Radiola R S

Regenerative Receiver and Amplifier

INTRODUCTION

A radio receiver is an instrument, which, in connection with an antenna in the form of an elevated wire or a suitable loop, is used to convert the high frequency electro magnetic waves into electric currents which in turn operate a telephone receiver and produce audible sounds.

Radio communication is effected by means of electromagnetic waves which are radiated from the transmitting station and travel in all directions at the velocity of light. This velocity is 186,000 miles or 300,000 kilometers per second which will carry a radio signal seven times around the earth in a second. These waves cannot be heard because they have no mechanical effect on the ear drum and

Fig. 1—Radiola RS

even if they did, the frequency would be so high that the ear could not respond to it. Sound waves have frequencies varying from about 16 cycles per second, which is the note produced by the largest organ pipe, up to about 20,000 cycles per second, which is the highest frequency to which the human ear will respond. The velocity of sound waves in air is about 1100 feet per second so that sound waves have a length varying from an inch or so up to 60 or 70 feet. Radio waves are usually much longer, the usual broadcasting wavelength being 360 meters or 1180 feet. Therefore the frequency of these waves will be about 833,000 cycles per second.

Much confusion has arisen among non-technical people between wavelength and distance from which signals may be heard. Actually there is little connection between them. The distance from which signals can be heard depends upon the power of the transmitting station and the efficiency of both the transmitting and receiving apparatus.

The ordinary wire line telephone works with electric currents of the same frequency as the sound waves. Radio communication works with electric currents of a constant high frequency whose amplitude changes at a low frequency corresponding to that of the sound waves. Therefore, the radio receiver must change the high frequency currents of variable amplitude into low frequency currents which will then operate a telephone receiver to produce audible sounds.

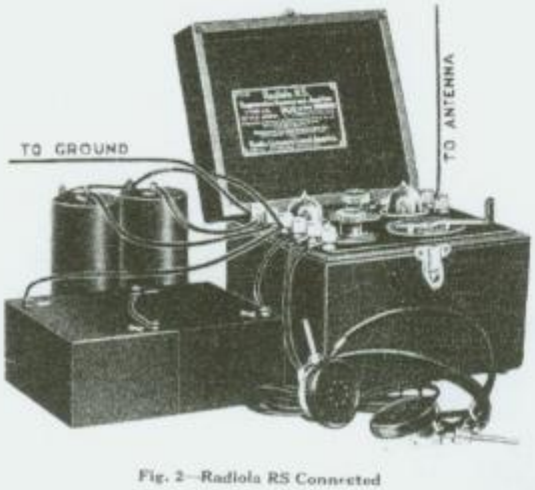

Fig. 2—Radiola RS Connected

THE RADIOLA RS

The Radiola RS is a complete radio receiver consisting of a continuously variable inductance with tickler regeneration, a capacity variable in two steps, a vacuum tube detector and one stage of audio frequency amplification. It has been designed to give strong, clear reproduction of voice and music without distortion, and to be sensitive, compact and easily operated. One of the principle features of this receiver is the use of a low current vacuum tube, the filament of which can be operated satisfactorily by an ordinary dry cell thus eliminating the need of a storage battery and the consequent necessity of charging periodically. Sensitivity and ease of operation combine to make the Radiola RS an ideal receiver for the unskilled operator and as one becomes proficient at its manipulation, he or she will be able to produce remarkable results.

EQUIPMENT

Standard Equipment of Radiola RS:—

The standard equipment of the Radiola RS consists of the following three items.

1—Single circuit regenerative receiver with one stage of audio amplification mounted in a mahogany cabinet
2—Radiotron dry cell vacuum tubes, type WD-11
1—Telephone headset

Additional Equipment Necessary:

It is necessary to have the following additional equipment for the installation and operation of the Radiola RS.

2—No. 6 Dry cells
2—22½ volt radio "B" batteries
1—Complete set of antenna material

Other sources of filament current than the dry cell mentioned above may be used if desired. Sources suggested are a single two volt lead storage cell or three Edison primary cells connected in series.

When either of these sources are used, the posts marked "$+A_1$" and "$+A_2$" should be connected together.

For convenience to purchasers and to meet the requirements of the Fire Underwriters it is recommended that the Radio Corporation of America antenna package, as specified above, be obtained since it contains approved equipment and directions for the installation of a proper out-door antenna.

INSTALLATION

Location:

The Radiola RS should be located as near as practicable to the incoming wire from the antenna. Certain limitations in the room and in the location of an antenna make it difficult to locate the instrument directly under the near end of the antenna. However, in all cases, arrangements should be made to meet the requirement as closely as possible.

Antenna:

Very many of the operating troubles in radio receivers are traced to poor antenna installation. There are several things which govern the size, location and type of antenna installation. If the antenna is not properly insulated the signals will be weakened by leakage. If the antenna runs parallel, and close to electric light wires or grounded metal structures, its efficiency will be greatly impaired. If all joints in the working part of the antenna circuit are not soldered or provided with approved splicing devices, they will corrode and reduce the signal strength because of the introduction of high resistance. If the antenna is too low or short the strength of signals will be reduced. If the antenna is too high or long, the receiver will not give good selectivity, i. e., it will be impossible to tune out nearby strong signals and select a weak signal from a distant point.

The best antenna for all around receiving consists of a single wire size 14 B & S gauge installed 20 to 30 feet from the ground and extending horizontally

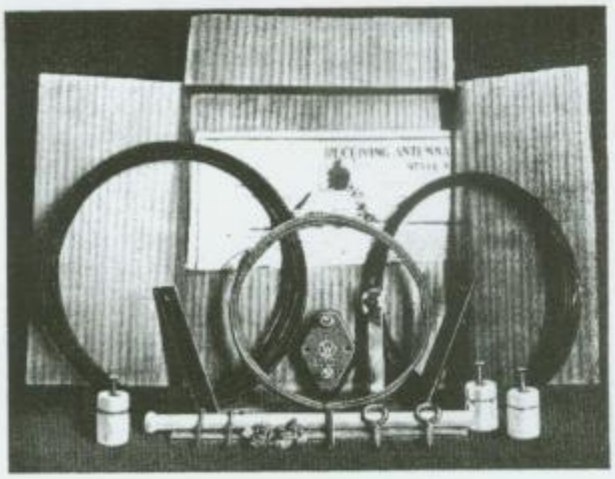

Fig. 3—Antenna Package Complete

100 to 130 feet from the receiver. This antenna should be equipped with an approved protective device and installed in strict accordance with the rules of the National Fire Protection Association.

When too much interference is experienced with the outdoor antenna of the dimensions given, it will be found advantageous to install a smaller antenna. This may be either indoors or outdoors, the outdoor installation in general giving slightly better results, but the indoor one is not subject to the rules of the underwriters and does not require a protective device. The small antenna should consist of not

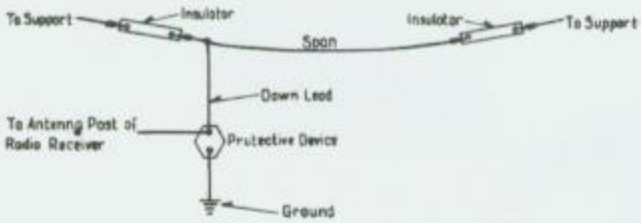

Fig. 4—Diagrammatic Antenna

more than 25 feet of wire. Indoors, it may be concealed in a picture molding or any other convenient place but slightly better results will be obtained if it is supported away from the wall. Such an antenna will produce almost as much strength of signal as a larger one but will tune much more sharply and thus reduce interference.

When the above rules are followed and the technical points mentioned above have been properly considered, the antenna will give good signal strength and there will be no fire hazard.

Figure 3 shows the complete antenna package equipment, type AD, and Figure 4 shows diagrammatically how an antenna should be installed. The center span of wire between insulators is the working span and is connected to the instrument by the "down lead" or lead-in wire. The protective device provides a discharge path from antenna to ground and thus protects the antenna during electrical storms.

The following quotations from the Underwriter's rules will be of value.

"The outside antenna must not be placed over or under power or electric light wires of any circuit of more than 600 volts or railway trolley or feeder wires, nor shall it be so located that a failure of either the antenna or the above mentioned electric light or power wires can result in contact between the antenna and power wires. Antennae shall be constructed and installed in a strong and durable manner"

"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 building". "The protector shall not be in the immediate vicinity of easily ignitible stuff or where exposed to inflammable gases, or dust, or flying combustible material."

"The protective 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 and if of copper clad steel it shall not be smaller than No. 17. 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 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".

"The receiving equipment ground wire may be bare or insulated and shall be of copper or copper clad steel as in the case of the protective ground wire". "The receiving equipment ground wire may be run inside or outside the building. When receiving equipment ground wire is run in full compliance with the rules for protective ground wire, it may be used as the ground conductor for the protective device."

CONNECTING RADIOLA RS

General:

The Radiola RS should be connected as shown in Figure 2. Detailed directions follow:

The Antenna Lead-in—The lead-in should be connected to one of the antenna binding posts at the right of the panel. The post marked "Short Wave" should be used for wavelengths from about 180 to 375 meters. The "Long Wave" post should be used for wavelengths from about 340 to 550 meters.

The Ground Wire—The ground wire should be connected to the post marked "Ground + A_1". This ground wire should run as directly as possible to a good permanent ground.

Connection of Filament or "A" Battery—The tubes used in the Radiola RS require a voltage of approximately 1.1 on the filaments so that an ordinary dry cell can be used. Since there are two tubes, two cells should be used. The negative or outside terminals of both cells should be connected together and to the post marked "-A-B Battery". One wire should run from each of the positive or center terminals to a binding post marked "+ A_1" and "+ A_2" respectively. The connections are so arranged that the rheostat will control the current to both tubes and yet each cell will heat the filament of only one tube. It is possible to operate both tubes in parallel from the same cell by connecting posts "+ A_1" and "+ A_2" together and connecting a wire from either to the positive terminal of the cell.

Connection of "B" Battery—Two of the usual 22½ volt "B" batteries should be connected in series by connecting the positive terminal of one to the negative terminal of the other. The remaining positive terminal should then be connected to the binding post marked "+B" and the negative terminal should be connected to the post marked "-A-B".

Connection of Telephone Headset—The two terminals at the end of the telephone headset cord should be connected to the two binding posts marked "Phones".

Insertion of Vacuum Tubes—After all connections have been made and checked, turn the rheostat knob as far to the left as possible. Insert the tubes in their sockets through the holes in the panel. It will be found that the tubes will fit the contacts in but one way. The sockets are so arranged that the large pin is toward the front of the box. Special care should be taken to see that the "A" and "B" batteries have not been interchanged as the high voltage of the "B" battery would instantly burn out the filaments of the tubes and render them worthless.

OPERATION

General:

The Radiola RS is made as simple to operate as is consistent with a high degree of sensitivity and selectivity. After a little practice, it will be found very easy to pick up signals from different stations and with care in making the adjustments, signals from stations many miles away may be heard. Connections are made in the set so that one step of audio frequency amplification is in use at all times.

Control and Tuning:

Figure 5 is a close-up view of the panel of the Radiola RS showing the controls used to make all adjustments during operation. The purpose and effect of each are as follows:

Fig. 5—Close-up of Panel

The Filament Rheostat, near the back of the panel between the two holes for the tubes is used to control the filament current in both tubes. When it is turned as far as possible to the left or "off" position, the filament circuit is open and no current can flow. THE RHEOSTAT SHOULD ALWAYS BE LEFT IN THIS POSITION WHEN THE SET IS NOT IN OPERATION. The correct operating position is best found by watching the filaments of the tubes as the rheostat is turned slowly to the right. At the correct position, the filaments will glow at a dull cherry red color. It is inadvisable to burn a filament at a higher temperature than necessary as this will shorten its life These 'ow current filaments have an exceptionally long life if not abused.

The Tuning Lever is the nickel plated ever operating over the larger dial at the right of the panel. This ever varies the inductance in the tuning circuit and thus changes the wavelength to which the set will respond When the index points to "0", the set is tuned to the shortest wavelength.

The Tickler Knob controls the regenerative action of the set. In this instrument, it is so designed that its adjustment will vary but little at the various wavelengths When the index points to "0", regeneration is practically nothing but increases to a point more than sufficient to produce oscillation when the pointer reaches '10" The best operating point is just below the point at which oscillation begins

The Antenna Binding Posts provide for two wavelength ranges by introducing different amounts of capacity into the tuning circuit. When the antenna is connected to the "Short Wave" post, the Radiola RS will respond to wavelengths of from about 180 meters to 375 meters. When the antenna is connected to the 'Long Wave" post, the range becomes about 320 meters to 550 meters. The ranges given are for an antenna as previously described and will vary somewhat as the antenna dimensions are changed.

Hunting Signals:

Start with all controls turned as far as possible to the left. Now turn the filament rheostat slowly to the right until the filaments of both tubes appear cherry red. Turn the tickler to "3." Put on the headset and turn the tuning lever s ow y back and forth over the scale. If no signal is found, increase the regeneration by turning the tickler about one half a division to the right and then turn the tuning lever back and forth as before. Repeat until signals are heard If still no signals are received, it is an indication that either something is wrong with the installation or that no station within range is transmitting within the wavelength band covered by the receiver. Try again after connecting the antenna lead to the other antenna post.

Final Adjustment of Rheostat:

In order to increase the life of the vacuum tube the filament current should be adjusted to as low a point as possible without affecting the efficiency of the set. On a relatively strong signal, adjust the rheostat to the point where any further decrease in filament current wi l cause the signal strength to decrease

Regeneration:

Regeneration is the name applied to the process of feeding some of the energy in the output circuit of the vacuum tube back into the input circuit. It is the ability to do this that makes the vacuum tube so much superior to the crystal as a detector for radio communication.

A vacuum tube has three electrical circuits connected with it, all of which are necessary for its operation. The first is the filament heating circuit composed of a battery to supply the current, a variable resistance commonly called a rheostat to control the current, the filament of the vacuum tube and the connecting wires. It is the function of this circuit to heat the filament, just as in an ordinary incandescent lamp, to the proper temperature when electrons are given off by the filament. These electrons are very small particles of electricity and have a negative charge. They are free to travel around inside the tube. The second circuit is the output circuit and is composed of the "B" battery, the telephone headset, the filament of the vacuum tube, the tickler coil, the plate of the vacuum tube and some of the electrons given off by the filament. The nega ive end of the battery is connected to one end of the filament while the positive end is connected to the telephone headset and through it to the plate of the vacuum tube. This makes the plate positive with respect to the filament and it therefore attracts the electrons which are given off by the filament so that instead of wandering around inside the tube, some of the electrons will reach the plate. These electrons then constitute a flow of negative electricity which is an electric current. The strength of this current will be directly proportional to the number of electrons reaching the plate. This will vary with the attractive force which depends upon the potential difference between the plate and filament or more simply upon the voltage of the "B" battery, and upon the supply of electrons which depends on the filament temperature and is usually kept constant. The third circuit is the input circuit and consists of the filament, part of the tuning circuit, the grid condenser and leak, the grid and the space between the grid and the filament inside the tube. When signals are being received, alternating currents flow in the tuning circuit causing differences of potential between the grid and filament. The grid is placed between the filament and the plate and is usually a helix of fine wire. When the grid is positive with respect to the filament it helps the plate to attract electrons and thus increases the plate current. When it is negative it decreases the plate current. Thus there is superposed on the steady plate current, a small alternating current which has such a high frequency that neither the telephone receiver nor the human ear can respond to it. The frequency is so high that the current prefers to pass through the by-pass condenser instead of the telephone receiver. At the same time, by means of the grid condenser and leak, other potentials of lower frequency and corresponding to the changes in amplitude of the signals are being impressed on the grid and these produce changes in the steady plate current which flows through the telephone receivers and cause changes in the pull on the diaphragms thus producing audible sound. The high frequency currents however are of the same shape as the currents in the tuning circuit and keep step with them. Therefore a coil of wire called the "tickler" is connected between the plate of the vacuum tube and the telephone headset and this coil is so located that the currents flowing in it can induce currents in the tuning circuit which add to those produced by the electro-magnetic waves intercepted by the antenna. Therefore, greater potentials are applied to the grid and greater changes of plate current are produced, which in turn produce a louder sound in the telephone receiver.

It is possible to carry the above process too far, that is, enough potential may be applied to the grid from the tickler so that no incoming signal is necessary. The set then acts as a converter of direct current supplied by the "B" battery into alternating current and is said to be "oscillating". The radio frequency currents produced by the set will combine with those picked up by the antenna and will produce whistling noises called beat notes in the receiver. The music or speech may still be heard but will be mushy and muffled. But it should be remembered that whenever the receiving set is oscillating, that it is acting like a miniature transmitter and is radiating electro magnetic waves. Any other receiving set that may be within range and which is tuned to the same frequency will pick up these waves. Therefore, if your set is adjusted to produce a beat note with a particular broadcasting station, your neighbor, who is listening to the same broadcasting station, will also hear the beat note and will be powerless to do anything about it even though it may ruin his enjoyment of the concert or speech. Therefore, never let your set oscillate when listening to a radio concert.

MAINTENANCE

General:

With reasonable care, nothing in the Radiola RS or the additional equipment should wear out or require replacement except the vacuum tubes and batteries. The following covers the renewal of these parts.

Renewal of Vacuum Tubes:

Radiotron WD-11 vacuum tubes have an exceptionally long life when they are not abused by rough handling or by overheating the filaments. After the filament is broken or burned out the tube is of no more use as it is impracticable to repair it. It should be replaced by a new tube of the same type.

Renewal of "A" Battery:

After a considerable period of use, the dry cells used to heat the filaments will become so weakened that it will be impossible to operate the filaments at a sufficiently high temperature even though the rheostats are turned all the way to the right. When this condition occurs, the cells should be replaced by new ones. A fresh cell should last about fifty days when used two hours per day, supplying one tube.

Renewal of "B" Battery:

After some eight to twelve months of use, the "B" batteries will become exhausted and will no longer be able to supply the proper plate current. They should be replaced by new batteries of the same voltage. The large size "B" battery will give longer service than the small size.

Replacing Grid Leak Condenser:

The combined grid leak and condenser should not require replacement. However, if moisture enters the unit, it will affect its operation. In this case it must be replaced by a new unit. It is mounted in fuse clips under one tube socket.

OPERATING TROUBLE

It is impossible to cover in detail all the possible operating troubles that may occur. The above instructions cover the usual renewals which may be made by the non-technical operator Troubles due to broken wires, loose connections, etc., are difficult to locate. If they occur, an experienced radio service man should be called in to locate and remedy the trouble. The following description and diagram of connections is included to facilitate trouble hunting.

ELECTRICAL CIRCUIT

Figure 6 gives the diagram of connections of the Radiola RS while Figure 7 is a view of the interior showing the apparatus mounted on the under side of the panel.

The tuning circuit is of the well known single circuit type consisting of a variable inductance (A) in series with a fixed condenser (B), the latter, having two values of capacity which are available through two antenna binding posts. The grid potential is taken off the whole inductance, the grid condenser and leak method of detection being used. The grid condenser and leak (C) are combined in one unit which is mounted in fuse clips.

Two vacuum tubes are provided, one (F) being used as the detector while the other (U) is used as an audio frequency amplifier. The rheostat (V) is connected in the negative lead which is common to both tubes and it therefore controls the filament current to both tubes at the same time. Separate binding posts "+ A_1" and "+ A_2" provide for the use of individual dry cells.

Regeneration is provided by an inductively coupled tickler consisting of a stationary winding (E) and a rotary winding (D) connected in series. Coupling is provided through the feeder windings (G) which are part of the tuning circuit. A by-pass condenser (H) permits the high frequency currents to pass the audio frequency transformer (J). The plate currents from the detector tube pass through the primary of the transformer and produce potentials in the secondary which are then applied to the grid of the amplifier tube (U) producing greater changes in the plate current than in that of the detector. This plate current from the amplifier passes through the telephone headset and produces the audible sounds.

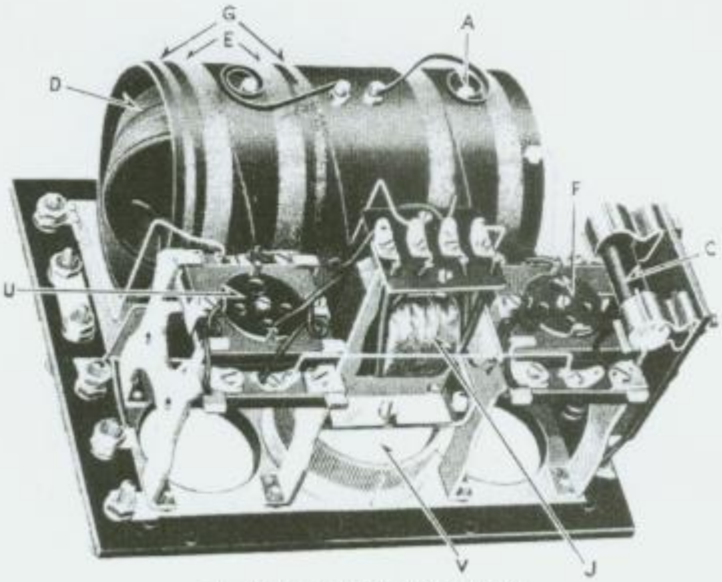

Fig. 7—Working Parts of Radiola RS

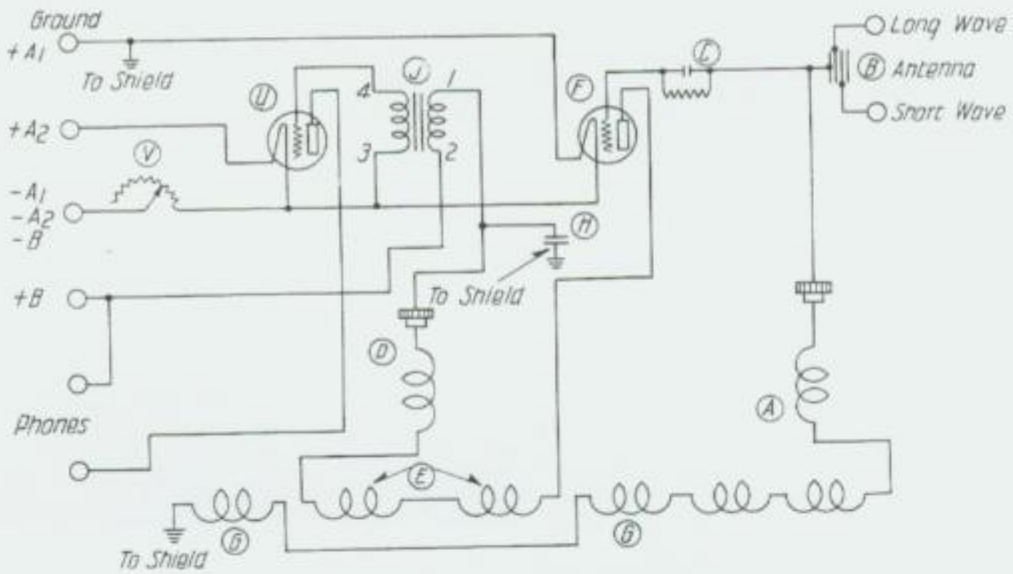

Fig. 6—Diagram of Connections Radiola RS