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(71) Applicant: **Kabushiki Kaisha Toshiba**
Tokyo 105-8001 (JP)

(72) Inventor: **Minemura, Takashi,**
c/o Toshiba Corporation
Minato-ku Tokyo (JP)

(74) Representative: **HOFFMANN - EITLE**
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

(54) **Radio communication apparatus**

(57) A radio communication apparatus has an RF current controller (5; 51; 52; 53), typically a one-fourth wavelength long conductor (5), controlling an RF current flowing over the ground plane to improve the antenna efficiency. The RF current controller (5; 51; 52; 53) is located no farther than one-fourth wavelength of a the lowest frequency in the frequency band where the apparatus is used, away from a feeding point (8) at which an antenna element (7) is fed. The RF current controller (5; 51; 52; 53) and the feeding point (8) are located within a pier-shaped portion (3) which is separated from an adjacent portion (4) by a gap (2) of the ground pattern, so that the RF current flowing over the ground plane decreases and the antenna efficiency is improved (refer to Figure 1B).

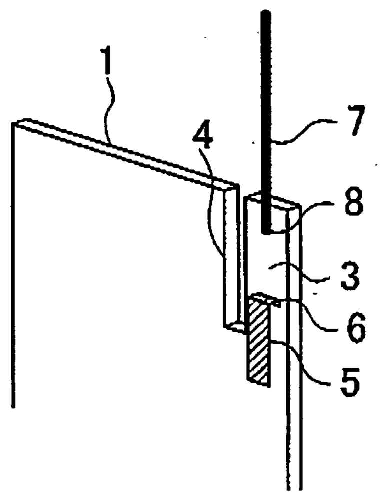

Figure 1B

EP 1 562 259 A1

Description

DESCRIPTION OF THE INVENTION

Technical Field

[0001] The present invention relates to radio communications (e.g., mobile communications), and more particularly to a radio communication apparatus such as an apparatus used as an ending node for radio communications.

Background Art

[0002] In a radio communication apparatus having a body, an antenna element, a printed circuit board with a ground pattern and a feeder end feeding the antenna element, currents of radio frequencies (RF currents) flow from the feeder end to the antenna element, and to a ground plane formed by the ground pattern and the body. The ground plane thus works as an additional antenna even if it is not intentionally designed. The RF current flowing over a wide area of the ground plane works to electrically vary the shape of the antenna element , and causes the efficiency of radiation from the antenna element (antenna efficiency) to be deteriorated.

[0003] A radio communication apparatus was improved to avoid such deterioration, and the improved appratuses are disclosed in the Japanese published patent applications, e.g., H05-327527 and 2001-274719, the English version of which is available on the Japan Patent Office website. This type of conventional apparatus has a slit in its body or its printed circuit board to prevent the RF current from spreading over the ground plane and thus keeping the antenna efficiency from serious deterioration.

[0004] A more positive way of RF current control is to place an element (named an RF current controller) to absorb the RF current at a controlling point on the ground plane so that the RF current does not spread. An apparatus of this conventional type is disclosed in the Japanese published patent application, e.g., 2001-308622, which has a plurality of RF current controllers of various sizes to expand the applicable bandwidth as the effect of the RF current controller depends on the frequency, and, thereby, on its size or location to be put on the ground plane.

[0005] These conventional techniques still have problems to be improved.

Technical Problem and its Solution; Advantageous Effects

[0006] In a configuration of a radio communication apparatus having an RF current controller, an RF current flowing out of the feeder end (located at a feeding point) goes to the antenna element, another RF current goes to the RF current controller, and the remaining goes to the ground plane. The distance between the feeding point and the controlling point should be carefully determined. The RF currents are excessively concentrated around the points if the distance is too short, and uncontrollable RF current widely flows over the ground plane other than the RF current controller if the distance is too long.

[0007] An electromagnetic field arises near and around the points and becomes so strong that the antenna efficiency may be affected by positional relationships among the points and a human body depending on how the apparatus, e.g., a mobile phone, is held by hands in the above "too short" case.

[0008] The antenna efficiency may also be affected by a positional relationship between the apparatus and a human body in the "too long" case because effective line impedance of the ground plane varies depending on how close the ground plane is to the human body.

[0009] Accordingly, it is necessary to keep the RF current concentration near and around the feeding point and the controlling point under control, and to have the RF current controller work properly not to excessively spread the RF current over the ground plane to solve the technical problem stated above, and in order to prevent the antenna efficiency from being deteriorated even when the apparatus is used close to a human body or in any other status.

[0010] According to one aspect of the present invention, there is provided a radio communication apparatus configured to be used in a frequency band characterized by comprising a printed circuit board having a substrate with a fringe area thereof covered by a ground pattern, where the ground pattern has a pier-shaped portion formed on the fringe area and an adjacent portion separated from the pier-shaped portion by a gap formed along an edge of the pier-shaped portion, an antenna element configured to be fed at a feeding point within the pier-shaped portion, and an RF current controller configured to be coupled with the ground pattern at a controlling point within the pier-shaped portion. In the above configuration, the antenna element is fed in the frequency band, and the distance between the feeding point and the controlling point is designed to be no greater than one-fourth wavelength of the lowest frequency in the frequency band.

[0011] In accordance with the above aspect of the present invention, the RF currents flowing to an area other than the antenna element are confined within the pier-shaped portion and most of them are absorbed in the RF current controller located within the pier-shaped portion and away from the feeding point, thus avoiding an excessive RF current concentration and wide RF current spread.

Brief Description of the Figures in the Drawings

[0012]

Figure 1A is a front view of a main part of a first embodiment of a radio communication apparatus. Figure 1B is a perspective view of the first embodiment shown in Figure 1A;

Figure 2A shows an arrangement to simulate antenna efficiency of the first embodiment of Figure 1A. Figure 2B is a table showing a result of a simulation conducted by using the arrangement of Figure 2A;

Figure 3 is a front view of a main part of a second embodiment of a radio communication apparatus. Figure 4 is a front view of a main part of a third embodiment of a radio communication;

Figure 5A is a perspective view of a fourth embodiment of a radio communication apparatus. Figures 5B and 5C are perspective views of other fourth embodiments of a radio communication apparatus; and

Figure 6 is a perspective view of a main part of a of a fifth embodiment of a radio communication apparatus Figures 7A and 7B are front views of other fifth embodiments of a radio communication apparatus.

Detailed Description of Embodiments

[0013] A first embodiment of the present invention will be described with reference to Figures 1A, 1B, 2A, and 2B. Figures 1A and 1B show a configuration of a main part of a radio communication apparatus of this embodiment.

[0014] This apparatus includes a printed circuit board 1 formed on a single- or multiple-layered substrate. A portion of (a layer of) the substrate is covered by a ground pattern. The ground pattern of the portion is shaped in a manner that an upright portion of its upper fringe area has been removed to form a gap 2. The gap 2 separates a pier-shaped portion 3 of the ground pattern from an adjacent portion 4 of the ground pattern.

[0015] It should be noted here that the gap 2 may be formed in a manner that a piece of the ground pattern is removed while the corresponding piece of the substrate is left, or that a piece of the ground pattern and the corresponding piece of the substrate are removed together.

[0016] The gap 2 may be formed in a manner that the blank is filled with other dielectric substance after a piece of the ground pattern and the corresponding piece of the substrate are removed to make a blank for a gap. It is equivalent to expanding the width of the gap 2 due to the wavelength shortening effect.

[0017] The gap 2 may also be formed in a manner that a long sideways piece of the ground pattern is removed.

[0018] An RF current controller 5 is attached to the front surface of the pier-shaped portion 3 at a controlling point 6. The RF current controller 5 is an "L"-shaped conductor, for example. The RF current controller 5 is electrically coupled with the ground pattern at the controlling point The controller 5 may be connected directly to the ground pattern at the controlling point 6. The term "coupled" used here in this patent specification and in claims, covers both "connected" and "coupled", and means directly connected, electrostatically coupled, or electromagnetically coupled.

[0019] The RF current controller 5 may be attached to the back surface of the pier-shaped portion 3. It may be attached in the upward direction from the controlling point 6 as well as in the downward direction as shown in Figures 1A and 1 B.

[0020] The apparatus has an antenna element 7 attached to the pier-shaped portion 3 at a feeding point 8. The antenna element 7 is configured to be fed at the feeding point 8 in a frequency band where the apparatus is used. The antenna element 7 is coupled with the one end of a feeder line at the feeding point 8. The other end of the feeder line is connected to a transmitter of the apparatus not shown in Figures 1 A and 1B.

[0021] The antenna element 7 is, for example, a rod-shaped conductors shown in Figures 1A and 1 B. The antenna element 7 may be helical, inverted-F or dielectric antenna.

[0022] In this embodiment, it is important that both the controlling point 6 and the feeding point 8 be located within the pier-shaped portion 3, and that the distance between the controlling point 6 and the feeding point 8 be no longer than one-fourth wavelength of a frequency in the frequency band. This frequency is distance-related and assumed here to be the same as a transmission frequency F0 within the frequency band.

[0023] When the antenna element 7 is fed at the frequency F0, an RF current of the frequency F0 flows from the feeding point 8 to the antenna element 7, and another RF current of the frequency F0 flows downward in the pier-shaped portion 3. The value of the RF current of the frequency F0 flowing in the pier-shaped portion 3 is non-zero between the feeding point 8 and the point (named PO) of one-fourth wavelength of F0 away from the feeding point 8, but decreases as going away from the feeding point 8, then becomes zero at the point P0. Beyond the point P0, the value of the RF current again increases but with a reversed phase. While the RF current goes down within the pier-shaped portion 3, most of the energy of the RF currents confined in the narrow pier— shaped portion 3. Once the RF current gets out of the pier— shaped portion 3, the RF current and its energy spreads over the vast ground plane of the printed circuit board 1.

[0024] The RF current controller 5 coupled with the ground plane absorbs some of the RF current flowing through the controlling point 6 at which it is located. It is assumed that the electrical length, i.e. the mechanical length if it is a conductor, of the RF current controller 5 is one-fourth wavelength of a frequency in the frequency band. This frequency is a length-related frequency. It is assumed that this frequency is the same as the transmission frequency, and also the same as the distance-related frequency F0 in this embodiment to be easily understood.

[0025] The impedance of the RF current controller 5 looked at the controlling point 6 is zero at the frequency F0, and most of the RF current of the frequency F0 reaching the controlling point 6 flows into the RF current controller 5. The controlling point 6 is between the feeding point 8 and the point P0, and the RF current at the controlling point 6 has not become zero. Most of its energy is concentrated around the controlling point 6. Therefore, the value of the RF current of the frequency F0 passing by the controlling point 6 to flow into the vast area of the ground plane is rendered very small.

[0026] When the above phenomenon occurs, most of the RF current of the frequency F0 equivalently flows into the antenna element 7, and as a result of it, the antenna efficiency is improved. It should be noted that the above effect more or less remains as long as the transmission frequency, the distance-related frequency, and the length-related frequency are in the same frequency band even though these three frequencies are not the same one another.

[0027] The distance between the controlling point 6 and the feeding point 8 should be set up in each design considering that a shorter distance has a benefit of decreasing the RF current flowing down the ground plane while a more excessive RF current concentration around the feeding point 8 occurs. The RF current concentration may cause the local electromagnetic field to become so strong that the antenna efficiency may be affected and be deteriorated in a case, for example, where the apparatus is close to a human body during voice communications. On the other hand, the size of the pier-shaped portion 3 may be flexibly determined as long as the distance between the controlling point 6 and the feeding point 8 is neither too short nor too long.

[0028] The distance-related frequency described above should be defined as the frequency at which the apparatus is used if that frequency is uniquely determined like F0. But actually in many cases, the apparatus may be used at various frequencies in the frequency band depending on, e.g., frequency assignment rules adopted by the network to which the apparatus belongs.

[0029] The distance-related frequency is thereby defined as "a frequency in the frequency band" in this patent specification and claims. And any implementation to set the distance between the feeding point 8 and the controlling point 6 shorter than the one determined by the frequency (or any one of the frequencies) at which the apparatus is used is covered by the present invention.

[0030] Since the frequency at which the apparatus is used may range in the full width of the frequency band, the upper limit of the above distance is one-fourth wavelength of the lowest frequency in the frequency band. It is obvious, however, that the apparatus is not always used at the lowest frequency.

[0031] The definition of the length-related frequency as "a frequency in the frequency band" in this patent specification and claims should be interpreted in the same way, and the upper limit of the length of the RF current controller 5 is provided in the same way.

[0032] It may be accepted that the distance between the controlling point 6 and the feeding point is longer than the one-fourth wavelength of the lowest frequency in the frequency band, however, it is preferable that the distance be no longer than the one-fourth wavelength of the lowest frequency in the frequency band...

[0033] The effect of the configuration shown in Figures 1A or 1 B can be described from another viewpoint as follows. There are two current paths in this configuration, each of which is associated with its own resonant frequency. The one is made up of the antenna element 7, the pier-shaped portion 3, and the RF current controller 5. The other is made up of the antenna element 7, the pier-shaped portion 3 and, the vast ground plane of the printed circuit board 1. Deterioration of the antenna efficiency caused by the RF current in the ground plane should be considered, and such deterioration has to be tolerated in a case where the second path is used as an antenna. The gap 2, the pier-shaped portion 3, and so forth may be designed in accordance with the way of usage of the two resonant frequencies.

[0034] Figures 2A and 2B are illustrated to explain a simulated effect of this embodiment in terms of the antenna efficiency..

[0035] Figure 2A shows an arrangement for the simulation where a modeled radio communication apparatus including the printed circuit board 1 and the antenna element 7 is positioned five-millimeter away from a cubic medium of dielectric loss with each side 200 millimeters long which models a human head. The cubic medium has relative permittivity of 40 and conductivity of 1.4.

[0036] Figure 2B is a table showing simulated antenna efficiency of several types of the apparatus. The antenna efficiency is given in normalized values in percent where the value in the free space is 100.

[0037] in "Type 1", the printed circuit board 1 has neither a gap of the ground pattern nor an RF current controller, and the antenna efficiency is nine percent. In "Type 2", the printed circuit board 1 has an RF current controller 5 but has no gap, and the antenna efficiency is 14 percent. In "Type 3", the printed circuit board 1 has a gap 2 but no RF current controller, and the antenna efficiency is nine percent. In "Type 4", the printed circuit board 1 has both the gap 2 and the RF current controller 5, and the antenna efficiency is 18 percent.

[0038] It is apparent from the table and the above description that "Type 4" having both the gap and the RF current controller shows the best antenna efficiency among the four types, and the value of the antenna efficiency is twice as high as "Type 1" and "Type 3" lacking in the RF current controller. The result shows an antenna efficiency improvement in the first embodiment described above.

[0039] A second embodiment of the present invention will be described with reference to Figure 3, which shows a configuration of a main part of a radio communication apparatus of this embodiment. The same reference numerals designate identical or corresponding portions, elements, or components to those of the first embodiment shown in Figure 1A, and a detailed explanation of these is omitted.

[0040] Figure 3 differs from Figure 1A in that the ground pattern is shaped in a manner that another piece of its upper fringe area has been removed to form another gap 20 in addition to the gap 2, and the pier-shaped portion 3 is between the gap 2 and the gap 20 . Substantially the same effect is obtained in this embodiment as obtained in the first embodiment shown in Figure 1A. This arrangement of the second embodiment is particularly useful in a case where it is difficult to locate the feeding point 8 near a corner of the printed circuit board 1 due to a mechanical restriction of the apparatus and so on.

[0041] A third embodiment of the present invention will be described with reference to Figure 4, which shows a configuration of a main part of a radio communication apparatus of this embodiment. The same reference numerals designate identical or corresponding portions, elements or components to those of the first embodiment shown in Figure 1A, and a detailed explanation of these is omitted.

[0042] Figure 4 differs from Figure 1A in that the adjacent portion 4 has an uneven-shaped edge.

[0043] This kind of shape is particularly useful in a case where much area of the printed circuit board 1 is required and the width of the gap 2 is limited.

[0044] If the edge of the adjacent portion 4 is even and the gap 2 is narrow, the RF current flowing from the feeding point 8 downward, in the case of Figure 4, in the pier-shaped portion 3 may excite an RF current in the adjacent portion 4 flowing in the reverse direction, and causing unnecessary radiation of an electromagnetic field. The uneven shape of the edge of the adjacent portion 4 may make the path of the excited RF current so complicated that its value is rendered small. The uneven shape is designed considering the above effect. According to this embodiment, an uneven edge of the adjacent portion 4 allows a narrower gap than an even edge does, and thus enables the printed circuit board 1 to leave more usable area.

[0045] A fourth embodiment of the present invention will be described with reference to Figure 5A, 5B, and 5C which respectively show configurations of this embodiment of radio communication apparatuses. The same reference numerals designate identical or corresponding portions, elements or components to those of the first embodiment shown in Figure 1 B, and a detailed explanation of these is omitted.

[0046] An RF current controller 51 of a spiral-shaped conductor is used in Figure 5A instead of the RF current controller 5 of an "L"-shaped conductor in Figure 1 B. An RF current controller 52 of a meander-shaped conductor is used in Figure 5B instead of the RF current controller 5 in Figure 1B. And an RF current controller 53 of dielectric substance is used in Figure 5C instead of the RF current controller 5 in Figure 1 B.

[0047] The RF current controller 51 or 52 may satisfy its required electrical length even in a small assigned space, which an "L"-shaped or any other straight type conductor may stick out of, owing to their winding or twisting shape. The RF current controller 53 may also satisfy such requirement owing to its wavelength reduction effect. According to this fourth embodiment, the RF current controller may be accommodated in a space smaller than the one required in the previous embodiments.

[0048] A fifth embodiment of the present invention will be described with reference to Figure 6, which shows a configuration of this embodiment of a radio communication apparatus. The same reference numerals designate identical or corresponding portions, elements or components to those of the first embodiment shown in Figure 1B, and a detailed explanation of these is omitted. There is an additional feeding point 81 at the controlling point 6 in Figure 6, while there is no such an additional feeding point in Figure 1B. That is, the RF current controller 5 is configured to be fed at the feeding point 81, and it may be fed in another frequency band.

[0049] It is assumed here that the antenna element 7 is fed at a frequency F1, and that the RF current controller 5 is fed at another frequency F2. The RF current controller 5 is so called a secondary antenna working on the RF current path formed by the antenna element 7, the pier-shaped portion 3, and the RF current controller 5, as described in the first embodiment, at the frequency F1. The RF current controller 5 works as a primary antenna at the frequency F2 at the same time, , and forms another RF current path of the frequency F2 linked with the ground plane through the feeding point 81. The RF current on this path emits radiation at the frequency F2.

[0050] The apparatus of this embodiment thus has two coexisting antennas; the one is formed by the antenna element 7, the pier-shaped portion 3, and the RF current controller 5 (through the two feeding points 8 and 81), and the other is formed by the RF current controller 5, and the ground plane (through the feeding point 81). The apparatus of this embodiment is able to work at two different frequencies. The feeding point 81 may be added to the other embodiments illustrated in Figures 3 through 5C as well. According to this fifth embodiment, the apparatus may work at multiple frequencies (two frequencies in this embodiment).,.

[0051] A sixth embodiment of the present invention will be described with reference to Figures 7A and 7B, which respectively show configurations of this embodiment of radio communication apparatuses. The same reference numerals designate identical or corresponding portions, elements or components to those of the first embodiment shown in Figure 1A, and a detailed explanation of these is omitted.

[0052] Figure 7A differs from Figure 1A in that the printed circuit board 1 is loaded with a lumped circuit element 9 in the gap 2. The gap 2 is bridged between the pier-shaped portion 3 and the adjacent portion 4 with the lumped circuit element 9. Figure 7B differs from Figure 1A in that the printed circuit board 1 is loaded with a distributed circuit element 10 in the gap 2. The gap 2 is bridged between the pier-shaped portion 3 and the adjacent portion 4 with the distributed circuit element 10.

[0053] Types and parameters of the lumped circuit element 9 or the distributed circuit element 10 is designed to make the impedance of the gap 2 frequency-selective so that the impedance peaks selectively at a desired frequency in the frequency band where the apparatus is used.

[0054] The lumped circuit element 9, e.g., an inductor, may be used to cause a resonance in parallel with stray capacitance within the gap 2 at a desired frequency in the frequency band in order that the impedance of the gap 2 peaks at that frequency. The distributed circuit element 10, e.g., a microstrip type filter, may be used within the gap 2 to bring similar effects.

[0055] Higher impedance of the gap 2 at the desired or selected frequency makes more effective confinement of RF currents in the pier-shaped portion 3, and leads to higher antenna efficiency at that frequency. According to the sixth embodiment, the antenna efficiency may be controlled on a frequency-selective basis.

[0056] It should be noted in the embodiments described above that any feature of the present invention is effective not only in transmitting signals but also in receiving signals because of the reciprocal (reversible) nature of antennas.

Claims

1. A radio communication apparatus configured to be used in a frequency band **characterized by** comprising:

    a printed circuit board (1) having a substrate with a fringe area thereof covered by a ground pattern, the ground pattern having a pier-shaped portion (3) and an adjacent portion (4), the pier-shaped portion (3) and the adjacent portion (4) being separated from each other by a gap (2);
    an antenna element (7) configured to be fed in the frequency band at a feeding point within the pier-shaped portion (3); and
    an RF current controller (5; 51; 52; 53) configured to be coupled with the ground pattern at a controlling point (6) within the pier-shaped portion (3), the controlling point (6) being located no farther than the one-fourth wavelength of a frequency in the frequency band away from the feeding point (8).

2. The radio communication apparatus defined in claim 1, wherein the one-fourth wavelength is of the lowest frequency in the frequency band.

3. The radio communication apparatus defined in claim 1, wherein the ground pattern has another adjacent portion separated from the pier-shaped portion (3) by another gap (20) formed along an opposite edge of the pier-shaped portion (3).

4. The radio communication apparatus as defined in claim 1, wherein the substrate has a gap corresponding to the gap (2) of the ground pattern separating the adjacent portion (4) from the pier-shaped portion (3).

5. The radio communication apparatus as defined in claim 1, wherein the substrate has a gap corresponding to the gap (2) of the ground pattern, the gap of the substrate being filled with a dielectric substance other than the substrate.

6. The radio communication apparatus as defined in claim 1, wherein the adjacent portion (4) has an uneven-shaped edge of the ground pattern.

7. The radio communication apparatus as defined in claim 1, wherein the RF current controller (5) has an electrical length of no longer than one-fourth wavelength of a the lowest frequency in the frequency band.

8. The radio communication apparatus as defined in claim 1, wherein the RF current controller (5; 51; 52; 53) is of a dielectric substance or an "L"-, spiral-, or meander-shaped conductor.

9. The radio communication apparatus as defined in claim 1, wherein the RF current controller (5; 51; 52; 53) is further configured to be fed as another antenna element at another feeding point (81) located at the controlling point (6).

10. The radio communication apparatus as defined in any one of claims 1 to 10, further comprising a circuit element (9; 10) configured to be put in the gap (2), the circuit element (9; 10) enabling the gap (2) to adjust impedance thereof on a frequency-selective basis.

11. The radio communication apparatus as defined in claim 9 wherein the circuit element (9; 10) is of a lumped- or distributed-constant

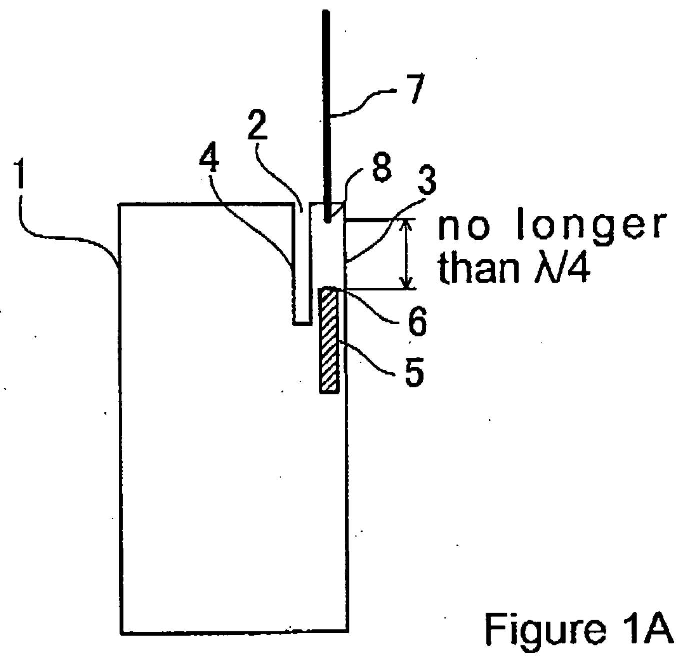

Figure 1A

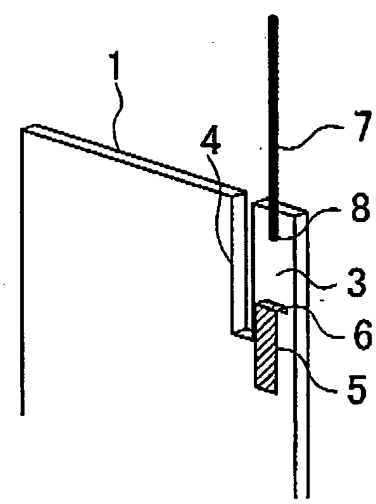

Figure 1B

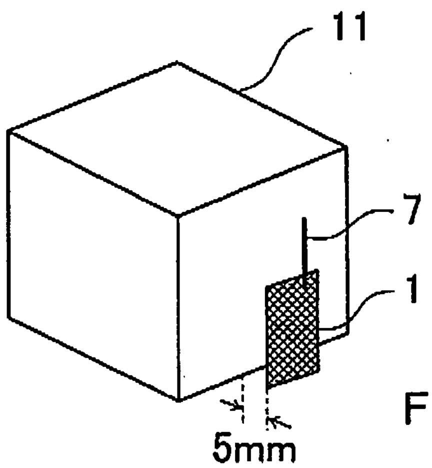

Figure 2A

	Gap	RF current controller	Antenna efficiency
Type 1	No	No	9
Type 2	No	Yes	14
Type 3	Yes	No	9
Type 4	Yes	Yes	18

Figure 2B

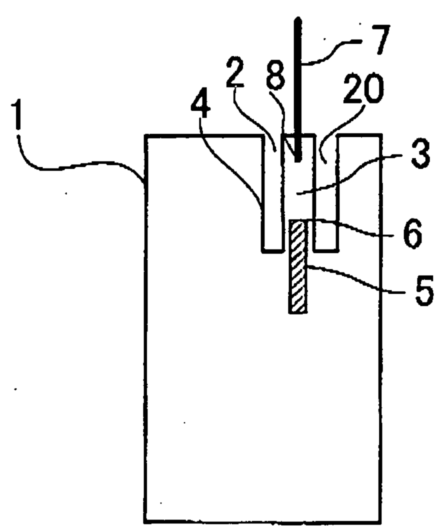

Figure 3

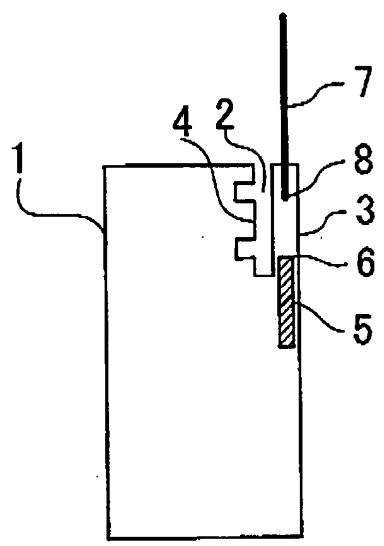

Figure 4

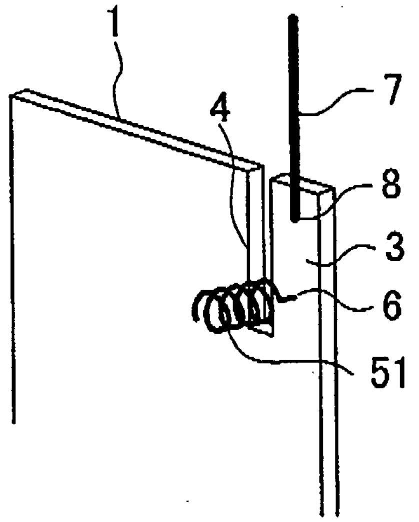

Figure 5A

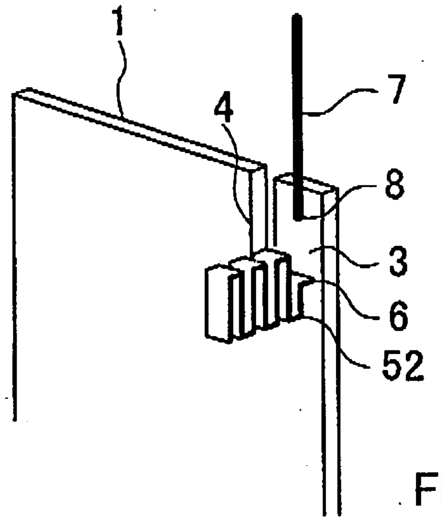

Figure 5B

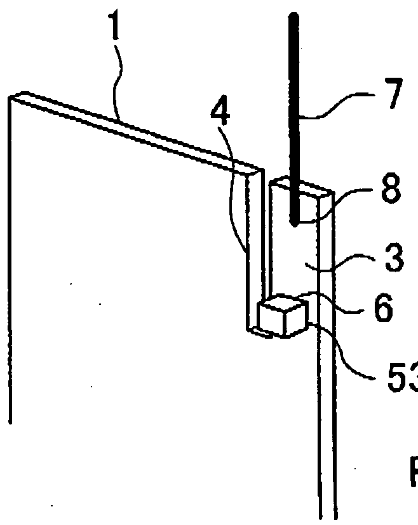

Figure 5C

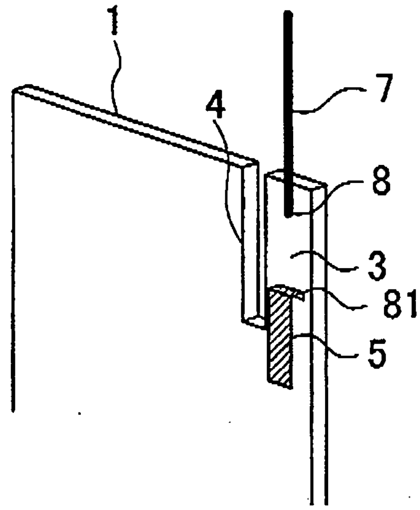

Figure 6

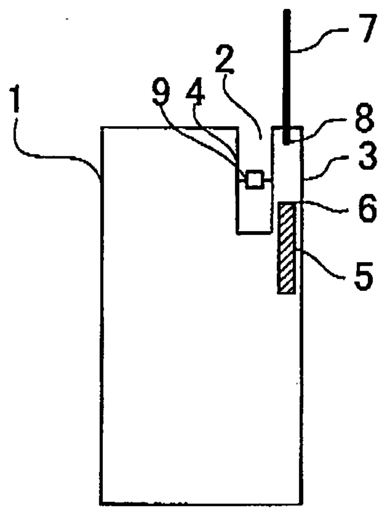

Figure 7A

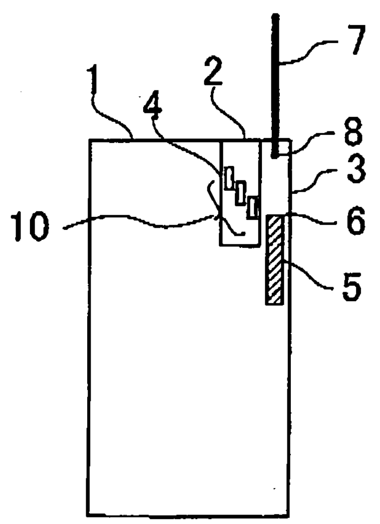

Figure 7B

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 02 5762

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
D,Y	PATENT ABSTRACTS OF JAPAN vol. 2002, no. 02, 2 April 2002 (2002-04-02) -& JP 2001 274719 A (MURATA MFG CO LTD), 5 October 2001 (2001-10-05) * abstract *	1,2,4, 6-8	H01Q1/48 H01Q1/38
Y	EP 1 271 688 A (TOKYO SHIBAURA ELECTRIC CO) 2 January 2003 (2003-01-02) * paragraph [0014] - paragraph [0019]; figure 1 *	1,2,4, 6-8	
A	DE 101 10 982 A (SIEMENS AG) 19 September 2002 (2002-09-19) * abstract; figures 11-14 *	1,2,7,8	
A	US 2002/037739 A1 (BOYLE KEVIN R ET AL) 28 March 2002 (2002-03-28) * paragraph [0043] - paragraph [0045]; figure 17 *	1	
A	US 2003/050094 A1 (BOYLE KEVIN R ET AL) 13 March 2003 (2003-03-13) * paragraph [0022] - paragraph [0025]; figure 1 *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.7): H01Q

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	3 December 2004	La Casta Muñoa, S

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
& : member of the same patent family, corresponding document

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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 04 02 5762

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