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(54) Title: AN ANTENNA ARRANGEMENT FOR COVERING A FREQUENCY BAND

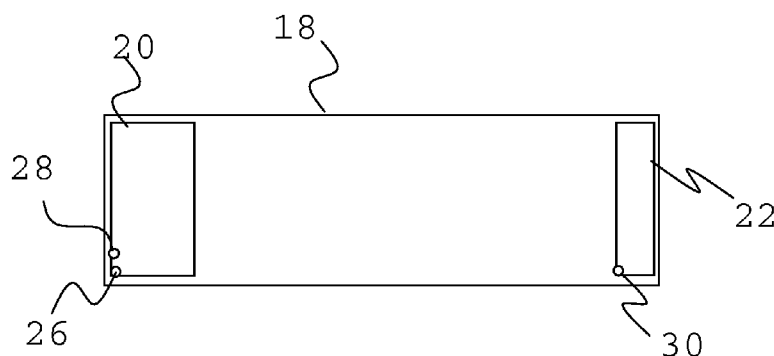


FIG. 3

(57) Abstract: The present invention relates to an antenna arrangement and a portable radio communication device comprising an antenna arrangement. The antenna arrangement comprises a radiating element (20) dimensioned for providing resonance at a first frequency, a board (18) including a ground plane, where the radiating element (20) is arranged at a first edge of the board (18), and a first parasitic element (22) arranged at a second opposite edge of the board (18). The radiating element (20) is dimensioned for providing resonance at a first frequency while the first parasitic element (22) is dimensioned for providing resonance at another frequency near the first frequency for providing coverage of a first frequency band. The major extension of the first parasitic element is along the second edge of the board (18).



AN ANTENNA ARRANGEMENT FOR COVERING A FREQUENCY BAND**FIELD OF THE INVENTION**

The present invention generally relates to antenna arrangements. In particular the present invention relates to
5 an antenna arrangement for covering a frequency band using a radiating element and a parasitic element.

BACKGROUND OF THE INVENTION

There is today a demand for mobile phones, and similar portable radio communication devices that communicate over a
10 plurality of frequency bands, such as GSM850, GSM900, GSM1800, GSM1900 and WCDMA2100. It is also desirable with thin and small sized mobile phones, which puts design restrictions on mobile phone antennas, particularly internal antennas.

One type of radiating antenna element having broad band
15 coverage is the planar inverted F antenna (PIFA) element. This element does in normal cases have good wide-band properties covering a wide low-frequency range. However, the bandwidth is dependent on the distance of this element from a ground plane. If the distance is lowered, the bandwidth is
20 also lowered.

Today the portable radio communication devices that employ such radiating elements are getting thinner and thinner. This means that there are severe limitations on the distance to the ground plane. This in turn leads to the width of the
25 frequency band covered by a radiating element being diminished, which is severe at low frequencies such as 850 and 900 MHz. This means that the coverage of low frequencies by such a radiating antenna element is not sufficient.

One way to improve the coverage of a low-frequency band is to add a parasitic element adjacent the radiating element in order to enhance the covered frequency band. However, modern antennas are normally adapted to cover more wide frequency
5 bands, i.e. being of the multiband type. This means that the radiating element will in many cases already be provided with a neighboring parasitic element, which enhances the high band coverage.

This may also mean that there is not enough space close the
10 radiating element for placing a further parasitic element in the vicinity of it.

One way of providing an additional parasitic element in relation to a radiating element in order to enhance the wideband properties is through placing the radiating element
15 at one edge of a printed wire board and a low-band enhancing parasitic element at an opposite edge of the printed wire board and then let this parasitic element stretch towards the radiating element. This type of antenna solution is described in WO 2007/084051.

20 However, there is room for improvement in relation to the type of parasitic element solution described in WO 2007/084051.

SUMMARY OF THE INVENTION

An object of the present invention is to provide an antenna
25 arrangement having a radiating element and a parasitic element, which arrangement provides good coverage of a desired frequency band despite the fact that the first parasitic element has to be placed far from the radiating element.

30 Another object of the present invention is to provide a portable radio communication device having such an antenna

arrangement, which device provides good wide band coverage of a desirable frequency band when the portable radio communication device has a limited size.

5 These objects, among others, are according to the present invention attained by an antenna arrangement and a portable radio communication device, respectively, as defined in the appended claims.

By providing an antenna arrangement, comprising a radiating element a board including a ground plane and a first
10 parasitic element, where the radiating element is arranged at a first edge of the board and dimensioned for providing resonance at a first frequency, while the first parasitic element is arranged at a second edge of the board opposite the first edge, dimensioned for providing resonance at
15 another frequency near the first frequency for providing coverage of a first frequency band and the major extension of the first parasitic element is along the second edge of the board, it is possible to obtain good coverage of the frequency band despite small distances to ground and despite
20 the fact that the first parasitic element is placed far from the radiating element.

Further features and advantages of the present invention will be evident from the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

25 The present invention will become more fully understood from the detailed description of embodiments given below and the accompanying drawings, which are given by way of illustration only, and thus, are not limited to the present invention, wherein:

30 Fig. 1 shows a front view of a portable electronic device according to the present invention;

Fig. 2 shows a sectional view of the portable electronic device according to the present invention;

Fig. 3 shows a plan view of an antenna arrangement according to a first embodiment of the present invention;

5 Fig. 4 shows a side view of the antenna arrangement shown in Fig. 3;

Fig. 5 shows a perspective view of an alternative realization of the first parasitic element on the board;

10 Fig. 6 shows a plan view of an antenna arrangement according to a second embodiment of the present invention;

Fig. 7 shows a return loss diagram for an antenna arrangement according to the second embodiment of the invention;

Fig. 8 shows a circuit diagram of a first variation of the antenna arrangement being connected to a radio circuit;

15 Fig. 9 shows a perspective view of a part of another variation of the antenna arrangement; and

Fig. 10 shows a return loss diagram for an antenna arrangement according to the second embodiment of the invention and one of the variations.

20 DETAILED DESCRIPTION OF EMBODIMENTS

In the following description, for purpose of explanation and not limitation, specific details are set forth, such as particular techniques and applications in order to provide a thorough understanding of the present invention. However, it
25 will be apparent for a person skilled in the art that the present invention may be practiced in other embodiments that depart from these specific details. In other instances, detailed description of well-known methods and apparatuses

are omitted so as not to obscure the description of the present invention with unnecessary details.

The invention is generally directed towards an antenna arrangement and a portable electronic device including an antenna arrangement, where the antenna arrangement is supposed to operate in at least one first frequency band, here a low-frequency band.

Fig. 1 shows a front view of a portable radio communication device 10, such as a mobile phone. The portable radio communication device can however be another type of device, such as a lap top computer, a palm top computer or an electronic organizer such as a personal digital assistant (PDA). The radio communication device 10 is, as an example, provided with a display 12 placed close to an upper end of the device and a keypad 14 placed close to a lower end of the device. These are here provided on the casing of the device 10. It should however be realized that the device may just as well be provided without a display and/or without a keypad. The radio communication device 10 is also provided with at least one antenna. However, all antennas are provided inside the device, i.e. in the interior of the device.

Fig. 2 shows a schematic side view of the radio communication device 10, which is a cross section through the casing 16. In order to clarify the description of the present invention only elements that are necessary for understanding the present invention are included. Thus a number of units in the device have here been omitted, like for instance the display and the keypad shown in fig. 1. The geometrical relationships between the elements and distances shown are furthermore only exemplifying and not according to scale. The radio communication device 10 here includes a board 18, which may be a printed wire board (PWB) or a printed circuit board

(PCB). Above this board 18, at a first edge of the board, there is provided a radiating element 20 and above another opposite edge of the board 18, there is provided a first parasitic element 22. The board 18, the radiating element 20 and the first parasitic element 22 make up the antenna arrangement in a first embodiment of the invention. There is here also a radio circuit 24, here in the form of a cellular transceiver circuit, which may for instance be used to modulate/demodulate radio frequency signals received and transmitted by the antenna arrangement. The board 18, which may be a multi-layer board furthermore includes a ground plane (not shown).

Fig. 3 shows a plan view of the antenna arrangement according to the first embodiment of the invention, while fig. 4 shows a side view of the same.

The board 20 may extend over an area that is limited by a number of corners. It may typically be rectangular in shape and thus have four corners. The radiating element 20 may be electrically connected to the board 18 at one of these corners. Here the ground plane of the circuit board 18 may be provided as a layer stretching through the whole of the circuit board. As an alternative it may only stretch through a part of the board 18. Normally though it may be provided beneath at least the radiating element 20.

The radiating element 20 is thus positioned at a first edge of the board 18 and the first parasitic element 22 is positioned at a second edge of the board 18, opposite the first edge. The radiating element 20 is connected to the board 18 through a feeding connection 26 leading to the radio circuit. The feeding connection 26 to the radiating element 20 is here provided at this first corner of the board. In this embodiment there is furthermore provided a separate

grounding connection 28 for the radiating element 20. Also this grounding connection 28 is here provided at this first corner. It should here be realized that the placing of the grounding and feeding connections is not central to the invention, but they can be provided essentially anywhere on the radiating element 20. However in this first embodiment they should be provided fairly close to each other. The first parasitic element 22 is also connected to the board 18 through a grounding connection 30.

10 With such a placing the radiating element 20 may stretch out across the board 20 from one long side to an opposite long side. The radiating element 20 may also stretch along a one short side or first edge of the board 18 that may be provided at the upper or lower end of the portable radio communication
15 device.

As mentioned earlier, the feeding and grounding connections 26 and 28 of the radiating element are provided at the first corner of the board 18, which corner is provided between a first short board side providing the first edge and a first
20 long board side joining the first edge to the second edge. The radiating element here furthermore essentially stretches along this first edge, i.e. in parallel with and adjacent the first short side, towards a second long side and ends at a second corner where the first short side and second long side
25 join each other. The second long side then leads to the second short side at the second edge of the board.

The first parasitic element 22 is here provided at the second edge of the board, i.e. opposite of the first edge, and stretches along and adjacent the second edge or second short
30 side, which second short side joins the first long side to the second long side. The second short side is thus provided opposite the first short side. The first parasitic element 22

thus has an extension that is parallel with the extension of the radiating element 20. It is with advantage straight and here also planar. Also the radiating element may planar. However, it should be realized that other shapes are possible, such as in the form of a wire. Both elements can combine this with for instance meandering shapes in at least parts of the elements. What is important though is that the major extension of the first parasitic element 22 is along the second edge. This means that it should run longer along this second edge than it runs at right angles to the second edge.

The first parasitic element 22 may thus be elongated, with its direction of elongation provided along the second edge. The first parasitic element may stretch along more than half of the second edge. In the first embodiment the first parasitic element stretches along essentially the whole of the second edge.

The radiating element 20 is dimensioned for providing resonance, i.e. for resonating, at a first frequency, a first low-band frequency, for instance a frequency providing coverage of the GSM 850 MHz band. The radiating element 20 is preferably a PIFA element. However it should be realized that the invention is in no way limited to this specific type of radiating element, but could be any kind of radiating element, such as an inverted F antenna (IFA), inverted L antenna (ILA), monopole and folded inverted conformal antenna (FICA) element. In the first embodiment of the invention the radiating element is thus planar, but it can have any other suitable shape and thus also be wire-shaped. Furthermore, since a radiating element can be a monopole element, it is also clear that the grounding connection can be omitted.

This resonance of the radiating element can according to known principles be obtained through providing an electrical

length of the radiating element that essentially is a quarter of a wavelength long for the frequency in question.

The radiating element here thus resonates at a first low band frequency. The first parasitic element 22 is in turn
5 dimensioned for providing resonance, i.e. for resonating, at another frequency near the first frequency, i.e. at a second low-band frequency, that is slightly higher than the first low band frequency and may thus be a frequency that provides coverage of the GSM900 MHz band. In this way a first
10 frequency band including the GSM 850 and GSM 900 bands is covered.

This resonance of the first parasitic element can also be obtained in the following way:

The parasitic element can be seen as having an inductance L
15 depending on the shape of the element, typically on the length, the thickness, and the width. If the element is bent, like if it has a meandering shape, the amount of bending of the element also influences the inductance. It also has a capacitance C determined by the area of the element and the
20 distance to ground.

These two properties provides an equivalent resonance circuit, the resonance frequency f_{rc} of which is determined through $f_{rc} = (2\pi \cdot \text{SQRT}(LC))^{-1}$.

Both the radiating element 20 and the first parasitic element
25 22 are placed above the board 18. The distance d2 between the first parasitic element 22 and the board 18 may be equal to the distance d1 between the radiating element 20 and the board 18. The distance d2 can be higher or smaller than d1, but if d2 is higher than d1 the portable radio communication
30 device may sometimes be thicker than necessary, so it is in fact in some variations of the invention smaller. d2 may here

be 4 mm and d_1 5 mm. The performance of the antenna arrangement will be improved if the distances are increased. This is however in many cases not possible. The width of the first parasitic element 22 may here be 9 mm, while the width
5 of the radiating element may be 20 mm.

The first parasitic element 22 is in Figs. 3 and 4 schematically shown as an element that supports itself. Both elements may with advantage be provided through the use of a flex film. The parasitic element 22 could also be attached to
10 a back cover of the portable radio communication device, i.e. a part of the casing, to be connected to the board 18 when the portable radio communication device is assembled. When the first parasitic element is attached to the back cover, then the above mentioned distance d_2 will normally be higher
15 than the distance d_1 .

The antenna arrangement according to the first embodiment is an internal antenna element essentially operating in first low-frequency band. However, because the height is so low, the radiating element does not have a good enough wide band
20 coverage. The parasitic element is provided for assisting this coverage. The ordinary placing of such a parasitic element would be such that it is coupled to the radiating element, which in many cases is through placing it in the vicinity of the radiating element.

25 As the antenna arrangement is provided within the casing of the portable electronic device, the dimensions of this device puts constraints on the size of the antenna arrangement. The dimensions of the portable radio communication device thus places constraints on the antenna arrangement, which
30 constraints may for instance function to limit the available antenna volume at the first edge of the board.

It may therefore not be possible to place the first parasitic element adjacent the radiating element, because of these size restrictions caused by the design of the portable radio communication device.

- 5 At the frequencies that are of interest, here from 824 MHz to 960MHz, one element of the antenna arrangement that has a significant contribution to the antenna arrangement performance is in fact the circuit board 18. It has a considerable contribution to the radiation of the antenna
- 10 arrangement. Because the radiating element 20 is provided at the first edge of the board, the electrical field strength, the E field, jointly caused by these two elements is the strongest at this first edge, i.e. in the area where the first and second long sides joins the first short side.
- 15 However, when this electrical field strength is then further investigated it can be seen that in the direction away from this first edge towards the second edge it first gets weaker. However, thereafter the field again gets stronger as the second edge is approached. At the second edge it is then
- 20 again fairly strong. This fairly strong field is furthermore retained along the second short side of the board, i.e. along the second edge. In order to obtain an effective parasitic element, this element is therefore according to the invention placed at the second edge of the board, so that it stretches
- 25 along this second short side. With this placing a good coupling between the first parasitic element 22 and the circuit board 18 is achieved because of the strong E field, which helps in broadening the frequency range covered by the first radiating element.
- 30 The first parasitic element does not need to be planar, but can have other shapes, as is evident from fig. 5, which shows a perspective view of this first parasitic element 22 and the board 18. As can be seen here, the first parasitic

element is shaped as piece of conductor having a first straight section running at a distance straight above the board along the second edge and then being bent for forming a second straight section leading back towards the point of origin. The second section is here furthermore angled ninety degrees in relation to the first section and placed essentially straight above the second edge.

As mentioned earlier, it is often of interest to provide multiband functionality with this type of antenna arrangement, i.e. to also cover a high-frequency band, for instance between 1710 and 2170 MHz. A second embodiment of the present invention is directed towards this situation.

This second embodiment is indicated in fig. 6, which shows a plan view of the antenna arrangement. In this second embodiment the antenna arrangement also includes a second parasitic element 32 in addition to the radiating element 20 and the first parasitic element 22. Here the radiating element 20 has two branches, a first low frequency branch 20-1 and a second high frequency branch 20-2, where the first branch provides resonance at the first low-band frequency and the second branch provides resonance at a first high-band frequency. Each branch is here essentially dimensioned for having a length providing a quarter of a wavelength of the frequency of interest. Also here meandering sections may be used for accomplishing this. It should here be realized that alternative ways of providing resonance are feasible, for instance using only one branch being folded back for forming a gap providing the desired additional resonance.

In order to enhance the coverage in the high-frequency band there is thus here a second parasitic element 32 placed above the board 18, which second parasitic element 32 has a connection 34 to ground. This connection 34 is provided

adjacent the feeding connection 26 of the radiating element 20. The second parasitic element 32 is also provided adjacent the radiating element in order to have a good coupling to it.

The first branch 20-1 of the radiating element is, as before,
5 dimensioned for resonating at the first low-band frequency, while the second branch 20-2 is dimensioned for resonating at a first high-band frequency. The second parasitic element 32 is dimensioned for resonating at a second high-band frequency that is here slightly lower than the first high-band
10 frequency. The first parasitic element 22 is, just as in the first embodiment, dimensioned for providing resonance at the second low-band frequency.

It is in this way possible to provide coverage of a very wide second high-frequency band, for instance between 1710 - 2170
15 MHz combined with a coverage of the first low-frequency band.

A return loss diagram RL showing the return loss in dB in dependence of frequency f in GHz is shown in fig. 7 for the second embodiment of the invention. As can be seen in that diagram the first branch of the radiating element provides a
20 first low band resonance frequency f_{L1} at around 0.840 GHz and -9 dB, while the first parasitic element provides a second low band resonance frequency f_{L2} at around 0.960 GHz and -5 dB. The second branch of the radiating element furthermore provides a first high band resonance frequency
25 f_{H2} at around 2.07 GHz and -21 dB, while the second parasitic element provides a second high band resonance frequency f_{H2} at around 1.74 GHz and -19 dB.

In this way there is provided an antenna arrangement that is able to cover the whole range of 824 - 960 MHz as well as the
30 whole range of 1710 - 2170 MHz even though the antenna volume is limited. This is furthermore done with a limited number of elements and therefore the production cost is also low.

It is here possible to use a tuning element, for instance in the form of a capacitor, in order to regulate the gain in the two bands. This can be done in order to provide a more even performance in the two frequency bands.

5 As is shown in the circuit diagram of fig, 8, such a tuning element may be provided in the form of a capacitor 36 between the feeding connection 26 of the radiating element 20 and the radio circuit 24. This indicates that it may be placed on the circuit board. However it may also be provided as a part of
10 the radiating element as is shown in fig. 9, which shows a perspective view of a part of the radiating element and the board. As can be seen here the tuning element, also here a capacitor 34, is provided in a first conductor leading from the feeding connection 26 to the radiating element 20. Here
15 there is also a conductor leading from the radiating element to the grounding connection 28 via a second meandering conductor. This meandering shape may be replaced by an inductor component.

As can be seen in both these figures a tuning element in the
20 form of a tuning capacitor 36 may be connected in a series connection between the radiating element and the radio circuit. This capacitor may, in dependence of the requirements of the depth of the resonances in the low-frequency band, have a value in the range of 1 - 5 pF and may
25 with advantage be 1.5 pF.

The capacitor may be provided as a separate component. However it may also be provided through the use of plates attached to the conductor or a bending of the conductor, where these plates and this bend form a distance between the
30 plates and parts of the conductor that forms the capacitance. It is also possible to use an inductive element instead,

which could then also be connected between the radiating element and the feeding connection.

A return loss diagram RL showing the return loss in dB in dependence of frequency f in GHz for an antenna arrangement according to an embodiment of the invention where multiband operation is combined with such a tuning element is shown in fig. 10. As is evident from this figure the return loss of the resonance frequencies has been evened out as compared with fig. 7.

There are many variations that may be made of the present invention. The ground plane need not cover the whole board, but may only be provided in parts and then parts under the radiating element. The radiating element and first parasitic elements need not stretch the whole way from the first long side to the second long side. The tuning element may be omitted as may the second parasitic element. The high-band frequency of the radiating element was in the example given above higher than the high band frequency of the second parasitic element. It should be realized that the opposite situation could also exist. The placing of the radiating element and the first parasitic element is not limited to adjacent short sides. All the sides of the board may for instance have equal length. These elements could also be placed adjacent the long sides of a board. Therefore the present invention is only to be limited by the following claims.

CLAIMS

1. An antenna arrangement comprising and
- a radiating element (20) dimensioned for providing resonance at a first frequency (f_{L1}),
- 5 a board (18) including a ground plane, wherein said radiating element (20) is arranged at a first edge of said board (18), and
- a first parasitic element (22) arranged at a second edge of said board (18) opposite said first edge, wherein said first
- 10 parasitic element (22) is dimensioned for providing resonance at another frequency (f_{L2}) near said first frequency for providing coverage of a first frequency band,
- wherein the major extension of said first parasitic element (22) is along said second edge of said board (18).
- 15 2. The antenna arrangement according to claim 1, wherein the first parasitic element is elongated, with its direction of elongation provided along said second edge.
3. The antenna arrangement according to claim 1 or 2, wherein the first parasitic element stretches along more than half of
- 20 the second edge.
4. The parasitic element according to claim 3, wherein the first parasitic element stretches along essentially the whole of the second edge.
5. The antenna arrangement as claimed in any previous claim,
- 25 wherein said radiating element is placed at a first distance ($d1$) above the board (18) and the first parasitic element (22) is placed a second distance ($d2$) above the board (18), wherein said second distance ($d2$) is equal to or less than the first distance ($d1$).

6. The antenna arrangement as claimed in claim 5, wherein said second distance (d2) is less than said first distance (d1).

7. The antenna device according to any of claims 1 - 4,
5 wherein said radiating element is placed at a first distance (d1) above the board (18) and the first parasitic element (22) is placed a second distance (d2) above the board (18), wherein said second distance (d2) is higher than the first distance (d1).

10 8. The antenna arrangement as claimed in any previous claim, further comprising a tuning element connected to the radiating element.

9. The antenna arrangement according to claim 8, wherein the tuning element is placed in a series connection between the
15 radiating element (20) and a radio circuit (24).

10. The antenna arrangement according to claim 9, wherein the tuning element is provided in a conductor leading from a feeding connection (26) of the radiating element to the radiating element.

20 11. The antenna arrangement according to any of claims 8 - 10, wherein the tuning element is a capacitor (36).

12. The antenna arrangement according to any previous claim, wherein the first frequency is a first low frequency and the second frequency is a second low frequency, the frequency
25 band covered by these two frequencies is a low-frequency band and the radiating element is further dimensioned for providing resonance at a first high frequency (f_{H1}) in order to cover a high-frequency band separate from said low-frequency band.

13. The antenna arrangement according to claim 12 further comprising a second parasitic element (32) provided adjacent the radiating element (20) and dimensioned for providing resonance at a second high frequency (f_{H2}) in order to assist
5 in covering said high-frequency band.

14. The antenna arrangement as claimed in claim 13, wherein said high-frequency band covers the frequency range between 1710 and 2170 MHz.

15. The antenna arrangement according to any previous claim,
10 wherein the radiating element (20) generally extends along said first edge of said board (18).

16. The antenna arrangement according to any previous claim, wherein said first frequency band covers the frequency range between 824 MHz and 960 MHz.

15 17. The antenna arrangement according to any previous claim, wherein said first parasitic element (22) has an inductance and a capacitance forming a resonance circuit defining the second frequency.

18. A portable radio communication device, **characterized in**
20 that it comprises an antenna arrangement as claimed in any previous claim.

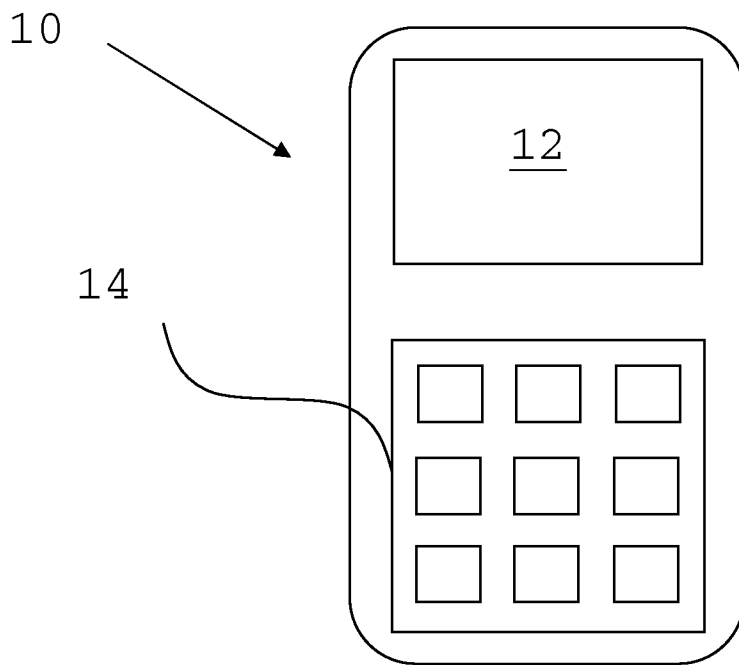


FIG. 1

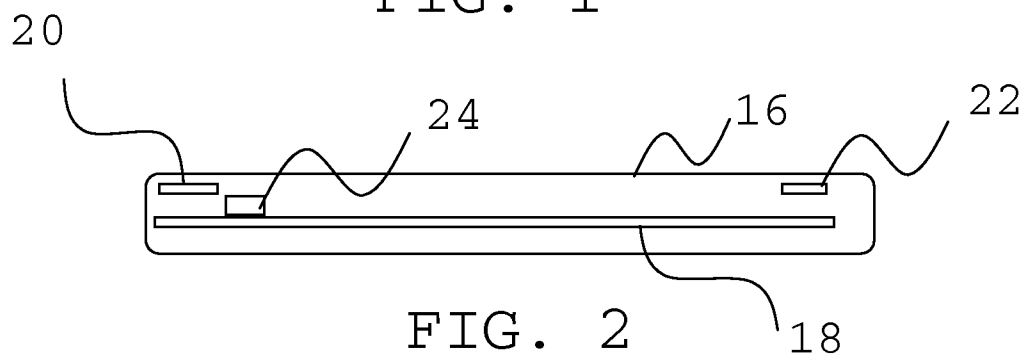


FIG. 2

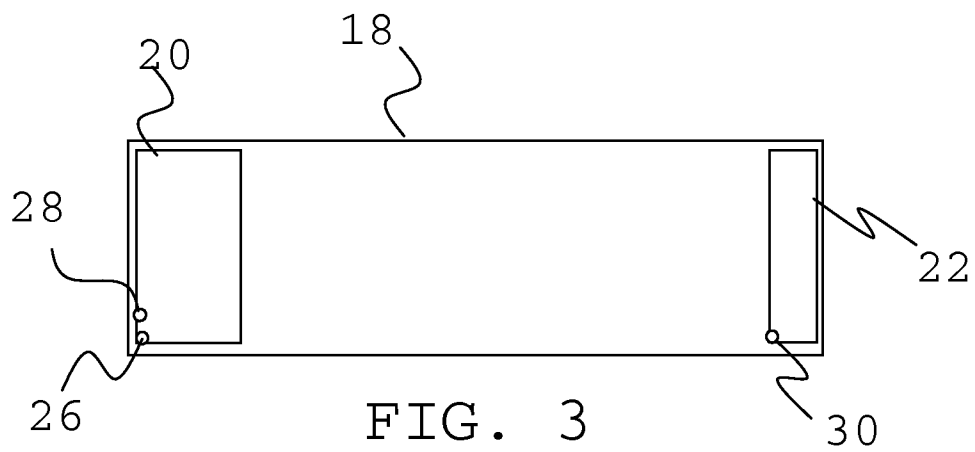


FIG. 3

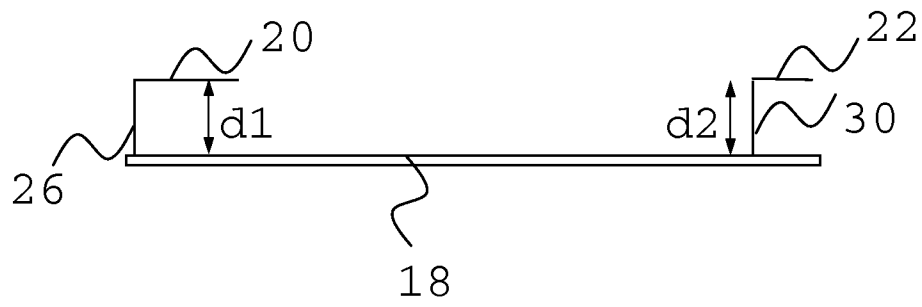


FIG. 4

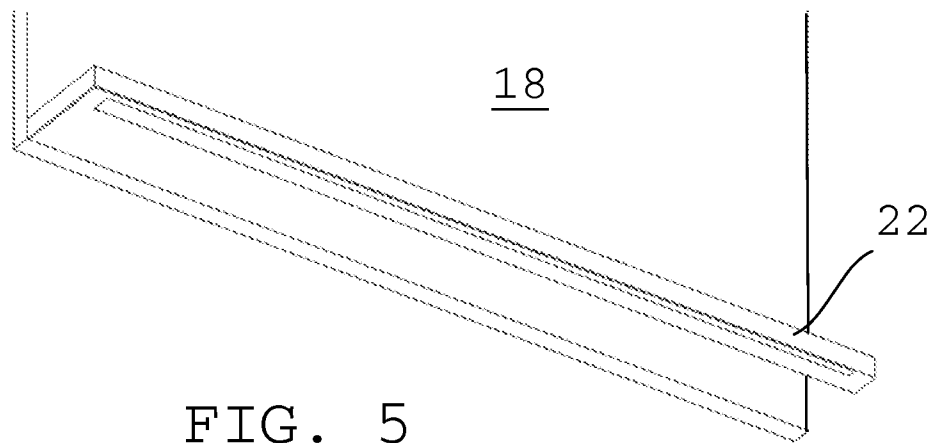


FIG. 5

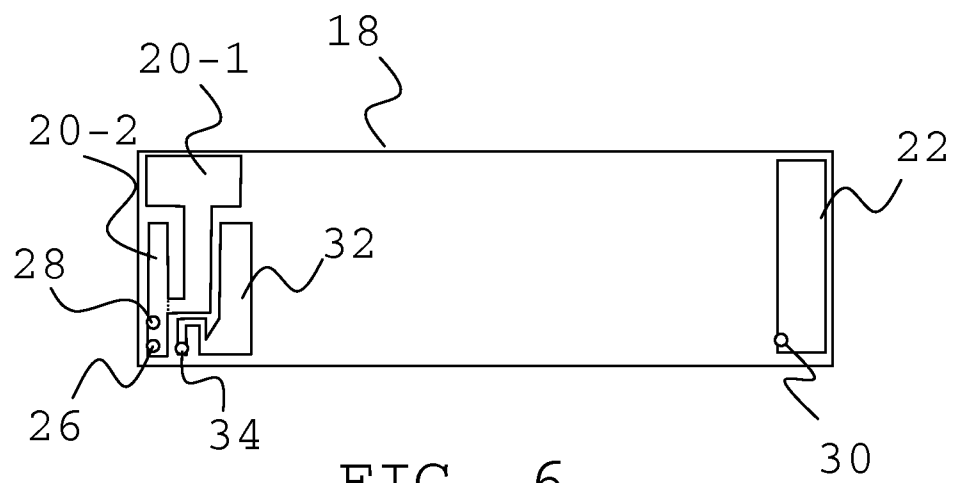


FIG. 6

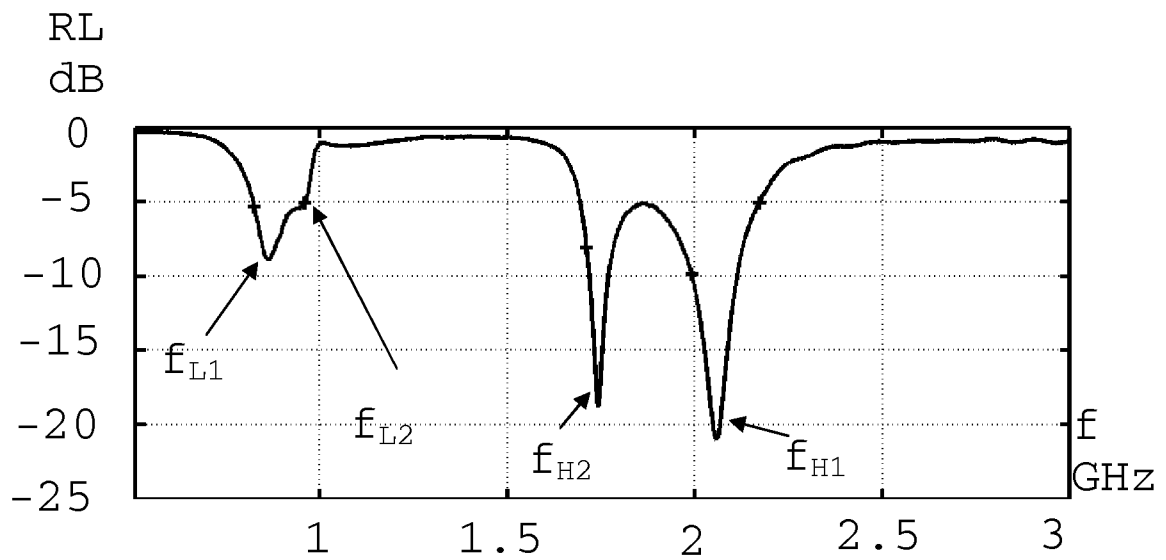


FIG. 7

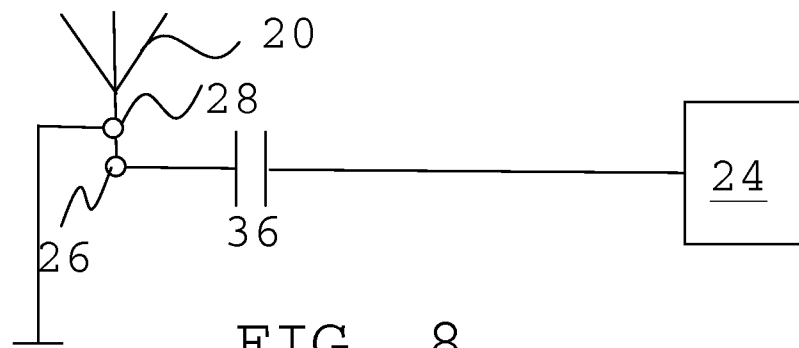


FIG. 8

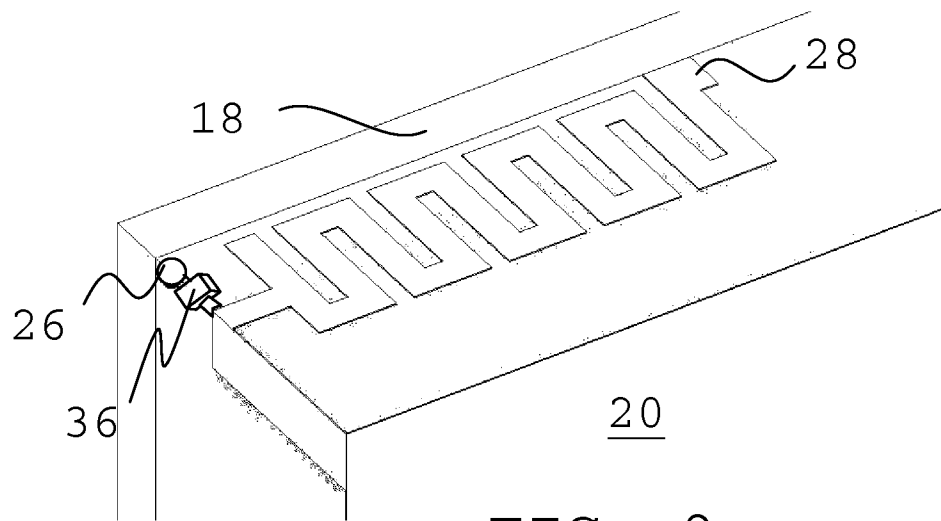


FIG. 9

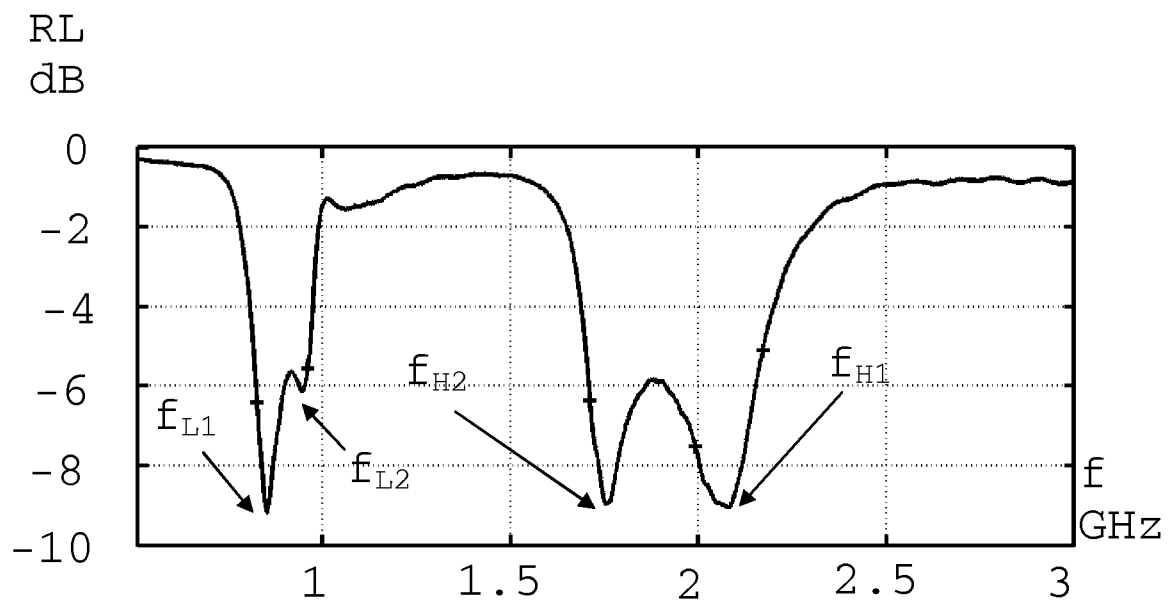


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2010/070729

A. CLASSIFICATION OF SUBJECT MATTER

H01Q1/27(2006.01)i

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: H01Q

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

VEN, CPRSABS, CNKI: ANTENNA, PARASITIC, PASSIVE, BOARD, PCB, PWB, PORTABLE, MOBILE, HANDHOLD+, HANDHELD, WIRELESS, DISTANCE, TUN+, CAPACIT+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP7131234A (NIPPON MEKTRON KK) 19 May 1995(19.05.1995) description paragraphs 0001, 0016-0019; figure 1	1-4,15,18
Y		8-11
X	US6456249B1(Johnson et al.) 24 Sep. 2002(24.09.2002) description column 4, lines 29-54, column 6, lines 4-15; figures 1-3, 5	1,2,5-7,12-18
Y		8-11
Y	JP10107671A(KOKUSAI ELECTRIC CO LTD) 24 Apr. 1998(24.04.1998) description paragraphs 0007-0008; figure 1	8-11

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 19 Nov. 2010(19.11.2010)	Date of mailing of the international search report 09 Dec. 2010 (09.12.2010)
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer JIANG, Shan Telephone No. (86-10)62411476

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/CN2010/070729

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
JP7131234A	19.05.1995	NONE	
US6456249B1	24.09.2002	US2002070902A1	13.06.2002
		US6429818B1	06.08.2002
		WO0133665A1	10.05.2001
		US6215447B1	10.04.2010
JP10107671A	24.04.1998	NONE	