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Lockwood

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[54] **FLEXIBLE HELICAL SPRING ANTENNA**

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[51] **Int. Cl.** **H01q 1/36**

[58] **Field of Search** 343/715, 880, 881, 343/895, 900

[56] **References Cited**

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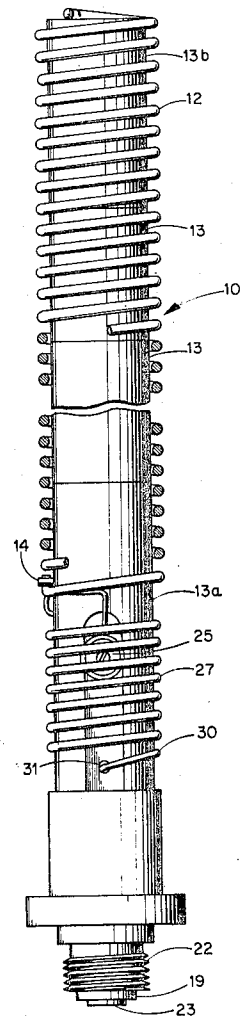
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[57] **ABSTRACT**

A flexible helical spring antenna including a helical spring member with a plurality of cylindrically shaped insulating spacers disposed centrally of the spring member to form a central core. The spring member is stretched so as to be under tension. When the antenna is bent, the force of tension in the spring member acting on the spacers tends to return the antenna to its normally assumed configuration.

6 Claims, 3 Drawing Figures



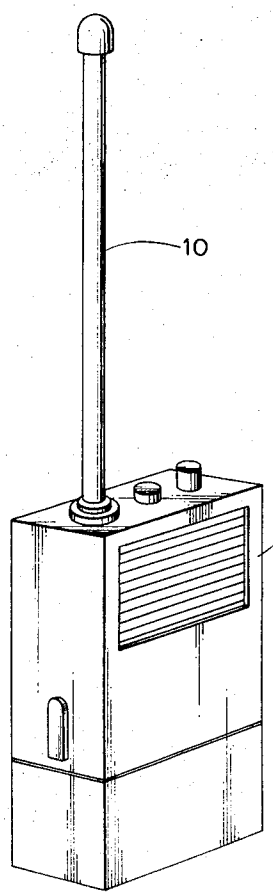


Fig. 1.

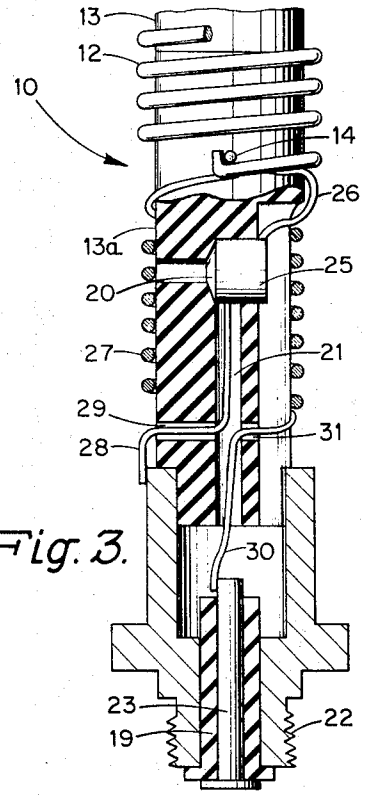


Fig. 3.

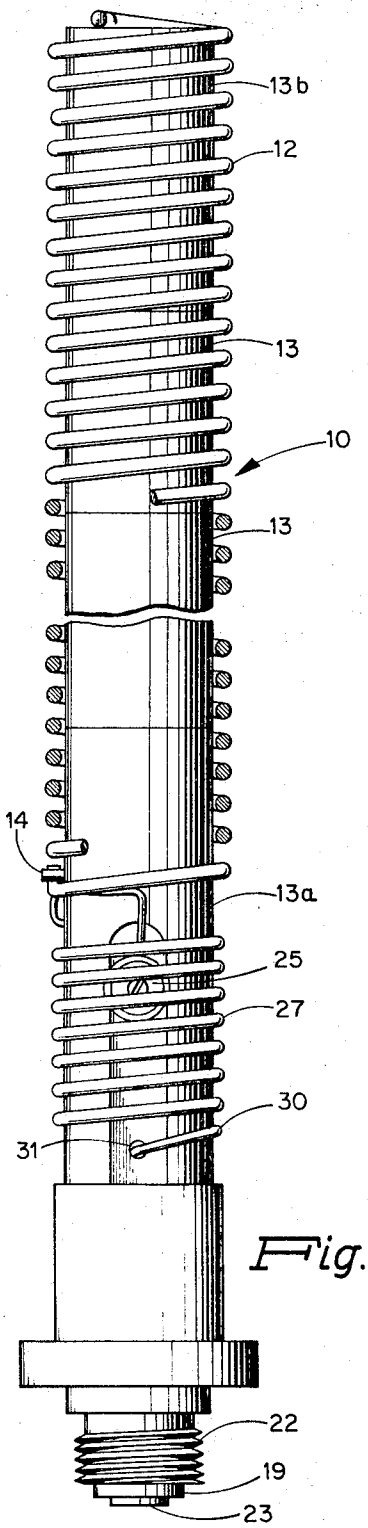


Fig. 2.

FLEXIBLE HELICAL SPRING ANTENNA

BACKGROUND OF THE INVENTION

This invention relates to antennas for radio communication equipment. More particularly, it is concerned with flexible helical antennas for use at VHF frequencies.

In the past monopole type antennas have been widely used with small hand-held radio communication equipment. Antennas of this type are satisfactory at higher frequencies in the UHF range where a quarter-wavelength radiating element is of a reasonable length. At lower frequencies in the VHF range a quarter-wavelength is relatively long making a quarter-wavelength monopole antenna impractical for use with a hand-held radio. Reducing the length of the antenna to a practical length, however, reduces its radiation efficiency and operating bandwidth.

Helical antennas which have a relatively short physical length and the electrical characteristics of a long monopole antenna are, therefore, commonly employed at low frequencies. These antennas which are essentially a helical coil of wire are rugged. If the antenna is bent out of its normal configuration, the inherent mechanical properties of the coil cause it to return to its normal configuration. However, a helical antenna designed for most efficient operation at certain VHF frequencies, for example about 40 MHz, is of such a length that its inherent physical properties are not sufficient to restore it to its proper operating configuration after flexing.

SUMMARY OF THE INVENTION

An antenna in accordance with the present invention is a completely self-supporting flexible helical spring antenna. The antenna includes a conductive helical spring member and a plurality of insulating spacers disposed centrally of the conductive helical spring member and forming a central core which is longer than the normal unstretched length of the conductive helical spring member. One end of the conductive helical spring member is fixed to the first spacer of the central core and the other end is fixed to the last spacer of the central core. Thus the conductive helical spring member is stretched and placed under tension. The plurality of insulating spacers of the central core permit the assembly to be flexed from its naturally assumed configuration and the force of the conductive helical spring member under tension acts to restore the assembly to its naturally assumed configuration after it has been flexed.

BRIEF DESCRIPTION OF THE DRAWINGS

Additional objects, features, and advantages of flexible helical spring antennas in accordance with the present invention will be apparent from the following detailed discussion together with the accompanying drawings wherein:

FIG. 1 is a perspective view of hand-held radio communication equipment employing an antenna in accordance with the present invention;

FIG. 2 is an elevational view of an antenna in accordance with the invention with portions broken away; and

FIG. 3 is an elevational view partially in cross-section illustrating the lowermost portion of the antenna of FIG. 2 at 90° from the showing in FIG. 2.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 illustrates an antenna 10 in accordance with the present invention shown mounted in position in radio communication equipment 11. The antenna is shown in detail in FIGS. 2 and 3 with a protective sleeve of silicone tubing removed. The antenna 10 includes a helical spring member 12. A plurality of individual cylindrically-shaped spacers 13 of insulating material are disposed within the spring member 12 to provide a central core. The total length of the spacers is longer than the normal length of the spring member. The spring member 12 and the insulating spacers 13 are assembled with the spring member 12 stretched so as to be under tension. The upper end of the spring member 12 is turned inward to bear against the upper surface of the last spacer 13*b*, and the lower end is held in position by a pin 14 fixed to the first spacer 13*a*. The length of the spacers between the pin 14 and the upper surface of the last spacer 13*b* is greater than the normal length of the spring member thus stretching the spring member and maintaining it under tension.

By virtue of the cylindrical shape of the spacers 13 and the tension in the spring member 12 acting on the spacers, the assembly naturally assumes a configuration as shown in the figures with the central axis of the assembly along a straight line. When the antenna is flexed, adjacent spacers pivot about points of contact at their peripheral edges. When the force bending the antenna out of its normally assumed configuration is removed, the force of tension in the spring member acting on the spacers immediately restores the assembly to its normally assumed configuration with the peripheral edges of adjacent spacers in contact. The spacers are of suitable size so that they remain confined within the spring member when the antenna is flexed.

The first insulating spacer 13*a* includes a rigid section extending below the spring member 12. A lateral recess 20 is provided in this rigid section and a passageway 21 extends centrally of the section from the recess to the bottom end. Fixed to the lowermost end of the rigid section of the first spacer 13*a* is a conductive mounting member 22 which is threaded to mate with a mating receptacle in the radio equipment 11. A center pin electrical contact 23 is positioned within a cylindrical insulator 19 fixed to the bottom end of the mounting member 22 and extends through a central opening in the mounting member. When the mounting member 22 is threaded into the receptacle in the radio equipment 11, the center contact member 23 makes electrical connection with an antenna contact and the threaded portion of the mounting member 22 contacts a ground connection.

An electrical matching network which may include the combination of a resistance in shunt with a variable capacitance 25 and a coil 27 is mounted on the first insulating spacer 13*a* below the spring member 12. The resistance-capacitance combination 25 is located in the recess 20 and the coil 27 encircles the spacer 13*a*. A lead wire 28 providing an electrical connection from the resistance-capacitance combination 25 passes through the passageway 21 and a lateral opening 29 in the spacer 13*a*. The lead wire 29 is connected to the mounting member 22 to provide a ground connection. Another electrical lead 26 from the resistance-capacitance combination 25 is connected to the lowermost turn of the spring member 12. The upper end of

the coil 27 is also connected to the lowermost turn of the spring member 12. The lower end of the coil 27 is connected to the center contact 23 by a lead wire 30 which passes through a lateral opening 31 and the passageway 21 in the spacer 13*a*. Thus, the coil 27 is in series with the helical antenna member 12 and the electrical contact 23, and the resistance-capacitance combination 25 is in series with the antenna and ground.

The antenna may be covered with a protective sleeve of silicone tubing and provided with a protective tip at the upper end as illustrated in FIG. 1.

A specific example of an antenna in accordance with the foregoing description which was employed for use at 40 MHz included a helical spring member of 135 turns of 0.067 inch diameter copper-plated spring steel wire. The internal diameter was approximately 0.375 inch and its length was approximately 9 inches. The spacers of the central core were of glass filled epoxy. The spacers were 0.365 inch in diameter and except for the first and last were one-half inch in length. Twenty-four spacers were provided in the central core and the spring member was stretched to a length of about 12 inches. The resulting assembly provided a radiating antenna element having satisfactory electrical characteristics while also providing a mechanically rugged, flexible, self-supporting structure which quickly returned to its proper naturally assumed configuration after flexing.

While there has been shown and described what is considered a preferred embodiment of the present invention, it will be obvious to those skilled in the art that various changes and modifications made be made therein without departing from the invention as defined in the appended claims.

What is claimed is:

1. A flexible helical spring antenna comprising

a conductive helical spring member;

a plurality of insulating spacers disposed centrally of the conductive helical spring member and forming a central core longer than the normal unstretched length of the conductive helical spring member;

one end of the conductive helical spring member being fixed to the first of the plurality of insulating spacers and the other end of the conductive helical spring member being fixed to the last of the plurality of insulating spacers to stretch the conductive helical spring member and place it under tension;

the conductive helical spring member stretched on said central core providing a radiating antenna element; and

the plurality of insulating spacers of the central core permitting the assembly to be flexed from its naturally assumed configuration and the force of the conductive helical spring member under tension acting to restore the assembly to its naturally assumed configuration after being fixed.

2. A flexible helical spring antenna in accordance with claim 1 wherein

the insulating spacers positioned intermediate the first and last of the plurality of spacers are of cylindrical shape, are arranged coaxial with the central axis of the conductive helical spring member, and are of size to be confined within the stretched conductive helical spring member.

3. A flexible helical spring antenna in accordance with calim 2 wherein

adjacent insulating spacers of said plurality are in contact at their peripheral edges with the surfaces in contact between each two adjacent spacers lying in a plane generally normal to the central axis of the conductive helical spring member.

4. A flexible helical spring antenna in accordance with claim 3 including

a rigid section fixed with respect to the first of the plurality of insulating spacers and extending beyond the conductive helical spring member along the direction of the central axis of the conductive helical spring member;

said rigid section having a mounting portion at the end thereof adapted for engagement with a mating receptacle in radio communication equipment.

5. A flexible helical spring antenna in accordance with claim 4 wherein

said mounting portion includes a conductive outer section and a central electrical contact at the end of the mounting portion, the central electrical contact being insulated from the conductive outer section;

said conductive outer section and said central electrical contact being adapted to make electrical connection with electrical contacts in a mating receptacle;

and including

a recess in said rigid section intermediate the mounting portion and the conductive helical spring member;

electrical elements mounted on said rigid section and in said recess;

openings in said rigid section intermediate the mounting portion and the conductive helical spring member;

electrical connections passing through said openings and connecting the electrical elements to the conductive outer section and to the central electrical contact of said mounting portion; and

electrical connections connecting the electrical elements to the conductive helical spring member.

6. A flexible helical spring antenna in accordance with claim 5 wherein

the conductive helical spring member is formed of copper-plated spring steel wire; and

the insulating spacers are of glass filled epoxy.

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