United States Patent

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[54] **HELICAL LAUNCHER**
6 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **343/895,** 343/843
[51] **Int. Cl.** **H01Q 1/36**
[50] **Field of Search** 343/895, 843, 874

[56] **References Cited**
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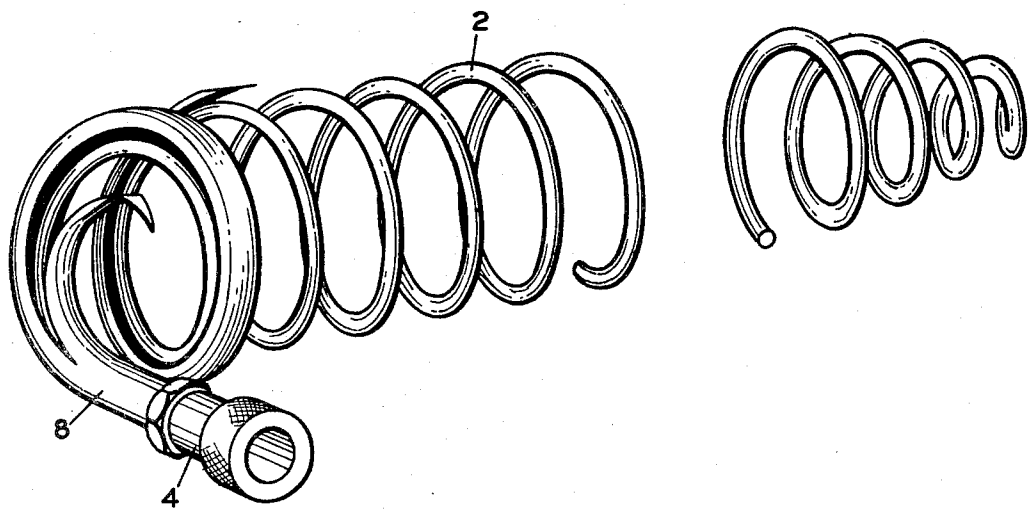
ABSTRACT: The invention is for a helical antenna assembly which utilizes a coaxial cable as a means of electrical excitation and provides a gradual transition from the coaxial cable to the helix wire to permit higher power excitation and elimination of a flat ground plane.



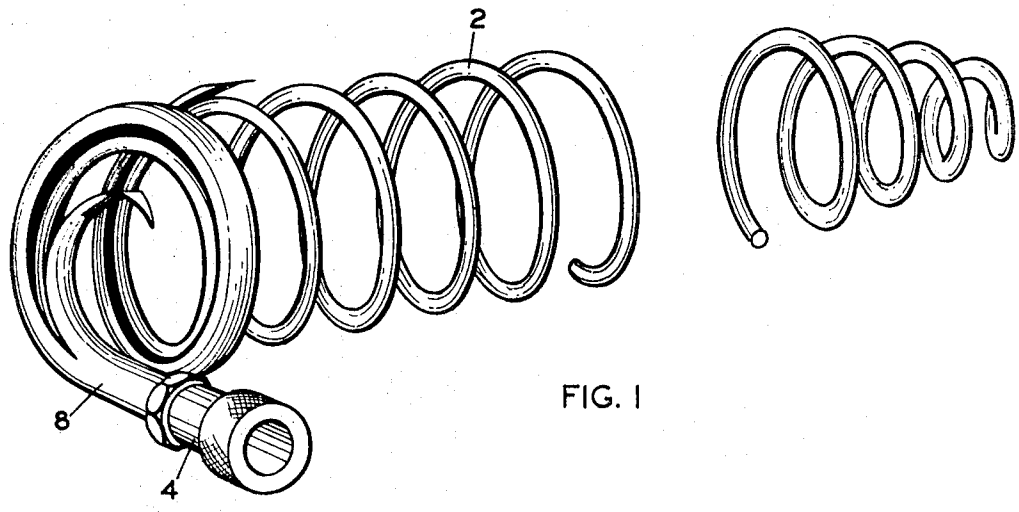


FIG. 1

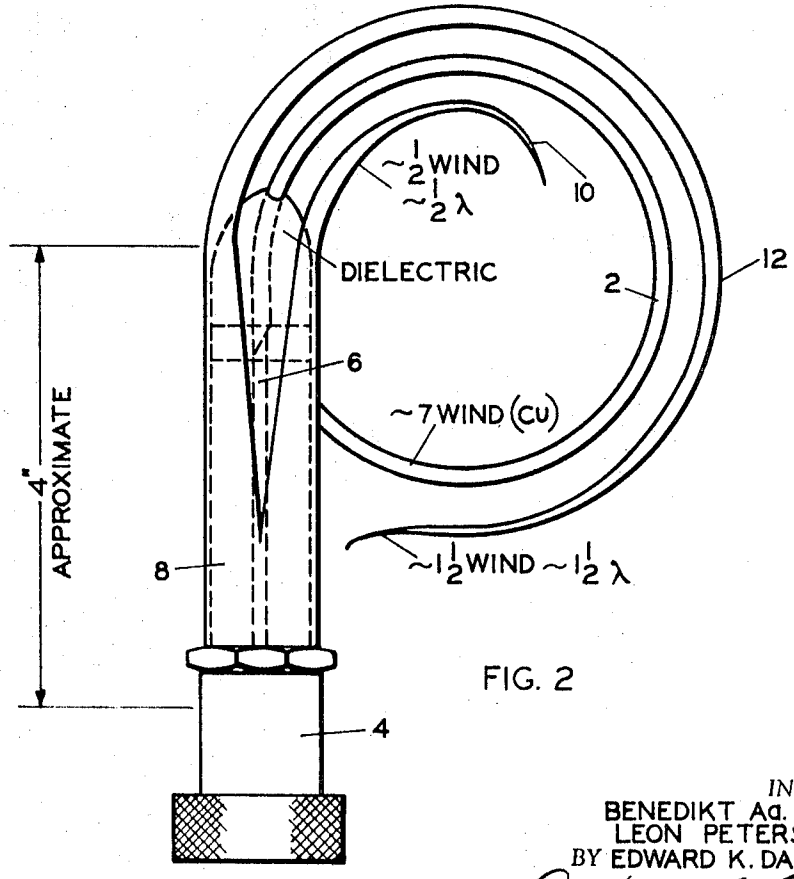


FIG. 2

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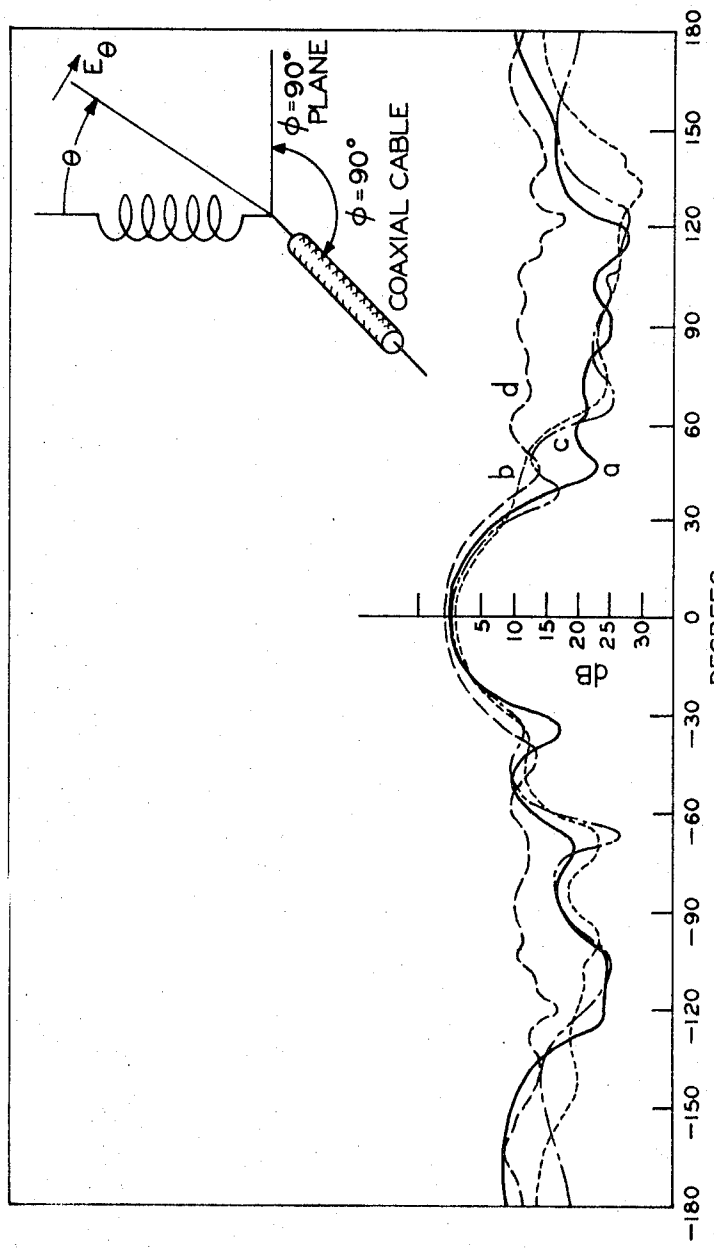

FIG. 3

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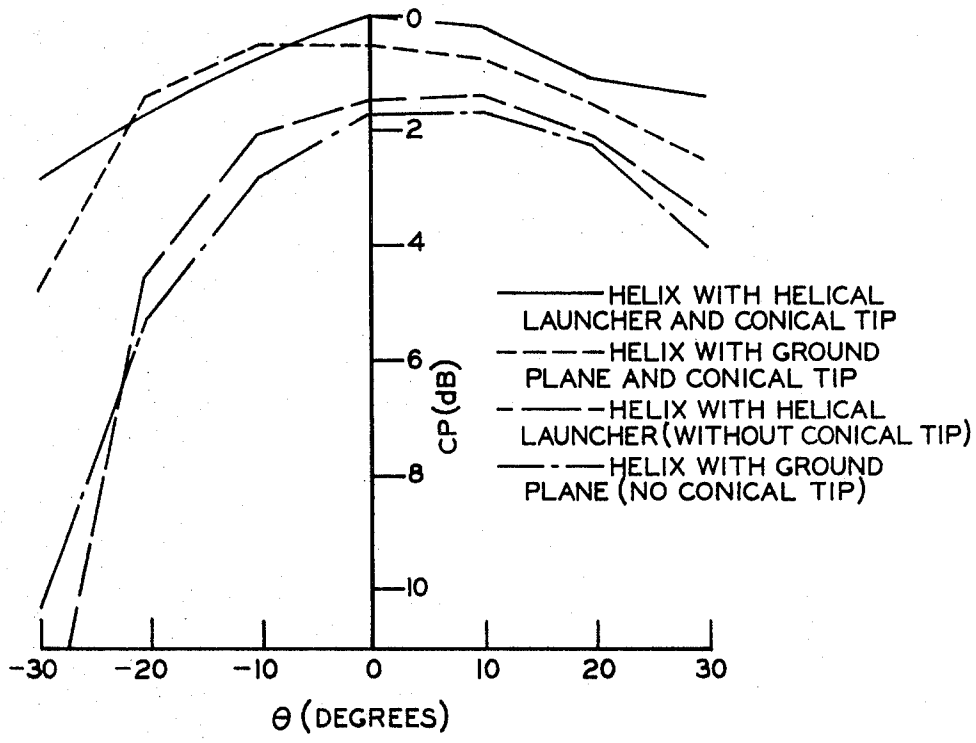

FIG. 4

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HELICAL LAUNCHER

BACKGROUND

The helical antenna is a common source of circularly polarized radiation. The helical antenna can radiate in many modes; however, the principal modes are the axial (end fire) and normal (broadside) modes. Both modes are capable of circular polarization, but the wide bandwidth (almost 2:1) of the axial mode makes it more useful than the normal mode. The normal mode operates over a relatively narrow band, and also it is less efficient than the axial mode.

The helical antenna is usually mounted above a ground plane. At microwave frequencies waveguide and dielectric rod feeds (excitation means) are the most practical. However, at lower frequencies the helix is very easily fed by a coaxial cable. Recently the ground plane has been formed into a conical horn by K. R. Carver ("Shielded End-fire Antenna," S. N. 694,139, filed Dec. 28, 1967) to provide a narrow beam antenna with low back lobes. Also the helix has been initiated with a conical transition section and terminated with a similar section to obtain an improved axial ratio.

SUMMARY OF THE INVENTION

The invention relates to a helical antenna assembly comprising a helical antenna and means to achieve reduced side beam radiation. The helical antenna utilized may be of any conventional design. The means to reduce the amount of energy radiated outside the antenna main beam has been denoted a helical launcher. The helical launcher consists of a coaxial cable from which the metal in the outer conductor has been removed over a distance of several wavelengths. This provides a gradual transition from the coaxial cable to the helical wire which is connected to the inner conductor of the cable. This launching section is then bent into the helical shape.

The present invention solves several problems previously existent in the prior art. The ground plane usually associated with the helical antenna has been eliminated altogether. This is a particular advantage in low frequency operation where the ground plane may be large physically thereby creating a size and weight limitation on its application. The main beam remains that of the original helix for those applications where the narrower beam obtained by Carver is not desirable. While the conical tip is not a part of this invention its use as a termination for the helix of the present invention produces an axial ratio of the antenna close to unity over the entire main beam. The radiation for directions other than the main beam is usually significantly lower when compared with the conventional helical antenna. Also, the usual abrupt discontinuity occurring at the end of the coaxial cable has been eliminated, and the energy launched more smoothly on the helical wire. This means that the antenna of the present invention can be operated at a higher power before breakdown occurs.

OBJECTS

It is accordingly the primary object of the invention to provide a helical launcher which significantly reduces the amount of energy radiated outside the main beam of a helical antenna.

Another object of the invention is to provide a helical launcher for the helical antenna which eliminates the ground plane.

Another object of the invention is to provide a helical launcher for the helical antenna which is simple and inexpensive to construct.

A further object of the invention is to provide a helical launcher for the helical antenna which is small in size and light in weight for low frequency operations.

A further object of the invention is to provide a helical launcher for the helical antenna which, when used in conjunction with a conical tip on the helix, permits approximately unity axial ratio over the entire main beam of the antenna.

Still a further object of the invention is to provide a helical launcher for the helical antenna which permits operation at higher power levels, without breakdown, than that achieved with a conventional helical antenna.

For a complete understanding of the invention, together with other objects and advantages thereof, reference may be made to the accompanying drawings, in which:

FIG. 1 is a perspective view of the preferred embodiment of the invention. Shown also in an unattached conical tip for the helical antenna;

FIG. 2 is a diagrammatic representation of the preferred embodiment illustrated in FIG. 1;

FIG. 3 is a graphical representation of the radiation pattern which compares the patterns produced by the preferred embodiment of FIG. 1 with the pattern of a conventional helical antenna with a flat ground plane; and,

FIG. 4 is a graphical representation of the measured axial ratio for several helical antenna configurations.

DETAILED DESCRIPTION OF THE DRAWINGS

A helical antenna is illustrated in FIG. 1 which differs from a conventional design in that the ground plane has been eliminated. The helix 2 is excited in the usual manner by a coaxial cable 4. FIG. 2 shows the manner in which the coaxial cable 4 is attached to the helical wire 2 of the antenna. The center conductor of the coaxial cable 6 is electrically attached to the helical wire 2.

There is then removed portions of the outer conductor 8 of the coaxial cable 4. This metal is removed over a distance of several wavelengths. The dimensions shown in FIG. 2 are for a RG-62 B/u coaxial cable with a brass outer conductor. This particular configuration of the preferred embodiment was used in the experimental verification of the invention.

The portion 10 of the outer conductor 8 of the coaxial cable which is internal to the helical antenna was linearly tapered to a length which was approximately one-half λ. Where λ is equal to the portion of the operating frequency. The portion 12 of the outer conductor 8 of the coaxial cable which is external to the helical antenna was linearly tapered to a length which was approximately $1\frac{1}{2}\lambda$. This portion of the coaxial cable from which material is removed forms the launching section of the helical antenna.

The combination of the launching section and the helical wire is then bent into the helical shape as illustrated in FIGS. 1 and 2. The helix of the experimental model was a 7-turn helical antenna, with a copper wire helix. Since the fields of the coaxial cable are confined to the region between the conductors, the wave essentially becomes bound to the inner conductor in this transition region. This causes the current on the outer conductor to be substantially reduced at the end of the helical launcher.

The configuration of the preferred embodiment avoids the usual abrupt discontinuity occurring at the end of the coaxial cable, and the energy is, therefore, launched more smoothly on the helical wire. The helical launcher antenna may, because of the elimination of this discontinuity, be operated at higher power levels than can be applied to a conventional helical antenna without breakdown.

Linearly polarized radiation patterns of a helical antenna excited by a conventional ground plane and by the helical launcher of the present invention are compared in FIG. 3 for two orthogonal linear polarizations, respectively. Curves *a*, *b*, and *c*, in FIG. 3, were obtained from the helical launcher antenna with the transmitting antenna at horizontal, vertical, and 45° polarization, respectively.

It is seen in FIG. 3 that the radiation for directions other than the main beam are substantially lower than that obtained with a conventional helical antenna with a flat ground plane (curve *d*). However, it is also to be noted that the main beam radiation is substantially equal for both antenna configurations. The helical launcher antenna is therefore ideally suited for applications which require a narrower beam than that ob-

tained with the conventional helical antenna. The antenna of the present invention is also substantially reduced in physical size by the elimination of the ground plane. There is also a corresponding reduction in weight, which could be substantial at low frequencies.

FIG. 4 illustrates the axial ratio that is obtained with and without a conical tip on both the helical launcher and a conventional helix with a ground plane. The axial ratio for the two different launching mechanisms was obtained by rotating a linearly polarized transmitting antenna. The axial ratio is seen to be strongly dependent on the radiation angle without the conical tip. The axial ratio is maintained close to unity over the entire main beam when the helix is terminated in the conical tip. The conical tip is not essential to the operation of the helical launcher antenna. The inclusion of measured axial ratios obtained with the conical tip is to indicate the performance of the conical tip on the helical launcher as compared with that of the ground plane and helix combination. The axial ratio is seen to be usually improved with the use of the helical launcher rather than the ground plane.

Although a certain and specific embodiment has been illustrated, it is to be understood that modifications may be made without departing from the true spirit and scope of the invention.

We claim:

1. A helical antenna including a coaxial cable as the means of electrical excitation of said antenna's helix, the improvement comprising said helix fixedly attached to the inner conductor of said coaxial cable, said coaxial cable having removed a predetermined length of the metal in said coaxial cable's outer conductor at the end of said cable coincident with said attachment of said helix, and said inner conductor having said predetermined length of said outer conductor of said coaxial cable removed therefrom formed into a helical shape conforming to that of said antenna's helix.

2. A helical antenna as set forth in claim 1 wherein said metal is removed in a tapered configuration from said outer conductor.

3. A helical antenna as set forth in claim 1 wherein said metal is linearly removed from said outer conductor.

4. A helical antenna as set forth in claim 1 wherein said metal is exponentially removed from said outer conductor.

5. A helical antenna as set forth in claim 1 wherein said outer conductor of said coaxial cable is tapered over a length of approximately one-half the wavelength of the operating frequency in that portion of said conductor which is internal to said antenna's helix.

6. A helical antenna as set forth in claim 1 wherein said outer conductor of said coaxial cable is tapered over a length of approximately 1½the wavelength of the operating frequency in that portion of said conductor which is external to said antenna's helix.