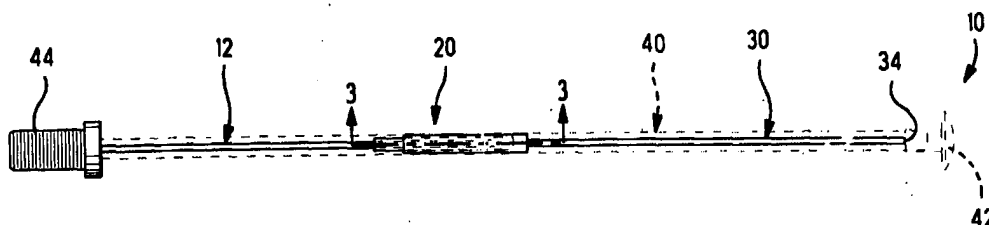




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(54) Title: MULTIPLE BAND WHIP ANTENNA**(57) Abstract**

This invention is directed to a multiple band whip antenna (10) having a first conductor (12), a second conductor (30) having a socket portion (26) at one end thereof, and disposed over an end of the first conductor (12). The socket portion (26) is electrically isolated from the first conductor (12) by the dielectric member (22). In the assembled antenna, the first and second conductors (12, 30) extend along a common axis.

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MULTIPLE BAND WHIP ANTENNA

This invention is directed to antennae and more particularly to multiple band antennae.

5 The cellular communications industry including cellular telephones and the like use a range of frequencies between 800 and 900 megahertz (MHz). Cellular telephones, paging devices, and the like generally use a whip antenna that is tuned to provide optimum performance in the above frequency range. With
10 the advent of personal communications services (PCS) for providing services such as data transmission, wireless voice mail, and the like, the FCC has established a center frequency of 1.92 gigahertz (GHz)
15 with a suitable band width, well known to one skilled in the art. As the new PCS technology expands, there is a need to provide devices that can receive and transmit communications in both the 800-900 MHz and 1.92 GHz frequency ranges. Cellular telephones and the like,
20 therefore, need to have antennae that will operate at each of the two frequency ranges. One way to achieve this is to provide two separate antennae. It is more desirable and economical, however, to provide a single antenna having at least dual band capability.

25 This invention is directed to a multiple band whip antenna. For purposes of illustration, the embodiment discussed is a dual band antenna. It is to be understood that the invention is not limited to dual band antennae. The multiple band whip antenna includes a
30 first conductor; at least one second conductor, the second conductor having a socket portion at one end thereof, the first and second conductors extending along a common axis and the socket portion surrounding an end of the first conductor; and a dielectric layer disposed
35 at least between the socket portion and the first conductor such that the socket portion is electrically isolated from the first conductor, defining a reactive

element. In one embodiment, the dual band antenna has first and second wires or conductors, a dielectric sleeve disposed over an end of the first wire, a conductive member disposed over the end of the dielectric sleeve and a second wire directly electrically connected to the conductive member. Each of the first and second wires have selected lengths to allow the antenna to resonate at the desired frequencies. The dielectric sleeve extends along a portion of the first wire. The conductive member extends along a section of the dielectric sleeve and is electrically isolated from the first wire by the dielectric sleeve. The first wire portion, the dielectric sleeve and the conductive member define a reactive element in the antenna. In the assembled antenna, the first and second wires extend along a common axis.

In a further embodiment, the dual band antenna includes a first conductor having at least a fully insulated end and a second conductor having a conductive member secured to and electrically connected to an uninsulated end thereof defining a socket portion. In another embodiment, an uninsulated end of a second conductor is wound into a spiral to define a socket portion which, in turn, is secured to an insulated end of a first conductor.

The antennae formed in accordance with the invention can be made to resonate or tuned to desired frequencies by adjusting the dimensions of the various components of the assembly.

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:

FIGURE 1 is an assembled view of an antenna made in accordance with the present invention, with the outer sheath shown in phantom.

FIGURE 2 is an exploded view of the antenna of Figure 1.

FIGURE 3 is a cross-sectional view taken along line 3-3 of Figure 1.

5 FIGURE 4 is a further embodiment of a multiple band antenna made in accordance with the invention.

FIGURE 5 is another embodiment of a multiple band antenna made in accordance with the invention in which the wires are wound into a spiral, such as a helix.

10 FIGURE 6 is a fragmentary sectioned view of a further embodiment of a dual band antenna in which one of the conductors is an insulated wire and the other conductor is an uninsulated wire secured together by a conductive ferrule.

15 FIGURE 7 is a partially sectioned view of another embodiment in which one of the conductors is an insulated wire and the other conductor is an unsulated wire having a spiral socket portion.

For purposes of illustration, the present invention will be described in terms of a dual band antenna for a cellular telephone. The antenna is also suitable for use with paging devices, two-way hand-held and base unit communication devices, GPS units, computer networking systems, transponders and other like devices.

25 Referring now to Figures 1 through 3, a dual band whip antenna 10 includes a first conductor or wire 12, a dielectric sleeve 22, a conductive member 26, and a second conductor or wire 30. The first wire 12 has a first end 14 that is adapted for being secured by a screw or other member 44 to an electrical article, such as a cellular telephone (not shown). The second end 16 of wire 12 is disposed within a dielectric sleeve 22 that extends along a portion 18 of the first wire 12. A conductive member 26, such as a ferrule or the like, is
30 disposed over the end 24 of the dielectric sleeve 22, surrounding a portion of the sleeve including some of the first wire 12. The conductive member 26 is
35

electrically isolated from the first wire 12 by the dielectric sleeve 22. The dielectric sleeve 22, conductive member 26 and the first wire portion 16 disposed therein define a reactive element 20. The antenna 10 further includes a second wire 30 having a second selected length with a first end 32 directly coupled to end 28 of the conductive member defining a socket portion of the second wire. 26 and extending to a second end 34. The first and second wires 12, 30 extend along a common axis.

The upper and lower frequencies are defined by the dependent interaction between the wires and the reactive element. The antenna can be tuned by adjusting the lengths of the wires, the diameters of the dielectric sleeve and conductive member, the length of the conductive member that extends over the dielectric sleeve, and the length of the portion of the first wire that is overlapped by the conductive member, thus adjusting the reactance of the assembly. For example, a dual band antenna was made from a first wire having a diameter on the order of 0.76mm, an insulating sleeve having an outer diameter of up to 1.75mm and a conductive member having an outer diameter of about 2.28 mm.

The antenna in this embodiment is assembled by disposing the dielectric sleeve over one end of the first wire 12, disposing the conductive member 26 over the end of the sleeve 22 and the first wire contained therein. The second wire 30 may be electrically connected to the end of the conductive member either before or after the member has been disposed over the sleeve. The wires may be copper, stainless steel, titanium or the like, as known in the art. The dielectric sleeve may be made from materials, such as, tetrafluoroethylene, polymethylpentene, polycarbonate or the like, as known in the art. Suitable materials for the conductive member include copper, brass or similar

materials. If desired, antenna 10 may be covered with a non-conductive sheath 40 made, for example, from polyurethane, vinyl or similar materials.

Figure 4 illustrates a whip antenna 110 in which three wires 112, 130, and 150 are interconnected by two reactive elements 120, 120'. A sheath 140 and end cap 142 therefor are shown in phantom. The antenna 110 of this embodiment can transmit and receive frequencies in three bands. It can be tuned in the same manner previously described.

Figure 5 illustrates a whip antenna 210 in which the respective wires 212 and 230 are first wound into a spiral structure and then joined together by the reactive element 220. The first end 214 of first coil 212 extends substantially at right angles to the coil and substantially along the center axis of the coil and is secured in a mounting screw or other member 244 for attaching the antenna 210 to an electrical article, not shown. The second end portion 217 at the opposite end of the coil extends substantially at right angles to the coil and substantially along the center axis of the coil with end 216 thereof disposed within reactive element 220. The first end portion 233 at the one end of the coil 230 extends substantially at right angles to the coil and substantially along the center axis of the coil and is electrically connected to the conductive member 226. The second end portion 235 is at the opposite end of the coil. Reactive element 220 is made in the same manner as element 20, with a conductive member 226 electrically connected to an end of the second coiled member defining a socket portion. The socket portion is dimensioned to be received over the dielectric sleeve 222. It is to be understood that additional reactive elements and additional coiled wire portions may be added to the antenna to increase the number of frequency ranges the antenna may receive. Each subsequent socket portions of additional wires is electrically connected

to its associated wire and electrically insulated from the previous conductors or wires. It is to be also understood that a multiple band antenna may include both coiled and straight wires. An antenna using coiled wire is shorter than a comparable antenna having straight wires.

Figures 6 and 7 illustrate further embodiments 310, 410 in which at least an end of the respective first conductors, 312, 412 is completely surrounded by insulation 322, 422, respectively. The insulation may be of the type known as a varnish coated magnet wire or the like. In embodiment 310, conductive member 326 is electrically connected and mechanically secured to an uninsulated end of a second conductor 330, defining reactive element 320. In embodiment 410, an uninsulated end of second conductor 430 is formed as a coil defining a socket portion, which, in turn, is secured over an insulated end of first conductor 412 defining reactive element 420.

The present invention provides a multiple band whip antenna that is compact, easily tunable and cost effective to manufacture. It is to be understood the antenna of the present invention is suitable for use with devices using other frequencies and that additional dielectric sleeves, conductive members and wires may be added to provide an antenna that may transmit and receive multiple frequencies.

WE CLAIM:

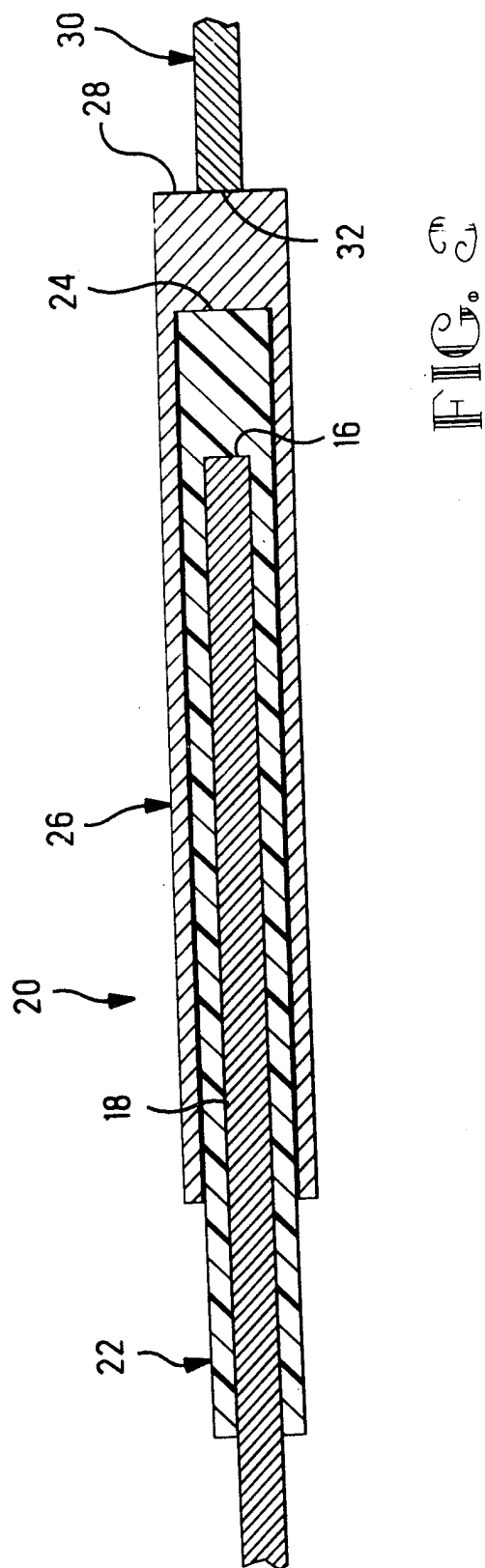
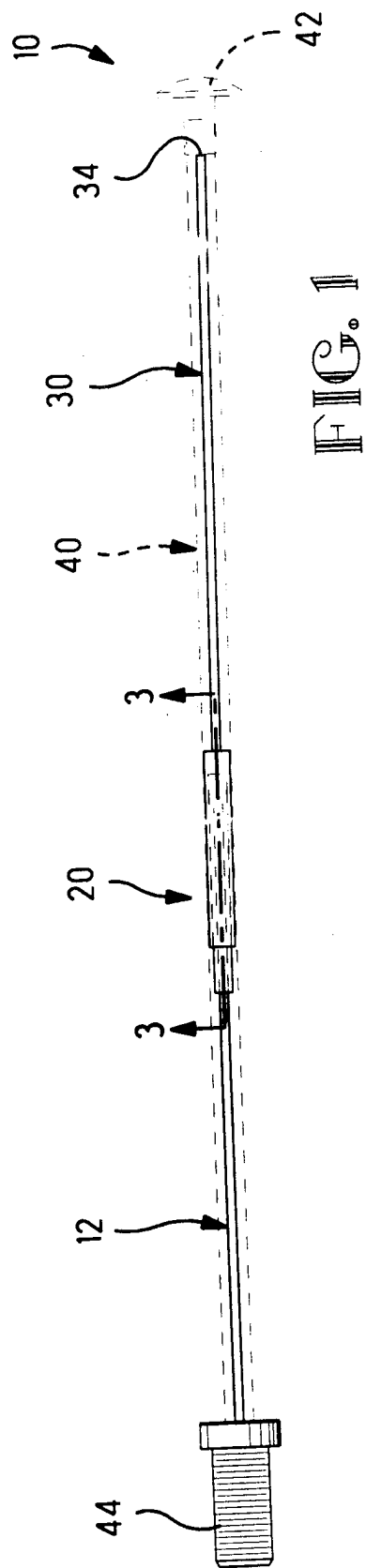
1. A multiple band whip antenna (10) comprising:
a first conductor (12);
at least one second conductor (30), said
5 second conductor (30) including a socket portion (26) at
one end thereof;
said first and second conductors (12,30)
extending along a common axis and said socket portion
(26) surrounding an end portion (18) of the first
10 conductor (12); and
a dielectric layer (22) disposed at least
between said socket portion (26) and said first
conductor (12) such that said socket portion (26) is
electrically isolated from said first conductor (12),
15 defining a reactive element (20).
2. The multiple band whip antenna (10) of claim 1
wherein said socket portion (26) is a conductive member
terminated to an end of said second conductor (30).
3. The multiple band whip antenna of claim 1
20 wherein said socket portion is a coiled portion of said
second conductor (430).
4. The multiple band whip antenna (10) of claim 1
wherein said dielectric layer (22) is a sleeve disposed
over an end (18) of said first conductor (12).
- 25 5. The multiple band whip antenna of claim 1
wherein said dielectric layer (322) is an insulative
coating disposed over at least an end of said first
conductor (312).
6. The multiple band whip antenna of claim 1
30 further including an other dielectric sleeve disposed
over a second end of said second wire and extending
along a portion of said second wire;
a conductive member disposed over an end
of said dielectric sleeve and extending along a section
35 of said sleeve, said conductive member being
electrically isolated from said second wire by said

dielectric sleeve, said sleeve and conductive member defining an other reactive element (120'); and

at least a third conductors (150) having a third electrically coupled to and extending from an end of said other conductive member such that said second and third conductors (130,150) extend along a common axis.

7. The multiple band antenna of claim (1,5,or 6) wherein at least one of said conductors is coiled.

10



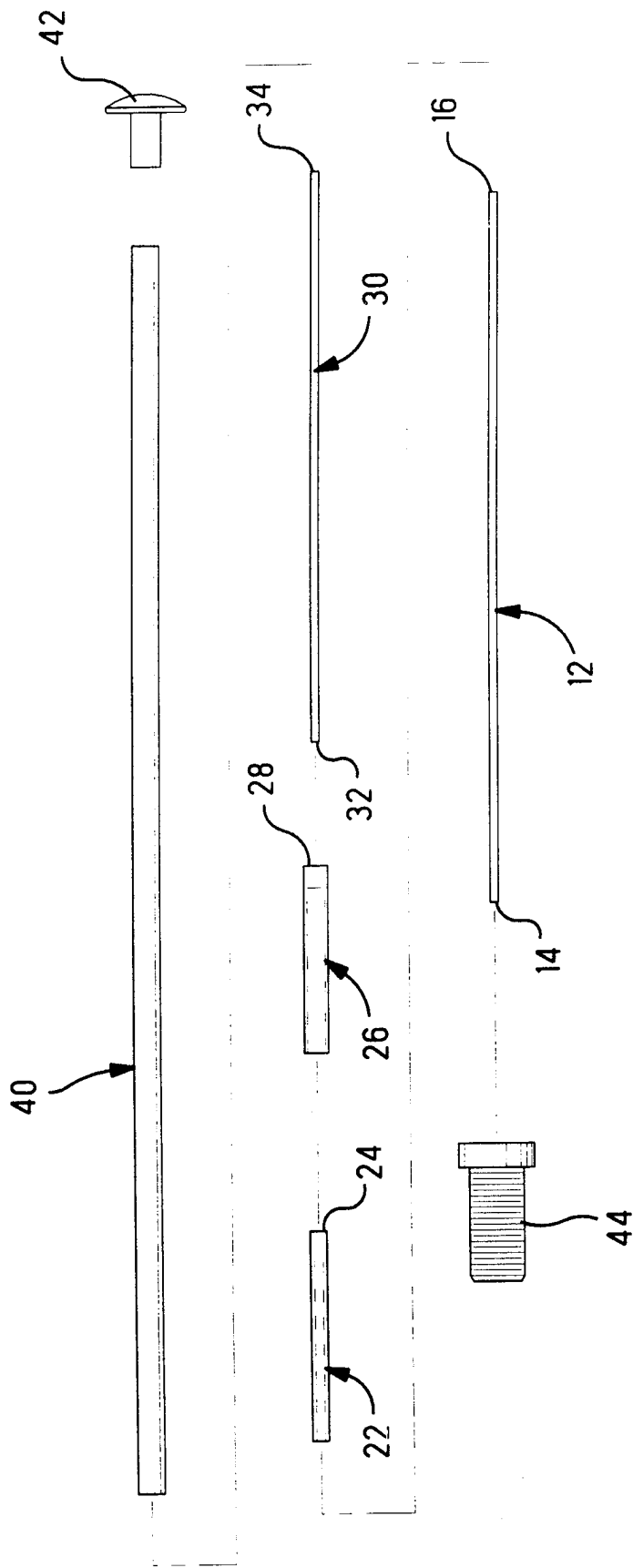


FIG. 2

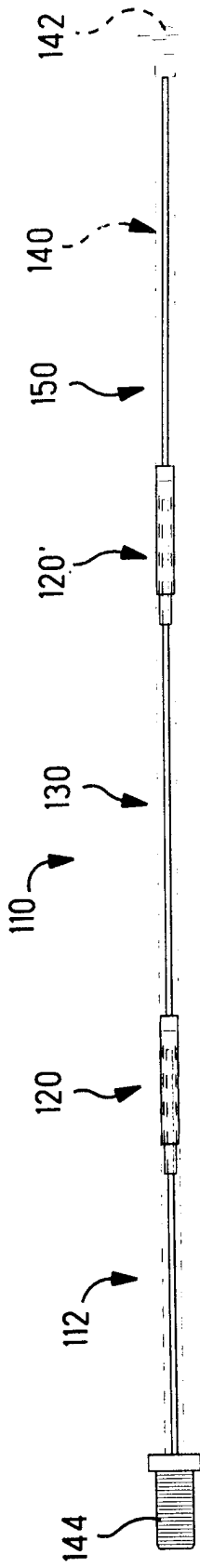


FIG. 4

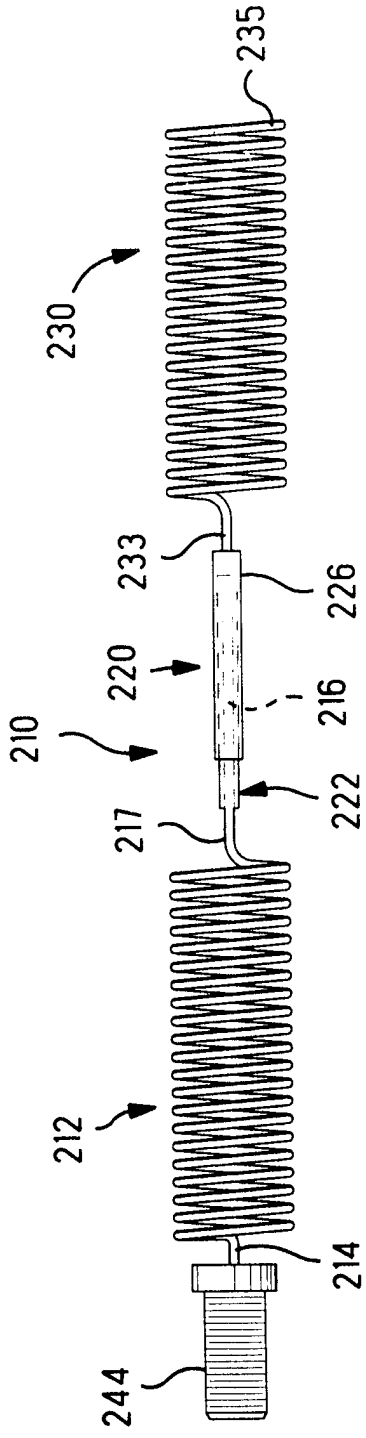


FIG. 5

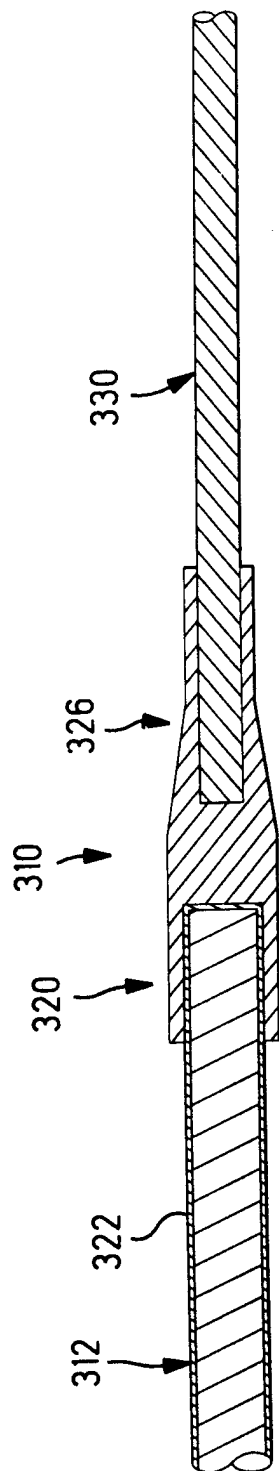


FIG. 6

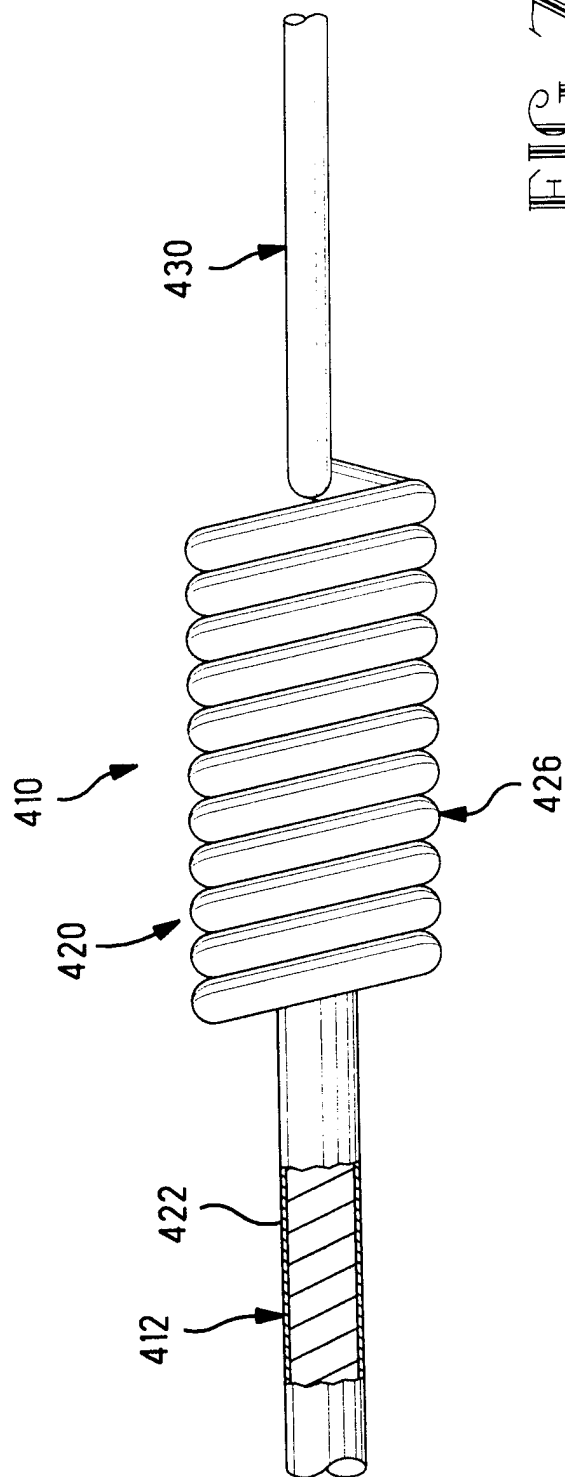


FIG. 7

INTERNATIONAL SEARCH REPORT

Inte. onal Application No

PCT/US 98/07940

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 H01Q5/00 H01Q5/01 H01Q9/36 H01Q9/30

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 148 604 A (PLESSEY CO PLC) 30 May 1985 see the whole document ---	1, 2, 4-7
X	EP 0 613 206 A (ANTEN CORP ; NIPPON ELECTRIC CO (JP)) 31 August 1994 see column 4, line 18-39; figure 1 ---	1, 3-5, 7
X	US 3 747 112 A (HIDAKA K) 17 July 1973 see column 3, line 17-45; figures 2, 3 ---	1, 2, 4, 5, 7
X	DE 36 39 106 A (KOLBE & CO HANS) 19 May 1988 see column 2, line 36-56; figure 2 --- -/--	1, 2, 4, 5, 7



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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 94 03939 A (R A MILLER IND INC) 17 February 1994 see page 12, line 28 - page 13, line 12; figure 2 ---	1
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 98/07940

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