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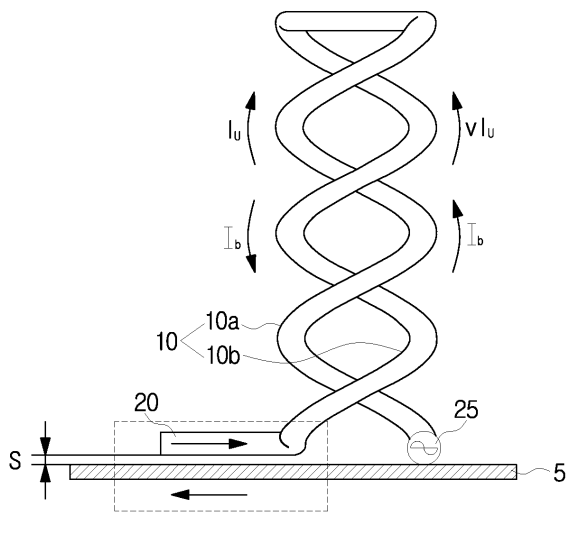
(54) **Low frequency band helical antenna having an open stub**

(57) A low frequency band helical antenna comprising an open stub is provided, which includes a helix formed on at least a part; and a radiator comprising the open stub formed on one end in parallel relation with a ground. As a result, a compact helical antenna, which is sized to a quarter length of a monopole antenna, can be provided. Additionally, efficiency of the antenna is improved and the frequency bandwidth can be increased, by increasing the input resistance and decreasing the input reactance.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a low frequency band helical antenna having an open stub. More particularly, the present invention relates to a low frequency band helical antenna having an open stub, which operates in a low frequency band and compact-sized, but without causing decrease of input resistance and increase of input reactance.

[0002] A wide variety of services are now available through mobile communication terminals, thanks to the advancement of mobile communications technologies.

[0003] The Digital Multimedia Broadcasting (DMB) or Digital Video Broadcasting-Handhelds (DVB-H), which receive VHF band broadcast signals and provide services, are particularly gaining customer's attention.

[0004] DMB or DVB-H is a new concept of mobile multimedia broadcasting service which combines communications and broadcasting. The low frequency band of DMB or DVB-H service can be used through a mobile communication terminal.

[0005] More specifically, the DMB service may be used through terminals having mobility such as terminals dedicated to DMB services, laptop computers, mobile phone terminals, vehicle terminals, PDAs, PMPs, or the like, and is generally classified into satellite DMB and terrestrial DMB services. The terrestrial DMB service in South Korea, for example, uses frequency band of 174 - 216MHz, and while the satellite DMB service uses S-band of 2.630-2.655GHz, which is higher than the terrestrial DMB.

[0006] The DMB services use antennas, such as a dipole antenna with length of $\lambda/2$ or a monopole antenna with length of $\lambda/4$. The length of the antenna decreases as the frequency band increases, and increases as the frequency band decreases. For the terrestrial DMB service which uses VHF, which is the general broadcast band, the antenna needs to have a longer length than that used in the satellite DMB. More specifically, the antenna should have the same length as the TV antenna, or above 30cm. The length of the antenna may be shortened if the output is strong.

[0007] However, the terrestrial DMB has relatively weak output which ranges between 1-2KW, because it uses taboo channels 8, 10 and 12. Especially channel 8 is highly likely to have interferences with channels 7 and 9 if the output is increased. However, it will be very inconvenient if the length of the antenna is prolonged in a mobile communication terminal which has to have portability and mobility.

[0008] It is therefore very important that the antenna developers decrease the length of the antenna of the terrestrial DMB, without compromising the receptivity of the antenna. Currently, it is almost impossible that the antenna for terrestrial DMB operate in the length below 15cm.

[0009] Meanwhile, the digital video broadcasting-handhelds (DVB-H) is the Digital Video Broadcasting-Terrestrial (DVB-T)-based service. The DVB-T was developed and used in Europe, and proposed to improve the low power consumption, mobility and portability of a mobile phone or portable video device. Because the DVB-H uses relatively low frequency band, it can suffer almost the same problem as the terrestrial DMB antenna.

[0010] Therefore, it is necessary to develop a compact antenna, which receives low frequency band signal usually used in the terrestrial DMB service or DVB-H services.

[0011] Furthermore, it is necessary to improve the drawbacks of the compact antenna, such as low input resistance which results in degradation of antenna quality, and relatively high input reactance which results in narrowed bandwidth of the antenna.

SUMMARY OF THE INVENTION

[0012] According to the invention, there is provided a low frequency band helical antenna comprising an open stub, comprising a radiator comprising the open stub formed on one end in parallel relation with a ground; and a helix formed on at least a part of the antenna.

[0013] The invention thus addresses the above-mentioned and other problems and disadvantages occurring in the conventional arrangement, and provides a low frequency band helical antenna having an open stub, which operates in low frequency band, and can be compact-sized without causing decrease of input resistance and increase of input reactance.

[0014] The radiator may comprise a pair of helixes which are arranged at a distance and in parallel relation with each other.

[0015] The open stub may be formed on a first end of a first helix and a feed point maybe formed on a first end of a second helix, and a second end of the first helix and a second end of the second helix may be inter-coupled with each other.

[0016] The pair of helixes may be wound in the same direction.

[0017] The radiator may comprise a first radiating helix, and a second radiating bar parallel to the first radiating helix.

[0018] A feed point may be formed on the first radiating helix or the second radiating bar, and the open stub may be formed on the second radiating bar or the first radiating helix which has no feed point, and the other end of the first radiating helix which has no feed point or open stub may be inter-coupled with the other end ofthe second radiating bar which has no open stub or feed point.

[0019] Additionally, a pair of helixes arranged at a distance from each other; and a pair of bar-shaped whips extending from a first end of each of the helixes in parallel relation with each other, may be provided.

[0020] Free ends of the whips may be inter-coupled with each other, and the open stub may be formed on one of the helixes and a feed point may be formed on the other.

[0021] The open stub may be a bar-shaped element extending across the length of the radiator to a predetermined length.

[0022] The open stub may be arranged at a distance from the ground.

[0023] An exterior surface of the open stub may be coated with a dielectric material.

[0024] A matching circuit may be attached to a side of the radiator to shift a frequency band.

[0025] The helix may be formed to have one of circular, oval, square, and polygonal configurations in a plan view.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

[0026] These and/or other aspects of the present invention will become more apparent and more readily appreciated from the following description of exemplary embodiments thereof with reference to the accompanying drawings, in which:

FIG. 1 is a perspective view of a low frequency band helical antenna having an open stub according to an exemplary embodiment ofthe present invention;
FIG. 2 is an equivalent circuit diagram of the helical antenna of FIG. 1 in antenna mode;
FIG. 3 is an equivalent circuit diagram of the helical antenna of FIG. 1 in a transmission mode;
FIG. 4 is an equivalent circuit diagram of the helical antenna of FIG. 1;
FIG. 5 is a graphical representation of S21 characteristics of the helical antenna of FIG. 1 and a conventional monopole antenna;
FIG. 6 is a perspective view of the helical antenna according to another exemplary embodiment ofthe present invention;
FIG. 7 is a perspective view of a helical antenna according to yet another exemplary embodiment of the present invention; and
FIG. 8 is a perspective view of a helical antenna according to yet another exemplary embodiment ofthe present invention.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

[0027] Certain exemplary embodiments of the present invention will now be described in greater detail with reference to the accompanying drawings.

[0028] In the following description, the same drawing reference numerals are used to refer to the same elements, even in different drawings. The matters defined in the following description, such as detailed construction and element descriptions, are provided as examples to assist in a comprehensive understanding of the invention. Also, well-known functions or constructions are not described in detail, since they would obscure the invention in unnecessary detail.

[0029] FIG. 1 is a low frequency band helical antenna having an open stub according to an exemplary embodiment ofthe present invention.

[0030] A helical antenna, according to an exemplary embodiment of the present invention, may include a spiral radiator 10, and an open stub 20 coupled to one end of the radiator 10.

[0031] The spiral radiator 10 may include a first and a second helixes 10a, 10b which are parallel to each other at a predetermined distance. The first and the second helixes 10a, 10b may turn in the same direction, but start at intervals approximately of 180 degrees. As a result, the first and the second helixes 10a, 10b are at intervals which correspond to the radius of one turn. Top ends of the first and the second helixes 10a, 10b, which face the exterior, are connected to each other.

[0032] A feed point 25 is formed at one end of the second helix 10b to provide the first and the second helixes 10a, 10b with electric currents.

[0033] The open stub 20 is coupled to the first helix 10a, and has the configuration of a bar perpendicularly extended in the lengthwise direction of the first helix 10a. The open stub 20 is at a distance S from a ground 5 in parallel relation, and includes a dielectric material coated on the outer surface.

[0034] Conventionally, a helical antenna, which is made by winding a monopole antenna, would have increased input reactance due to inter-helix coupling and decreased input resistance such that the helical antenna usually has a lower efficiency than the monopole antenna. Accordingly, a helical antenna needs to have a longer length than the monopole antenna. However, according to the exemplary embodiment of the present invention, because the helical antenna is designed such that the input reactance varies according to the length of the open stub 20 and according to the distance between the open stub 20 and the ground 5, the input reactance can be decreased. Additionally, the dielectric material coated on the open stub 20 also acts to increase input resistance. As a result, it is unnecessary to prolong the helical antenna, and the helical antenna can be compact-sized.

[0035] More specifically, a helical antenna, which has a pair of helixes 10a, 10b and the open stub 20 according to the exemplary embodiment, can be sized as compact as approximately 8cm.

[0036] Although FIG. 1 shows a circular cross section of the first and the second helixes 10a, 10b, one will understand that other various sections such as square, oval or polygon may also be incorporated.

[0037] The helical antenna constructed as above may be interpreted as the combination of an antenna mode (unbalanced mode) having radiation, and a transmission mode (balanced mode) without radiation.

[0038] In the antenna mode, with referring to FIG. 1, electric currents I_U and VI_U flow through the helixes 10a, 10b in the same direction, radiating electromagnetic waves. The current I_U flows from the feed point 25 through the second helix 10b which is connected with the feed point 25. The current VI_U is induced by I_U, and flows through the first helix 10a which is connected with the open stub 20. The character 'V' denotes an amplitude ratio of the induced electric current.

[0039] In the antenna mode, the current flowing through the open stub 20 is not radiated due to the current of the ground 5 which flows opposite to the current on the open stub 20. In other words, the operation of the open stub 20 is negligible in the antenna mode. Accordingly, the equivalent circuit as shown in FIG. 2 is established in the antenna mode, and has the load impedance, $Z_{in\_u} = n^2 Z_u$, where 'n' is the number of spirals. Accordingly, the load impedance Z_{in_u} of the antenna increments by the number of spirals squared.

[0040] Referring again to FIG. 1, the same current I_b flows in opposite directions through the helixes 10a, 10b in the transmission mode. That is, the current I_b is fed from the feed point 25, flows through the helixes 10a, 10b and reaches the open stub 20. At this time, capacitance is generated between the open stub 20 and the ground 5. In other words, the open stub 20 operates as a capacitor.

[0041] Accordingly, in the equivalent circuit of FIG. 3, a resistor R is connected in series with the capacitor C. The resistor R indicates the loss by the dielectric material coated on the surface of the open stub 20. The impedance in the transmission mode may be expressed as,

$$Z_{in_b} = R + \frac{1}{j\omega C} + jZ_0 \tan(\beta l).$$

[0042] FIG. 4 shows an equivalent circuit an antenna, with the antenna mode and the transmission mode combined.

[0043] Referring to FIG. 4, input impedance Z_{in} of the helical antenna is obtained by parallel adding input impedance Z_{in_u} of antenna mode with input impedance Z_{in_b} of transmission mode. Accordingly, input impedance Z_{in} of the helical antenna can be adjusted using the capacitance generated by the open stub 20.

[0044] FIG. 5 is a graphical representation of the S21 characteristics of the helical antenna of FIG. 1 and a conventional monopole antenna. Both the helical antenna and the monopole antenna are sized to have length of 8cm.

[0045] The graphical representation in FIG. 5 is plotted based on the measurements of transmissivity of the helical antenna according to the exemplary embodiment of the present invention and the conventional monopole antenna, wherein the conventional monopole antenna has the radiator 10 of 40cm length, and located away from the helical antenna by the distance of 180cm.

[0046] As shown, the helical antenna according to theexemplary embodiment shows an S21 characteristic which is above the conventional monopole antenna by more than 10dB, in the DMB band including 170 - 240MHz. In other words, the helical antenna according to exemplary embodiment of the present invention operates with higher efficiency than the conventional monopole antenna.

[0047] FIG. 6 is a perspective view of the helical antenna according to another exemplary embodiment ofthe present invention.

[0048] The helical antenna of this exemplary embodiment is constructed with almost the same structure as the helical antenna as shown in FIG. 1, except for a matching circuit 30 which is provided to shift the operating frequency band of the helical antenna. The respective channels of the DMB service are generally formed with 6MHz, and there are seven (7) DMB channels. The matching circuit 30 may be used to match the operating frequency of the helical antenna to the frequency bandwidths of the respective channels, and to shift the operating frequency in accordance with the channel shift. FIG. 6 shows an exemplary case where the matching circuit 30 is attached to an end of the open stub 20, but it will be understood that the matching circuit 30 may be connected to any part of the radiator 10.

[0049] FIG. 7 is a perspective view of a helical antenna according to yet another exemplary embodiment ofthe present invention.

[0050] The helical antenna according to this exemplary embodiment may include a radiator 110 which includes a first radiating helix 110a, and a second radiating bar 110b.

[0051] The first radiating helix 110a has a spiral winding in one direction as in the helical antenna of FIG. 1, and feed point 125 at one end thereof. The second radiating bar 110b may be arranged parallel to the first radiating helix 110a, and have an open stub 120 at one end thereof. The feed point 125 of the first radiating helix 110a and the second radiating bar 110b may be inter-coupled with the other end ofthe open stub 120.

[0052] Alternatively, the open stub 120 may be formed on one end of the first radiating helix 110a, while the feed point 125 is formed on one end of the second radiating bar 110b.

[0053] Like the above exemplary embodiment, a matching circuit 130 is attached to one side of the helical antenna.

[0054] FIG. 8 is a perspective view of a helical antenna according to yet another exemplary embodiment ofthe present invention.

[0055] According to the embodiment, the helical antenna has a radiator 210 which includes a helix 210b and a whip 210a.

[0056] More specifically, the helix 210b includes a pair of helixes which are arranged parallel to each other at a distance from each other. The pair of helixes are wound in the same direction. An open stub 220 may be formed on one of the helixes 210b, while a feed point 225 is formed on the other.

[0057] The whip 210a may also include a pair of whips, which are substantially vertically extended from ends of the helixes 210b. The whips 210a may be arranged parallel to each other, and coupled with each other at their free ends.

[0058] Although FIG. 8 omits a matching circuit, one will understand that a matching circuit may be provided as need arises.

[0059] The helical antenna constructed according to this exemplary embodiment combines the features of a helical antenna and a monopole antenna, which is relatively longer than that of the exemplary embodiment best shown in FIG. 1, but provides more stabilized antenna characteristics.

[0060] As explained above, by adding open stub 20, 120, 220 to a helical antenna, input impedance and reactance can be decreased. Furthermore, input resistance can be further increased if a dielectric material is coated on the open stub 20, 120, 220.

[0061] Additionally, a helical antenna can be sized to a quarter length of a conventional monopole antenna. Also the input impedance can be adjusted by adjusting the length of the open stub 20, 120, 220 and the distance between the open stub 20, 120, 220 and the ground 5, so it is convenient to adjust the input impedance.

[0062] According to exemplary embodiments ofthe present invention explained above, a compact helical antenna, which is sized to a quarter length of a conventional monopole antenna, can be provided. Additionally, efficiency of the antenna is improved and the frequency bandwidth can be increased, by increasing the input resistance and decreasing the input reactance.

[0063] The low frequency antenna is for example for signals below 1GHz, more preferably below 500MHz and even more preferably below 250MHz.

[0064] While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the scope ofthe invention as defined by the appended claims.

Claims

1. A low frequency band helical antenna comprising an open stub, comprising:

   a radiator comprising the open stub formed on one end in parallel relation with a gr ound; and
   a helix formed on at least a part ofthe antenna.

2. The low frequency band helical antenna of claim 1, wherein the radiator comprises a pair of helixes which are arranged at a distance and in parallel relation with each other.

3. The low frequency band helical antenna of claim 2, wherein the open stub is formed on a first end of a first helix and a feed point is formed on a first end of a second helix, and a second end ofthe first helix and a second end of the second helix are inter-coupled with each other.

4. The low frequency band helical antenna of claim 2 or 3, wherein the pair of helixes are wound in the same direction.

5. The low frequency band helical antenna of claim 1, wherein the radiator comprises a first radiating helix, and a second radiating bar parallel to the first radiating helix.

6. The low frequency band helical antenna of claim 5, wherein a feed point is formed on the first radiating helix or the second radiating bar, and the open stub is formed on the second radiating bar or the first radiating helix which has no feed point, and
   the other end of the first radiating helix which has no feed point or open stub is inter-coupled with the other end of the second radiating bar which has no open stub or feed point.

7. The low frequency band helical antenna of claim 1, comprising:

   a pair of helixes arranged at a distance from each other; and
   a pair of bar-shaped whips extending from a first end of each of the helixes in parallel relation with each other.

8. The low frequency band helical antenna of claim 7, wherein free ends of the whips are inter-coupled with each other, and the open stub is formed on one of the helixes and a feed point is formed on the other.

9. The low frequency band helical antenna of any preceding claim, wherein the open stub is a bar-shaped element extending across the length of the radiator to a predetermined length.

10. The low frequency band helical antenna of any preceding claim, wherein the open stub is arranged at a distance from the ground.

11. The low frequency band helical antenna of any preceding claim, wherein an exterior surface of the open stub is coated with a dielectric material

12. The low frequency band helical antenna of any preceding claim, further comprising a matching circuit which is attached to a side of the radiator to shift a frequency band.

13. The low frequency band helical antenna of any preceding claim, wherein the helix is formed to have one of circular, oval, square, and polygonal configurations in a plan view.

FIG. 1

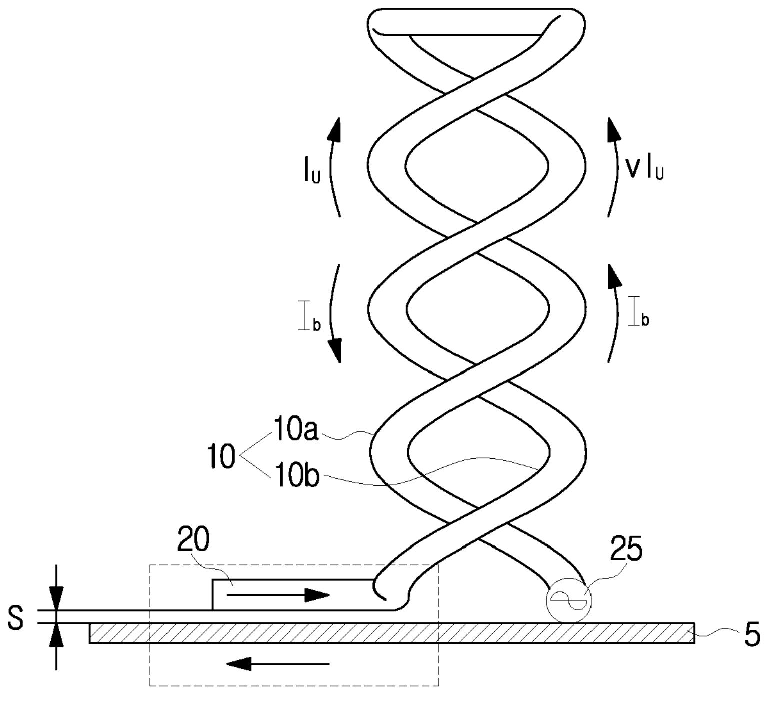
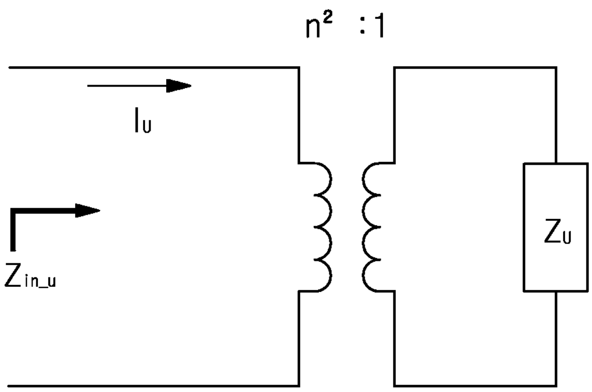


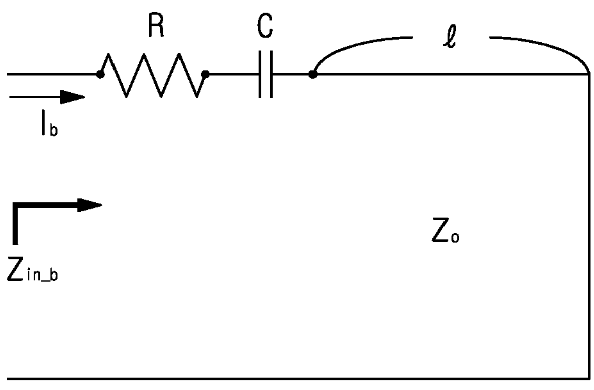
FIG. 2



Z_U : impedance in unbalanced mode

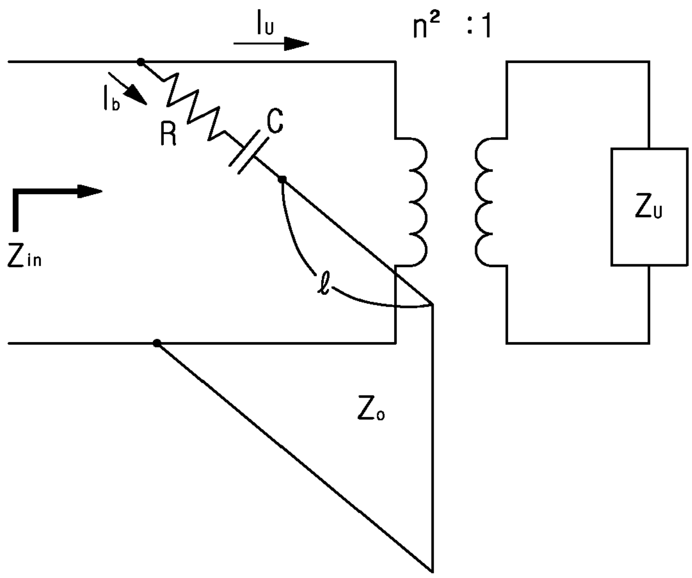
$Z_{in\_u} = n^2 Z_U$

FIG. 3



$$Z_{in\_b} = R + \frac{1}{jwC} + jZ_o \tan(\beta \ell)$$

FIG. 4



$$Z_{in} = \frac{Z_{in\_u} + Z_{in\_b}}{Z_{in\_u}\, Z_{in\_b}}$$

FIG. 5

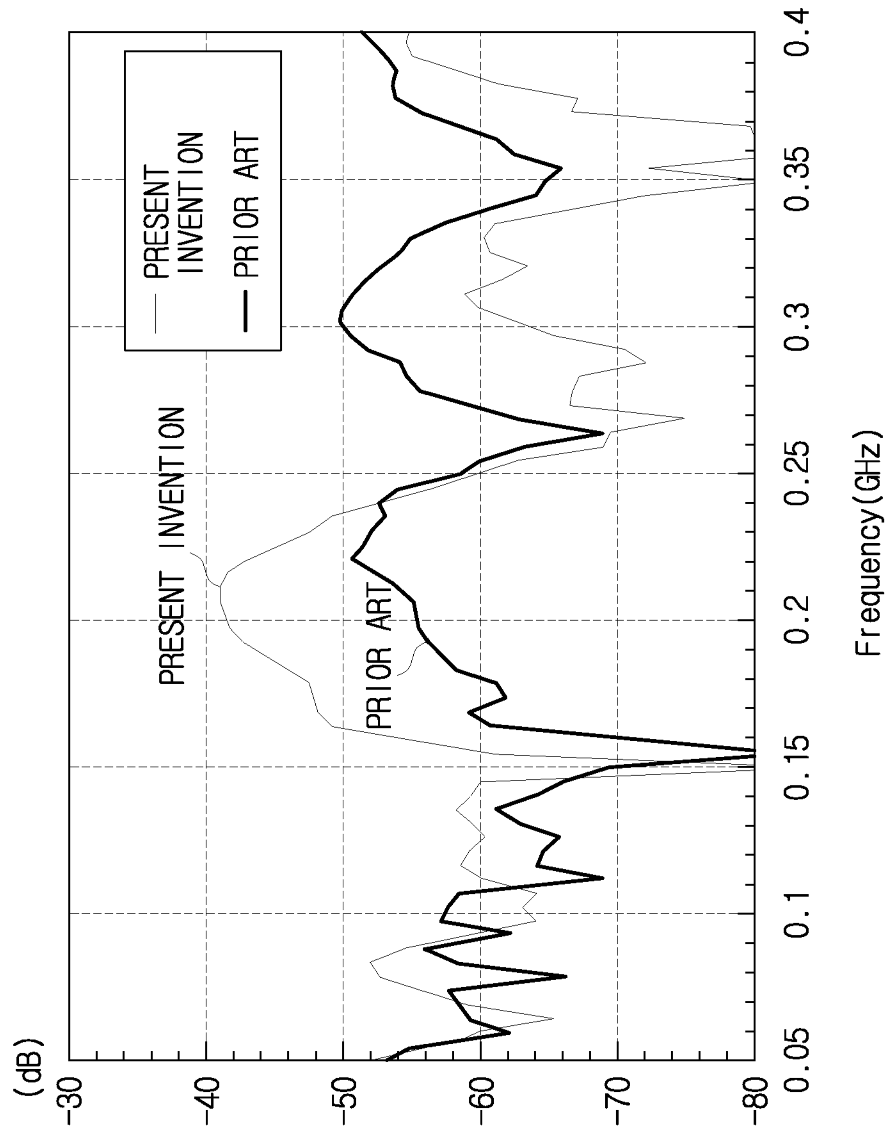

PRESENT INVENTION
PRIOR ART
(dB)
-30
-40
-50
-60
-70
-80
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
Frequency(GHz)

FIG. 6

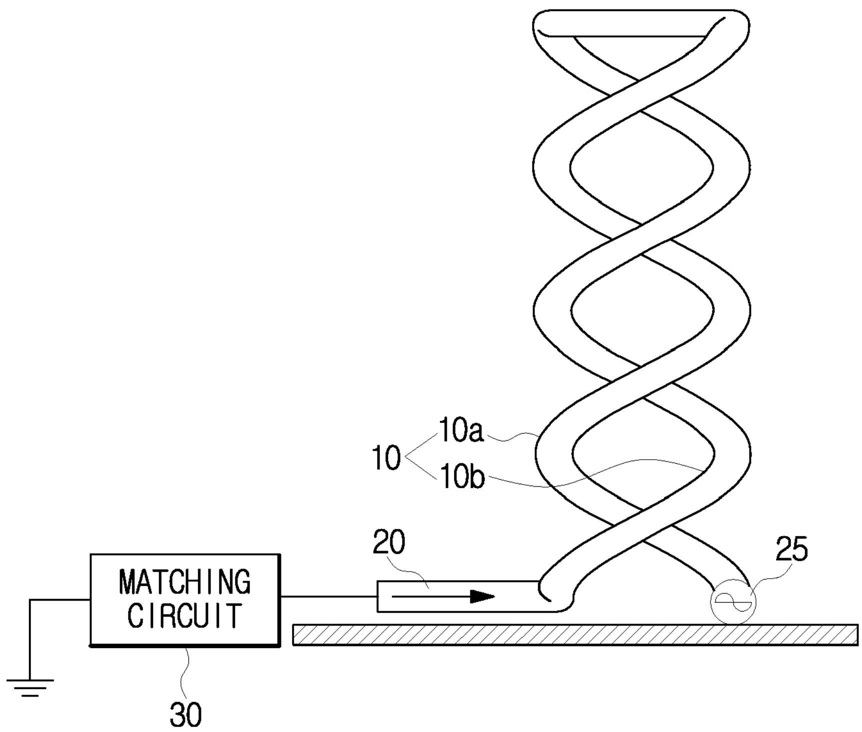


FIG. 7

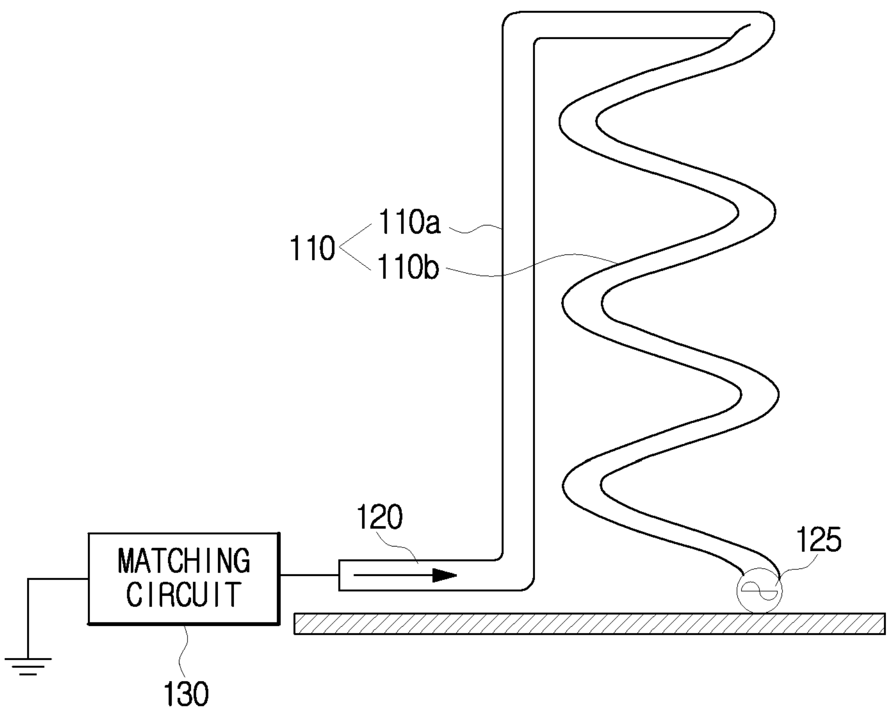
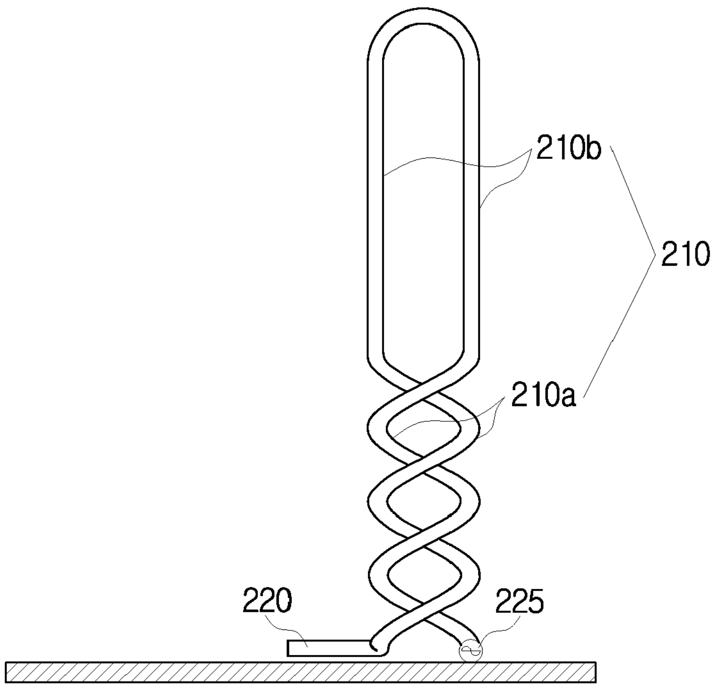


FIG. 8



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EUROPEAN SEARCH REPORT

Application Number
EP 06 12 7215

DOCUMENTS CONSIDERED TO BE RELEVANT

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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	15 February 2007	Van Dooren, Gerry

CATEGORY OF CITED DOCUMENTS

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....
& : member of the same patent family, corresponding document

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EUROPEAN SEARCH REPORT

Application Number
EP 06 12 7215

DOCUMENTS CONSIDERED TO BE RELEVANT

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The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
The Hague	15 February 2007	Van Dooren, Gerry

CATEGORY OF CITED DOCUMENTS

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L : document cited for other reasons
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 12 7215

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82