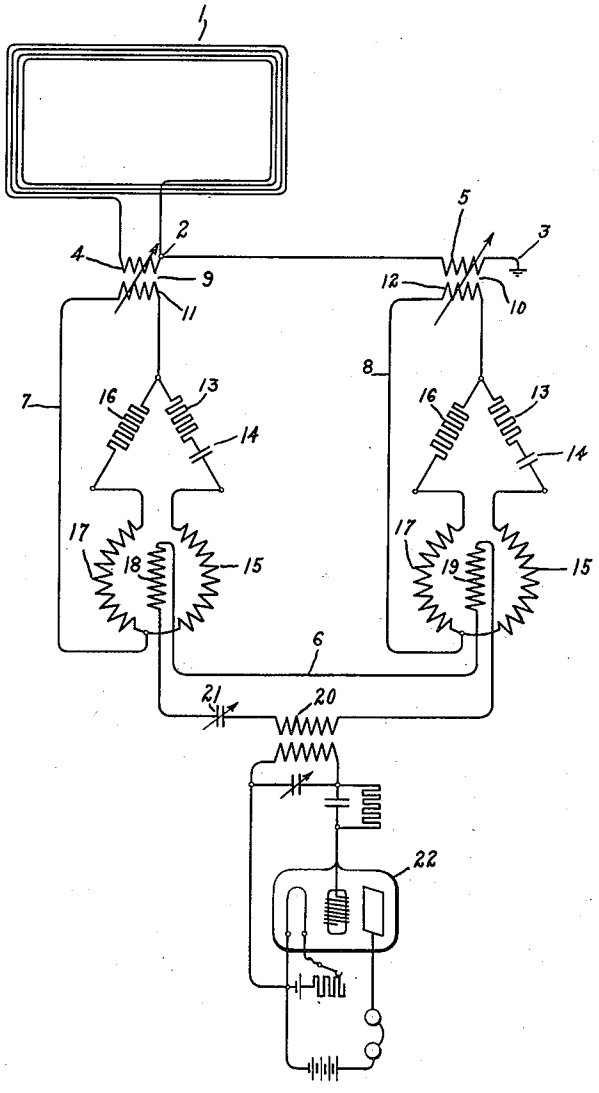
E. F. W. ALEXANDERSON.

RADIO RECEIVING SYSTEM.

APPLICATION FILED APR. 18, 1919.

1,375,992. Patented Apr. 26, 1921.



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UNITED STATES PATENT OFFICE.

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RADIO-RECEIVING SYSTEM.

1,375,992. Specification of Letters Patent. Patented Apr. 26, 1921.

Application filed April 18, 1919. Serial No. 291,114.

To all whom it may concern:

Be it known that I, ERNST F. W. ALEXANDERSON, a citizen of the United States, residing at Schenectady, in the county of Schenectady, 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 systems of the type commonly known as directional receiving systems.

The directive receiving properties of a loop antenna have long been known. Such an antenna however has the disadvantage that it receives signals equally well from either one of two opposite directions. Bellini and Tosi in U. S. Patent No. 948,086 have proposed a way in which this disadvantage may be overcome by providing a second antenna in which the currents produced by incoming signals coming from a desired direction, may be in phase with those produced in the first antenna while currents produced by signals coming from the opposite direction will be opposite in phase in the two antennæ. By applying the currents produced in the two antennæ to a receiving circuit the currents produced by the desired signals will add in the receiving circuit while the currents produced by signals coming from the opposite direction will be neutralized in the receiving circuit.

In the Bellini-Tosi system one antenna is of the magnetic loop form and the other antenna is an electrostatic antenna. I have discovered that similar results may be obtained by the use of a single antenna of the loop form which is so arranged that two separate currents may be derived therefrom, one due to the magnetic exposure and one due to the electrostatic exposure. These two currents will differ in phase and the phase relation of the two currents produced by signals coming from one direction will differ from the phase relations of the two currents produced by signals coming from the opposite direction. The currents produced by means of the two exposures may be applied to the receiving circuit by means of variable intensity couplers and suitable phase shifting means in such a way that the currents produced by the desired signal will add in the receiving circuit while the currents produced by the undesired signals will be neutralized in the receiving circuit.

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 I have indicated diagrammatically one way in which my invention may be carried into effect.

I have indicated in the drawing an antenna 1 of the magnetic loop form, the point 2 of which is grounded at 3. Currents due to the electromagnetic exposure of this antenna will be produced in the coupling coil 4 which is inserted in series with the loop and currents due to the electrostatic exposure will be produced in the coupling coil 5 which is inserted in the ground connection. The currents produced in the coils 4 and 5 are impressed upon the receiving circuit 6 by means of two intermediate circuits 7 and 8, which contain suitable phase modifying devices.

The currents produced in coils 4 and 5 are impressed upon intermediate circuits 7 and 8 by means of variable intensity coupling transformers 9 and 10, the secondaries 11 and 12 of which are included in the intermediate circuits 7 and 8. Each of these circuits preferably comprises two portions having different phase angle characteristics. In the case illustrated each circuit comprises two branches, one branch which includes resistance 13, capacity 14 and inductance 15, and a second parallel branch which includes resistance 16, and inductance 17. The two branches are preferably so designed that the resultant impedance of the first branch is capacitive and the resultant impedance of the second branch is inductive. Coupling coils 18 and 19, which are included in the resonant receiving circuit 6 are so arranged that the coupling between these coils and the inductances 15 and 17 may be varied at will in order to vary the phase of the resultant currents impressed upon the receiving circuit 6. By suitable

variation of the coupling of coils 18 and 19 it is possible to adjust the system so that the two currents produced by desired signals will add in the receiving circuit 6 while currents produced by signals coming from other directions will oppose each other in receiving circuit and will be neutralized therein. The desired neutralizing effect may be obtained both by adjustment of the coupling coils 18 and 19 and by adjustment of the intensity couplers 9 and 10. The receiving circuit 6 includes an inductance 20 and a tuning condenser 21. The currents set up in the receiving circuit are impressed in the manner indicated upon the grid circuit of a detector 22 of the pliotron type. The precise manner in which the balancing effect is brought about is described more fully in my prior application, Serial No. 254,179, filed September 16, 1918.

I find it preferable in carrying out my invention that the receiving antenna should be aperiodic and that the intermediate circuits which contain phase shifting devices should also be aperiodic. By arranging the apparatus in this way so that the phase differences are obtained in untuned circuits the adjustment of the apparatus is rendered much more nearly independent of frequency variations than would be the case if tuned circuits were employed before the current is impressed upon the receiving circuit.

While I have illustrated and described a single modification of my invention, it will be apparent to one skilled in the art that many modifications may be made in the precise arrangement of the circuits employed and in the form of the antenna provided without departing from the scope of my invention as set forth in the appended claims.

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

1. The combination in a radio receiving system of an aperiodic receiving antenna, means for deriving from said antenna two separate currents, one due to the magnetic exposure and one due to the electrostatic exposure, a receiving circuit associated with said antenna, means for impressing the two currents derived from the antenna upon said receiving circuit, and means for varying the phase of either of the currents thus impressed upon the receiving circuit.

2. The combination in a radio receiving system of a receiving antenna of loop form, means for deriving from said antenna two separate currents, one due to the magnetic exposure and one due to the electrostatic exposure, a receiving circuit associated with said antenna, means for impressing the two currents derived from the antenna upon said receiving circuit, and means for varying the phase of either of the currents thus impressed upon the receiving circuit.

3. The combination in a radio receiving system of an aperiodic receiving antenna of loop form, means for deriving from said antenna two separate currents, one due to the magnetic exposure and one due to the electrostatic exposure, a receiving circuit associated therewith, means for impressing the two currents derived from the antenna upon said receiving circuit, and means for varying the phase of either of the currents thus impressed upon the receiving circuit.

4. The combination in a radio receiving system of an aperiodic receiving antenna, means for deriving from said antenna two separate currents, one due to the magnetic exposure and one due to the electrostatic exposure, a receiving circuit associated with said antenna, means for impressing the two currents derived from the antenna upon said receiving circuit, and means for varying the phase of the currents thus impressed upon the receiving circuit, said phase varying means comprising an aperiodic intermediate circuit having two parallel branches having different phase angle characteristics, means for coupling both of said branches to the receiving circuit, and means for varying the coupling of both branches to the receiving circuit.

5. The combination in a radio receiving system of an aperiodic receiving antenna, means for deriving from said antenna two separate currents, one due to the magnetic exposure and one due to the electrostatic exposure, a receiving circuit associated with said antenna, means for impressing the two currents derived from the antenna upon said receiving circuit, comprising two aperiodic intermediate circuits each of said intermediate circuits comprising two portions having different phase angle characteristics, means for coupling both of said portions of each intermediate circuit to the receiving circuit, and means for varying said coupling in order to vary the phase of the currents impressed upon the receiving circuit.

6. The combination in a radio receiving system of an antenna of loop form, a coupling coil included in series with said loop, a ground connection to one point in said loop, a coupling coil in series with said ground connection, means for impressing currents produced in said coupling coils upon a receiving circuit, and means for varying the phase of the currents thus impressed upon the receiving circuit from either coupling coil.

In witness whereof, I have hereunto set my hand this 17th day of April, 1919.

ERNST F. W. ALEXANDERSON.