

[54] **ELECTRICALLY SMALL RESONANT ANTENNA WITH CAPACITIVELY COUPLED LOAD**

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[22] Filed: **Feb. 15, 1974**

[21] Appl. No.: **442,933**

[52] U.S. Cl. .... **343/708, 343/807, 343/895**

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

[58] Field of Search ..... 343/705, 708, 752, 807, 343/828, 829, 830, 846, 895

[56] **References Cited**

**UNITED STATES PATENTS**

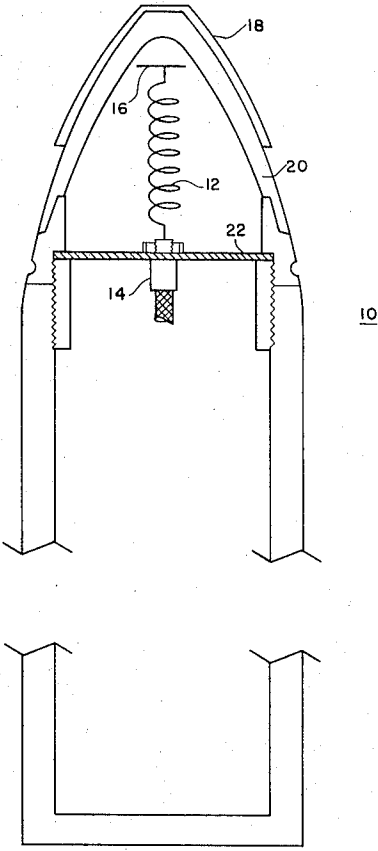
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[57] **ABSTRACT**

An antenna having dimensions as small as 0.03 wavelength of the wavelength to be received comprising a helix wire having a loading disc attached to one end and an RF connector attached to the other. The connector shield is mounted on a grounded disc and a conductive member is electrically associated with, but spaced from the loading disc.

**10 Claims, 2 Drawing Figures**



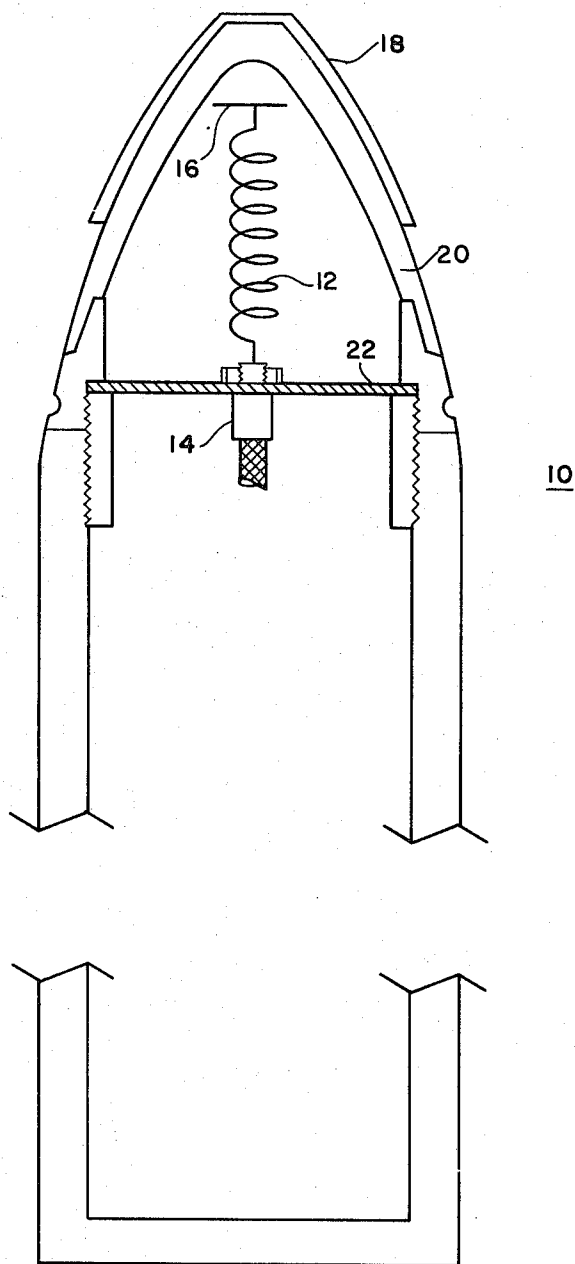


Fig. 1

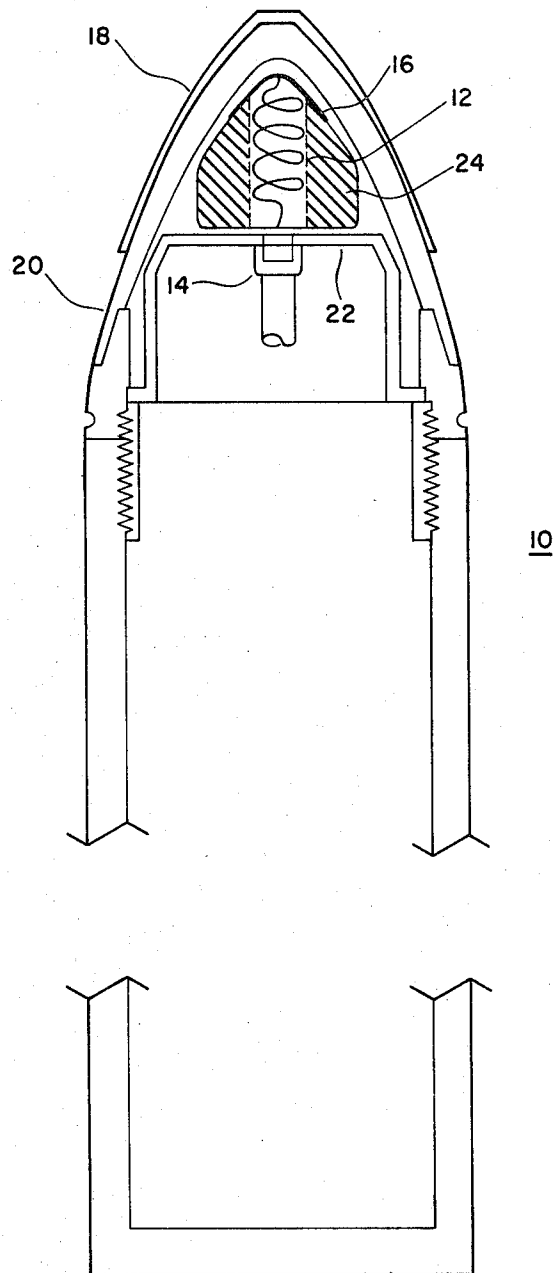


FIG. 2

# ELECTRICALLY SMALL RESONANT ANTENNA WITH CAPACITIVELY COUPLED LOAD

## BACKGROUND OF THE INVENTION

In the antenna field, there are many possible applications, and a pressing need, for electrically small antennas. Standard antenna elements become essentially inoperative when their dimensions become less than 0.1 wavelengths. That is, when the dimensions of the antenna become less than 1/10 the wavelength to be received, or sent, they become highly inefficient. The present invention, on the other hand, provides efficient operation with dimensions as small as 0.03 wavelengths.

The present invention may be used anywhere a small antenna is desired or required, such as in the restricted volume of the nose cone of a missile or projectile. The antenna may be designed for any frequency, but is especially beneficial at the lower frequencies where standard antenna elements are relatively large.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a first embodiment of the present invention; and

FIG. 2 is a plan view of a second embodiment of the present invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

The first preferred embodiment of the present invention is shown in FIG. 1. The embodiment is shown incorporated in the nose cone of a missile 10, as an example of one possible application of the present invention. The embodiment comprises a wire helix 12 as an extension of the inner conductor of coaxial cable 14. The free end of helix 12 terminates in a loading disc 16 which may be in the shape of a circular disc, a square or rectangular plate, a cone as shown in the second embodiment, or in any other shape designed for the intended application, including the wheel and spoke design shown in U.S. Pat. No. 3,573,840 entitled "Small Bulk Helically Wound Antennae And Method For Making Same" by R. L. Gouillou et al.

Helix 12 and loading disc 16 are electrically associated with cone 18 which is attached, such as by plating, to the exterior surface to nose cone 20. Nose cone 20 may be the nose cone designed for the missile 10, or may be specially designed to incorporate conductive cone 18. In most applications, nose cone 20 will be Teflon, some form of low loss plastic, or other material chosen for its ability to transmit the frequency of interest. Cone 18 is electrically associated with helix 12 and loading disc 16, as mentioned above, but is not physically connected thereto, although it is an integral part of the antenna.

The other conductor of coaxial cable 14 is connected to ground plate 22. When the antenna is employed in a missile, the body of missile 10, which is usually metallic and conductive, may be coupled to ground plate 22 to provide an increase in the apparent ground plate for the antenna.

Electrically, the antenna resembles a dipole wherein the outer conductor of the coaxial cable is connected to one element of the dipole comprising the shell of missile 10 and ground plate 22. The inner conductor of coaxial cable 14 is connected to the other element of the dipole which in this case comprises helix 12, load-

ing disc 16 and conductive cone 18. In a dipole antenna the elements are chosen for the wavelength of interest, and must be equal in electrical length as seen at their terminals for optimum operation. This invention though assymetrical in configuration greatly improves the ratio of the dipole elements by increasing the electrical length of the short (helix) side.

If prior techniques were utilized in an attempt to provide a small, resonant, helical antenna, the simulated dipole would fail to radiate significantly. The failure results from the antenna's inability to set up sufficient resonant currents in the radiating elements. The antenna would also fail as a receiving antenna for the same reason, i.e., the antenna's insufficient electrical length to develop and maintain a resonant current of significant value at the frequency of interest.

All electrically small antennas characteristically have a high value of capacitive reactance. A helical antenna is a series of turns of wire that adds inductance to the circuit when the antenna is exposed to alternating currents, such as are employed in transmitting and receiving. By adding capacitance to the circuit, it becomes LC tunable to achieve a resonant condition. In the present invention, the "top hat" 16 connected to the free end of helix 12 decreases the capacitive reactance of the antenna and permits radio frequency coupling to conductive cone 18 on the exterior of dome 20. Thereby, the resonant tuned circuit is able to excite the entire shell body of the missile 10, which becomes the radiating antenna. The radiating pattern of the equivalent dipole has its maximum beam broadside to the shell, with nulls along the shell axis.

FIG. 2 shows an embodiment that is designed for a space even smaller than that intended for the embodiment of FIG. 1. The further reduction in size is achieved by additionally decreasing the capacitive reactance. As before, the interior conductor of coaxial cable 14 is directly connected to helix 12 which terminates in "top hat" 16. Although loading disc 16 is normally flat it may be shaped to fit the container in which it is to be placed to further reduce the volume filled by the antenna. As before, conductive cone 18 on dome 20 is electrically coupled to helix 12 and loading disc 16. The outer conductor of the coaxial cable 14 is connected through ground plate 22 to the shell of the container 10.

The capacitive reactance is additionally reduced by including dielectric cylinder 24 around helix 12. As the capacitive reactance is decreased the physical length of helix 12 necessary to attain resonance is also decreased. The dielectric cylinder, which should be of a high K material, decreases the capacitive reactance ( $\frac{1}{2}\pi fC$  where C is capacitance) by increasing the capacitance appearing in the circuit. The effect is to increase the effective length of helix 12. By reducing the capacitive reactance, the original antenna may be operated at a lower frequency. Or, a smaller helix 12 may be used for operation at the same frequency. The addition of the dielectric does, however, absorb some of the power which reduces the antenna gain.

A primary advantage of the present invention over the prior devices is that antennas having dimensions less than 1/10 wavelength are attainable. For other frequencies the antenna is changed by simply scaling the dimensions of the invention for the wavelength of interest. In addition to the possible reduction of size, another advantage is a substantial increase in gain attain-

able. The combination of the resonant helix and RF coupling to the external cone has demonstrated gain increases of from 5 to 20 dB over other configurations of equal size.

What is claimed is:

1. A physically small resonant antenna designed for utilization in applications having a relatively small volume in which to position an antenna for the wavelength to be transmitted or received, comprising:

an electrically conductive helical member having first and second opposite ends;

means for reducing the capacitive reactance of said antenna, including first and second electrically conductive members wherein said members are physically spaced apart and the first member is coupled near the first end of said helical member;

circuit means for processing an electrical signal, having at least first and second terminals;

a coaxial member having a plurality of electrically conductive elements wherein the first element couples said circuit means to the second end of said helical member; and

an electrically conductive enclosure containing said circuit means and said coaxial member, wherein the second terminal of said circuit means is coupled by the second element of said coaxial member to said enclosure;

such that said antenna is a dipole antenna having first and second arms wherein the apparent electrical length of the first arm sufficiently approximates the electrical length of the second arm so that said antenna operates as a dipole antenna for the chosen frequency of interest.

2. The antenna of claim 1 wherein the first member of said reactance reducing means is an element having

a circular profile which is attached at its center to said helical member.

3. The antenna of claim 2 wherein said enclosure is a missile body including a ground plate to which said coaxial member is attached and said second element of said coaxial member is electrically connected, and through which said first element of said coaxial member passes to said helical member, wherein said missile body also includes an electrically non-conductive shroud in covering relationship to said helical member and the first member of said reactance reducing means.

4. The antenna of claim 3 wherein the second member of said reactance reducing means is on the outer surface of said shroud with respect to the first member of said reducing means.

5. The antenna of claim 4 wherein said coaxial member is a coaxial cable having its inner conductor connected to said helical member and its outer conductor connected to said ground plate.

6. The antenna of claim 5 including an annular member having a high dielectric constant surrounding said helical member.

7. The antenna of claim 6 wherein the first member of said reducing means is a cone.

8. The antenna of claim 6 wherein the first member of said reducing means is a disc.

9. The antenna of claim 6 wherein the first member of said reducing means is a plurality of arms radiating at right angles to the helical member, connected to one another at their outermost extremity by a circular ring.

10. The antenna of claim 6 wherein the length of said antenna is less than one-tenth the wavelength of the electrical signal, and the antenna and circuit means form a radar.

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