(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 833 116 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
12.09.2007 Bulletin 2007/37

(51) Int Cl.:
H01Q 11/08 *(2006.01)* ***H01Q 1/36*** *(2006.01)*

(21) Application number: **07075467.6**

(22) Date of filing: **24.05.2005**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU MC NL PL PT RO SE SI SK TR

(30) Priority: **26.05.2004 US 574520 P**
30.11.2004 US 999385

(62) Document number(s) of the earlier application(s) in accordance with Art. 76 EPC:
05076197.2 / 1 601 050

(71) Applicant: **Delphi Technologies, Inc.**
Troy, Michigan 48007 (US)

(72) Inventors:
- **Yegin, Korkut**
  Grand Blanc, MI 48439 (US)
- **Morris, Daniel G.**
  Ovid, MI 48866 (US)
- **Livengood, William R.**
  Grand Blanc, MI 48439 (US)

(74) Representative: **Denton, Michael John et al**
Delphi European Headquarters,
64 avenue de la Plaine de France,
Paris Nord II,
B.P. 65059, Tremblay en France
95972 Roissy Charles de Gaulle Cedex (FR)

Remarks:
This application was filed on 13 - 06 - 2007 as a divisional application to the application mentioned under INID code 62.

(54) Quadrifilar helical antenna

(57) An antenna (13) having a plurality of elongated conductors (18) is disclosed. The elongated conductors (18) have a substantially straight portion (26) and a substantially helical portion (28).

Printed by Jouve, 75001 PARIS (FR)

Description

TECHNICAL FIELD

[0001] The present invention relates generally to antenna systems for satellite digital audio radio service and more specifically to a quadrifilar helical antenna used in satellite digital audio radio service communications.

BACKGROUND OF THE INVENTION

[0002] Communications between terrestrial devices such as radios and earth-orbiting satellites are well known. A commercial application of these satellite systems is satellite digital audio radio service (SDARS). SDARS systems broadcast high quality uninterrupted audio through satellites and earth-based stations. SDARS systems typically include an antenna with a low-noise amplifier and a receiver. The antenna initially receives encoded signals from the satellites and/or terrestrial transmitters. The amplifier, which is conventionally housed within the antenna, amplifies the received signal. The receiver decodes the transmitted signal and provides the signal to the radio.

[0003] Referring to Figure 1, a simplified block diagram of a typical satellite digital audio radio service (SDARS) system is shown. An Earth-orbiting satellite 11 broadcasts SDARS signals. The SDARS signals may be received by a SDARS-receiving device 14, such as a radio (shown) or a television (for example), and/or they may be received by stationary transmitters 12. The terrestrial transmitters 12 re-broadcast the SDARS signals, which may then be received by SDARS-receiving devices 14. The SDARS-receiving device includes an antenna (not shown in Figure 1) to receive the broadcast SDARS signals. Typical SDARS-receiving devices further include other components, such as an amplifier, receiver, speakers, etc. to convert the SDARS signals into audible sounds and/or visual images.

[0004] Terrestrial SDARS-receiving devices commonly use a quadrifilar helix antenna to receive SDARS signals. An exemplary known quadrifilar helix antenna is shown in Figure 2. The illustrated quadrifilar helix antenna 16 includes four conductive elements 18a - 18d, such as electrically-conductive wires, arranged to define two separate helically twisted loops. Each of the loops is connected between an antenna feed and a ground plane, and the conductive elements each fold over itself at a distal point from the antenna feed and the ground plane to form a loop, as shown in Figure 1. The two conductive elements of a quadrifilar helix antenna 16 are excited in phase quadrature. That is, each conductive element is excited at a 90° phase shift from the adjacent conductive element.

[0005] Conventional quadrifilar helix antennas used in SDARS-receiving devices have a number of disadvantages. Known quadrifilar helix antennas are most effective when receiving signals from a satellite at zenith. Known quadrifilar helix antennas are typically less effective at receiving SDARS signals transmitted from low elevation satellites and from stationary terrestrial transmitters. As a result, some SDARS-receiving devices include a second antenna dedicated to receiving SDARS signals from stationary terrestrial transmitters. Further, known quadrifilar helix antennas have limited utility for portable and/or wearable SDARS-receiving devices, such as personal radios, headphones, etc. The interference created by the human body degrades the ability of conventional quadrifilar helix antennas to receive SDARS signals. Moreover, the fact that known quadrifilar helix antennas require a relatively large ground plane makes using such antennas in portable/wearable devices impractical.

[0006] The embodiments described below were developed in light of these and other disadvantages of known quadrifilar helix antennas.

SUMMARY OF THE INVENTION

[0007] An antenna for receiving satellite digital audio radio service (SDARS) communications is disclosed. The antenna has a plurality of elongated conductors. The elongated conductors have both a straight portion and a helical portion.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Figure 1 generally illustrates an Earth-orbiting satellite, a terrestrial transmitter, and an SDARS-receiving device.

Figure 2 is an illustration of a known quadrifilar helix antenna.

Figures 3A and 3B illustrate different embodiments of a quadrifilar helix antenna according to an embodiment of the present invention.

Figure 4 illustrates an exemplary embodiment of a portable SDARS-receiving system that incorporates a quadrifilar helix antenna, according to the embodiments disclosed herein.

detailed Description

[0009] Figure 3A illustrates an embodiment of a quadrafilar helix antenna 13 for an SDARS-receiving device. Antenna 13 includes a plurality of elongated conductors 18a - 18d, such as copper wires for example. The conductors 18 are mounted in a mylar base 29, though other types of mounting structures could be used. Each conductor 18 has a substantially straight portion 26a - 26d near the base 29 (shown in Figures 3A and 3B as extending directly from the base 29) and a substantially helical portion 28a - 28d thereafter. The helical portion 28a - 28d of each conductor 18 further extends away from the base 29. In Figure 3A, the straight portion 26a - 26d is shown as significantly shorter than the helical portion 28a - 28d. The respective lengths of the straight portion 26a - 26d and the helical portion of the conductors 18 may be adjusted relative to each other to optimize signal reception. At the point of the antenna 13 most distal from the base 29, the conductors 18 are electrically connected together by a substantially circular conductor 20, such as a copper wire. The conductors 18 together approximately define a hollow cylinder shape. The elongated conductors may wrap around a solid core material, such as a dielectric 22, which may be a ceramic material for example.

As shown in Figure 3A, antenna 13 may be electrically coupled to a phasing network at the base 29. The phasing network includes a substrate 27 and a conductive transmission line 30, which electrically couples antenna 13 to other components in an SDARS-receiving device, such as an amplifier (not shown). The phasing network may excite conductors 18 in phase quadrature as is known in the art.

[0010] Figure 3B illustrates another embodiment of antenna 13. In this embodiment, conductors 18 are capacitively loaded, which enables the antenna 13 to be tuned to a particular frequency. Conductors 18 may be capacitively loaded by including a break in one or more of the conductors 18 and maintaining the ends of the conductor at the point of the break in close proximity to each other, as shown at segment A of Figure 3B. This structure effectively creates a capacitive effect at the point of the break (segment A). The voltage differential across the break (segment A) tunes the antenna 13. Other known methods for capacitively loading and/or tuning antenna 13 may also be used.

[0011] The embodiment of antenna 13 in Figure 3B further includes conductive tuning stubs 24 coupled to conductors 18. Tuning stubs 24 enable impedance matching between the antenna 13 and other proximate components, such as an amplifier, which improves transmission of the SDARS signal from the antenna to other components, such as an amplifier. The impedance of the antenna 13 may be adjusted by varying the length of the tuning stubs 24a - 24d.

[0012] The above-described embodiments have resulted in the ability to reduce the overall length and volume of the antenna 13 relative to known SDARS antennas. Further, the described configurations have demonstrated increased reception efficiency, including reception of signals from relatively low-elevation satellites and stationary terrestrial transmitters. Additionally, the described configurations have demonstrated less susceptibility to interference from human bodies, thus better enabling them to be used in SDARS-receiving devices configured to be used in close proximity to human bodies, such as personal wearable radios for example. In certain embodiments - for example, when the disclosed SDARS antenna is used in connection with a portable and/or wearable SDARS-receiving device- a hollow bore may be made longitudinally through the dielectric core 22. Audio wires, such as for headphones, may be routed through the bore, causing the antenna to appear to be coupled "around" the headphone wire, which improves the aesthetics of the SDARS-receiving device. As shown in Figure 4, the antennas 13 described herein can be configured to allow audio wires to pass there through to electrically couple, for example, ear phones 42 to a primary housing 40 (housing an amplifier, receiver, etc.).

[0013] Various other modifications to the present invention may occur to those skilled in the art to which the present invention pertains. Other modifications not explicitly mentioned herein are also possible and within the scope of the present invention. It is the following claims, including all equivalents, which define the scope of the present invention.

Claims

1. A portable SDARS-receiving device, comprising:

a primary housing unit (40);
at least one ear phone (42) electrically coupled to said primary housing using by an audio wire; and
an antenna (13), said antenna (13) comprising:

a plurality of elongated conductors (18) together forming a substantially cylindrical shape;
said elongated conductors (18) having a substantially straight portion (26) and a substantially helical portion (28); and
a substantially circular conductor (20) electrically coupled to said elongated conductors (18);

wherein said antenna (13) is positioned between said primary housing unit (40) and said ear phone (42) such that said audio wire passes through said substantially cylindrical shape defined by said elongated conductors (18).

2. The SDARS-receiving device of claim 1, further comprising:

a solid core (22) within said substantially cylindrical shape defined by said elongated conductors (18), said solid core (22) having a longitudinal bore therethrough; and

wherein said audio wire passes through said longitudinal bore.

3. The SDARS-receiving device of claim 1, wherein said elongated conductors (18) are coupled to and extend from a base (29).

4. The SDARS-receiving device of claim 3, wherein said substantially circular conductor (20) electrically couples said elongated conductors (18) together at a distal end from said base (29).

5. The SDARS-receiving device of claim 3, wherein said substantially straight portion (26) is positioned between said base (29) and said substantially helical portion (28).

6. The SDARS-receiving device of claim 1, wherein said substantially straight portion (24) is shorter than said substantially helical portion (28).

7. The SDARS-receiving device of claim 1, wherein said elongated conductors (18) are wrapped around a solid core (22).

8. The SDARS-receiving device of claim 7, wherein said solid core (22) includes a longitudinal bore therethrough.

9. The SDARS-receiving device of claim 7, wherein said solid core (22) comprises a dielectric material.

10. The SDARS-receiving device of claim 1, wherein said elongated conductors (18) are capacitively loaded.

11. The SDARS-receiving device of claim 1, further comprising tuning stubs (24) coupled to said elongated conductors (18).

12. The SDARS-receiving device of claim 1, further comprising a phasing network that is electrically coupled to said elongated conductors (18).

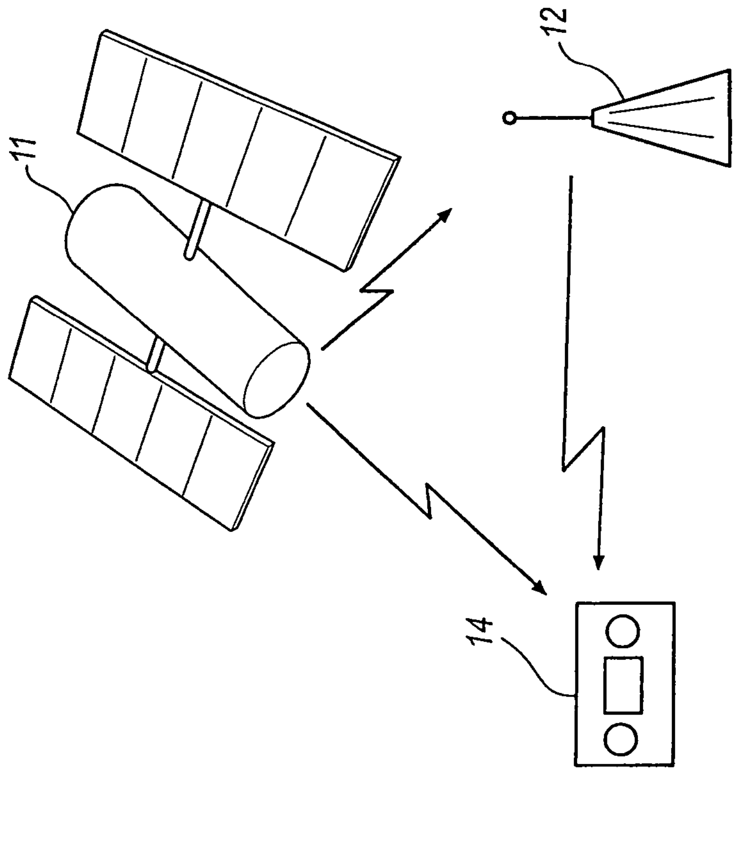

Fig.1.

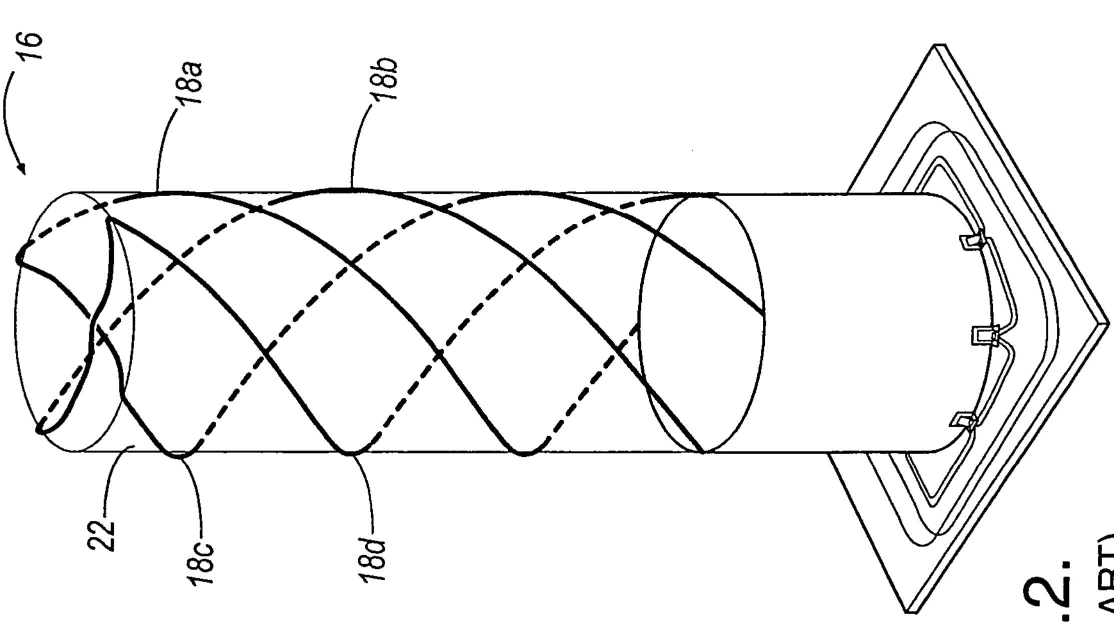

Fig.2.
(PRIOR ART)

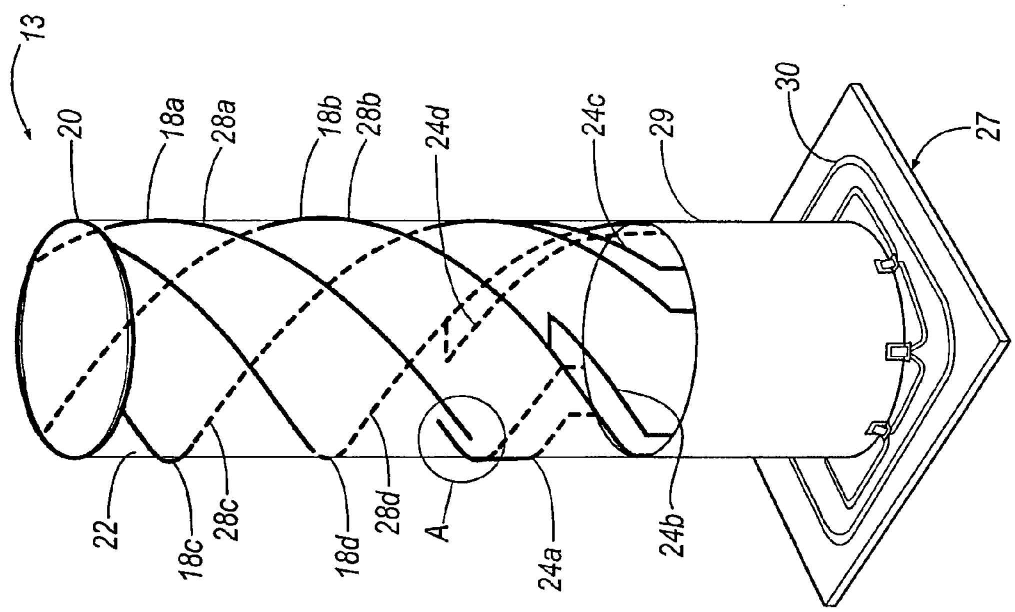
13
20
18a
28a
18b
28b
24d
24c
29
30
27
22
18c
28c
18d
28d
A
24a
24b

Fig.3B.

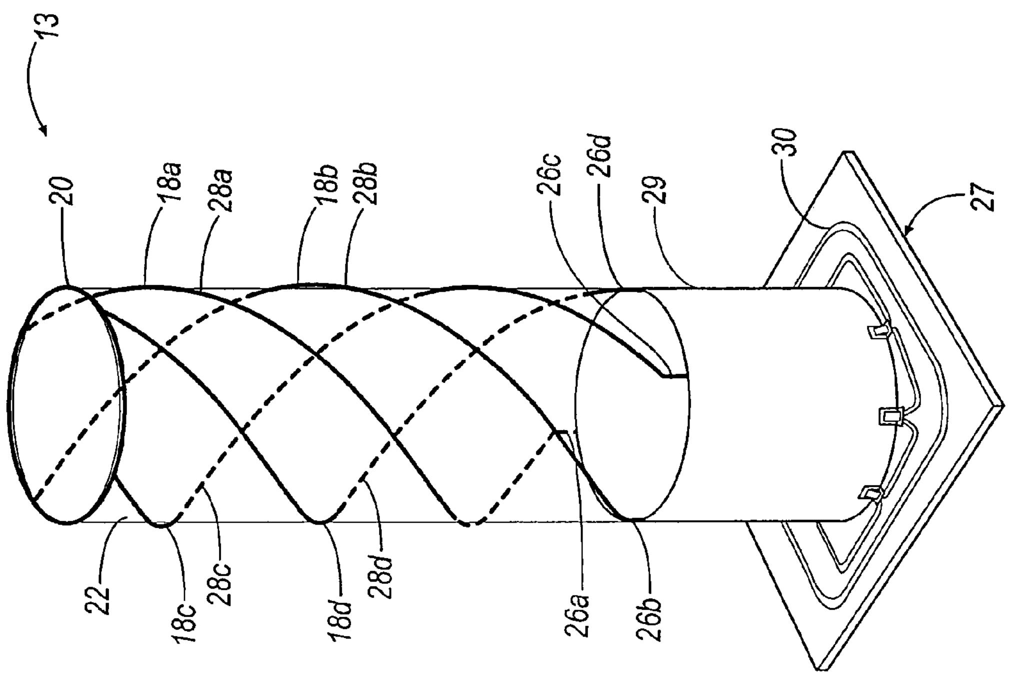
13
20
18a
28a
18b
28b
26c
26d
29
30
27
22
18c
28c
18d
28d
26a
26b

Fig.3A.

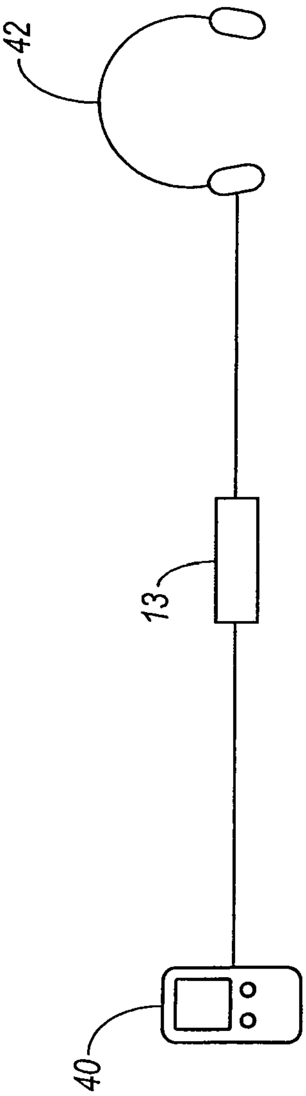

Fig.4.