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(54) Title: STUB LOADED HELIX ANTENNA

(57) Abstract

A helical antenna having stubs spaced along the helix curve length and extending toward the central axis of the helix, such that the performance characteristics of the antenna, such as gain and circular polarization, are maintained while the size of the antenna, diameter and length, are reduced.

STUB LOADED HELIX ANTENNA

Field of the invention

The present invention generally relates to helical antennas, and more particularly to helical antenna geometrics which support reduced antenna size.

Background of the invention

The helical antenna is old in the art, having first appeared in the late 1940's. In a helical configuration, a length of conducting material is wound at a radius and with a pitch angle around a central axis. The radius of curvature of the helix is defined by the radius of the enclosing cylinder. The helix antenna produces a directional antenna pattern, generates circularly polarized radio waves, and has a wide operational frequency bandwith.

In certain communication applications the antenna may be the largest component of the system. Thus there is a need for a way to reduce antenna size without reducing antenna performance.

Summary of the invention

It is therefore an object of the present invention to reduce the antenna size without reducing antenna performance.

The present invention is an improved geometry for a helical antenna. Along its length are a plurality of stubs which project from the outer radius of curvature of the helix toward the central axis of the helix. The stubs are not in electrical contact with one another. The stub loaded helical geometry is defined by a) the circumference of the helix (which is 2.pi. times the radius of the enclosing cylinder), b) the number of turns of the helix, c) the pitch of the helical windings, d) the number of stubs per turn, e) the depth of the stubs, and f) the angular width of each stub (i.e. the angle subtended by the width of the stub at the radius of the enclosing cylinder). A stub loaded helix antenna in accordance with the invention exhibits performance characteristics such as gain and circular polarization similar to the traditional helical antenna, but is

approximately one third smaller in diameter and one-half as long. The stub loaded helix antenna can be used in wireless local area networks, satellite communications, microwave point-to-point systems and personal communication systems. The antenna is most useful in applications which use frequencies from the low VHF to low microwave range.

In a first aspect of the invention, there is provided an antenna, comprising a continuous length of conductive material formed in the shape of a helix and having a plurality of stub regions along a curve length of said helix which extends towards a central axis of said helix, said helix having a non-zero pitch angle.

Preferably said helix is comprised of a plurality of turn windings arranged at a pitch angle around said axis, each of said turn windings having at least one of said stub regions spaced along said curve length.

Preferably each of said stub regions projects toward said axis to a depth less than a radius of said helix. Preferably said stub depth is between two-thirds and three-fourths of said helix radius.

Preferably the pitch angle is in the range of 7° to 9°.

The number of turn windings is preferably in the range of 3 to 15.

The number of stubs per turn is preferably in the range of 4 to 10.

Preferably the antenna has four stubs for each of said turn windings, each said stub having a depth of approximately three-fourths of said helix radius.

Preferably each of said stubs has a width at said helix curve length and is truncated towards said centre of said helix in a side having a length less than said width.

The length of said side preferably is zero.

The antenna can additionally comprise a reflector, wherein said helix is mounted on said reflector, and wherein said centre axis of said helix is along a beam axis of said reflector.

In a second aspect of the invention, there is provided an antenna, comprising a continuous length of conductive wire wound around a plurality of turns in a cylinder shape forming a helix having a non-zero pitch angle α, a circumference of said helix being 2π times a radius of said cylinder shape; and a plurality of wedge-shaped stub regions formed along said continuous length of said conductive wire directed toward a centre axis of said helix, said plurality of wedge-shaped stub regions having a depth less said radius of said cylinder shape.

Preferably further comprising a flat truncated portion at a far end of said plurality of wedge-shaped stub regions.

A number of said wedge-shaped stub regions per turn is preferably in the range 4 to 10, wherein said pitch angle α is in the range of 7° to 9°, and wherein the number of turns is in the range of 3 to 15.

Each of said wedge-shaped stub regions preferably has a depth of approximately three-fourths of said cylinder radius.

Preferably further comprising a reflector, wherein said helix is mounted on said reflector, and wherein a centre axis of said helix is along a beam axis of said reflector.

Brief description of the drawings

The foregoing and other objects, aspects and advantages will be better understood from the following detailed description of a preferred embodiment of the invention with reference to the drawings, in which:

FIG. 1 is a top view of a single turn of a stub loaded helix antenna.

FIG. 2 is a side view of a four turn stub loaded helix antenna.

FIG. 3 is an oblique view of a stub loaded helix antenna.

Detailed description of the embodiments

It will be understood that the invention disclosed and defined herein extends to all alternative combinations of two or more of the individual features mentioned or evident from the text or drawings. All of these different combinations constitute various alternative aspects of the invention.

The foregoing described embodiments of the present invention and modifications, obvious to those skilled in the art can be made thereto, without departing from the scope of the present invention.

Referring now to the drawings, and more particularly to FIG. 1, there is shown a top view of a single turn of a stub loaded helix antenna. The antenna is formed from a continuous length of conducting material.

The distance from the centre 10 to the circumference 11 of the enclosing cylinder of the helix is a radius "R" (hereinafter called "radius of the helix" or "helix radius"). The diameter "D" of the helix is the diameter (2R) of the enclosing cylinder, and the circumference of the enclosing cylinder is "C". The helical shape is a continuous curve, and along the length of that continuous curve (hereinafter "curve length of the helix" or "helix curve length") the distance around one turn of the helix is

$$T_d = \frac{C}{\cos(\alpha)}$$

where C =πD and a=pitch angle between successive turns of the helix. Each stub 12 (four are shown in this example) is formed by bending the conducting material at approximately right angles from the circumference at points 13 and 13' toward the centre 10 extending a distance "d", less than radius "R". The angular width β of the stub 12 is the angle subtended by the arc defined by the width of the stub at the radius of the enclosing cylinder (i.e. between points 13 and 13'). For each turn of the helix there are a number ("n") of stubs 12 extending from the circumference 11 along the helix curve length, In the example shown, n=4 and each stub has a depth of about two thirds of a radius and is truncated in a side 14 length "s". In general "n" need not be an integer, nor need it be the same from turn to turn, although it would be the same in typical implementations. Typically, as well, "s" would be less than the width of the stub at the radius, and could be zero so that the stub end in the direction of the centre axis is pointed (as indicated in FIG.3.)

Turning now to FIG.2 there is shown a side view of a stub loaded helix antenna. The helix has a pitch angle α, which is measured by taking a tangent 21 along the helix curve length and, at the point where the tangent meets the enclosing cylinder defined by the helix, taking another tangent 22 which lies in a plane perpendicular to the central axis of the helix. If the length of the central axis of the helix is "L" and the length of a single helical turn without stubs is "T_d", then

$$L = NT_d \sin\alpha = N\frac{C}{\cos\alpha}\sin\alpha = NC\tan\alpha$$

where "N" is the number of turns in the helix.

The actual length of conductor in a single turn of the stub loaded helix antenna is not "T_d" (which is the length of a helical turn without stubs). From "T_d" there must be subtracted the length corresponding to the angular width of the stubs (yielding an angular component of 2π-nβ), and then there must be added the length of conductor taken by the stubs. In the example shown in FIG. 1, the conductor length taken by each stub is

$$S_L = (2d+s)$$

Therefore, the length of conductor for each turn of the stub loaded helix antenna is

$$T_L = \frac{(2\pi - n\beta)R}{\cos\alpha} + nS_L$$

where $S_L \geq 2d$.

FIG.3 shows an oblique view of an antenna in accordance with the invention, having a stub loaded helical winding mounted on a reflector 30 in the conventional manner, with the central axis 31 of the helix being along the beam axis of the reflector. In a typical implementation of the preferred embodiment of the invention, which achieves size reduction of about one-third in diameter and one-half in length over a conventional helix antenna with comparable performance characteristics such as gain and circular polarisation, preferably the pitch angle is in the range of 7° to 9°, the number of stubs per turn may range from 3 to 15, the number of turns may range from 4-10, and the depth of stubs may range from two-thirds to three-quarters of a helix radius. The stub regions are generally wedge-shaped, and project inwardly towards the centre axis of the helix. The stubs have a depth less than the radius of the cylinder defined by the helix. The stubs also have substantially flat truncated portions at their innermost ends. Other embodiments of the invention may show different, yet still significant, levels of size reduction over a conventional helix antenna having comparable performance characteristics.

While the invention has been described in terms of a preferred embodiment, those skilled in the art will recognise that the invention can be practised with modification within the spirit and scope of the appended claims.

The claims defining the invention are as follows:

1. An antenna, comprising:

a continuous length of conductive material formed in the shape of a helix and having a plurality of stub regions along a curve length of said helix which extend towards a central axis of said helix, said helix having a non-zero pitch angle.

2. The antenna as claimed in claim 1, wherein said helix is comprised of a plurality of turn windings arranged at a pitch angle around said axis, each of said turn windings having at least one of said stub regions spaced along said curve length.

3. The antenna as claimed in either of claims 1 or 2, wherein each of said stub regions projects toward said axis to a depth less than a radius of said helix.

4. The antenna as claimed in any one of claims 1 to 3, wherein said stub depth is between two-thirds and three-fourths of said helix radius.

5. The antenna as claimed in any one of claims 1 to 4, wherein said pitch angle is in the range of 7° to 9°.

6. The antenna as claimed in any one of claims 1 to 5, wherein the number of turn windings is in the range of 3 to 15.

7. The antenna as claimed in any one of claims 1 to 6, wherein the number of stubs per turn is in the range of 4 to 10.

8. The antenna as claimed in any one of claims 1 to 7, having four stubs for each of said turn windings, each said stub having a depth of approximately three-fourths of said helix radius.

9. The antenna as claimed in any one of claims 1 to 8, wherein each of said stubs has a width at said helix curve length and is truncated towards said centre of said helix in a side having a length less than said width.

10. The antenna as claimed in any one of claims 1 to 9, wherein said length of said side is zero.

11. The antenna as claimed in any one of claims 1 to 10, additionally comprising a reflector, wherein said helix is mounted on said reflector, and wherein said centre axis of said helix is along a beam axis of said reflector.

12. An antenna, comprising:

a continuous length of conductive wire wound around a plurality of turns in a cylinder shape forming a helix having a non-zero pitch angle α, a circumference of said helix being 2π times a radius of said cylinder shape; and a plurality of wedge-shaped stub regions formed along said continuous length of said conductive wire directed toward a centre axis of said helix, said plurality of wedge-shaped stub regions having a depth less said radius of said cylinder shape.

13. An antenna as claimed in claim 12, further comprising a flat truncated portion an a far end of said plurality of wedge-shaped stub regions.

14. An antenna as claimed in either of claims 12 or 13 wherein a number of said wedge-shaped stub regions per turn is in a range 40 to 10, wherein said pitch angle α is in the range of 7° to 9°, and wherein the number of turns is in the range of 3 to 15.

15. An antenna as claimed in any one of claims 12 to 14 wherein each of said wedge-shaped stub regions has a depth of approximately three-fourths of said cylinder radius.

16. An antenna as claimed in any one of claims 12 to 15 further comprising a reflector, wherein said helix is mounted on said reflector, and wherein a centre axis of said helix is along a beam axis of said reflector.

17. An antenna, substantially as hereinbefore described with reference to the accompanying drawings.

DATED this 7th day of April 2003

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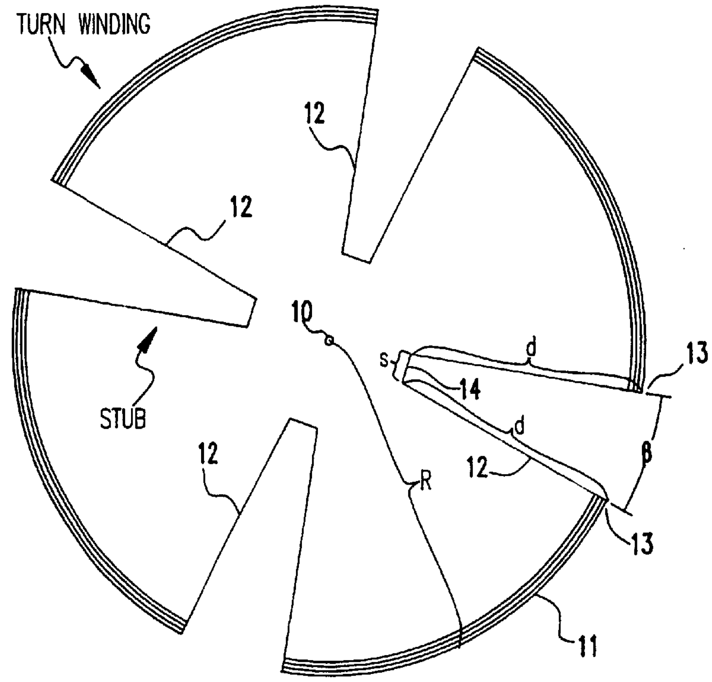

FIG.1

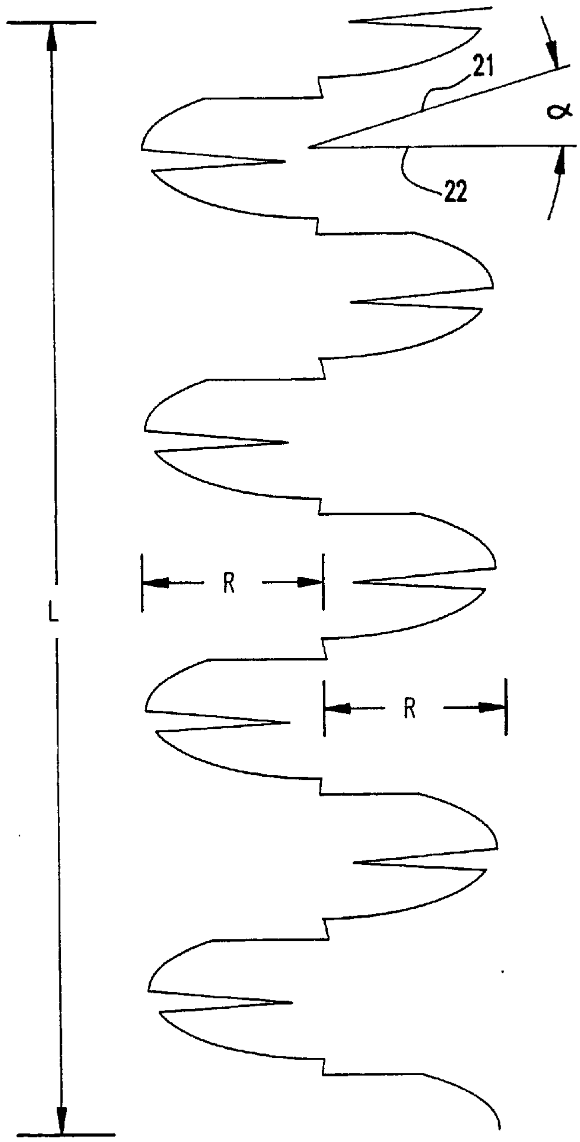

FIG.2

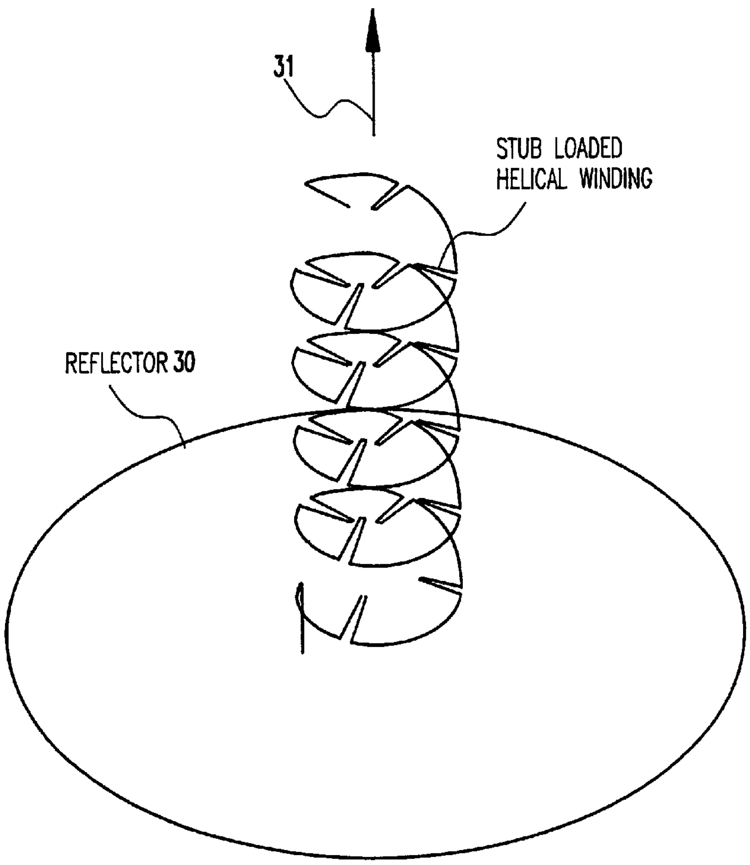

FIG.3