United States Patent

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[54] **HEXAGRAM ANTENNA**
7 Claims, 4 Drawing Figs.

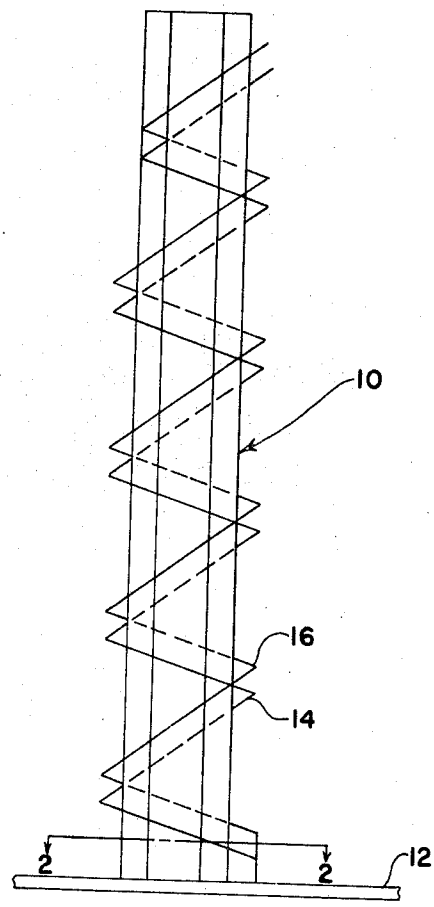
[52] **U.S. Cl.** **343/848,** 343/895
[51] **Int. Cl.** **H01q 1/36,** H01q 1/48
[50] **Field of Search** 343/874, 895, 843, 848

[56] **References Cited**
UNITED STATES PATENTS

2,616,046	10/1952	Marston et al.	343/895X
3,083,364	3/1963	Scheldorf	343/843

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Assistant Examiner—Marvin Nussbaum
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ABSTRACT: Two triangular radiating elements are interlaced in a helical winding about a common axis to form a single antenna structure. The elements are wound in opposite directions and are laterally separated, thus reducing the RF coupling between them and improving the circularity of each radiating pattern with one radiating element wound in one direction and the other in the opposite direction, a dual circularity is achieved from the same physical volume.



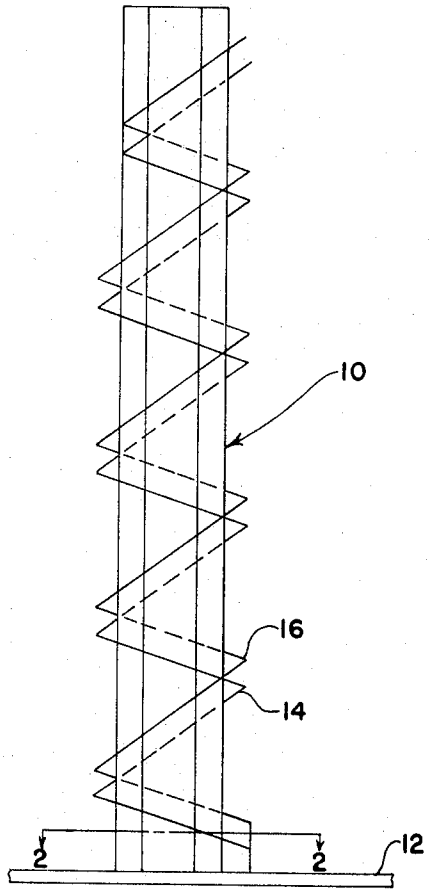


FIG.-1

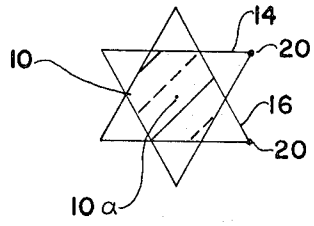


FIG.-2

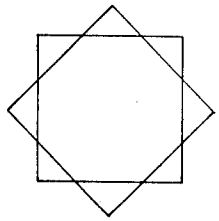


FIG.-4

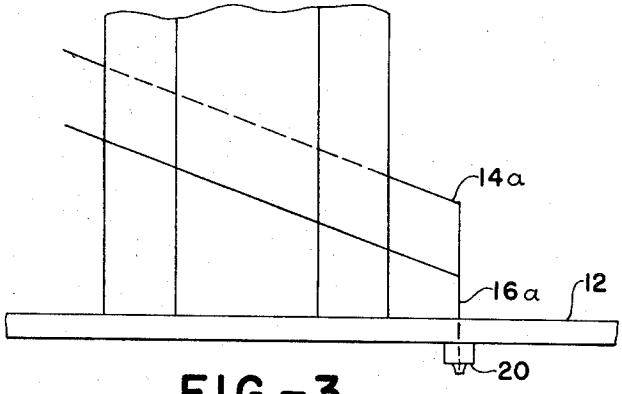


FIG.-3

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HEXAGRAM ANTENNA

Heretofore the use of helical antennas has been well known, with these antennas designed to provide a predetermined directional radiating and reception pattern. Various methods have been utilized to achieve circularity in the patterns, and to prevent mutual RF coupling between separate radiating elements if more than one element is utilized. However, the problem of preventing mutual RF coupling, and obtaining dual circularity in one composite antenna structure is needed by the art.

Therefore, it is the general object of the invention to meet the needs of the art by providing dual circularity in radiating and reception patterns on a single radiating structure, and where mutual coupling between separate radiating elements is substantially reduced.

For a better understanding of the invention reference should be had to the accompanying drawings wherein:

FIG. 1 is a side elevational view of an antenna made according to one embodiment of the invention;

FIG. 2 is a cross-sectional plan view of the antenna of FIG. 1 taken on line 2–2 thereof;

FIG. 3 is an enlarged broken away side view of the base of the antenna of FIG. 1 showing how the feed is provided to the separate radiating elements;

FIG. 4 is a cross-sectional plan view of a second embodiment of the antenna of the present invention.

With reference to the embodiment of the invention shown in FIG. 1 of the drawings, the numeral 10 indicates generally an elongated supporting post having an axis which is carried by a mounting base 12 in any conventional manner so the axis is substantially normal to the surface of the base 12. The post is preferably hexagonal in cross section as seen in FIG. 2. The invention comprises a pair of radiating elements 14 and 16 which are wound in an interrelated triangular helix up the length of the support post 10, and concentric with the axis thereof with equal and uniform longitudinal spacing between the windings, as illustrated. The triangular shape will fit around the hexagonal post 10 as shown in FIG. 2. Preferably, the triangles are equilateral, although this is not absolutely necessary. The elements 14 and 16 will normally be copper wire, but any suitable element to provide electromagnetic radiation will meet the objects of the invention. It should be understood that the post 10 is purely for purposes of support, and that any low loss material for supporting the antenna would be used. Also, of course, if the wires themselves have sufficient strength, or if the antenna is to be used in a space environment the post 10 may not be necessary. The only requirement is that the antenna windings be concentric to some common axis.

The antenna of FIG. 1 was made as an experimental model. The pitch angle of the triangular helices was equal to 19.5° with a design bandwidth of between 1.00 to 2.00 GHz. The ground plane diameter established by base 12 was 10 inches. The base 12 was made from a conductive material whereas the post 10 was made from a dielectric material. However, it is to be understood that the pitch angle and bandwidth would change depending upon the specific requirements of the antenna.

The pitch angle of the antenna elements could be continually decreasing along the structure with a similar decrease in the dimension of the triangles to form a pyramidal like antenna. A structure of this type would have a broader frequency bandwidth.

The unique aspect of this antenna and that critical to its proper operation is that the triangular helices are wound in opposite direction about a common axis 10*a*, as is best illustrated in FIG. 2. Essentially, winding 14 is in a right-hand pattern while winding 16 is in a left-hand pattern. The winding 14 is thus capable of transmitting and receiving right-hand circularly polarized radiation, with the winding 16 capable of transmitting and receiving left-hand circularly polarized radiation. With the exception of the feed line lengths at the base of the antenna, the physical dimension of both helices are the same, depending on bandwidth requirements and pitch angle. The

interlacing of the two helices requires that one of them be displaced some predetermined pitch distance higher off the ground plane. This distance to achieve minimum RF coupling can be determined either experimentally or mathematically. The opposite directing of the windings in the triangular helix pattern provides the greatest actual spaced relationship between the wires so as to substantially reduce mutual coupling. Specifically, as is quite clearly shown in FIG. 2, the triangular points of each winding 14 and 16 are at considerable spaced distances from the flat bases adjacent thereto, thus providing the maximum spaced relationship possible which greatly reduces mutual coupling.

FIG. 3 illustrates the base feed wires designated 14*a* and 16*a*, respectively, and shows the vertical displacement in the right-hand circular polarization feed on line 14*a* to provide the predetermined pitch distance displacement. The lines are actually fed from a coaxial cable 20 with the shield of the cable electrically connected to the ground plane. The purpose of coordinating displacement and pitch angle is to hold VSWR to the lowest possible value at the junction between the coaxial cable 20 and the antennas.

The radiation pattern and reception pattern with respect to each of the windings 14 and 16 is a uniformly directed lobe which has much greater predictability than normal counterwound helical antennas because of the lack of mutual coupling between windings. Also, it should be understood that while one winding can be operating on the right-hand circularly polarized pattern, the other winding could be receiving left-hand circularly polarized signals, thus making the antenna extremely desirable for use with earth orbiting satellites, for example, where one ground station would radiate right-hand circularly polarized waves to be detected by the right-hand circularly polarized antenna on the satellite, to trigger a left-hand circularly polarized signal from the satellite to be received at the left-hand circularly polarized antenna on the earth. This can be achieved in compact relationship on the single antenna structure.

FIG. 4 illustrates a modified embodiment of the invention utilizing substantially a square pattern in the windings in lieu of the triangular pattern. Again the points or corners are alternately positioned to provide the greatest possible spacing to prevent mutual coupling. It is believed that a figure with any more sides than four would not meet the objects of the invention.

It should be understood that the angular relation of the radiating elements to the ground plane could vary according to the particular radiation requirements of the antenna, but that the antenna should have a ground plane, and some helical configuration to the triangular windings. The antenna is an intermediate frequency bandwidth antenna transmitting and receiving with different sense polarizations at slightly different frequencies, and is quite effective for these purposes. The mutual coupling between antennas is greatly reduced because of the hexagram configuration of the antenna. Proper phasing of the radiating elements 14 and 16, both in space and time will provide the best operating characteristics for each construction, determined for a particular required condition.

While in accordance with the patent statutes, only one best known embodiment of the invention has been illustrated and described in detail, it is to be understood that the invention is not limited thereto or thereby, but that the inventive scope is defined in the appended claims.

I claim:

1. An antenna which comprises:

at least two radiating elements wound in a geometric pattern of not more than four sides in opposed helixes along a common axis with a uniform longitudinal spacing between elements and alternate positioning of angular changes in the elements whereby maximum spacing between elements is achieved to reduce mutual coupling; and

means to form a ground plane on one end of the elements.

2. An antenna according to claim 1 which includes a connector for feeding the elements, where said means to form a ground plane is a base and where the connector is electrically connected to the base whereby the base provides a ground plane for the antenna.

3. An antenna according to claim 2 which includes a post to support the radiating elements, which post in cross section has the shape of a hexagon, and the shape of the elements in plan is an equilateral triangle closely fitting around the longitudinal axis of the post.

4. An antenna according to claim 3 where the longitudinal displacement between elements is predetermined as a portion of the pitch distance for one convolution of the helical wrap of each element to achieve minimum VSWR between the connector and the radiating elements.

5. An antenna according to claim 4 where the pitch angle of the elements is 19.5° and where each element has a designed bandwidth between 1.00 to 2.00 GHz.

6. An antenna which comprises:

a base to provide a ground plane; and

a pair of elements capable of transmitting and receiving electromagnetic radiation mounted to the base and extending substantially normal thereto in concentric relation to an axis substantially perpendicular to the surface of the base which is characterized by the elements being wound in opposed triangularly shaped helical convolutions about the axis with a uniform longitudinal spacing between elements whereby each apex is associated with a corresponding base of the adjacent element to reduce mutual coupling therebetween upon energization.

7. An antenna which comprises:

at least two radiating elements wound in a geometric pattern of not more than four sides in opposed helixes along a common axis with uniformly decreasing longitudinal spacing between elements, with a similar uniform decrease in the size of the convolutions of each helical wrap, and with alternate positioning of angular changes in the elements whereby maximum spacing between elements is achieved to reduce material coupling; and

means to form a ground plane on one end of the elements.