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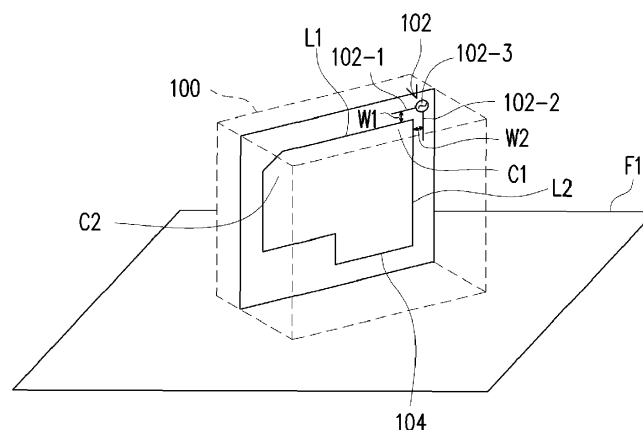
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(54) **VERTICAL COMMUNICATION DEVICE**

(57) Provided is a vertical communication device, which is adapted to vertically stand on a bearing plane or attach to a non-horizontal plane by vertically standing relative to a horizontal plane. The vertical communication device includes a metal reflective plate and at least one antenna. The reflective plate may be at least one of a shielding metal plate and a circuit board. The reflective plate is perpendicular to the bearing plane or the horizontal plane, and the reflective plate has a first corner and a second corner away from the bearing plane or the horizontal plane. Each antenna is disposed corresponding to the first corner or the second corner. A plane where

the first radial arm and the second radial arm of the antenna are located is parallel to or overlapping with a plane where the reflective plate is located, and an opening included between the first radial arm and the second radial arm face the corresponding first corner or the corresponding second corner. The first radial arm and the second radial arm radiate an electromagnetic wave according to a feed-in signal, and form an omni-directional antenna pattern by a reflection effect of the reflective plate in extending directions of the bearing plane, so as to improve a communication quality of the vertical communication device.



**FIG. 1A**

**Description****BACKGROUND OF THE INVENTION****FIELD OF THE INVENTION**

**[0001]** The invention relates to a communication device, more particularly, to a vertical communication device.

**DESCRIPTION OF RELATED ART**

**[0002]** With advancements in communication electronic product development, product size is often subject to restrictions for achieving a lighter, thinner, shorter, and smaller appearance. Therefore, how to increase a communication range of a built-in antenna by completing design of an omni-directional antenna pattern becomes a great technical challenge. The built-in antenna of the conventional communication electronic product is usually implemented by structures including a PIFA antenna, a dipole antenna or such like. However, due to influences caused by a circuit board, a shielding metal plate or other large size components, the antenna pattern is prone to notches or becoming an antenna pattern with a specific directionality. As such, transmission and reception of antenna signals may be affected to lower a communication quality of communication electronic product adopting the antenna.

**SUMMARY OF THE INVENTION**

**[0003]** The invention provides to a communication device capable of significantly improving the communication quality of the vertical communication device.

**[0004]** The vertical communication device of the invention is adapted to vertically stand on a bearing plane or attach to a non-horizontal plane by vertically standing relative to a horizontal plane, and includes a metal reflective plate and at least one antenna. The reflective plate is perpendicular to the bearing plane or the horizontal plane, and the reflective plate has a first corner and a second corner away from the bearing plane or the horizontal plane. Each antenna is disposed corresponding to the first corner or the second corner. Each antenna has a first radial arm and a second radial arm. A plane where the first radial arm and the second radial arm are located is parallel to or overlapping with a plane where the reflective plate is located, and an opening included between the first radial arm and the second radial arm face the corresponding first corner or the corresponding second corner.

**[0005]** To make the above features and advantages of the invention more comprehensible, several embodiments accompanied with drawings are described in detail as follows.

**BRIEF DESCRIPTION OF THE DRAWINGS**

**[0006]** The accompanying drawings are included to provide a further understanding of the disclosure, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the disclosure and, together with the description, serve to explain the principles of the disclosure.

FIG. 1A and FIG. 1B are schematic diagrams of a vertical communication device according to an embodiment of the invention;

FIG. 2A and FIG. 2B are schematic diagrams of the included angle between the radial arms of the antenna according to an embodiment of the invention;

FIG. 3 is a schematic diagram of an antenna pattern of the antenna in extending directions of a bearing plane according to an embodiment of the invention;

FIG. 4 is a schematic diagram of a vertical communication device according to another embodiment of the invention;

FIG. 5 is a schematic diagram of an antenna pattern of the antenna in extending directions of a bearing plane according to another embodiment of the invention;

FIG. 6 is a schematic diagram of a vertical communication device according to another embodiment of the invention;

FIG. 7 and FIG. 8 are schematic diagrams of the antenna according to an embodiment of the invention.

**DESCRIPTION OF THE EMBODIMENTS**

**[0007]** Reference will now be made in detail to the present preferred embodiments of the disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or like parts.

**[0008]** FIG. 1A is a schematic diagram of a vertical communication device, i.e. a vertically aligned antenna device, according to an embodiment of the invention. Referring to FIG. 1A, a vertical communication device 100 includes an antenna 102 and a reflective plate 104. The vertical communication device 100 is adapted to vertically stand on a bearing plane or attach to a non-horizontal plane (e.g., a wall surface) by vertically standing relative to a horizontal plane. For instance, in the embodiment of FIG. 1A, a bearing plane F1 may be, for example, a horizontal table surface or a vertical wall surface and the vertical communication device 100 is adapted to vertical-

ly stand on the bearing plane F1. In this case, the reflective plate 104 is perpendicular to the bearing plane F1, and the reflective plate 104 has a corner C1 and a corner C2 away from the bearing plane F1. As another example, FIG. 1B is a vertical communication device according to another embodiment of the invention. In the embodiment of FIG. 1B, the vertical communication device 100 may also attach to a non-horizontal plane F3 by vertically standing relative to a (hypothesized) horizontal plane F2. In the embodiment of FIG. 1B, the non-horizontal plane F3 (which may be the wall surface, for example) is perpendicular to the horizontal surface F2. In this case, the reflective plate 104 is perpendicular to the horizontal plane F2, and the reflective plate 104 has a corner C1 and a corner C2 away from the horizontal plane F2. It should be noted that, in other embodiments, it is also possible that the non-horizontal plane F3 is not completely perpendicular to the horizontal plane F2. The non-horizontal plane F3 may also be a curved surface, or may include an angle not equal to 90 degree together with the horizontal plane F2. In that case, the vertical communication device 100 also attaches to the wall surface F3 by vertically standing relative to the (hypothesized) horizontal plane F2 (the vertical communication device 100 may be perpendicular to the horizontal plane F2 or approximately perpendicular to the horizontal plane F2.) To simplify the description, the following examples are all described by using the vertical communication device 100 which vertically stands on the bearing plane F1 as shown in the embodiment of FIG. 1A.

**[0009]** The reflective plate 104 may include, for example, at least one of a shielding metal plate or a circuit board, but the invention is not limited thereto. The antenna 102 may be disposed corresponding to, e.g. outside, the corner C1 or the corner C2. For example, in the present embodiment, the antenna 102 is disposed at a location corresponding to, i.e. outside, the corner C1. In the present embodiment, the antenna 102 is a dipole antenna, but the invention is not limited thereto. The antenna 102 includes a radial arm 102-1, a radial arm 102-2 and a feed-in point 102-3.

**[0010]** In the present embodiment, a plane where the radial arm 102-1 and the radial arm 102-2 are located is overlapping with a plane where the reflective plate 104 is located, and an opening included by the radial arm 102-1 and the radial arm 102-2 is outside and faces the corner C1. An included angle between the radial arm 102-1 and the radial arm 102-2 may be, for example, 90 degree. The included angle between the radial arm 102-1 and the radial arm 102-2 may be adjusted according to actual situation to be between 50 degree and 130 degree. Specifically, in the present embodiment, the corner C1 includes a first side L1 and a second side L2 perpendicular to each other. The radial arm 102-1 and the first side L1 include a first predetermined angle, and the radial arm 102-2 and the second side L2 include a second predetermined angle. When the first predetermined angle and the second predetermined angle are both 0 degree, the

radial arm 102-1 is parallel to the first side L1 and the radial arm 102-2 is parallel to the second side L2 and the included angle between the radial arm 102-1 and the radial arm 102-2 is 90 degree. Further, in the present embodiment, the radial arm 102-1 is separated from the first side L1 by a distance W1, and the radial arm 102-2 is separated from the second side L2 by a distance W2. In the present embodiment, a frequency band covered by the antenna 102 is between 2500 MHz and 2700 HHZ and the distance W1 and the distance W2 are 8 mm. The distance W1 between the radial arm 102-1 and the first side L1 and the distance W2 between the radial arm 102-2 and the second side L2 are negatively correlated to a center frequency of the antenna 102. In other words, if the center frequency of the antenna 102 is lower, the distance W1 and the distance W2 are greater.

**[0011]** The first predetermined angle and the second predetermined angle may be set according to actual situation. For example, the first predetermined angle and the second predetermined angle may be controlled to be between -40 degree and 40 degree so the vertical communication device 100 can obtain the optimal communication quality. For example, FIG. 2A and FIG. 2B are schematic diagrams of the included angle between the radial arms of the antenna according to an embodiment of the invention. In FIG. 2A, the radial arm 102-1 is parallel to the first side L1 and the second predetermined angle is -30 degree so the included angle between the radial arm 102-1 and the radial arm 102-2 becomes 60 degree. In FIG. 2B, the radial arm 102-1 is parallel to the first side L1 and the second predetermined angle is 30 degree so the included angle between the radial arm 102-1 and the radial arm 102-2 becomes 120 degree.

**[0012]** Further, in some embodiments, the plane where the radial arm 120-1 and the radial arm 120-2 are located may be parallel to but not overlapping with the plane where the reflective plate 104 is located (e.g., separating the plane where the radial arm 120-1 and the radial arm 120-2 are located from the plane where the reflective plate 104 is located by a distance within 10 mm). In this case, a projection of the antenna 102 on the plane where the reflective plate 104 is located is disposed outside the reflective plate 104. In addition, a first end of the radial arm 102-1 includes a feed-in point connected to a signal end of the feed-in point 102-3, and a second end of the radial arm 102-1 is an open circuit end. A first end of the radial arm 102-2 includes a grounding point connected to a grounding end of the feed-in point 102-3, and a second end of the radial arm 102-2 is an open circuit end. The radial arm 102-1 and the radial arm 102-2 can radiate an electromagnetic wave according to a feed-in signal provided by the feed-in point 102-3, and form an omnidirectional antenna pattern by a reflection of the reflective plate 104 in extending directions of the bearing plane F1.

**[0013]** As shown in FIG. 3, which is a schematic diagram of an antenna pattern of the antenna 102 in extending directions of the bearing plane, by disposing the antenna 102 on the location corresponding to the corner

C1, the electromagnetic wave radiated by the radial arm 102-1 and the radial arm 102-2 may be reflected by the reflective plate 104. As such, gains of the antenna pattern of the antenna 102 are all maintained at approximately 0 dBi in the extending directions of the bearing plane F1 (i.e., the omni-directional antenna pattern). Accordingly, the communication quality of the vertical communication device 100 may be significantly improved because the antenna pattern does not show excess notches or form the specific directionality as the conventional technology.

**[0014]** In other embodiments, the antenna 102 may also be disposed on a location corresponding to the corner C2, and the corner C2 may also include a first side L1 and a second side L3 perpendicular to each other. As shown in FIG. 4, which is a schematic diagram of the vertical communication device according to another embodiment of the invention, an antenna 402 includes a radial arm 402-1, a radial arm 402-2 and a feed-in point 402-3. The radial arm 402-1 may also be disposed parallel to the first side L1 and the radial arm 402-2 may also be disposed parallel to the second side L3, so as to accomplish the goal of improving the communication quality of a vertical communication device 400. As shown in FIG. 5, which is a schematic diagram of an antenna pattern of the antenna 402 in extending directions of the bearing plane, by disposing the antenna 402 on the location corresponding to the corner C2, the electromagnetic wave radiated by the radial arm 402-1 and the radial arm 402-2 may be reflected by the reflective plate 104. As such, gains of the antenna pattern of the antenna 402 are all maintained at approximately 0 dBi in the extending directions of the bearing plane F1 such that the antenna pattern thereof is the omni-directional antenna pattern. Accordingly, the communication quality of the vertical communication device 400 may be significantly improved. Configuration of the antenna 402 may also be adjusted similar to the antenna 102 of the foregoing embodiment, and thus related description is omitted hereinafter.

**[0015]** Referring to FIG. 6, FIG. 6 is a schematic diagram of a vertical communication device according to another embodiment of the invention. In the present embodiment, the antenna 102 and the antenna 402 are disposed on locations corresponding the corner C1 and the corner C2, respectively. Configurations of the antenna 102 and the antenna 402 are identical to those described in the foregoing embodiment, which are not repeated hereinafter. A coupling effect between the antenna 102 and the antenna 402 may be reduced by adjusting the configurations of the antenna 102 and the antenna 402 to thereby improve an isolation of the antenna 102 and the antenna 402. For example, the coupling effect between the antenna 102 and the antenna 402 may be reduced by adjusting the included angle between the radial arms of each of the antenna 102 and the antenna 402 to thereby improve the isolation of the antenna 102 and the antenna 402, so as to further improve the communication quality of a vertical communication device 600.

**[0016]** It should be noted that, implementations of the antenna 102 and the antenna 402 are not limited only to be the implementations described in the foregoing embodiment. In some embodiments, the antenna 102 and the antenna 402 may also be implemented by a folded dipole antenna or a sleeve dipole antenna, for example. FIG. 7 and FIG. 8 are schematic diagrams of the antennas according to embodiments of the invention. In the embodiment of FIG. 7, an antenna 700 may include a radial arm 702-1 with a folding structure, a radial arm 702-2 with a folding structure and a feed-in point 702-3. In the embodiment of FIG. 8, the antenna 800 includes a radial arm 802-1, a radial arm 802-2 with a sleeve structure and a feed-in point 802-3. Configurations of the radial arm 702-1 and the radial arm 702-2 of the antenna 700 and the radial arm 802-1 and the radial arm 802-2 of the antenna 800 may be implemented similar to the radial arms of the antenna 102 or the antenna 402 so the same effect of improving the communication quality of the vertical communication device may be achieved.

**[0017]** From the above, according to the embodiments of the invention, by disposing the antenna corresponding to the corner away from the bearing plane to make the opening included between the radial arms of the antenna face the corresponding corner, the omni-directional antenna pattern may be formed in the extending directions of the bearing plane by the electromagnetic wave radiated by the radial arms and reflected by the reflective plate, such that the communication quality of the vertical communication device may be significantly improved. In addition, the coupling effect between the antennas may be reduced by properly adjusting the configuration of each antenna (e.g., adjusting the included angle between the radial arms), the isolation between the antennas may be improved to further improve the communication quality of the vertical communication device.

**[0018]** In summary there is provided is a vertical communication device (vertically alignable, mountable or arrangeable device with at least one antenna), which is adapted to vertically stand on a bearing plane or attach to a non-horizontal plane by vertically standing relative to a horizontal plane. The vertical communication device includes a metal reflective plate and at least one antenna. The reflective plate may be at least one of a shielding metal plate and a circuit board. The reflective plate is perpendicular to the bearing plane or the horizontal plane, and the reflective plate has a first corner and a second corner away from the bearing plane or the horizontal plane. Each antenna is disposed corresponding to the first corner or the second corner. A plane where the first radial arm and the second radial arm of the antenna are located is parallel to or overlapping with a plane where the reflective plate is located, and an opening included between the first radial arm and the second radial arm face the corresponding first corner or the corresponding second corner. The first radial arm and the second radial arm radiate an electromagnetic wave according to a feed-in signal, and form an omni-directional an-

tenna pattern by a reflection effect of the reflective plate in extending directions of the bearing plane, so as to improve a communication quality of the vertical communication device.

### Claims

1. A vertical communication device (100, 400, 600), adapted to vertically stand on a bearing plane (F1) or attach to a non-horizontal plane (F3) by vertically standing relative to a horizontal plane (F2), and **characterized by** comprising:
  - a reflective plate (104), the reflective plate (104) being perpendicular to the bearing plane (F1) or the horizontal plane (F2), the reflective plate (104) having a first corner (C1) and a second corner (C2) away from the bearing plane (F1) or the horizontal plane (F2); and
  - at least one antenna (102, 402, 700, 800), respectively disposed corresponding to the first corner (C1) or the second corner, each of the at least one antenna (102, 402, 700, 800) having a first radial arm (102-1, 402-1, 702-1, 802-1) and a second radial arm (102-2, 402-2, 702-2, 802-2), a plane where the first radial arm (102-1, 402-1, 702-1, 802-1) and the second radial arm (102-2, 402-2, 702-2, 802-2) are located being parallel to or overlapping with a plane where the reflective plate (104) is located, and an opening included between the first radial arm (102-1, 402-1, 702-1, 802-1) and the second radial arm (102-2, 402-2, 702-2, 802-2) facing the corresponding first corner (C1) or the corresponding second corner.
2. The vertical communication device (100, 400, 600) according to claim 1, **characterized in that**, an included angle between the first radial arm (102-1, 402-1, 702-1, 802-1) and the second radial arm (102-2, 402-2, 702-2, 802-2) is between 50 degree and 130 degree.
3. The vertical communication device (100, 400, 600) according to claim 1 or 2, **characterized in that**, each of the first corner (C1) and the second corner (C2) comprises a first side (L1) and a second side (L2, L3) perpendicular to each other, the first radial arm (102-1, 402-1, 702-1, 802-1) and the first side (L1) include a first predetermined angle, and the second radial arm (102-2, 402-2, 702-2, 802-2) and the second side (L2, L3) include a second predetermined angle.
4. The vertical communication device (100, 400, 600) according to claim 3, **characterized in that**, the first predetermined angle and the second predetermined angle are between -40 degree and 40 degree.
5. The vertical communication device (100, 400, 600) according to claim 3 or 4, **characterized in that**, a distance (W1) between the first radial arm (102-1, 402-1, 702-1, 802-1) and the first side (L1) and a distance (W2) between the second radial arm (102-2, 402-2, 702-2, 802-2) and the second side (L2, L3) are negatively correlated to a center frequency of the antenna (102, 402, 700, 800).
6. The vertical communication device (100, 400, 600) according to claim 3 or 4, **characterized in that**, a distance (W1) between the first radial arm (102-1, 402-1, 702-1, 802-1) and the first side (L1) and a distance (W2) between the second radial arm (102-2, 402-2, 702-2, 802-2) and the second side (L2, L3) are 8 mm.
7. The vertical communication device (100, 400, 600) according to any one of claims 1 to 6, **characterized in that**, a projection of the antenna (102, 402, 700, 800) on the plane where the reflective plate (104) is located is disposed outside the reflective plate (104).
8. The vertical communication device (100, 400, 600) according to any one of claims 1 to 6, **characterized in that**, the antenna (102, 402, 700, 800) is a dipole antenna (102, 402), a folded dipole antenna (700) or a sleeve dipole antenna (800).
9. The vertical communication device (100, 400, 600) according to any one of claims 1 to 6, **characterized in that**, the reflective plate (104) comprises at least one of a shielding metal plate and a circuit board.
10. The vertical communication device (100, 400, 600) according to any one of claims 1 to 6, **characterized in that**, the first radial arm (102-1, 402-1, 702-1, 802-1) and the second radial arm (102-2, 402-2, 702-2, 802-2) radiate an electromagnetic wave according to a feed-in signal, and form an omni-directional antenna pattern by a reflection of the reflective plate (104) in extending directions of the bearing plane (F1) or the horizontal plane (F2).

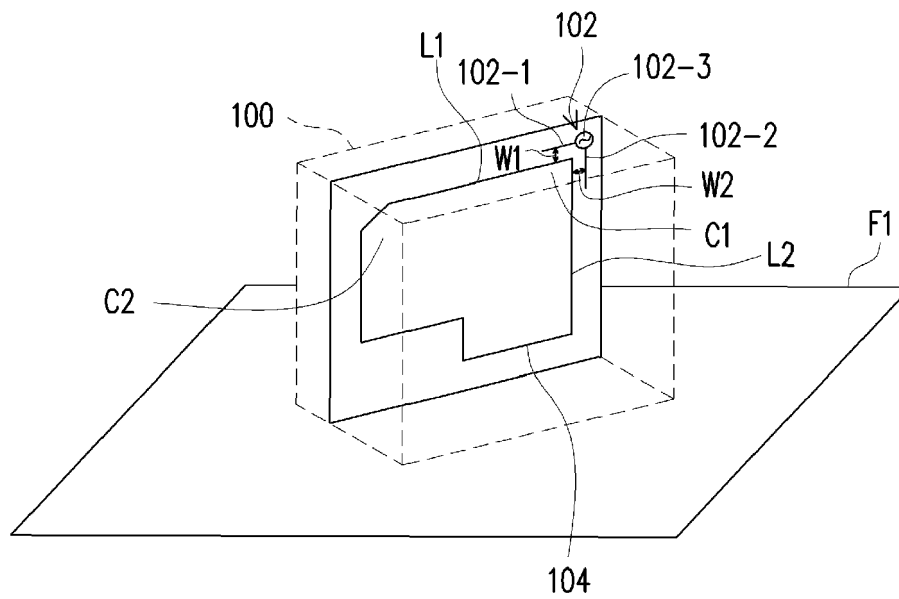


FIG. 1A

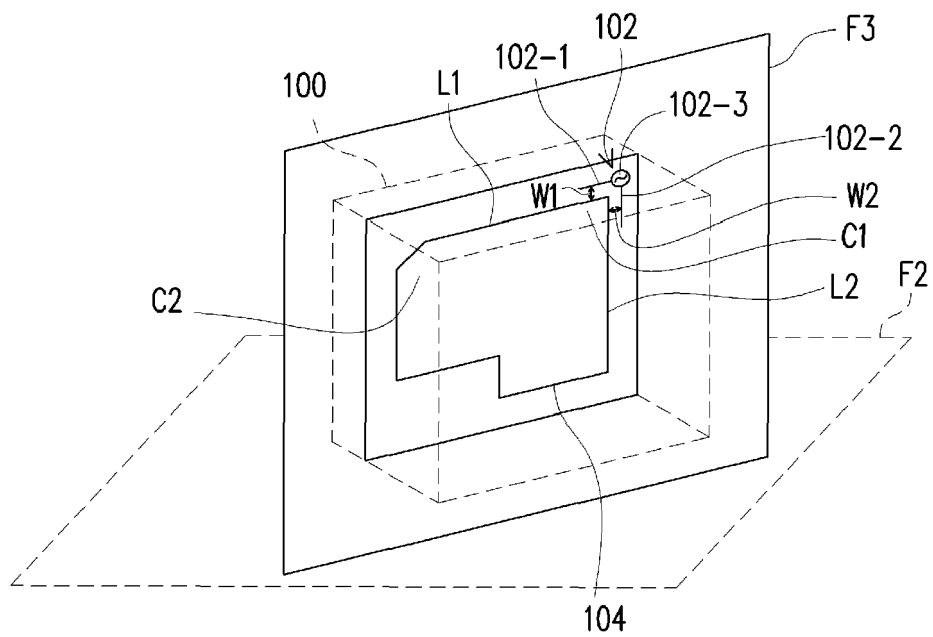


FIG. 1B

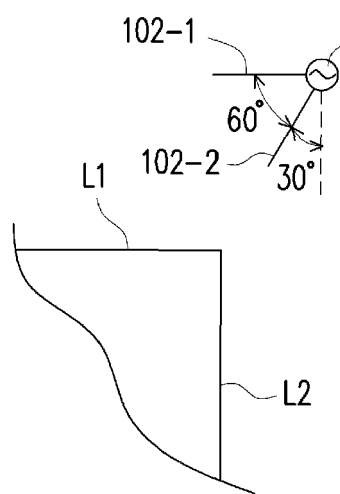


FIG. 2A

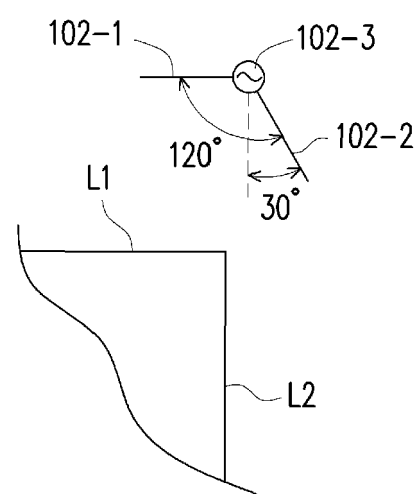


FIG. 2B

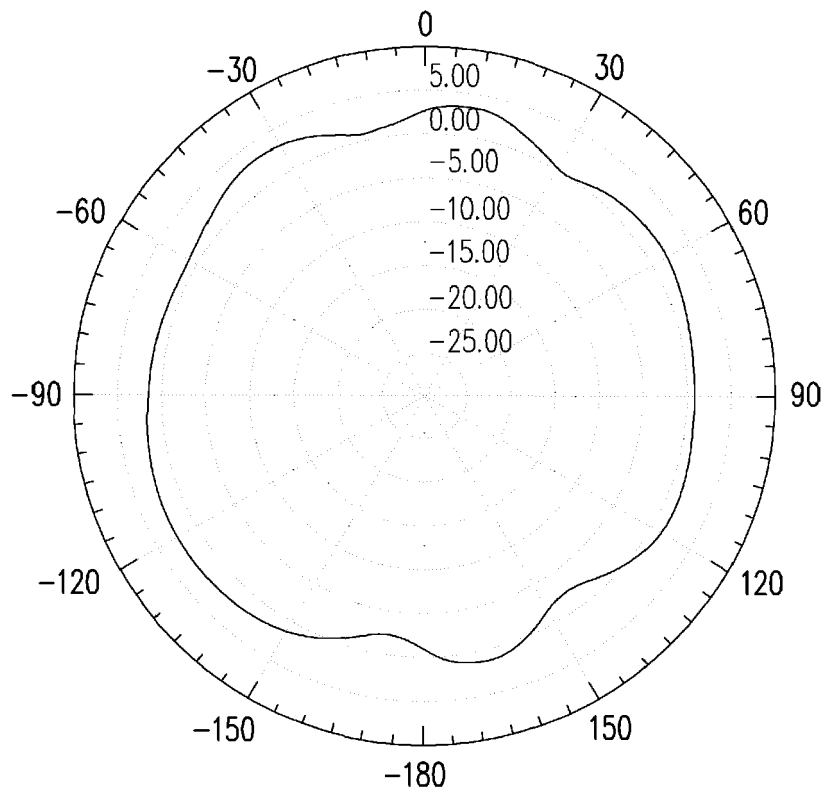


FIG. 3

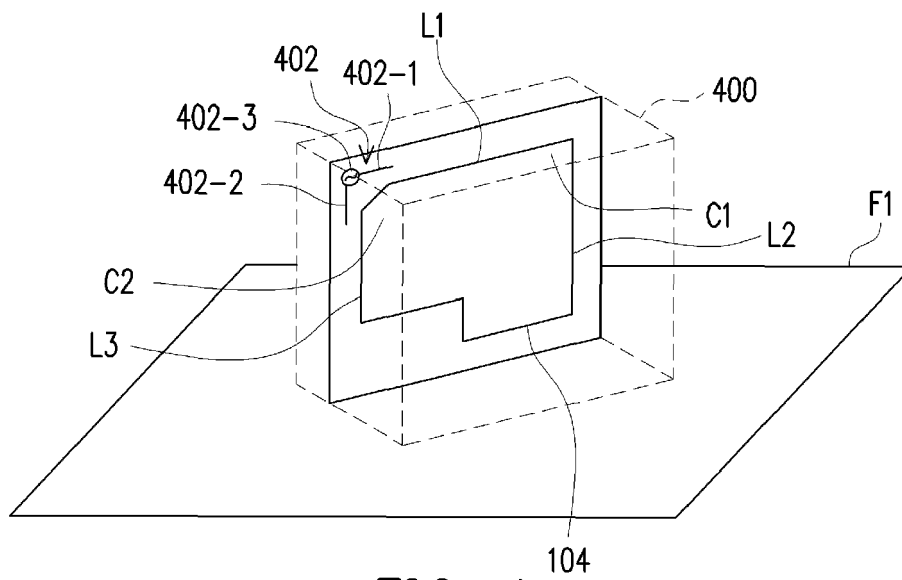


FIG. 4

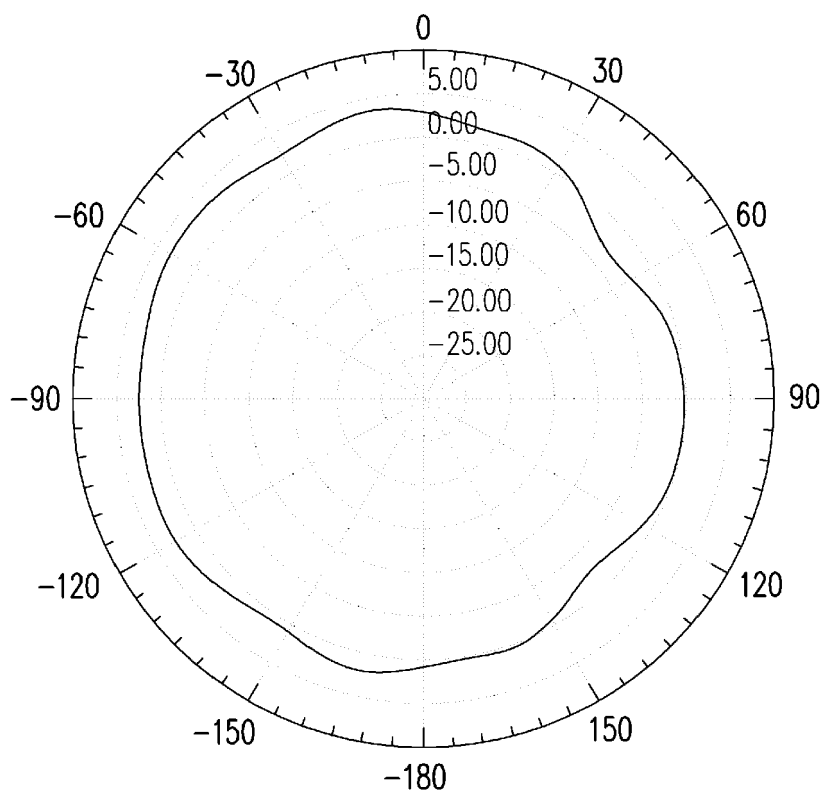


FIG. 5

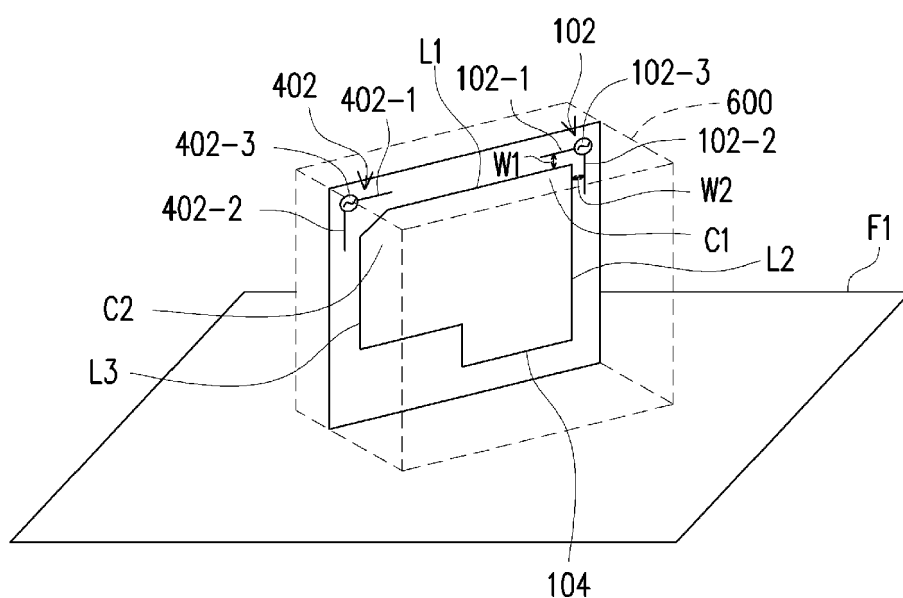


FIG. 6

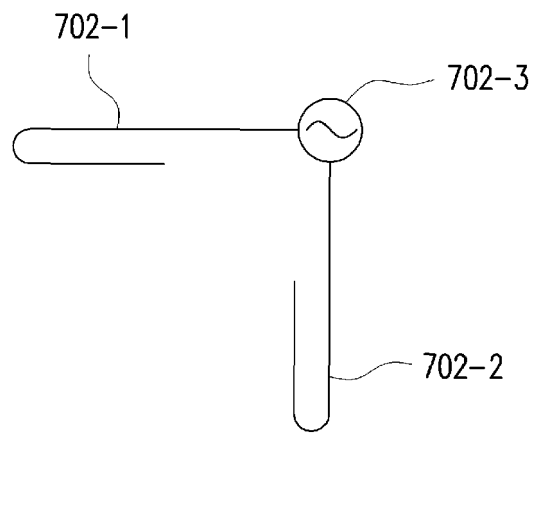


FIG. 7

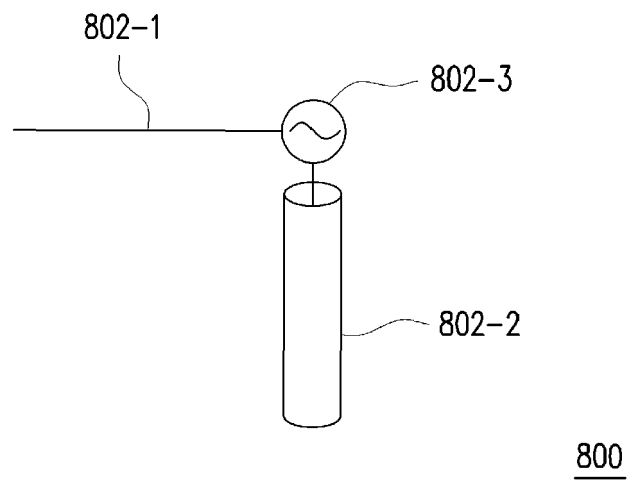


FIG. 8



## EUROPEAN SEARCH REPORT

Application Number  
EP 16 19 4726

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| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                     |                                  |                                                                    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|--------------------------------------------------------------------|
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Citation of document with indication, where appropriate, of relevant passages                                                                                                                                                                                                                                                                                                       | Relevant to claim                | CLASSIFICATION OF THE APPLICATION (IPC)                            |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | EP 1 154 513 A1 (MATSUSHITA ELECTRIC IND CO LTD [JP]) 14 November 2001 (2001-11-14)<br>* figures 3A-4B, 8, 9, 17, 70 *<br>* paragraph [0001] *<br>* paragraph [0016] *<br>* paragraph [0023] - paragraph [0024] *<br>* paragraph [0038] - paragraph [0039] *<br>* paragraph [0076] - paragraph [0077] *<br>* paragraph [0082] - paragraph [0084] *<br>* paragraph [0330] *<br>----- | 1-10                             | INV.<br>H01Q9/16<br>H01Q9/26<br>H01Q9/18<br>H01Q15/14<br>H01Q19/10 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                     |                                  | TECHNICAL FIELDS SEARCHED (IPC)                                    |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                     |                                  | H01Q                                                               |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                     |                                  |                                                                    |
| Place of search                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                     | Date of completion of the search | Examiner                                                           |
| The Hague                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                     | 11 July 2017                     | Yvonnet, Yannick                                                   |
| CATEGORY OF CITED DOCUMENTS<br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document<br>T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>& : member of the same patent family, corresponding document |                                                                                                                                                                                                                                                                                                                                                                                     |                                  |                                                                    |

EPO FORM 1503 03/82 (P04C01)

11-07-2017

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date      |
|-------------------------------------------|---------------------|----------------------------|--------------------------|
| EP 1154513                                | A1                  | 14-11-2001                 | AU 5428200 A 09-07-2001  |
|                                           |                     |                            | CN 1345473 A 17-04-2002  |
|                                           |                     |                            | EP 1154513 A1 14-11-2001 |
|                                           |                     |                            | WO 0148860 A1 05-07-2001 |
| -----                                     |                     |                            |                          |

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82