

June 26, 1951

L. COHEN

2,558,339

INTERFERENCE REDUCING RADIO RECEIVING SYSTEM

Filed Aug. 18, 1947

FIG. 1.

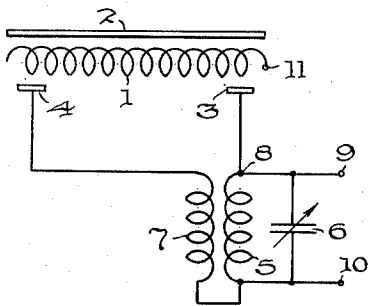


FIG. 4.

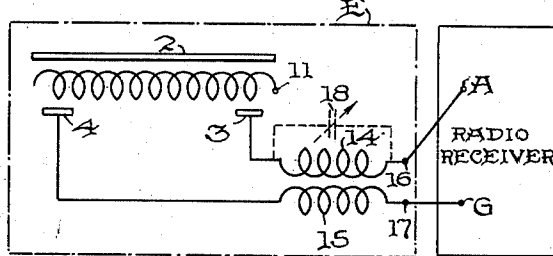


FIG. 2.

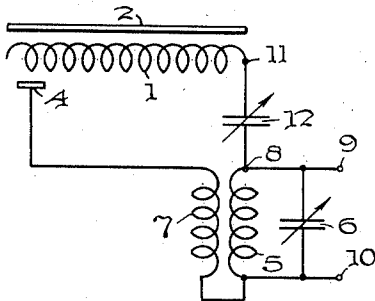


FIG. 5.

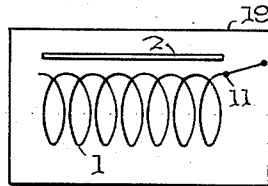


FIG. 6.

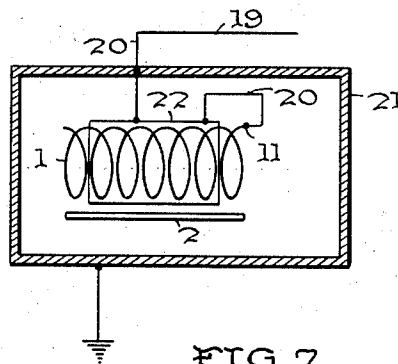
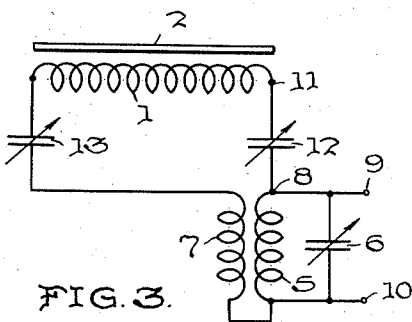
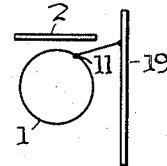


FIG. 7.

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2,558,339

INTERFERENCE REDUCING RADIO
RECEIVING SYSTEM

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Application August 18, 1947, Serial No. 769,216

24 Claims. (Cl. 250—20)

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This invention relates to the art of radio signaling, and more specifically to methods and means for reducing the effect of interfering electrical disturbances on the reception of radio signals.

One object of the invention is to provide a simple device for the elimination or substantial reduction of foreign electrical disturbances in the reception of radio signals.

Another object of the invention is to provide a radio receiving system in which the effects of foreign electrical disturbances are substantially reduced and the necessity of using external antennas is eliminated.

A further object of the invention is to provide a simple device which may be used with any radio receiver to substantially reduce or eliminate the effect of foreign electrical disturbances in the reception of radio signals.

Further objects are in part obvious and in part will appear from the detailed description hereinafter.

Patent 2,415,810 issued to applicant on February 18, 1947, discloses a circuit system employing a wave conductor as one element thereof in which the interfering effects of foreign electrical disturbances on the reception of radio signals are eliminated or sharply reduced. By the term "wave conductor" is meant a conductor having such distributed inductance and capacity that its electrical length is a substantial fraction of the wave length of the desired signal, thereby permitting a substantial wave development thereon. A convenient form of a wave conductor is a solenoidal coil wound with a sufficient number of turns of wire, and with its distributed capacity increased by a metal plate adjustably located in proximity thereto. Such a wave conductor is disclosed in said Patent 2,415,810 and the theory and operation of wave conductors generally are set out in applicant's paper in "Proceedings of the Institute of Radio Engineers," volume 17, No. 10, pp. 1868-1892 (1929).

In the present application such a wave conductor is also used as an element of the circuit system, but in such manner as to obtain improved results and simplified operation in the elimination or substantial reduction of the effects of foreign electrical disturbances.

The current and voltage distribution on a wave conductor as used in the circuits of the present invention is governed by the electrical length of the conductor and the nature and the location of the impedances connected thereto. For different frequencies the current and voltage distribution

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on the conductor is different, and accordingly, the voltage and current at any point where an impedance is connected will vary with the frequency. If impedances are connected to two different points on a wave conductor, and the energy transmitted therethrough is applied differentially to the input circuit of a radio receiver, it is possible to obtain a substantial resultant of signal while substantially balancing out interfering electrical energy, which is either of a different order or frequency than the desired signal or behaves as if it were. This, in broad outline, appears to be the basic theory of the invention. Irrespective of the correctness of this or any other theory, it has been found that the circuit systems hereinafter described will eliminate or substantially reduce the effect of foreign electrical disturbances in the reception of radio signals.

In the accompanying drawings:

Figure 1 is a typical embodiment of the invention.

Figure 2 is a modification wherein one end of the wave conductor is coupled through a variable condenser to the input of the first tube of a radio receiver.

Figure 3 is another modification in which both ends of the wave conductor are coupled through variable condensers.

Figure 4 is a modification of the invention adopted for use with any radio receiver.

Figure 5 is a schematic front view of a special antenna arrangement for use with the invention.

Figure 6 is a schematic end view of the wave conductor and associated antenna shown in Figure 5.

Figure 7 is a sectional schematic view of an electrostatically coupled antenna lead-in.

In all the figures, the same numbers designate similar elements.

In Figure 1, the wave conductor 1 serves as the energy collector of both desired signals and interferences. The metal plate 2, which is in close proximity to the wave conductor 1, is adjustable in its spacing from it to secure the required electrical length of the wave conductor. Metal plate 2 in the simplest form is a flat metal plate, but it may be curved to conform more closely to the surface of the wave conductor, or even be in the form of a cylinder surrounding part of the wave conductor. In this latter case, tuning is obtained by varying the amount of wave conductor inserted within the metal cylinder. Two metal strips 3 and 4 couple electrostatically two elements of the wave conductor to the input circuit 5 and 6. Metal strip 3 is connected directly to

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the common point 8, the junction point of inductance 5 and condenser 6. Metal strip 4 is connected to inductance 7 which is in inductive relation to inductance 5. The metal strips 3 and 4 are movable along the wave conductor and adjustable with regard to distance separation from the wave conductor. By suitably adjusting the metal strips with regard to their positions on the wave conductor and distance separation from it and also adjusting the mutual inductance between 5 and 7 in the matter of direction and magnitude, a condition is obtained whereby interferences are balanced out in circuit 5, 6 without appreciably impairing the efficiency of the response to the desired signals. This is apparently a consequence of the difference in the apparent frequency of the interferences and the desired signals. The points 9 and 10 connect to grid and filament, respectively, of an amplifier or detector tube in the well known manner.

In practice it will be found that generally it is not necessary to vary the magnitude of the mutual inductance 5, 7, although it is essential that the direction should be properly chosen. Likewise it will be found that by suitably adjusting strip 4 and plate 2, it is possible to produce a balance over a large range of frequencies by varying only 3 with respect to its position along and distance from the wave conductor. Similar results may be obtained by fixing the position of strip 3 and making necessary adjustment by varying the position of strip 4.

Figure 2 is a modification of Figure 1 in which the adjustable capacity between metal strip 3 and wave conductor 1 is replaced by a variable condenser 12. One terminal condenser 12 is connected to one end of the wave conductor at 11 and the other terminal of condenser 12 is connected to the input circuit at 8. This circuit arrangement is more convenient for operation in balancing out interferences. In most cases the metal strip 4 can be left stationary at some selected point of the wave coil, the plate 2 placed at a suitable position, and the required balancing adjustment obtained by varying condenser 12.

Another modification is shown in Figure 3 in which both metal strips 3 and 4 of Figure 1 are replaced by variable condensers 12 and 13. In this arrangement the entire wave conductor is included in the circuit system, the two ends thereof being coupled through condensers 12 and 13 to the input circuit. If desired a small fixed condenser may be substituted for one of the variable condensers 12 and 13, preferably for condenser 13.

In each of Figures 1, 2, and 3 the circuit 5, 6 is adjusted by the tuning condenser 6 for resonance to the signals desired to receive. If high efficiency for signal reception is not essential, the variable condenser 6 may be omitted and the resultant voltage developed across inductance 5 applied to the grid filament of an amplifier or detector tube.

Applicant finds the circuit arrangement of Figure 2 the most convenient form for making the necessary adjustments to balance out interfering disturbances, especially if a small fixed condenser is substituted for strip 4.

The embodiments of the invention shown in Figures 1, 2 and 3 present some difficulties in their application to existing radio receivers because of the necessity of opening the receiver to make connections to the tuned input circuit at 8 and also, in some cases, the further necessity of reversing the connections of either the primary or the secondary of the input transformer. Figure 4

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is an embodiment of my invention intended for use with existing radio receivers without the necessity of making any modification therein. According to this modification the interference eliminating device may be constructed as a separate unit for use with any type of radio receiver. Referring now to Figure 4, E represents the interference eliminator, the terminals 16 and 17 of which connect to aerial and ground terminals, respectively, of any receiver. One end of the transformer coil 14 is connected electrostatically to a point on the wave conductor, while one end of the transformer coil 15 is electrostatically connected to a different point on the wave conductor. Although the electrostatic couplings are shown as made through the medium of metal strips 3 and 4, as in Figure 1, it is obvious, as indicated above, that one of the couplings may be replaced by a small fixed condenser or one or both may be replaced by variable condensers. The other end of the transformer coil 14 is connected to terminal 16, which is in turn intended for connection to the antenna terminal A of a radio receiver, while the other end of transformer coil 15 is attached to terminal 17 which is in turn intended for connection to ground or the ground terminal G of a radio receiver. The ground terminal G of the receiver which is generally connected to the receiver chassis may, in addition, be connected directly to a ground. In some cases it may be advantageous to shunt the transformer coil 14 with a capacity 18 which may be either fixed or variable. By the suitable selection or adjustment of capacity 18, an improvement in efficiency may in some cases be obtained.

Some increase in the efficiency of signal reception by the circuits of Figures 1 through 4 may be obtained by connecting an antenna at one end of the wave conductor 1, preferably at the end designated 11, by connecting an antenna to plate 2, or by using two antennas, one connected to plate 2 and the other to one end of the wave conductor, preferably the end 11. The antennas may be the usual open end wire antennas, loop antennas, or in the form of metal plates. Where two antennas are used it is not at all essential that both be of the same type. An especially efficient arrangement using one antenna is obtained when such antenna is connected to end 11 of wave conductor 1 and positioned so as to be electrostatically coupled to the wave conductor. For this purpose a metal plate antenna with its surface parallel to the axis of the wave conductor and spaced from the surface thereof is especially useful. Such an arrangement is shown in Figures 5 and 6 where metal plate antenna 19 is connected to wave conductor 1 at end 11 and is in such position as to be electrostatically coupled to the wave conductor. As indicated in Figure 6, it is preferable that antenna 19 be at right angles to the plate 2 used in adjusting the distributed capacity of wave conductor 1.

Alternatively, instead of having the antenna itself electrostatically coupled to the wave conductor, good results may be obtained by electrostatically coupling the antenna lead-in to the wave conductor. This is especially useful where the wave conductor and associated plate 2 are shielded as discussed below, and it is desired to use only one antenna. In Figure 7, the wave conductor 1 and plate 2 are contained within a grounded metal box 21. The antenna 19 is connected to end 11 of the wave conductor through lead-in 20 which is electrostatically coupled to wave conductor 1 through metal plate 22 closely

associated therewith. The remaining circuit connections are as in Figures 1, 2, 3 or 4.

To minimize loss of energy from the plate 22 by electrostatic coupling to shielding 21, the metal plate 22 may be placed inside the solenoidal wave conductor 1. In place of a separate plate 22, the tuning plate 2 may be used to couple the lead-in 20 to the wave conductor by connecting both branches of lead-in 20 to plate 2. This, however, complicates adjustment because every change in tuning also varies the degree of lead-in coupling.

The embodiments of the invention shown in Figures 1 through 4 operate quite efficiently without the necessity of shielding the wave conductor and associated plate 2. In certain cases, however, where there are especially strong local or static disturbances, improved results may be obtained by shielding the wave conductor and associated plate 2, for example by enclosing the same in a grounded metal box. In extreme cases it may be desirable to similarly shield the radio receiver. Where such shielding is used it is obviously necessary to use an auxiliary energy collector as described above. The most efficient operation in cases where the wave conductor and associated plate are shielded is obtained by using two antennas, one connected to plate 2 and the other to end 11 of wave conductor 1, but as described above one antenna with its lead-in electrostatically coupled to the wave conductor will give good results.

While the invention has been described as embodied in a specific form and as operating in a specific manner for the purpose of illustration, it should be understood that the invention is not limited thereto, since various modifications will suggest themselves to those skilled in the art without departing from the spirit of the invention the scope of which is set forth in the annexed claims.

I claim:

1. In a radio receiving system containing a radio receiver having an input circuit, means for substantially reducing the effect of interfering energy associated with desired high frequency signal energy, said means comprising a wave conductor at the input of said receiving system, two capacitative couplings to said wave conductor at different points thereon, and means to differentially combine the energies transferred through said couplings in their effect on the input circuit of the radio receiver so as to substantially reduced the ratio of interfering energy to desired signal energy in the energies transmitted to the receiver from said input circuit.

2. A radio receiving system as in claim 1, wherein an antenna is connected to one end of the wave conductor.

3. A radio receiving system as in claim 1 wherein the wave conductor is tunable by means of a metal plate adjustably positionable with respect thereto.

4. A radio receiving system as in claim 3 wherein an antenna is connected to one end of the wave conductor.

5. A radio receiving system as in claim 4 wherein said antenna is positioned in such proximity to the wave conductor as to provide a substantial electrostatic coupling thereto.

6. A radio receiving system as in claim 5 wherein the antenna is a metal plate.

7. A radio receiving system as in claim 1, wherein the conductor is tunable by means of a metal plate adjustably positionable with respect

thereto, and an antenna is connected to said metal plate.

8. A radio receiving system as in claim 7, wherein a second antenna is connected to one end of the wave conductor.

9. In a radio receiving system, a radio receiver having a tuned input circuit, containing inductance and capacity elements at the input thereof, a wave conductor, means for capacitatively coupling a point on the wave conductor and the tuned circuit, an inductance inductively coupled to the tuned circuit, and means for capacitatively coupling a second point on the wave conductor to said inductance.

10. A radio receiving system as in claim 9, wherein the wave conductor is tunable by means of a metal plate adjustably positionable with respect thereto.

11. A radio receiving system as in claim 10, wherein the capacitative coupling between the wave conductor and the tuned circuit is a variable condenser connected to one end of the wave conductor.

12. A radio receiving system as in claim 11, wherein an antenna is connected to that end of the wave conductor which is coupled to the tuned circuit.

13. A radio receiving system as in claim 12, wherein a second antenna is connected to the metal plate used to tune the wave conductor.

14. A radio receiving system as in claim 13, wherein at least one of the antennas is in the form of a metal plate.

15. A radio receiving system as in claim 9, wherein the wave conductor is tunable, the capacitative coupling between the wave conductor and the tuned circuit is a variable condenser connected to one end of the wave conductor, and a metal strip adjustably positionable in proximity to the wave conductor and connected to the inductance inductively coupled to the tuned circuit capacitatively couples said inductance to the wave conductor.

16. A device for substantially reducing the effect of interfering energy associated with desired signal energy comprising a wave conductor and a transformer having a primary and secondary inductively coupled to each other, means for capacitatively coupling a point on the wave conductor to one end of said primary, the other end of said primary being adapted to be connected to the aerial terminal of a radio receiver, and means for capacitatively coupling a different point on the wave conductor to one end of said secondary, the other end of said secondary being adapted for connection to ground or the ground terminal of the radio receiver.

17. A device as in claim 16, wherein the transformer secondary is shunted by a condenser.

18. A device as in claim 16, wherein an antenna is connected to the end of the wave conductor adjacent the point at which the primary of the transformer is coupled.

19. A device as in claim 16, wherein the wave conductor is tunable by means of a metal plate adjustably positionable in proximity thereto.

20. A device for reducing the effect of interfering signal energy comprising a wave conductor, a terminal adapted to be connected to the aerial terminal of a radio receiver, two capacitative couplings to said wave conductor at different points thereon, and means to differentially combine the energies transferred through said couplings and impress upon said terminal a resultant in which the ratio of desired signal

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energy to interfering energy is substantially increased.

21. A device as in claim 20 in which the wave conductor is tunable by a metal plate adjustably positionable in proximity thereto.

22. A device as in claim 21 in which the metal plate is movable so as to vary both the total amount of coupling between plate and conductor and the relative amount of coupling between different points on the plate and the wave conductor.

23. A device as in claim 22 including means for connecting an antenna to one end of the wave conductor and a second antenna to the metal plate.

24. A radio receiving system as in claim 1 wherein the wave conductor is tunable by means of a metal plate adjustably positionable with respect thereto and an antenna is connected to one end of the wave conductor through a lead-in of such size and shape and such proximity to

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the wave conductor as to produce a substantial electrostatic coupling thereto.

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