Inventor:
Harold H. Beverage,
by Albert C. Stain
His Attorney.
To all whom it may concern:

Be it known that I, HAROLD H. BEVERAGE, a citizen of the United States, residing at Riverhead, county of Suffolk, State of New York, have invented certain new and useful Improvements in Radio Receiving Systems, of which the following is a specification.

My present invention relates to radio receiving systems, and more particularly to receiving systems by means of which signal waves from a desired direction may be received without interference from disturbing waves coming from other directions.

One of the objects of my invention is to provide in conjunction with a unidirectional receiving antenna, a simple and efficient means whereby the receiving station may be located at any desired point which may be some distance from the point in the antenna at which the desired signaling currents are strongest.

In my prior application, Serial No. 372,933, filed April 10, 1920, issued June 7, 1921 as Patent 1,381,089 of which this application is a continuation in part, there is described and claimed a receiving antenna which will have marked unidirectional properties. In this case, a long horizontal antenna is employed which extends preferably in the general direction of transmission of the signals to be received, and which preferably has a length of the order of magnitude of a half wave length of the signal to be received. In case such an antenna is properly constructed signals coming from a desired station will be found to be strongest at the end of the antenna which is farthest from the transmitting station, while signals coming from the opposite direction will be very weak at that end.

In my prior application referred to, I have indicated one method whereby the desired signaling currents may be transmitted from a point in the antenna where they are strongest to a receiving station located at some distance from that point. In the present application I will describe other ways in which this desired result may be accomplished.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims, the invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following description taken in connection with the accompanying drawing in which Figs. 1 and 2 show diagrammatically two different arrangements whereby my invention may be carried into effect.

As indicated in Fig. 1, I provide a long horizontal antenna 1, the opposite ends of which are grounded at 2 and 3. This antenna is preferably so constructed or its constants so adjusted that the current wave therein will travel along its length at the same velocity as that of the signaling wave in space so that the current wave will gradually grow in amplitude as it travels along the conductor. If it is desired to receive a signal which approaches the antenna from the end 2 the amplitude of the current set up in the antenna at 2 by the desired wave will be extremely small while at the end 3 the amplitude of the current will be maximum. It may, however, in some cases be more convenient to locate the receiving station at some point distant from the end 3 of the antenna. In such case I have found that a transmission line may be employed between the antenna and the receiving station. I have indicated in Fig. 1 such a transmission line 4, which is coupled to the antenna at the end 3 by means of the coupling transformer 5. The two conductors of this transmission line are preferably located in the same horizontal plane so as to be symmetrically located with respect to ground. Since any simple transmission line will also act as an antenna the use of an ordinary transmission line in such case will tend to modify the directivity of the receiving system. To overcome this difficulty I have indicated transpositions along the length of the transmission line to neutralize the effect of currents received thereon. When this expedient is employed the receiver which is connected to the transmission line by means of the coupling transformer 6 will be substantially unaffected by currents received on the two conductors of the transmission line in parallel.

The end 2 of the antenna is preferably grounded through a resistance 7 approximately equal to the surge impedance of the
antenna so that no reflection can occur from this end of the antenna, and therefore no transmission line from waves traveling from the end 3 toward the end 2 of the antenna. The end 3 of the antenna may also, if desired, be grounded through a resistance 8.

In Fig. 2 I have shown a modification in which the transmission line is made up of a pair of conductors 9 and 10 which extend parallel to the antenna conductors 11 and 12. In this case mid points of the secondary of transformer 5 and the primary of transformer 6 are grounded through damping resistances 13 and 14 so that any currents which may be received upon the transmission line will flow in opposite directions through the two portions of these transformer windings and hence will produce equal and opposite effects upon transformer 6 and as a result the receiver will be unaffected by such currents. In this case also the transmission line may be loaded by means of inductances 15, or by other suitable apparatus in order to eliminate any inductive effects between the transmission line and the antenna.

While the long horizontal antenna such as that I employ has decided unidirectional properties, mathematical analysis indicates and experience shows that at the end farthest from the transmitting station small currents will under some conditions be produced by waves coming from the opposite direction even though the end nearest the transmitting station is grounded through a resistance approximately equal to the surge impedance of the antenna so that no reflection occurs. In some cases also it may happen that while the antenna is adjusted so that the receiving apparatus is not affected by disturbing waves coming from a direction exactly opposite to that of the signal it is affected by disturbances coming from some other direction, for instance, 160° from the transmitting station, and that it is more important to limit the effect of the disturbing waves coming from this direction than of those coming from a direction 180° from the transmitting station. In order to eliminate the effect upon the receiving apparatus of the undesired waves mentioned, I insert in the ground connection of the antenna at end 2 a phase rotator by means of which currents of the desired phase to neutralize the undesired currents may be selected and impressed upon the receiving apparatus by means of the coupling transformer 16. This coupling transformer may be varied to adjust the intensity of the currents thus impressed upon the receiving apparatus to the desired value.

While in this case I have indicated the receiving station as being located at the end 2 of the antenna where all of the apparatus which requires any adjustment in the operation of the system may be conveniently controlled by the receiving operator, the receiving apparatus may, if desired, be located at any other point and the neutralizing currents conveyed to the receiving apparatus by means of a suitable transmission line.

While I have illustrated and described the preferred embodiment of my invention, it will be apparent that my invention is not limited to the particular embodiments indicated, but that many modifications in the particular means whereby my invention may be carried into effect, may be made without departing from the scope of my invention as set forth in the appended claims.

As an example of one particular construction which may be employed in carrying my invention into effect I have found that satisfactory results can be obtained with an antenna about 14,000 meters long consisting of a pair of wires supported on poles about thirty feet high. By means of a transmission line consisting of a pair of conductors supported on the same poles below the antenna the signaling currents have been successfully transmitted from one end of the antenna to the other. Signals have been successfully received by this arrangement varying from 10,000 to 28,000 meters in wave length.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. A receiving system for radio signals comprising a long horizontal unidirectional receiving antenna, a transmission line for conveying signaling currents from a selected point in said antenna to a distant receiving station, and means for eliminating in the receiving apparatus the effect of currents received upon the transmission line due to the exposure of said line to the effect of ether waves.

2. A receiving system for radio signals comprising a long horizontal unidirectional receiving antenna, a transmission line for conveying signaling currents from a selected point in said antenna where signaling currents from a desired station are strongest, to a distant receiving station, and means for eliminating in the receiving apparatus the effect of currents produced in the antenna at the selected point by waves coming from a different direction from that of the desired signaling waves.

3. A receiving system for radio signals comprising a long horizontal unidirectional receiving antenna, a transmission line for conveying signaling currents from a selected point in said antenna to a distant receiving station, a receiving apparatus, means for impressing upon said receiving apparatus currents transmitted over said transmission line, and means for impressing upon
said receiving apparatus currents of equal magnitude and opposite phase to those produced in the antenna at the selected point by waves coming from a different direction from that of the desired signaling waves.

4. A receiving system for radio signals comprising a long horizontal unidirectional receiving antenna, a transmission line for conveying signaling currents from a selected point in said antenna to a distant receiving station, a receiving apparatus, means for impressing upon said receiving apparatus currents transmitted over said transmission line, and means for selecting from said antenna at a point distant from the selected point, and impressing upon said receiving apparatus currents of equal magnitude and opposite phase to those produced in the antenna at the selected point by waves coming from a different direction from that of the desired signaling waves, and means for eliminating in the receiving apparatus the effect of currents received upon the transmission line due to the exposure of said line to the effect of ether waves.

5. A receiving system for radio signals comprising a long horizontal unidirectional receiving antenna, a transmission line for conveying signaling currents from a selected point in said antenna to a distant receiving station, means for eliminating in the receiving apparatus the effect of currents received upon the transmission line due to the exposure of said line to the effect of the ether waves, and means for eliminating in the receiving apparatus the effect of currents produced in the antenna at the selected point by waves coming from a different direction from that of the desired signaling waves.

6. A receiving system for radio signals comprising a long horizontal unidirectional receiving antenna, a transmission line for conveying signaling currents from a selected point in said antenna to a distant receiving station, a receiving apparatus, means for impressing upon said receiving apparatus currents transmitted over said transmission line, means for impressing upon said receiving apparatus currents of equal magnitude, and opposite phase to those produced in the antenna at the selected point by waves coming from a different direction from that of the desired signaling waves, and means for eliminating in the receiving apparatus the effect of currents received upon the transmission line due to the exposure of said line to the effect of ether waves.

7. A receiving system for radio signals comprising a long horizontal unidirectional receiving antenna, a transmission line for conveying signaling currents from a selected point in said antenna to a distant receiving station, a receiving apparatus, means for impressing upon said receiving apparatus currents transmitted over said transmission line, means for selecting from said antenna at a point distant from the selected point, and impressing upon said receiving apparatus currents of equal magnitude and opposite phase to those produced in the antenna at the selected point by waves coming from a different direction from that of the desired signaling waves, and means for eliminating in the receiving apparatus the effect of currents received upon the transmission line due to the exposure of said line to the effect of ether waves.
means for eliminating in the receiving apparatus the effect of currents produced in the antenna at the selected point by waves coming from a different direction from that of the desired signaling waves.

12. A receiving system for radio signals comprising a long horizontal receiving antenna which is grounded at both ends, a transmission line for conveying signaling currents from a selected point in said antenna to a receiving station located at a distant point along the length of said antenna, receiving apparatus at the receiving station, means for impressing upon the receiving apparatus the signaling currents conveyed over said transmission line and means for selecting from the ground connections at one end of said antenna and impressing upon the receiving apparatus currents of equal magnitude and opposite phase to those produced in the antenna at the selected point by waves coming from a different direction from that of the desired signaling waves.

13. A receiving system for radio signals comprising a horizontal receiving antenna which is grounded at both ends, a receiving set, means for impressing upon said receiving set desired signaling currents produced in said antenna at a selected point, and means for impressing upon the receiving set to neutralize the effect of undesired currents therein currents of equal intensity and opposite phase derived from said antenna at a second selected point.

14. A receiving system for radio signals comprising a horizontal receiving antenna which is grounded at both ends, a receiving set, means for impressing upon said receiving set desired signaling currents produced in one of the ground connections of said antenna, and means for impressing upon the receiving set to neutralize the effect of undesired currents therein currents of equal intensity and opposite phase derived from the second ground connection of said antenna.

15. A receiving system for radio signals comprising a horizontal receiving antenna which is grounded at both ends, a receiving set, a transmission line for transmitting to said receiving set desired signaling currents produced in said antenna at a selected point, and means for impressing upon the receiving set to neutralize the effect of undesired currents therein currents of equal intensity and opposite phase derived from said antenna at a second selected point.

16. A receiving system for radio signals comprising a horizontal receiving antenna which is grounded at both ends, a receiving set, a transmission line for transmitting to said receiving set desired signaling currents produced in one of the ground connections of said antenna, and means for impressing upon the receiving set to neutralize the effect of undesired currents therein currents of equal intensity and opposite phase derived from the second ground connection of said antenna.

17. A receiving system for radio signals comprising a horizontal receiving antenna which is grounded at both ends, a receiving set, means for impressing upon said receiving set desired signaling currents produced in said antenna at a selected point, and means for impressing upon the receiving set to neutralize the effect of undesired currents therein currents of equal intensity and opposite phase derived from said antenna at a second selected point, said receiving set being located adjacent one of said selected points and one of said means including a transmission line connecting the receiving set with the other ground connection.

18. A receiving system for radio signals comprising a horizontal receiving antenna which is grounded at both ends, a receiving set, means for impressing upon said receiving set desired signaling currents produced in one of the ground connections of said antenna, and means for impressing upon the receiving set to neutralize the effect of undesired currents therein currents of equal intensity and opposite phase derived from the second ground connection of said antenna, said receiving set being located adjacent one of said ground connections and one of said means including a transmission line connecting the receiving set with the other ground connection.

19. The method of operating a radio receiving system comprising a horizontal receiving antenna which is grounded at both ends and a receiving set which consists in impressing upon said receiving set currents produced in said antenna at a selected point by desired signaling waves and neutralizing the effect in the receiving set of undesired currents therein by impressing thereon cur-
rents of equal intensity and opposite phase produced in said antenna at a second selected point.  
20 The method of operating a radio receiving system comprising a horizontal receiving antenna which is grounded at both ends and a receiving set which consists in impressing upon said receiving set currents produced by desired signaling waves in one of said ground connections and neutralizing the effect in the receiving set of undesired currents therein by impressing thereon currents of equal intensity and opposite phase produced in the second ground connection.  
In witness whereof, I have hereunto set my hand this 13th day of January, 1921.

HAROLD H. BEVERAGE.