SHORT-WAVE ANTENNA

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Fig. 1

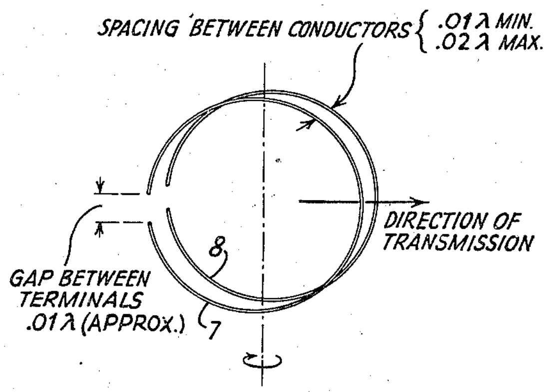


Fig. 2

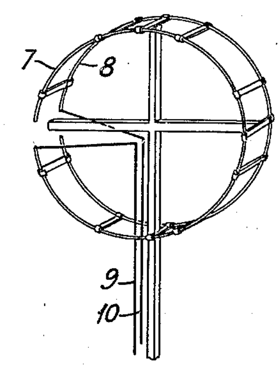


Fig. 3

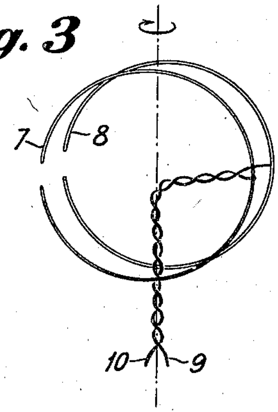


Fig. 4

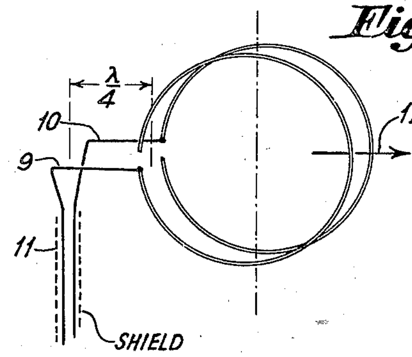


Fig. 5

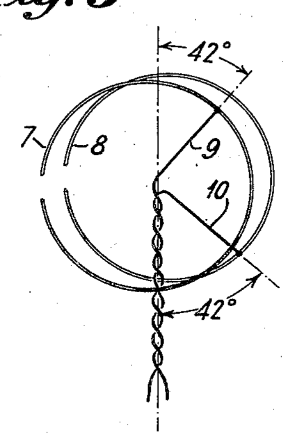
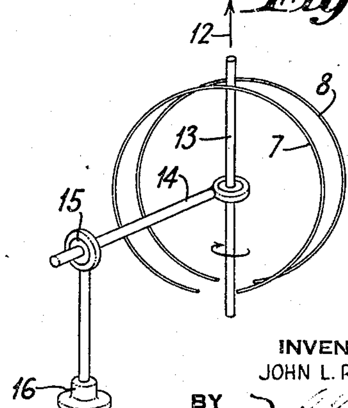


Fig. 6



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UNITED STATES PATENT OFFICE

2,116,734

SHORT-WAVE ANTENNA

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12 Claims. (Cl. 250—33)

This invention relates to antenna systems especially adapted for radio waves of relatively short length, say in the region of 2 to 60 meters.

An object of my invention is to provide an antenna system of great simplicity of construction and one which has marked directive characteristics.

Another object of my invention is to provide a directive antenna system which may be oriented so as to transmit or receive waves having any predetermined directivity of propagation.

Another object of my invention is to provide an antenna system for short waves in which the radiating or energy collecting conductors are parallel to one another and formed about the surface of a cylinder, the ends of the conductors being spaced apart by a small portion of the cylindrical surface.

Another object of my invention is to provide an antenna system of the character described in the preceding paragraph in combination with a transmission system suitably connected thereto and adapted to transfer the radio energy between said antenna system and the radio apparatus with a minimum of losses.

The foregoing and other objects of my invention will be more clearly understood from the following description when read in connection with the accompanying drawing in which

Figure 1 shows diagrammatically an arrangement of two substantially circular shaped parallel conductors, the ends of which are somewhat spaced apart,

Fig. 2 shows the antenna system of my invention in combination with an arrangement of transmission wires connected to diagonally opposed terminals of the circular conductors.

Fig. 3 shows a modification of my invention in which the transmission line is connected to points on the antenna conductors equi-distant from diagrammatically opposed terminals thereof.

Fig. 4 shows still another modification of my invention in which the connecting leads to the antenna conductors are brought out for a distance of one-quarter wave length in a direction opposed to the direction of maximum radiating effect.

Fig. 5 shows still another modification of my invention in which the transmission line is connected at suitable points along the circular conductors of the antenna system remote from the terminals thereof, and,

Fig. 6 shows more or less diagrammatically a preferred form of structure for orienting the antenna system to vary its directive axis both vertically and horizontally.

Referring first to Fig. 1, I show two radiating or energy collecting conductors 7 and 8, the ends of which are spaced apart by a small distance, say about 1/100th of a wave length λ. The circumferential length of each conductor is preferably about $.45\lambda$ and the diameter of the cylinder about the surface of which these conductors are formed is preferably about $.152\lambda$. The conductors may, if desired, be made of copper tubing in order that they may be relatively rigid without having too much weight. I have found that for this purpose tubing having a diameter of approximately ⅜″ is satisfactory where the lengths of the conductors are, say approximately 8′. These dimensions are suitable for an antenna system especially adapted for the radiation and collection of energy in the five meter wave band. If antennas are required for other wave bands they should be proportionately larger or smaller.

While the antenna conductors are disposed parallel to one another, the distance separating their planes is not critical. I have found that for practical purposes, however, a separation of about 2″ between the conductor planes is suitable in the case of a 5-meter wave length antenna. In this case also the terminals of the conductors may be located substantially at the four corners of a square whose sides have a 2″ dimension.

Various means which may be chosen according to the dictates of good mechanical construction should be provided for supporting the antenna conductors in fixed relation to each other and so as to enable them to be oriented for propagating or receiving energy in a given direction. The orientation may be either horizontal or vertical, or both, as required for different conditions.

I have found that for a transmitting antenna the directive axis is aimed away from the open end and is parallel to the planes in which the arcuately formed conductors lie. It is my belief that the reason for this marked directive characteristic may be attributed to the occurrence of a considerable static field between the terminals of the conductors, which static field opposes the magnetic forces that would otherwise be radiated in that direction from the magnetic center of the system.

Referring to Fig. 2, I show one way in which the antenna system may be utilized either as a transmitting or a receiving antenna. The connections of this system to the radio apparatus may in this case be made by means of a transmission line having two conductors 9 and 10. Conductor 9 is connected to one terminal of the antenna conductor 7, while conductor 10 is connected to a diagonally opposed terminal of the conductor 8. The remaining terminals of these conductors are dead-ended.

Referring to Fig. 3, I show another method of connecting the transmission line to the antenna conductors. In this case a twisted pair of transmission line conductors is employed. One of the wires therein is connected to some point along the conductor 7 which is not equi-distant from the ends thereof. The other transmitting line conductor is connected to the antenna 8 in the same manner and so that the two connections form a symmetrical arrangement; that is to say, one above and the other below the horizontal axis of symmetry. According to Fig. 3 the transmission line conductors are carried from their points of connection to the antenna conductors, first to the center of the antenna system and then straight downward along the axis of rotation of the antenna system which is provided for horizontal orientation.

I have found that the arrangement of transmission conductors or feeders 9 and 10 as shown in Fig. 3 has a tendency to produce the equivalent of a transformer which matches the inductive components of the antenna system itself. This effect is not altogether desirable and can, however, be avoided by the arrangement shown in Fig. 4. Thus, by carrying the feeders out in a direction opposed to the axis of radiation and for a distance of about one-quarter wave length, these transmission line conductors 9 and 10 can then be directed downwardly and preferably through shielding means 11. The conductors 9 and 10 are then disposed outside of the principal magnetic field of the circular conductors and they do not offer any opposition to the radiation effect along the principal axis 12.

Referring to Fig. 5, I show another modification in which the transmission wires 9 and 10 are connected respectively to the antenna conductors 7 and 8, but with a considerable difference between the distances of each connection to one, and to the other end of a given antenna conductor. In this case the points of connection are shown as approximately 42 degrees away from the vertical axis. Other angles may be chosen, however, according to given cases.

Referring to Fig. 6, I show an arrangement for orienting the antenna system both horizontally and vertically in order that its directive axis may be aimed in any desired direction. In this case the conductors 7 and 8 may be suitably supported on an insulating arm 13, at the center of which pivotal bearings are provided so that the antenna conductors may be first rotated on a substantially vertical axis. The support 13 is mounted on a horizontal member 14 which is adapted to rotate in bearings 15. The bearings 15 may also be made rotatable on a vertical axis, being supported by a stationary pedestal 16. It may be seen from the arrangement of Fig. 6 that with three axes of rotation provided, it is possible to orient the antenna conductors 7 in any desired direction in space, and with the null point of directivity opposed to the direction of the maximum field intensity 12.

From practical experiments I have found that the antenna system, when constructed according to any of the exemplary embodiments herein shown and described, has a number of advantages over antenna systems heretofore known. The successful operation of the system in the band of wave lengths from 5 to 20 meters is particularly gratifying. It has been noted that in connection with a 40 watt transmitter which would normally deliver 20 watts to the antenna, the effectiveness of the antenna in the particular direction in which it is aimed is as much as a non-directive antenna radiating 160 watts. In this case the gain in directivity is eight-fold.

The antenna system is relatively small and compact. It is, therefore, a unit which can be utilized with systems of remote control and in limited spaces to very great advantage. The antenna conductors may be readily supported on any rotatable mounting and with such insulating spacers between the two conductors as may be necessary to obtain a rigid construction.

I have noted that the capacity effects between the antenna loops and ground are not a serious consideration, but the balance of each half section to ground is quite important. In order to obviate stray capacity unbalance it has been found useful to supply a coupling transformer and a static shield near the loop terminals. Such an arrangement has not been shown in the drawing, but may obviously be provided in accordance with well known practice.

When transmitting radio waves in the 20 meter band it has been observed that reflected waves are required for obtaining great distances. It is, therefore, advantageous to tilt the directional axis of the antenna system. A 45° angle of this axis with respect to a horizontal plane appears to be decidedly serviceable where the greatest distance of transmission is a criterion. Other angles of tilt may be chosen, however, for reaching near points of reception.

The directional properties of an antenna system such as shown and described are extremely advantageous where it is desired to receive signals from a given direction and to suppress the reception of interfering signals coming in from other directions.

Various modifications of my invention will suggest themselves in view of the foregoing description. I do not wish, therefore, to be limited in the scope of the claims other than as may be necessitated by the state of the prior art.

I claim:

1. An antenna system comprising a pair of arcuately formed conductors disposed in parallel planes, each of said conductors having a length of the order of $.4\lambda$ to $.5\lambda$ where λ is the wave length for which the system is adapted to operate with strongly directive characteristics, the arcs subtended by said conductors being of the order of 345° to 355° and the terminals of said conductors being located substantially at the four corners of a rectangle, said rectangle being perpendicular to said parallel planes, and said parallel planes being separated by a very small fraction of said wave length λ.

2. An antenna system according to claim 1 and further characterized in that the spacing between the planes in which said conductors are disposed is of the order of $.01\lambda$ to $.02\lambda$.

3. An antenna system according to claim 1 and further characterized in that the conductor terminals are located substantially at the four corners of a square whose sides have a dimension of the order of $.01\lambda$ to $.02\lambda$.

4. An antenna system according to claim 1 in

combination with means for orienting its directional axis horizontally and vertically.

5. An antenna system according to claim 1 in combination with a two-conductor transmission line, each conductor of which is connected respectively with one of the antenna conductor terminals located at diagonally disposed corners of said rectangle.

6. A short-wave antenna system comprising a pair of parallel conductors formed about the surface of a cylinder whose length between the conductors is a small fraction of the wave length λ at which said system has an optimum operational characteristics, the circumference of said cylinder being slightly greater than the length of each conductor, and the length of each conductor being substantially of the order of .45λ.

7. An antenna system especially adapted for radio waves of length λ, said system comprising two parallel conductors each having a length of substantially .45λ and being formed about the surface of a cylinder whose diameter is substantially .152λ, said conductors being spaced apart by a distance substantially .02λ maximum, and .01λ minimum.

8. An antenna system according to claim 7 in combination with a transmission system comprising two conductors, each conductor being connected to one of said antenna conductors respectively and at points equi-distant from diagonally opposed terminals of said antenna conductors.

9. An antenna system especially adapted for radio waves of length λ, said system comprising a pair of parallel tubular conductors each formed about the circumference of a cylinder, and said parallel tubular conductors being separated from one another by a very small fraction of said wave length λ.

10. An antenna system comprising a pair of parallel conductors spaced apart by a very small fraction of a wave length λ of the radiant energy at which said system is best adapted to function, said conductors being formed about a major arc of a cylindrical surface, and having a minimum arcuate length of .4 λ, and means including a twin-conductor feed line having negligible radiating and energy-collecting characteristics for connecting said antenna system with a radio device.

11. An antenna system in accordance with claim 10 and having said feed line disposed in part radially from the axis of said cylindrical surface and the respective conductors thereof connected each to its appropriate one of the parallel conductors.

12. An antenna system in accordance with claim 10 and having said feed line disposed in part along the major directional axis of said system.

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