W, Telegraph Key UQ-809 and 100-watt Motor Generator Unit	305.00
65-a	ET-3619	G. E. Radio Telephone and Telegraph Transmitter, 20-watts with 4-UV-202 Radiotrons, Send-Receive Switch UQ-809 Key, Desk Microphone, 284-W, and 4 Dry Cells (Microphone Battery)	235.00
65-b	ET-3620	G. E. Rectifier for V. T. Transmission, 20-watts, with 4 Kenotrons UV-216	150.00

MOTOR-GENERATOR UNITS FOR VACUUM TUBE TRANSMITTERS

66	ME	Motor-Generator, 100-watts, 500-volts D.C., 110-volt 60-cycle single phase Motor, complete	85.00
67	MH	Motor-Generator, 250-watts, 1000-volts D.C., 110-volt 60-cycle single phase Motor, complete	170.00

POWER TRANSFORMERS FOR C. W. TRANSMITTING SETS

68	UP-1368	C. W. Transformer, 325-watts	25.00
69	UP-1016	C. W. Transformer, 750-watts	38.50

C. W. TRANSMITTER COMPONENT PARTS AND ACCESSORIES

70	UL-1008	Oscillation Transformer	11.00
71	UT-1643	Magnetic Modulator, ½ to 1½ amperes	9.50
72	UT-1357	Magnetic Modulator, 1½ to 3½ amperes	12.00
73	UT-1367	Magnetic Modulator, 3½ to 5 amperes	17.00
74	UP-1653	Filter Reactor, 5-20 watt Tube Transmitter	12.50
75	UP-1654	Filter Reactor, 50-100 watt Tube Transmitter	18.00
76	UP-415	Plate Reactor, 5-20 watt Tube Telephone Transmitter	5.75
77	UC-487	Filter Condenser, 750-volts, ½ mfd	1.40

C. W. TRANSMITTER COMPONENT PARTS AND ACCESSORIES—(*Continued*)

Item No.	Type	Description	List Price
78	UC-488	Filter Condenser, 750-volts, 1 mfd.	$2.25
79	UC-489	Filter Condenser, 1750-volts, ½ mfd.	1.60
80	UC-490	Filter Condenser, 1750-volts, 1 mfd.	2.50
81	UP-1718	Transmitter Grid Leak, for 50-watt Radiotron	1.65
82	UP-1719	Transmitter Grid Leak, for 5-watt Radiotron	1.10
83	UM-530	Antenna Ammeter, 0-2.5 amperes	6.00
84	UM-533	Antenna Ammeter, 0-5.0 amperes	6.25
85	UQ-809	Telegraph Key	3.00
86	UP-414	Microphone Transformer	7.25
87	PR-535	Filament Rheostat, for Detector, Amplifier, 5-watt Radiotron and 20-watt Kenotron	3.00
88	PT-537	Filament Rheostat, for 50-watt Radiotron, 250-watt Radiotron and 150-watt Kenotron	10.00
89	PX-1638	Rotary Grid Chopper, including wheel and brush	7.25
90 90-a	PX-1640 PX-1641	Rotary Grid Chopper Shaft Bushings, 5/16 in. (PX-1640) or ¼ in. (PX-1641), each	.20
90-b	UL-1655	Radio Frequency Choke	3.85

SPECIAL CONDENSERS FOR C. W. TRANSMITTING SETS

91	UC-1015	Faradon Antenna Series Condenser (.0003, .0004, .0005 mfd. 7500 v.)	5.75
92	UC-1014	Faradon Plate and Grid Condenser (.002 mfd., 3000 volts)	2.50
93	UC-1803	Faradon Antenna Coupling Condenser (.000025 mfd., 10,000 volts)	5.00
94	UC-1806	Faradon Special Grid and Plate Condenser .002 mfd., 6000 volts)	7.00
95	UC-1846	Faradon Special Coupling Condenser (.000075, .000037, .000018 mfd., 10,000 volts)	10.00
96	UC-1831	Faradon Variable Mica Transmitting Condenser (.0001 to .0012 mfd., 4000 volts)	9.00

SPECIAL HIGH GRADE RECEIVING APPARATUS

97	IP-500	Wireless Specialty Radio Receiver, 300-6800 meters, with Crystal Detector, less Telephone Receivers	595.00
98	IP-501	Wireless Specialty Vacuum Tube Radio Receiver, 300-7500 meters, with Crystal Detectors, less Telephone Receivers	550.00
99	Triode A	Wireless Specialty Vacuum Tube Control Unit, including Detector and 1-step Amplifier, less tubes	190.00
100	Triode B	Wireless Specialty Two-Step Tone Frequency Amplifier, less tubes	95.00
101	IP-306	Wireless Specialty Audibility Meter	135.00
102	......	Load Coil, 30 Milihenries	10.00
103	......	Load Coil, 50 Milihenries	15.50
104	......	Load Coil, 100 Milihenries	21.50

PRECISION VARIABLE AIR CONDENSERS

105	IP-300	Wireless Specialty Variable Air Condenser .005 mfd., max	90.00
106	IP-301	Wireless Specialty Variable Air Condenser, .003 mfd., max	72.00
107	IP-302	Wireless Specialty Variable Air Condenser, .0015 mfd., max	45.00
108	IP-303	Wireless Specialty Variable Air Condenser, .0007 mfd., max	41.50

COMPLETE RADIO TELEPHONE RECEIVER SETS

Westinghouse Aeriola Grand Combination No. 1

109	RG	Aeriola Grand Receiver, 150-550 meters, comprising one Aeriotron Detector, three Aeriotron Amplifiers, four Ballast Vacuum Tubes, and four "B" Batteries, with stand	350.00
	6HR-9	Storage Battery, 6 volts, 100 ampere hours	24.00
	AD	Receiving Antenna Equipment	7.50
	285168	Rectigon Battery Charger, 6 amperes	28.00
		Total	$409.50

Westinghouse Aeriola Sr., Combination No. 2

Item No.	Type	Description	List Price
110	RF	Aeriola Sr., Receiver, 190-500 meters, with Brandes Telephones and one WD-11 Aeriotron Detector Tube	65.00
	......	One Dry Cell for Aeriotron Filament	.40
	......	One "B" Battery, 22.5 volts	3.00
	AD	Receiving Antenna Equipment	7.50
		Total	$75.90

Westinghouse Aeriola Jr., Combination No. 3

Item No.	Type	Description	List Price
111	RE	Aeriola Jr., Receiver, 150-700 meters, with Brandes Telephones and Spare Crystals	25.00
	AD	Receiving Antenna Equipment	7.50
		Total	$32.50

Westinghouse Regenerative-Vacuum Tube Receiver Combination No. 4

Item No.	Type	Description	List Price
112	RC	Short Wave Regenerative Receiver, 170-700 meters, less tubes	132.50
	CB	Load Coil	6.00
	UV-200	One Radiotron Detector Tube	5.00
	UV-201	Two Radiotron Amplifier Tubes	13.00
	6HR-9	Storage Battery, 6 volts, 100 ampere hours	24.00
	UD-790	Brandes Telephone Receivers	8.00
	UD-824	Telephone Plug	1.75
	......	Two "B" Batteries	6.00
	AD	Receiving Antenna Equipment	7.50
	LV	Vocarola (Loud Speaker)	30.00
	285168	Rectigon Battery Charger, 5 amperes	28.00
		Total	$261.75

Westinghouse Crystal Receiver Combination No. 5

Item No.	Type	Description	List Price
113	RA	Short Wave (Regenerative) Tuner, 170-700 meters	68.00
	DB	Crystal Detector, complete	6.50
	UD-790	Brandes Telephone Receivers	8.00
	AD	Receiving Antenna Equipment	7.50
		Total	$90.00

General Electric Regenerative-Vacuum Tube Receiver Combination No. 1

Item No.	Type	Description	List Price
114	AR-1300	Radiophone Receiver, 170-700 meters	50.00
	AA-1400	Detector 2-Stage Amplifier, less Tubes	75.00
	UV-200	One Radiotron Detector Tube	5.00
	UV-201	Two Audiotron Amplifier Tubes	13.00
	UD-790	Brandes Telephone Receivers	8.00
	3LXL-9	Storage Battery, 6 volts, 80 ampere hours	23.00
	2156	Three "B" Batteries each 22.5 volts	9.00
	LV	Vocarola (Loud Speaker)	30.00
	219865	Tungar Battery Charger, 5 amperes	28.00
	UD-824	One Telephone Plug	1.75
	AG-788	Receiving Antenna Equipment	7.50
		Total	$250.25

General Electric Crystal Receiver Combination No. 2

Item No.	Type	Description	List Price
115	AR-1300	Crystal Radiophone Receiver, 170-700 meters, complete	50.00
	UD-790	Brandes Telephone Receivers	8.00
	AG-788	Receiving Antenna Equipment	7.50
		Total	$65.50

General Electric Crystal Receiver Combination No. 3

Item No.	Type	Description	List Price
116	ER-753	Crystal Radiophone Receiver, 300-700 meters, with Telephone Receivers	18.00
	AG-788	Receiving Antenna Equipment	7.50
		Total	$25.50

Wireless Specialty Crystal Receiver Combination No. 1

Item No.	Type	Description	List Price
117	AR-1375	Crystal Radiophone Receiver, 170-2650 meters, with Telephone Receivers	40.00
		Receiving Antenna Equipment	7.50
		Total	$47.50

Price Changes: All prices listed in this catalogue are subject to change without notice.

Quotations: Quotations:—F.O.B. Warehouse, 326 Broadway, New York City, factories, or other points to be designated later.

NOTICE TO PURCHASERS

THE radio products of the Radio Corporation of America are distributed to the trade through its specially selected wholesale distributors located throughout the United States and its possessions. These distributors generally carry a complete line of Radio Corporation apparatus. Broadcast enthusiasts and experimenters are urged to place their orders with the dealers of these accredited representatives rather than through the General Offices of the Corporation. By placing orders with these dealers, the purchaser not only buys in the most economical way and reduces the time of delivery but he also assists the dealer to keep his shelves stocked with up-to-date radio apparatus.

The Radio Corporation of America's wholesale distributors and retail dealers have been selected after a careful investigation of their methods and practices. Consideration has been given to those who give quick service and are able, in addition to effecting radio sales, to assist experimenters in solving their technical problems.

Purchasers are requested to investigate our faith in these supply houses and to place their orders with them directly. If the purchaser is located so far from any of the Corporation's wholesale distributors and their dealers that he cannot conveniently deal with them direct, the Corporation will be pleased to give him counsel and advice, and to point out the type of equipment which it deems most suitable for the purchaser's requirements.

The Wireless Man's BOOKSHELF

Title	Author	Price
Practical Wireless Telegraphy	**Elmer E. Bucher**	**$2.25**
Vacuum Tubes in Wireless Communication	**Elmer E. Bucher**	**2.25**
Wireless Experimenter's Manual	**Elmer E. Bucher**	**2.25**
How to Pass U. S. Govt. Wireless License Examinations	**Elmer E. Bucher**	**.75**
How to Conduct a Radio Club	**Elmer E. Bucher**	**.75**
The Alexanderson System for Radio Telegraph and Radio Telephone Transmission	**Elmer E. Bucher**	**1.25**
Practical Amateur Wireless Stations	**Compiled by J. Andrew White, Editor of Wireless Age**	**.75**
Radio Telephony	**Alfred N. Goldsmith, Ph.D.**	**2.50**
Prepared Radio Measurements with Self-Computing Charts	**Ralph R. Batcher**	**2.00**
Radio Instruments and Measurements		**1.75**
Acquiring the Code	**E. P. Gordon**	**.50**
Sound Method of Learning the Code		**.50**
Elementary Principles of Wireless Telegraphy (in two volumes)	**R. D. Bangay**	
Volume 1		**1.75**
Volume 2		**1.75**
Practical Aviation (including Construction and Operation)	**Major J. Andrew White**	**2.25**
Military Signal Corps Manual	**Major J. Andrew White**	**2.25**
"What You Want to Say and How to Say It"	**W. J. Hernan**	
In French, or Spanish, or Italian or German		**.25**
In Russian		**.50**
Continuous Wave Telegraphy. Part I	**W. H. Eccles**	**8.00**
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STATIONS HEARD

Call Letters	Date	Location	Distance	Wave Length	Receiver Adjustments

DEPARTMENT OF COMMERCE
BUREAU OF NAVIGATION
RADIO SERVICE

INTERNATIONAL RADIOTELEGRAPHIC CONVENTION
LIST OF ABBREVIATIONS TO BE USED IN RADIO COMMUNICATION

ABBREVIATION	QUESTION	ANSWER OR NOTICE
PRB	Do you wish to communicate by means of the International Signal Code?	I wish to communicate by means of the International Signal Code.
QRA	What ship or coast station is that?.........	This is........
QRB	What is your distance?....................	My distance is........
QRC	What is your true bearing?................	My true bearing is........degrees.
QRD	Where are you bound for?..................	I am bound for........
QRF	Where are you bound from?.................	I am bound from........
QRG	What line do you belong to?...............	I belong to the........Line.
QRH	What is your wave length in meters?.......	My wave length is........meters.
QRJ	How many words have you to send?..........	I have........words to send.
QRK	How do you receive me?....................	I am receiving well.
QRL	Are you receiving badly? Shall I send 20? .. . — . for adjustment?	I am receiving badly. Please send 20. .. . — . for adjustment.
QRM	Are you being interfered with?............	I am being interfered with.
QRN	Are the atmospherics strong?..............	Atmospherics are very strong.
QRO	Shall I increase power?...................	Increase power.
QRP	Shall I decrease power?...................	Decrease power.
QRQ	Shall I send faster?......................	Send faster.
QRS	Shall I send slower?......................	Send slower.
QRT	Shall I stop sending?.....................	Stop sending.
QRU	Have you anything for me?.................	I have nothing for you.
QRV	Are you ready?............................	I am ready. All right now.
QRW	Are you busy?.............................	I am busy (or: I am busy with......). Please do not interfere.
QRX	Shall I stand by?.........................	Stand by. I will call you when required.
QRY	When will be my turn?.....................	Your turn will be No. ....
QRZ	Are my signals weak?......................	Your signals are weak.
QSA	Are my signals strong?....................	Your signals are strong.
QSB	{Is my tone bad?.......................... {Is my spark bad?.........................	The tone is bad. The spark is bad.
QSC	Is my spacing bad?........................	Your spacing is bad.
QSD	What is your time?........................	My time is........
QSF	Is transmission to be in alternate order or in series?	Transmission will be in alternate order.
QSG	....	Transmission will be in series of 5 messages.
QSH	....	Transmission will be in series of 10 messages.
QSJ	What rate shall I collect for........?....	Collect........
QSK	Is the last radiogram canceled	The last radiogram is canceled.
QSL	Did you get my receipt?...................	Please acknowledge.
QSM	What is your true course?.................	My true course is........degrees.
QSN	Are you in communication with land?.......	I am not in communication with land.
QSO	Are you in communication with any ship or station (or: with........)?	I am in communication with........ (through........).
QSP	Shall I inform........that you are calling him?	Inform........that I am calling him.
QSQ	Is........calling me?.....................	You are being called by........
QSR	Will you forward the radiogram?...........	I will forward the radiogram.
QST	Have you received the general call?.......	General call to all stations.
QSU	Please call me when you have finished (or: at......o'clock)?	Will call when I have finished.
*QSV	Is public correspondence being handled?....	Public correspondence is being handled. Please do not interfere.
QSW	Shall I increase my spark frequency?.......	Increase your spark frequency.
QSX	Shall I decrease my spark frequency?.......	Decrease your spark frequency.
QSY	Shall I send on a wave length of........ meters?	Let us change to the wave length of........ meters.
QSZ	....	Send each word twice. I have difficulty in receiving you.
QTA	....	Repeat the last radiogram.
QTE	What is my true bearing?	Your true bearing is ..... degrees from .....
QTF	What is my position?	Your position is .... latitude .... longitude.

*Public correspondence is any radio work, official or private, handled on commercial wave lengths.

When an abbreviation is followed by a mark of interrogation, it refers to the question indicated for that abbreviation.

DEPARTMENT OF COMMERCE
BUREAU OF NAVIGATION
RADIO SERVICE

INTERNATIONAL MORSE CODE AND CONVENTIONAL SIGNALS

TO BE USED FOR ALL GENERAL PUBLIC SERVICE RADIO COMMUNICATION

1. A dash is equal to three dots.
2. The space between parts of the same letter is equal to one dot.
3. The space between two letters is equal to three dots.
4. The space between two words is equal to five dots.

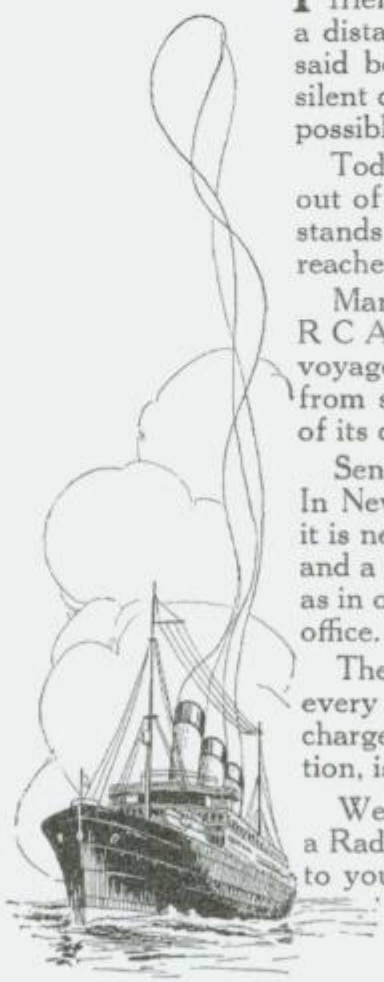
A . —
B — . . .
C — . — .
D — . .
E .
F . . — .
G — — .
H . . . .
I . .
J . — — —
K — . —
L . — . .
M — —
N — .
O — — —
P . — — .
Q — — . —
R . — .
S . . .
T —
U . . —
V . . . —
W . — —
X — . . —
Y — . — —
Z — — . .

Ä (German) . — . —
Á or Å (Spanish-Scandinavian) . — — . —
CH (German-Spanish) — — — —
É (French) . . — . .
Ñ (Spanish) — — . — —
Ö (German) — — — .
Ü (German) . . — —

1 . — — — —
2 . . — — —
3 . . . — —
4 . . . . —
5 . . . . .
6 — . . . .
7 — — . . .
8 — — — . .
9 — — — — .
0 — — — — —

Period	. . . . . .
Semicolon	— . — . — .
Comma	. — . — . —
Colon	— — — . . .
Interrogation	. . — — . .
Exclamation point	— — . . — —
Apostrophe	. — — — — .
Hyphen	— . . . —
Bar indicating fraction	— . . — .
Parenthesis	— . — — . —
Inverted commas	. — . . — .
Underline	. . — — . —
Double dash	— . . . —
Distress Call	. . . — — — . . .
Attention call to precede every transmission	— . — . —
General inquiry call	— . — . — — . —
From (de)	— . . .
Invitation to transmit (go ahead)	— . —
Warning—high power	— — . . — —
Question (please repeat after......)—interrupting long messages	. . — — . .
Wait	. — . . .
Break (Bk.) (double dash)	— . . . —
Understand	. . . — .
Error	. . . .
Received (O. K.)	. — .
Position report (to precede all position messages)	— . — .
End of each message (cross)	. — . — .
Transmission finished (end of work) (conclusion of correspondence)	. . . — . —

THE SILENCE OF THE SEA IS BROKEN



IT happens to each of us, at some time or other, that a friend or loved one must leave our midst and voyage to a distant land. In years gone by, the last good-bye was said before the ship carried its passengers out into the silent deep. No after thought, no last good wish, was then possible.

Today we thrill at the thought that we are no longer out of touch with our friends at sea, for at our command stands Radio, the ever-willing genie, whose long arm reaches to the furthest waters of the oceans.

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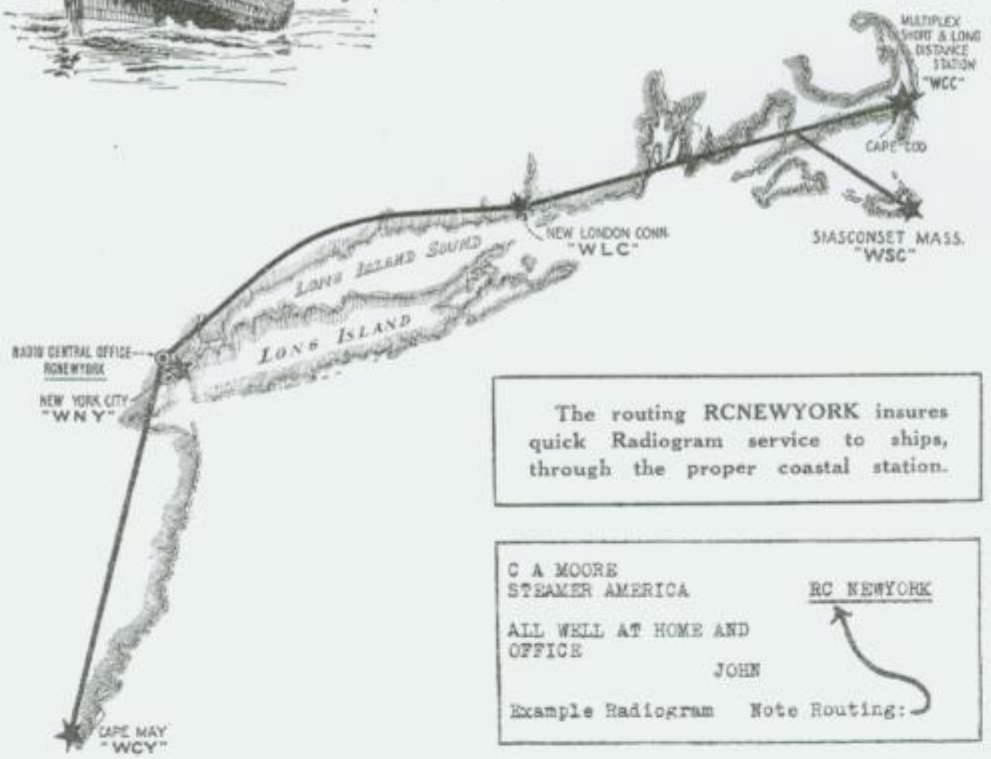

The routing **RCNEWYORK** insures quick Radiogram service to ships, through the proper coastal station.

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STEAMER AMERICA                RC NEWYORK

ALL WELL AT HOME AND
OFFICE
                  JOHN

Example Radiogram   Note Routing:
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Radio Enters the Home

How to enjoy popular Radio Broadcasting
Complete instructions and description of apparatus

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Radio Corporation of America

World Wide Wireless

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