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2,469,209

SINGLE ENDED ANTENNA SYSTEM

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Fig. 1.

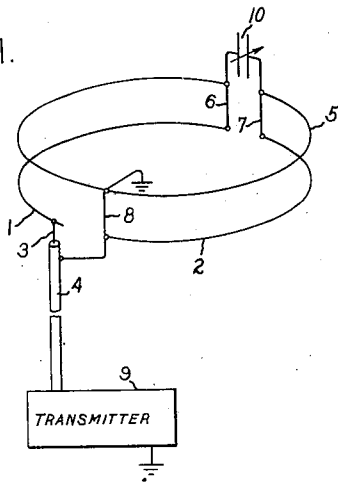


Fig. 3.

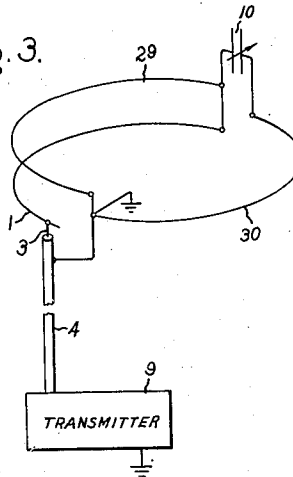


Fig. 2.

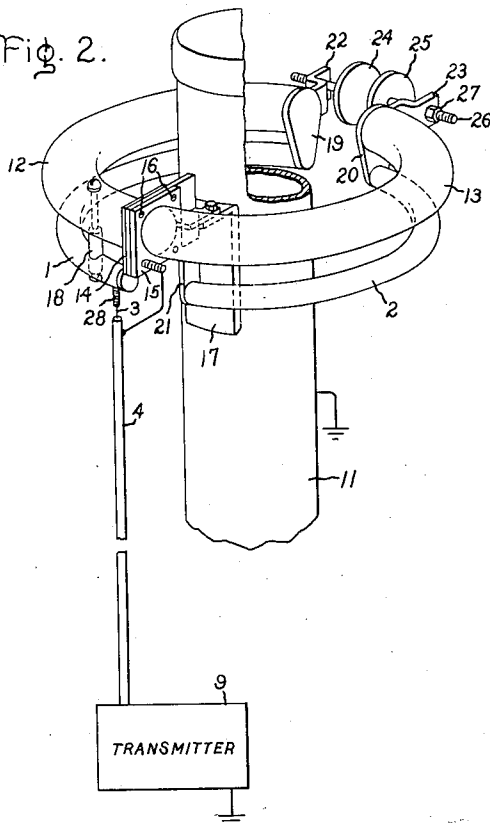
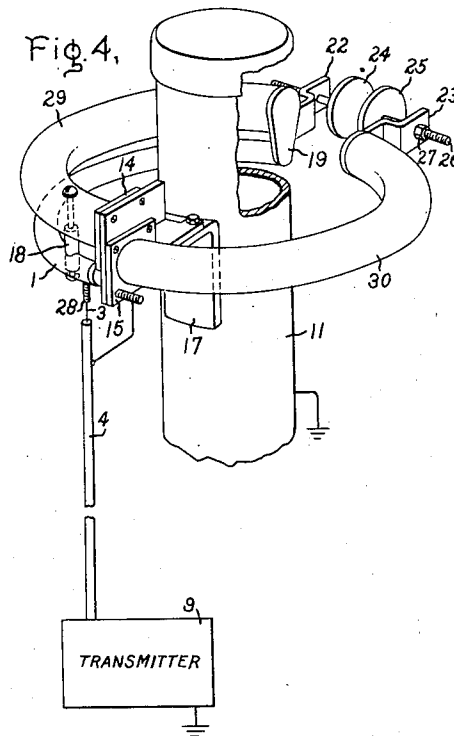


Fig. 4.



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SINGLE-ENDED ANTENNA SYSTEM

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4 Claims. (Cl. 250—33)

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My invention relates to antennae for radio apparatus and, in particular, for apparatus utilizing a wide range of ultra high frequency oscillations, such as employed in frequency modulation broadcasting. While my invention is useful in receiving antennae, as well as in transmitting antennae, I have described it more particularly with reference to transmitting or radiating antennae. It is a primary object of my invention to provide a new and improved single ended antenna structure.

In United States Letters Patent No. 2,324,462, granted July 13, 1943, and assigned to the same assignee as the present application, a radiation antenna is disclosed comprising two symmetrically oriented loops positioned in parallel horizontal planes. The two loops are conductively coupled and one of the loops is provided with a pair of input terminals to which exciting currents are supplied from a source of signals. With such an antenna it is customary to use a conventional line balance converter or elevating means to permit feeding this antenna from a single concentric transmission line. It is an object of my present invention to provide a new and improved antenna structure which employs but a single input terminal and which does not require the use of elevators.

It is still another object of my invention to provide a new and improved single ended antenna structure which may be connected directly to a source of signals to be radiated by a single coaxial transmission line.

It is a still further object of my invention to provide a new and improved antenna structure which maintains the desirable electrical characteristics of previously known structures and yet is considerably simpler, lighter, and less expensive in construction.

In accordance with one embodiment of the present invention a pair of symmetrically oriented conductive loops are positioned in parallel planes. One of the loops is provided with a single input terminal and the other terminal of the one loop is connected to the other loop and to ground. In still another embodiment, the antenna employs a semi-circular driven conductor and a circular conductor which is inductively coupled with the semi-circular conductor.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. My invention itself, however, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection

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with the accompanying drawing in which Fig. 1 is a schematic diagram of one embodiment of my improved antenna structure; Fig. 2 illustrates the physical structure of an antenna embodying the invention of Fig. 1; Fig. 3 illustrates schematically a modification of the antenna of Fig. 1; and Fig. 4 illustrates the physical structure of an antenna embodying the invention of the antenna of Fig. 3.

Referring to the drawing, in Fig. 1 I have shown two semi-circular conductors 1, 2 which are connected, respectively, to the inner and outer conductors 3, 4, of a coaxial transmission line. The semi-circular conductors 1, 2 preferably are located in the same horizontal plane and are positioned below a similarly oriented circumferentially incomplete conductive loop 5. The end of the conductor 1 remote from the inner conductor 3 is connected to one of the open ends of the loop 5 by a vertical conductor 6. Similarly, the end of the conductor 2 remote from the point of connection with the outer conductor 4 is connected to the other of the open ends of the loop 5 by a vertical conductor 7. The conductor 2 at its point of connection to the outer conductor 4 is likewise connected to the conductor 5 by means of the vertical conductor 8. The point of connection of the conductor 3 with the members 2 and 5 is shown as grounded as to a metallic supporting mast (not shown) of the antenna structure. Signals may be supplied directly to the radiating conductor 1 from the transmitter 9 over the transmission line conductor 3. Means are provided for tuning the antenna to the frequency of the signals to be radiated and comprise a variable capacitance 10 connected between the open ends of the loop 5 and the corresponding ends of the members 1, 2.

In the structure thus described, a truly single ended antenna is provided in which exciting signals are supplied to one terminal only of the antenna, the remaining terminals of the antenna being grounded. Thus, the semi-circular conductor 1 is inductively coupled to the corresponding portion of the circular conductor 5 and is capacitively coupled by means of the capacitance 10 to excite the conductor 2 and the other portion of the circular conductor 5.

Considered in another way, the antenna shown in Fig. 1 comprises a transformer in which one portion of the primary winding which corresponds to the conductor 1 is capacitively coupled to a second portion of the primary winding which corresponds to the conductor 2. The primary winding is, in turn, inductively coupled to

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a secondary winding which corresponds to the loop-like conductor 5. The impedance of the respective windings, and consequently the transformation ratio, depends upon the size of the respective conductors. For practical considerations, the dimensions of the conductors 1, 2, and 5 are such that the impedance at the terminal of conductor 1 matches the impedance of the coaxial transmission line to which it is connected. In this way, direct connection between the transmitter 9 and the antenna is achieved without use of any elevators and for a chosen frequency without the use of any impedance matching devices.

In order for a single ended antenna to be workable, it is essential that the return current path for the driven conductor lie in the same polarization plane as the driven conductor and in such a manner as to provide the desired radiation pattern. Thus, in the structure of Fig. 1, if the conductor 1 lies in a horizontal plane, the return conductor 2 must similarly lie in a horizontal plane.

In Fig. 2, I have shown the physical arrangement of an antenna embodying the circuit illustrated in Fig. 1. The semi-circular conductors 1, 2 are supported from a vertical metallic pole or mast 11. The circular conductor 5 of Fig. 1 comprises two portions 12, 13 which have their adjacent ends fastened, such as by welding, for example, to a pair of plates 14, 15. These plates are, in turn, attached by means of a plurality of bolts 16 to a supporting structure or bracket 17 which, in turn, may be welded to the mast 11. The conductors 1, 2 depend, respectively, from the members 12, 13. Thus, the conductor 1 is supported at its input end by means of an insulator 18 which is, in turn, attached to the conductor 12. At its opposite end, the semi-circular conductor 1 is supported from the member 12 by means of a conductive plate 19 which corresponds to the conductor 6 of Fig. 1. The semi-circular conductor 2 is similarly supported from the member 13 by means of a pair of conductive plates 20, 21 which correspond respectively to the conductors 7, 8 of Fig. 1. In this way, the ends of the semi-circular conductor 2 are short-circuited, respectively, to the corresponding ends of the member 13. A pair of brackets 22, 23 are connected to the open ends of the members 12, 13 and support a pair of disks 24, 25. These disks are mounted on threaded studs 26 which engage cooperating threads in the brackets 22, 23. By varying the spacing between the disks 24, 25, the capacitive coupling across the open ends of the conductors 12, 13, which coupling corresponds to the variable capacitance 10 in Fig. 1, may be adjusted to tune the antenna to a desired operating frequency. After tuning, the disks may be maintained in a set position by means of lock nuts 27. The input transmission line connecting the antenna to the transmitter 9 has its inner conductor 3 connected to an input terminal 28 at the open end of the semi-circular conductor 1. The outer conductor 4 of the input transmission line is preferably directly connected to the grounded plate 15.

In Fig. 3, I have shown a modification of my antenna structure which dispenses with the semi-circular conductive loop 2. In the antenna circuit there illustrated, the semi-circular input conductor 1 is inductively coupled to a first semi-circular conductive loop 29 which forms one portion of the analogous secondary winding. A second semi-circular conductor 30 is excited by having one of its ends connected to the grounded

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end of the member 29 and its opposite end connected through the tuning capacitance 10 to the short-circuited ends of the semi-circular conductors 1, 29. This antenna system may be excited in the same manner as the system illustrated in Fig. 1, being connected to the transmitter 9 through a coaxial cable having an inner conductor 3 connected to the open end of the conductor 1 and an outer conductor 4 connected to ground.

A physical structure embodying the circuit illustrated in Fig. 3 is shown in Fig. 4 in which the vertical mast 11 supports the radiators by means of the bracket 17 and the plates 14, 15. The input conductor 1 is supported from the semi-circular secondary member 29 by means of a conductive plate 19 and one or more insulators 18. Preferably, the semi-circular loop 30 lies in a plane approximately mid way between the central planes of the semi-circular conductors 1, 29. Thus, physically, the conductor 30 is lower than the conductor 29. The antenna structure includes the tuning capacitance comprising the disks 24, 25 with their supporting brackets 22, 23 and studs 26.

In the structure shown in Fig. 4, the arm or semi-circular conductor 29 is driven directly by inductive coupling with the conductor 1, while the semi-circular loop 30 is excited through its direct connection at one end and its capacitive coupling at the other end with the member 29. In this manner, the member 30 forms the conductor for the returning current path of conductor 29 in the necessary manner. Thus, this antenna is single-ended employing a single input terminal 28 with signals to be radiated being connected between the input terminal 28 and ground. The pair of conductors 2, 13, short circuited at both ends in the structure of Fig. 2 are replaced in the antenna of Fig. 4 by a single conductor 30 which serves the functions of both of the conductors 2, 13.

An important advantage of my improved single ended antenna system is that the antenna may be connected directly to a source of signals to be radiated without the requirement of any intervening elevators or similar structures. As a result, the antenna provides the desirable electrical characteristics of previously known structures while reducing the overall cost and weight. Thus, I have found that my invention provides a horizontally polarized antenna which gives an essentially circular pattern with low vertical radiation and which may properly be operated with only one input terminal.

While I have shown and described particular embodiments of my invention, many changes and modifications will occur to those skilled in the art and I therefore aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

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

1. A single-ended antenna system comprising a pair of parallel, similarly oriented, circumferentially incomplete, loop-like conductors, each of said conductors having a pair of spaced ends, corresponding spaced ends of said pair of conductors being conductively connected together, one of said pair of conductors having a pair of terminals at a point mid way between said spaced ends, one of said terminals being conductively connected to the other of said conductors, input means connected to the other of said terminals,

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said one terminal being connected to ground, whereby signal voltages may be impressed between said input terminal and ground, and a capacity coupling between said spaced ends.

2. A single-ended antenna system comprising a vertical, grounded, conductive mast, a circumferentially incomplete, horizontal, loop-like conductor surrounding said mast and having a pair of adjacent terminals, said conductor being supported by and conductively connected to said mast at a point mid way between said terminals, an arcuate conductor having a length equal to one-half the length of said loop-like conductor and positioned in a horizontal plane spaced vertically from said loop-like conductor, said arcuate conductor being oriented parallel to one-half of said loop-like conductor and having one of its ends connected to the corresponding one of said terminals, said arcuate conductor having an ungrounded input terminal at its other end, a transmission feed line connected between said input terminal and said grounded mast, and means capacitively coupling said adjacent terminals together to tune said antenna system to a desired operating frequency.

3. A single-ended, circular antenna system comprising a vertical, grounded, conductive mast, a pair of parallel, similarly oriented semi-circular conductors uniformly spaced throughout their lengths from said mast, one of said conductors having one of its ends conductively connected to said mast, the other of said conductors having an input terminal at its end adjacent said one end, said conductors being conductively connected together at their other ends, a transmission feed line connected between said input terminal and ground, a third, semi-circular conductor spaced uniformly from said mast by a distance equal to the spacing between said mast and said pair of conductors, said third conductor

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lying in a plane parallel to said pair of conductors and on the diametrically-opposite side of said mast, said third conductor having one of its ends conductively connected to said mast adjoining said one end of said one conductor, and capacity coupling means connected between the other end of said third conductor and said other ends of said pair of conductors for tuning said antenna to a desired operating frequency.

4. A single-ended antenna system comprising a grounded supporting mast, a pair of parallel, similarly oriented, circumferentially incomplete, arcuate conductors encircling said mast and supported thereby, each of said conductors having a pair of spaced ends, corresponding ends of said pair of conductors being conductively connected together, one of said conductors being connected to said mast at a point mid way between said pair of ends and the other of said conductors having an opening at a point mid way between said pair of ends, an input terminal connected to said other conductor on one side of said opening, the other side of said opening being conductively connected to said point of said one conductor, a transmission feed line connected between said input terminal and ground, and capacity tuning means connected between said spaced ends for tuning said system to a desired operating frequency.

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The following references are of record in the file of this patent:

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