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W. L. CARLSON ET AL
ALL-WAVE ANTENNA SYSTEM

2,189,309

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2 Sheets-Sheet 1

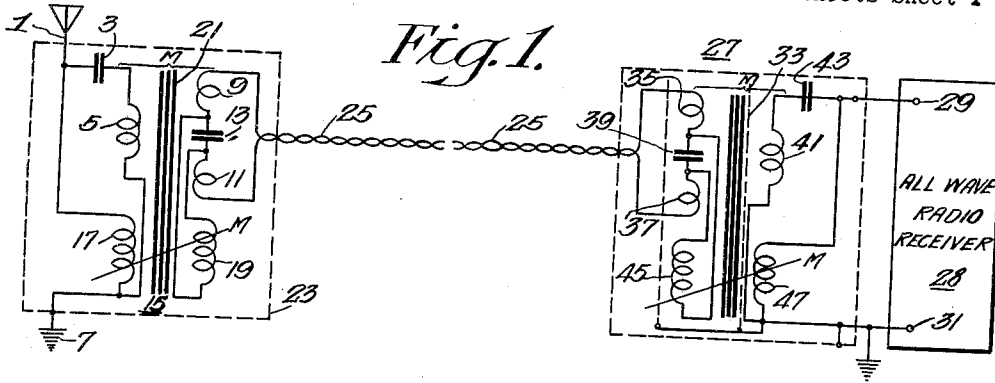


Fig. 2.

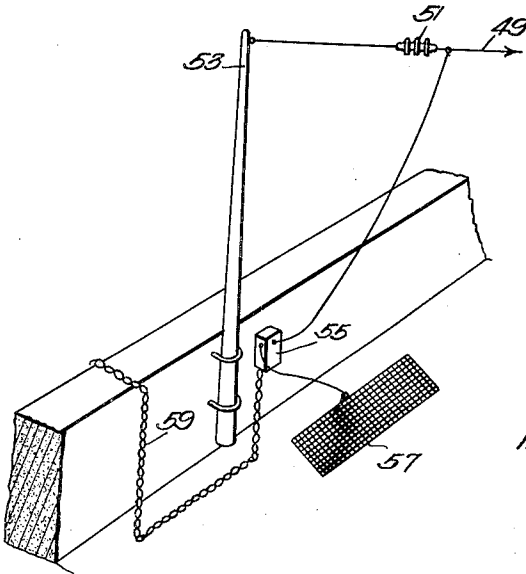
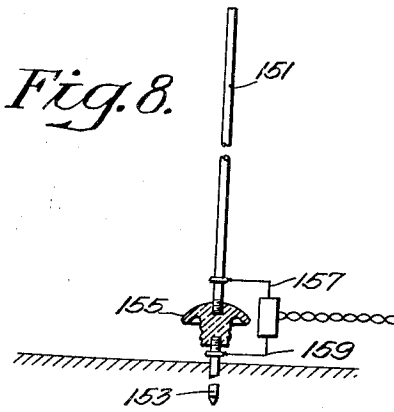
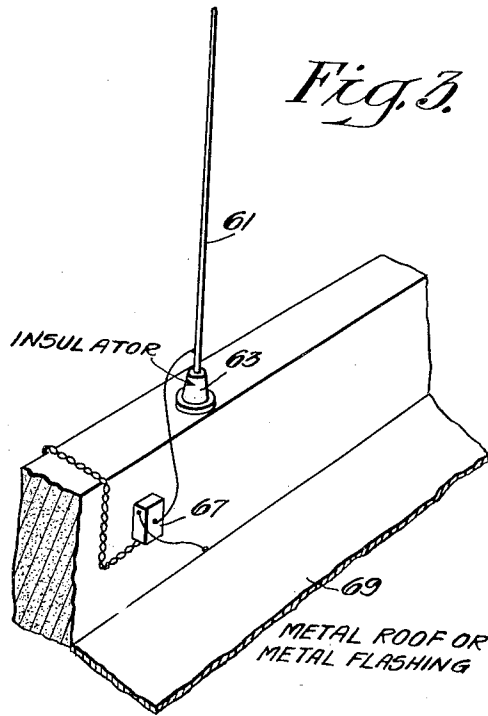


Fig. 3.



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Fig. 4.

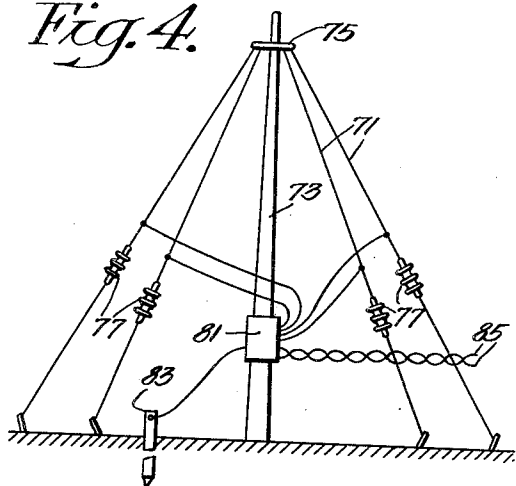


Fig. 7.

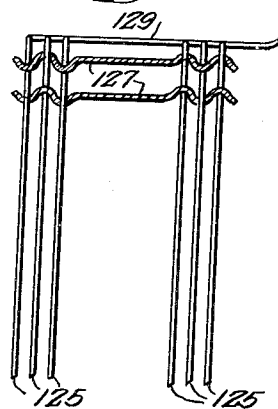


Fig. 5.

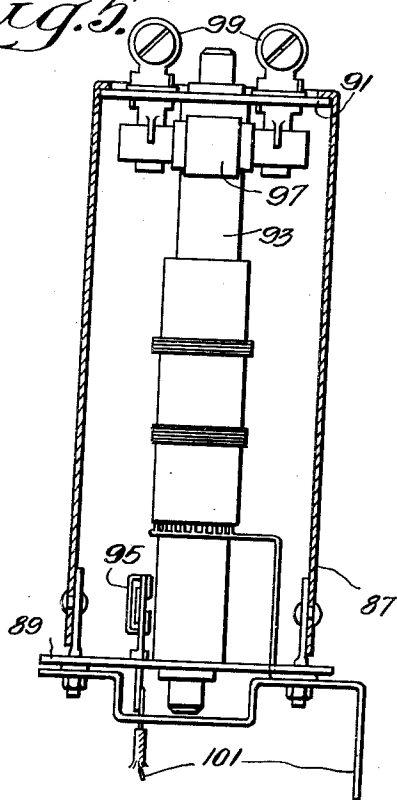
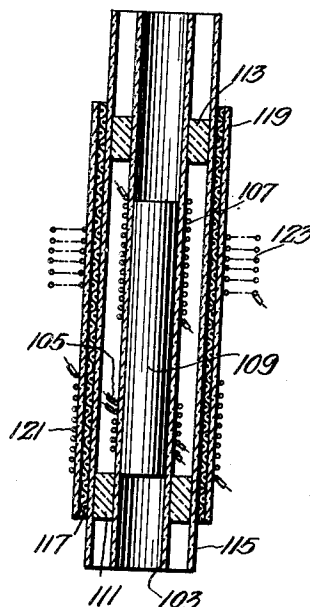


Fig. 6.



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ALL-WAVE ANTENNA SYSTEM

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6 Claims. (Cl. 250—33)

Our invention relates to antenna systems. Specifically, our invention relates to an all-wave antenna system and the means for coupling said system to a radio receiver.

In all-wave receiving systems, it has been considered desirable to use one or more dipole antennas, which are coupled through suitable transformers and a transmission line to the radio receiver. The dipole antenna or antennas, as often more than one are required, are responsive to the waves of a few meters length. The dipoles act as an ordinary capacity antenna for waves of the present broadcasting band. Such systems generally require considerable space and two or more supports, which are often not available in the urban areas where the foregoing systems are most useful in the reduction of man-made interference.

Our present antenna system may be used in connection with almost any type of antenna conductor. For example, a vertical wire, such as a metal fishing rod or water pipe, a vertically arranged wire, an L antenna, a T antenna, a V antenna or an umbrella antenna may be used. Not only is our present system especially adapted to existing forms of antenna conductors, but we have found that the signal to noise ratio shows an improvement over many dipole installations. Our invention may be installed in a space which is smaller than for all-wave dipole installations.

We have been able to balance out a large amount of interfering electrical impulses by carefully arranging a symmetrical or balanced circuit. While some of the symmetry is obtained by a conventional transmission line, the larger portion is effected by a novel construction of the coupling means which connect the antenna to the line and the line to the receiver. We have found that capacity coupling between the primary and secondary circuits of the coupling means and between these circuits and ground should be minimized and the mutual inductive coupling made as large as possible. These two requirements lead in opposite directions: if the capacity is minimized, the inductive coupling is reduced; while an increase in inductive coupling ordinarily tends to increase the capacity effects. The capacity coupling is substantially eliminated by an electrostatic shield. The capacity to ground is reduced by suitable spacing and arrangement of the windings of the coupling transformers. This in turn reduces the mutual inductive coupling which is restored to the required value by a magnetite core. Other means for

balancing and the like are provided which will be hereinafter described.

One of the objects of our invention is to provide means for coupling an all-wave antenna to an all-wave receiver.

Another object is to provide means for coupling an all-wave antenna to a transmission line.

Another object is to provide means for coupling an all-wave receiver to a transmission line.

A further object is to provide a coupling means which is characterized by low capacity couplings, tight magnetic couplings, and balanced circuits.

A still further object is to provide means for improving the signal to noise ratio in a receiver by balancing out undesired electrical impulses.

Other objects will appear in the following specification, which may be best understood by referring to the accompanying drawings in which:

Figure 1 is a schematic circuit diagram of one embodiment of our invention,

Figures 2, 3 and 4 are illustrations of our invention applied to several different forms of antenna conductors,

Figure 5 is an elevational view of the balanced coupling means,

Figure 6 is a sectional view of the windings of the coupling transformer,

Figure 7 is an elevational view of a suitable electrostatic screen, and

Figure 8 illustrates a modification of our invention.

In Fig. 1, an antenna 1 is coupled through a capacitor 3 to a primary winding 5, which is suitably grounded as indicated by reference numeral 7. The primary 5 is symmetrically coupled to a balanced secondary, which is composed of bifilar windings 9 and 11, which are coupled together by a capacitor 13. The antenna 1 is also connected to a second transformer 15, which consists of a primary winding 17 and a secondary winding 19. The terminals of the secondary winding are connected to the capacitor 13. The transformers preferably include a magnetite core 21. The transformer is housed in a container of any suitable material, such as aluminum, copper, or the like, 23. The container may be filled with a weatherproofing material, such as wax, etc.

The terminals of the windings 9 and 11, which are not connected to the capacitor 13, are joined to one pair of terminals of a transmission line 25. This line may be a twisted pair of conductors, which are suitably insulated from each other and from ground. The other or remote pair of terminals of the transmission line 25 are connected

to a second coupling means 27, which couples the transmission line to a radio receiver 28 of the all-wave type. The input terminals of the radio receiver 28 are represented by the binding posts 29, 31. The coupling means 27 is similar to the antenna coupling means previously described. An exception is that an electrostatic shield 33 is positioned between the primary windings 35, 37, 45 and secondary windings 41, 47 of the transformers.

The present coupling means 27 includes bifilar primary windings 35, 37, which are joined by a capacitor 39. A secondary winding 41 is symmetrically coupled to the bifilar windings. One terminal of the secondary winding 41 is grounded. The other terminal is connected through a capacitor 43 to the antenna binding post 29. A second transformer consists of a primary 45, which is connected across the capacitor 39, and a secondary 47. One of the terminals of the secondary 47 is connected to ground and to the binding post 31. The other terminal of the secondary is connected to the antenna binding post 29. The transformers include a magnetite core 43. A metal container is provided around the transformers and is grounded to the receiver chassis.

The operation of the circuits thus described is briefly as follows:

High frequency signaling currents pass from the antenna through the capacitor 3 and the transformer primary 5 to ground. These currents induce circulating currents in the secondary windings 9, 11 and transmission line 23. These circulating currents flowing through the primary windings 35, 37 induce currents in the secondary winding 41, which flow through the coupling capacitor 43 to the antenna binding post 29 and to the grounded binding post 31. When signaling currents of the broadcast frequency range are impressed upon the antenna 1, these currents flow through the primary winding 17 to ground and induce currents in the secondary winding 19. The induced currents are circulated through the transmission line 25 and the primary 45. The currents flowing through the primary 45 induce currents which flow through the secondary 47 to ground and to the antenna binding post 29.

The reactances of the capacitors 3, 13, 39 and 43 are low for high frequency currents, as compared with their reactance for currents of the broadcast frequency range. It will be seen from inspection that the circuits are symmetrically arranged and, therefore, balanced.

It will also be observed that the antenna 1 is preferably of a type which may be insulated from ground. The ground connection 7 should be made close to the antenna termination and may consist of a suitable conductor imbedded in the earth near the antenna or a counterpoise. In either event, we have found that a good ground adjacent to the antenna is highly desirable in the reduction of the effect of disturbing electrical impulses.

We have also found it desirable to arrange the coupling means adjacent the base of the antenna so that the leads to the transformer and to ground are made as short as possible. The second coupling means 27 is preferably arranged as near the receiver as possible to thereby shorten the lengths of the connecting leads. The receiver and the coupling means 27 are preferably connected to a ground which is independent of the ground 7 at the antenna.

As previously pointed out, one of the advantages of the antenna system of our invention is

its adaptability to numerous types of antennas. In Fig. 2, an L antenna 49 is supported by an insulator 51, which is fastened to a mast 53. The antenna coupling means is housed in a water-proof container 55. The ground is represented by a counterpoise 57, which may be a conductive screen, a metal roof, or a metal flashing on the roof. If the mast is supported on the earth, the ground may be a buried screen, counterpoise or the like. The transmission line is represented as a twisted pair of conductors 59, which are suitably insulated from each other and from ground.

In Fig. 3, the antenna conductor is represented as a metal rod 61, which is suitably insulated from ground by a base insulator 63. We have found that the antenna conductor may be made from six feet high to thirty or more feet depending upon location and freedom from shielding objects. The antenna lead 65 is connected from the base of the conductor 61 to the antenna coupling means 67. The ground connection is represented as a metal roof or metal flashing 69.

In Fig. 4, an umbrella type antenna is represented by conductors 71, which are insulated at the top of the mast 73 by an insulating support 75. The wires 71 are insulated from earth by insulators 77. Several wires of the antenna are connected by lead-ins 79 to the coupling means 81, which is grounded by a ground pipe 83. The coupling between the antenna and the receiving transformer, which is not shown, is represented by a transmission line 85.

By way of example, the antenna may be from 20 to 40 feet high and, if an L antenna is used, from 30 to 60 feet long. Antennas of the foregoing dimensions have shown efficient response over the present standard broadcast band of 550 to 1600 kilocycles, with a corresponding efficiency in the short-wave broadcast band covering from approximately 5 megacycles to 20 megacycles. The ground system adjacent the antenna may be a few square feet of screening buried six inches under the surface of the earth, or a ground pipe of the order of one inch diameter, which is driven into the earth about four feet.

The transmission line to set coupling means is represented in Figs. 5 and 6. A metal shield 87 is arranged with insulating supports 89, 91 at its ends. These supports engage the ends of a winding form 93. The winding form will be more fully illustrated by Fig. 6, which is hereinafter described. The coupling capacitors 95, 97 are supported on the insulators 89 and 91 respectively. This minimizes the coupling effect between the capacitors. The capacitors are preferably of small physical dimensions. The capacitors are symmetrically positioned with respect to the shield 87 and spaced therefrom. It will be observed that the input terminals 99 are arranged at one end of the transformer, while the output leads 101 are arranged at the opposite end to minimize over all capacity coupling.

The transformer windings are shown in Fig. 6. In this figure an insulated tube 103 supports the primary windings 105. These windings are preferably of the bifilar type to insure a symmetrical arrangement of the windings with respect to their secondary. The primary winding 107 for the broadcast frequency range is also supported on the tube 103. A magnetite core 109 is positioned within the tube 103 as shown. Insulating shoulders 111, 113 are included on the tube 103 to support a second insulating tube 115. An electrostatic shield 27, such as shown in Fig. 7, is wrapped around the tube 115. A third in-

insulating tube 119 is positioned on the outside of the shield 117. The secondary windings 121 and 123 are supported by the last-mentioned tube 119. These windings are arranged in juxtaposition with respect to the primary windings 105 and 107, respectively. The winding 123 is preferably of the multi-layer type.

Figure 7 represents a suitable embodiment of an electrostatic shield. This shield is composed of a series of parallel conductors 125, which are insulated from one another and supported by cotton threads 127, which are woven through the conductors 125. This construction forms a cloth which includes a plurality of parallel conductors. These conductors 125 are connected together at one end by a conductor 129, which is grounded. This electrostatic shield, as is well known, eliminates or minimizes capacity coupling without preventing mutual magnetic coupling. The primary windings 105, 107 are spaced from the shield 117 to thereby minimize the capacity from these windings to the shield and to ground.

In Fig. 8 the ground rod 151 is also used as a support for an antenna conductor 153. The antenna conductor may be metal pipe, seamless metal tubing, a metal rod or the like. The ground rod is threaded or suitably flanged to receive an insulator 155. The antenna conductor is mounted on this insulator by a threaded portion, bayonet fitting or any socket connection. The transformer input leads 157, 159 are connected to the antenna conductor 153 and ground rod 151 as shown.

In the design of the broadcast portions of the coupling transformers we prefer not to match the surge impedance of the transmission line. The line is preferably treated as a capacity. This capacity is used to resonate the windings to which it is connected. The several windings and capacities are so arranged that the antenna circuit, the line circuit and the receiving set input circuit are each resonant to substantially the middle frequency of the broadcast frequency range. The tight coupling between the circuits broadens the response of the network. The resulting characteristic is a three-peak response curve which substantially covers the broadcast frequency range. We have found that the resonant conditions of the line varies with changes in line length. The effects of changes in line length are relatively small and may be neglected within the ordinary limits of a home antenna installation.

We have found that the selectivity characteristics of the receiver are apparently varied for frequencies removed from the resonant frequency of the receiver. For example, the antenna system may resonate at frequencies differing from the frequency of reception and thus reduce the apparent selectivity of the receiver. These effects are substantially reduced by including a small amount of resistance in the antenna, transmission line, or receiver input circuit. One convenient arrangement for including this resistance is to wind the primary or secondary of the broadcast section of one or both of the transformers with resistance wire.

We have found that many disturbing noises are transferred to the receiver through the associated lighting lines to which the receiver is connected. The disturbing noises, coming in on the power supply, put a radio frequency noise voltage on the chassis of the receiver. It is generally difficult to reduce this voltage by grounding the chassis because the ground lead cannot

be made short enough to have a low impedance. We prefer to reduce these disturbing noises by carefully balancing the transmission line, and the transformer windings and by substantially reducing the capacity coupling between the windings. In addition to these precautions, we have found it desirable to ground the secondary transformer windings to the radio receiver chassis by short leads. When thus arranged, the disturbing noises are substantially reduced from the secondary circuits of the coupling means connecting the transmission line to the radio receiver. We prefer to ground the electrostatic shield to a short lead connected to the radio receiver chassis, as shown in the drawings.

Thus, we have described an antenna system which is suitable for all-wave reception. It is characterized by a high ratio of signal to noise and an efficient transfer of currents over a wide range of frequencies. The coupling means at the antenna and the ground are arranged on a form which minimizes the capacity coupling between transformer windings and the capacity between the secondary windings and ground. The mutual inductive coupling is made large by the inclusion of a magnetite core. A symmetrical arrangement of the winding is maintained so that the transmission line is balanced with respect to ground.

We claim as our invention:

1. An antenna system comprising a single antenna conductor; means insulating said conductor from ground; a transmission line; means located adjacent said antenna and ground for coupling said antenna to a transmission line, said last mentioned means including a transformer primary winding, a series capacitor and second transformer primary winding, a low impedance ground connection for said primary windings, connections from said first named primary and said capacitor to said antenna conductor, a core of magnetic material within and coaxial to said primary windings, secondary windings respectively mutually coupled to and substantially spaced from said primary windings, and connections from said secondary windings to said transmission line, and means for coupling the remote terminals of said transmission line to a radio receiver, said coupling means including a transformer primary winding, a second transformer primary winding, a core of magnetic material within and coaxial to said primary windings, secondary windings respectively coupled to and substantially spaced from said primary windings, an electrostatic shield between said primary and secondary windings and closely associated with said secondary windings, a capacitor connected to one of said secondary windings and to the input terminals of said radio receiver, connections from the other of said secondary windings to said input terminals and means for grounding said radio receiver, said electrostatic shield, and said secondary windings.

2. A coupling device including a pair of secondary windings, low impedance means for grounding said windings, a capacitor serially connected to one of said windings, a coaxial primary winding within and symmetrically coupled to one of said secondary windings, but substantially spaced therefrom, a pair of balanced coaxial primary windings serially connected by a capacitor within and mutually coupled to said secondary winding including the first named capacitor, connections from said first named primary winding to said second named capacitor, 75

connections from said balanced primary windings to input terminals, means for increasing the mutual magnetic coupling between said primary and secondary windings, said means comprising a magnetic core within and closely coupled to said primary winding and means for reducing the capacity coupling between said primary and secondary windings, said means comprising a cylindrical electrostatic shield between said primary and secondary windings, substantially spaced from said primary windings.

3. A coupling device including an outer insulating tube supporting a pair of coaxial secondary windings, a capacitor serially connected between one of said windings and an output terminal, an inner insulating tube, a pair of annular spacers supporting said inner tube within and substantially spaced from said outer tube, a primary winding supported by said inner tube symmetrically coupled to one of said secondary windings, a pair of balanced primary windings supported by said inner tube, serially connected by a capacitor, and mutually coupled to said secondary winding including the first named capacitor, a core of magnetic material within said inner tube, connections from said first named primary winding to said second named capacitor, and connections from said balanced primary windings to input terminals.

4. A device of the character described in claim 3 which is further characterized by a grounded electrostatic shield within and in close proximity to said outer insulating tube.

5. A noise reducing antenna system which includes an antenna for receiving radio frequency signals, said antenna being characterized by a common signal path at all frequencies, an antenna coupling transformer located near and

connected to an effective ground potential, an output transformer, a transmission line connecting said output transformer and said antenna transformer, said output transformer comprising a plurality of primary windings closely associated with a core of magnetic material, a plurality of secondary windings, a grounded electrostatic shield substantially spaced from said primary windings placed between said primary and secondary windings whereby the capacity from said primary windings to said shield is minimized, said secondary windings being closely associated with said electrostatic shield, and grounded.

6. A coupling transformer including an outer insulating tube supporting a pair of coaxial secondary windings adapted to resonate at different frequencies, a pair of output terminals, connections from one end of said secondary windings to one of said terminals, connections from the other end of said secondary windings to said other output terminal, an inner insulating tube, a pair of annular spacers supporting said inner tube within and substantially spaced from said outer tube, a primary winding supported by said inner tube, symmetrically coupled to one of said secondary windings but substantially spaced therefrom, a pair of balanced primary windings supported by said inner tube, serially connected by a capacitor, and mutually coupled to the other of said secondary windings, connections from said first named primary winding to said capacitor, and connections from said balanced primary windings to a pair of input terminals.

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