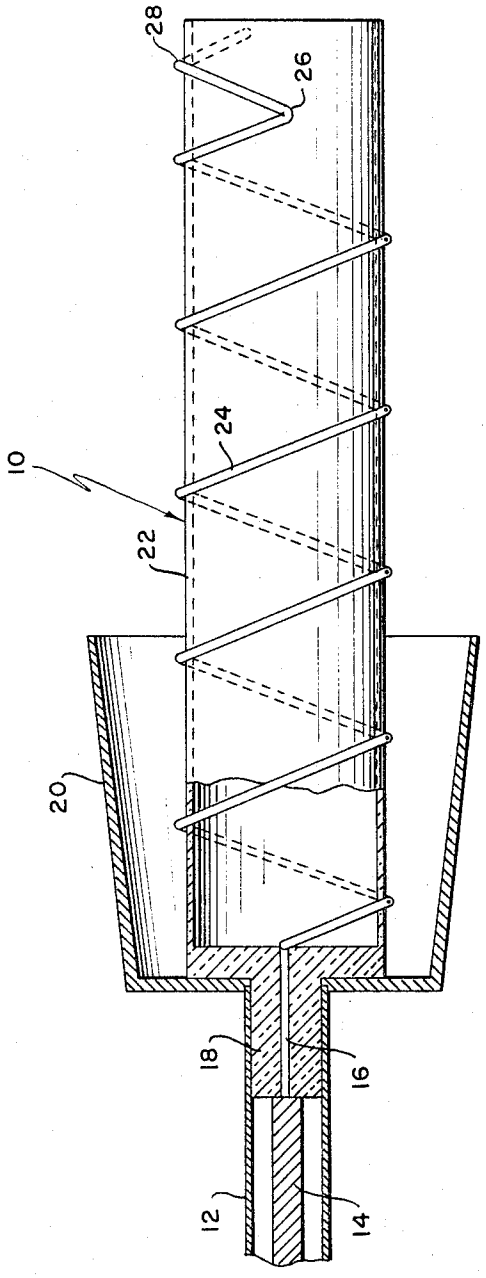
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HELICAL ANTENNA WITH END DISTORTION TO IMPROVE POLARIZATION PURITY

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HELICAL ANTENNA WITH END DISTORTION TO IMPROVE POLARIZATION PURITY

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This invention relates to antennas and more particularly to a helical beam antenna having improved circular polarization characteristics.

Helical beam antennas are well known in the art for the unique characteristics they exhibit. In particular, in the beam or axial mode of radiation the field is at a maximum in the direction of the axis of the helix and the radiated waves are either elliptically or circularly polarized. Furthermore, operation in this mode is possible over a relatively wide frequency range with little reduction in gain and directivity.

It has been found that ideal circular polarization of a radiated electromagnetic wave is a desirable property, useful for several applications. One such application is the use of a circularly polarized antenna to provide response to a linearly polarized wave having an arbitrary orientation. Another application is the suppression or elimination of precipitation echo in radar systems caused by snow or rain. Because of the nearly spherical shape of raindrops waves will be reflected therefrom symmetrically. The circularly polarized antenna is incapable of seeing its own reflected image and therefore does not respond to the echo from the raindrop.

Helical antennas capable of propagating circularly polarized radiation have been described and constructed. However the design parameters are such that dimensions on the order of a wavelength or larger are necessary for satisfactory circularity of the polarized wave. Any reduction of dimensions causes severe deterioration of the circularity because the radiated wave is partially reflected resulting in waves which are elliptically polarized. Such elliptically polarized radiation is less suitable for the applications mentioned above due to signal response degradation.

The present invention modifies prior art helical antennas by providing at the propagation end a partial winding wound in a direction opposite to the main helix winding. This oppositely-wound section acts to correct those wave components which cause elliptical rather than circular polarization. The deviation from circularity is caused by partial reflection of the signal from the propagation end of the antenna. This reflected wave results in a rotating component of opposite sense to that created by the forward traveling component which disturbs the equality of the orthogonal components which generate the circularly polarized wave. The partial oppositely-wound section creates its own reflected wave which corrects the orthogonal components toward equality resulting in perfect circular polarization.

Accordingly, it is an object of this invention to provide a helical antenna having improved circular polarization characteristics.

A further object of the invention is to provide a circularly polarized helical antenna of smaller dimensions than has heretofore been possible.

A still further object is to provide a helical antenna which compensates and corrects for reflections which cause deviations from circular polarization of the radiated wave.

The accomplishment of these and other objects will become apparent from the following description considered with the drawing in which the figure shows a partially

broken view of a helical antenna constructed according to the principles of the invention.

The antenna **10** comprises a conductive helix **24** wound on a cylindrical coil form **22**. Coil form **22** is constructed of suitable insulating material such as fiberglass. The length of coil form **22** is determined by the helical length required for desired antenna characteristics. The helix **24** may be wound in either a right- or left-hand direction depending on the sense of circular polarization desired. The number of turns and the length of the winding are selected for the gain and beam width pattern characteristics required according to known design techniques.

At the propagation end of helix **24** the direction of winding is reversed as shown at **26** in the figure and the winding is extended for approximately one turn in the direction opposite to the winding direction of the main helix **24**. This reverse or oppositely-wound winding is shown at **28** in the figure and the transition thereto is made as abruptly as possible without damaging the conductor. The final length of reverse winding **28** is determined by successively trimming off a small part of the end while measuring the antenna characteristics until the desired parameters are achieved.

The antenna **10** is fed, preferably, by means of coaxial cable transmission line comprising inner and outer conductors **14** and **12**, respectively. The inner coaxial conductor **14** is connected to transmission feed line **16** which, in turn, is connected directly to helix **24**. An insulating plug **18** completely surrounds feed line **16** and serves as a support for the cylindrical coil form **22**. The outer coaxial conductor **12** is connected to a ground plane **20** of conductive material here shown in the form of a horn. Ground plane **20** is an effective part of the helical antenna and directs the radiation in one direction along the helical axis towards the propagation end. The diameter of ground plane **20** is preferably 0.8λ and exhibits effects which are decreasingly small as the diameter is increased beyond this size. The ground plane is most effective for short helices and the effect of a given ground plane exhibits decreasingly small effects with increasing helical length. The ground plane **20** may be planar in shape or may be formed in the shape of a cylinder or cone enclosing the helix to isolate it from the immediate environment such as other antennas on an array. Preferably, the antenna **10** is extended beyond the end of ground plane **20**.

An actual embodiment of the antenna described was constructed for operation in the 1700–1900 mc./s. band and was found to have excellent circular polarization characteristics. The wire used was 0.030" copper, tinned and the fiberglass coil form had an inside diameter of 1⅝" with 1/32" walls. The helical winding consisted of 5 turns wound in one direction with 1⅜" spacing between adjacent turns. The reverse winding extended 11/16" beyond one-quarter of a turn. The transmission line employed was 50 ohm coaxial cable having a diameter of ⅝"

In theory, the antenna **10** operates in the following manner. Helical antennas having a satisfactory circular polarization may be constructed according to known design techniques. The antenna dimensions required to achieve adequate circularity are on the order of a wavelength or more. Any attempt to construct a more compact antenna results in severe degradation of the circularity as the polarization becomes elliptical in form. The circularity deteriorates because the wave no longer radiates unimpeded off the end of the helix but has a portion reflected. The reflected wave causes a rotating component of opposite sense to that created by the forward traveling wave to disturb the equality of the orthogonal components which generate the circular form. The reverse or oppositely-wound winding **28** has the effect of creating reflected wave which corrects the orthogonal components

toward unity with improvement of the polarization circularity.

Having described the construction and operation of the invention, it will be apparent that other modifications will be obvious within the scope of the invention as defined in the following claims.

What is claimed is:

1. A helical antenna having improved circular polarization characteristics comprising:
first means for propagating a wave having a first polarization mode; and
second means for changing polarization components of said wave;
said second means causing reflections opposing reflections associated with said first wave.

2. A helical antenna as set forth in claim 1 wherein:
said reflections caused by said second means have an opposite polarization sense than that of said reflections associated with said first wave.

3. A helical antenna as set forth in claim 2 wherein:
said first polarization mode is elliptical in form.

4. A helical antenna as set forth in claim 3 wherein:
said second means changes polarization components of said wave towards orthogonal equality.

5. A helical antenna as set forth in claim 1 wherein:
said first means includes a first conductive winding comprising a plurality of turns helically wound along an axis.

6. A helical antenna as set forth in claim 5 wherein:
said second means includes a second helical conductive winding continuous with said first winding and further extending along said axis.

7. A helical antenna as set forth in claim 6 wherein:
said second winding is wound in a direction opposite to the direction of winding of said first winding.

8. A helical antenna as set forth in claim 7 wherein:
said second winding has a length of less than one turn.

9. A helical antenna as set forth in claim 8 including:
a conductive ground plane electrically associated with said antenna.

10. A helical antenna as set forth in claim 9 wherein:
said ground plane is oriented substantially perpendicular to said helical axis and further including transmission line means feeding said first winding and said ground plane.

References Cited

UNITED STATES PATENTS

2,863,148	12/1958	Gammon et al.	343—895
3,083,364	3/1963	Scheldorf	343—895 X

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