FORM – 2

THE PATENTS ACT, 1970

(39 of 1970)

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THE PATENTS RULES, 2003

COMPLETE

SPECIFICATION

(See section 10; rule 13)

ANTENNA DEVICE

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THE FOLLOWING SPECIFICATION PARTICULARLY DESCRIBES THE INVENTION AND THE MANNER IN WHICH IT IS TO BE PERFORMED.

The present invention relates to the field of antennas, in particular to an antenna device.

BACKGROUND OF THE INVENTION

Mainstream commercially-available wireless devices (e.g., ZigBee, Wi-Fi, Bluetooth, or the like) operate in the ISM bands. The ISM bands are license-free bands defined by the ITU-R (International Telecommunication Union Radiocommunication Sector). The appearance of the wireless devices operating in the ISM bands is becoming increasingly diversified and fashionable. In order to fulfill customer needs, different materials such as aluminum, stainless steel, copper, and so on, as well as different manufacturing processes such as electroplating, wiredrawing, sand blasting, mirror finishing, nickel coating, and so on have been used to make the metal panels of the wireless devices.

Currently, the wireless devices having a metal panel are facing a serious reflection problem on their dipole antennas. For the dipole antenna, reflection by the metal panel may significantly decrease the communication range of a wireless device, and the reflection may significantly decrease the bandwidth and radiation efficiency of the dipole antenna. Conventionally, it is difficult to solve the dilemma between the metal panel and the communication range of a wireless device. For example, the disadvantages of the reflection effect can be mitigated by decreasing the area of the metal surface on the metal panel to the lowest possible level. This method, with proper impedance matching, can reduce the bandwidth decrease of the dipole antenna caused by the reflection effect of the metal panel; however, it cannot fundamentally eliminate the reflection by the metal panel, and requires a large area of non-metallic surface to replace the metal, thus failing to fulfill the aesthetic requirement.

SUMMARY OF THE INVENTION

The embodiments of the present invention provide an antenna device, which can solve the reflection effect of the metal panel and thus increase the bandwidth and radiation efficiency of the dipole antenna.

An antenna device is provided, including:

a metal panel 1 and a dipole antenna 2, wherein the metal panel 1 is provided with a resonant slot 11 thereon; the resonant slot 11 has a resonant frequency that matches an operating frequency of the dipole antenna 2; and a direction of polarization of the resonant slot 11 is at a preset angle to a direction of polarization of the dipole antenna 2.

Preferably, the resonance frequency of the resonant slot 11 is the same as the operating frequency of the dipole antenna 2.

Optionally, the angle between the direction of polarization of the resonant slot 11 and the direction of polarization of the dipole antenna 2 ranges from -30 ° to +30 °.

Preferably, the angle between the direction of polarization of the resonant slot 11 and the direction of polarization of the dipole antenna 2 is 0 °.

Preferably, the resonant slot 11 is λg/2 long, where λg denotes the wavelength of the dipole antenna 2.

Preferably, the width of the resonant slot 11 ranges from 1mm to 5mm.

Preferably, the resonant slot 11 is in the middle of the metal panel 1.

As can be seen from the above technical solution, the embodiments of the present invention have the following advantages:

The present invention may include a metal panel 1 and a dipole antenna 2, wherein the metal panel 1 is provided with a resonant slot 11 thereon; the resonant slot 11 has a resonant frequency that matches an operating frequency of the dipole antenna 2; and the direction of polarization of the resonant slot 11 is at a preset angle to the direction of polarization of the dipole antenna 2. The embodiment adds a resonant slot 11 onto the metal panel 1, and can adjust the impedance characteristics of the dipole antenna 2 by adjusting the angle between the direction of polarization of the resonant slot 11 and the direction of polarization of the dipole antenna 2 as well as the resonant frequency of the resonant slot 11, thereby realizing impedance matching, effectively solving the reflection effect of the metal panel 1 and thus increasing the bandwidth and radiation efficiency of the dipole antenna 2 in the applications with a metal panel.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the technical solution according to the embodiments of the present invention, the accompanying drawings used in the description of the embodiments are briefly described below. Clearly, the drawings described herein are merely some embodiments of the invention, and those skilled in the art can obtain other drawings based on these drawings without inventive effort.

Figure 1 is a schematic diagram illustrating an antenna device according to an embodiment of the present invention;

Figure 2 is a schematic diagram illustrating an antenna device according to another embodiment of the present invention;

Figure 3 is a schematic diagram illustrating an antenna device according to yet another embodiment of the present invention;

Figure 4 is a schematic diagram illustrating an antenna device according to yet another embodiment of the present invention;

Figure 5 is a schematic diagram illustrating an antenna device according to yet another embodiment of the present invention;

Figure 6 is a schematic diagram illustrating an antenna device according to yet another embodiment of the present invention;

Figure 7 is a schematic diagram illustrating an antenna device according to yet another embodiment of the present invention;

Figure 8 is a schematic diagram illustrating an antenna device according to yet another embodiment of the present invention;

Figure 9 is a schematic diagram illustrating an antenna device according to yet another embodiment of the present invention; and

Figure 10 is a schematic diagram illustrating an antenna device according to yet another embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The technical solutions according to the embodiments of the present invention will be described hereinafter clearly and fully in conjunction with the accompanying drawings of the embodiments. Clearly, the embodiments described herein do not numerate all embodiments of the invention, and are merely some of the embodiments. However, any other embodiment obtained by those skilled in the art based on the embodiments herein without inventive effort shall fall within the scope of protection of the invention.

The embodiments of the present invention provide an antenna device, which can solve the reflection effect of the metal panel and thus increase the bandwidth and radiation efficiency of the dipole antenna.

An antenna device is provided, including: a metal panel 1 and a dipole antenna 2, wherein the metal panel 1 is provided with a resonant slot 11 thereon; the resonant slot 11 has a resonant frequency that matches an operating frequency of the dipole antenna 2; and the direction of polarization of the resonant slot 11 is at a preset angle to the direction of polarization of the dipole antenna 2.

It shall be understood that the direction of polarization of the resonant slot 11 refers to the direction of a Radio frequency (RF) current flow on the surface of the resonant slot 11; and the direction of polarization of the dipole antenna 2 refers to the direction of a RF current flow on the surface of the antenna.

In some embodiments of the invention, the dipole antenna 2 may be used for a radiator at a RF power, and the dipole antenna 2 may transmit and receive signals at a fixed frequency.

This embodiment provides the resonant slot 11 on the metal panel 1 to reduce the reflection effect of the metal panel 1, so that electromagnetic power of the dipole antenna 2 is not significantly reflected by the metal panel 1, and the dipole antenna 2 is less affected by the metal panel.

By adjusting the angle between the orientation of the resonant slot 11 and the orientation of the dipole antenna 2, and adjusting the resonant frequency of the

resonant slot 11, the impedance characteristics of the dipole antenna 2 can be adjusted, thereby realizing impedance matching, effectively solving the reflection effect of the metal panel 1, increasing the bandwidth of the dipole antenna 2 with the metal panel 1, and thus improving radiation performance of the dipole antenna 2 with the metal panel 1.

It shall be understood that the resonant slot 11 may have various shapes, such as those shown in Figure 1 to Figure 10, which are schematic diagrams of antenna devices. As shown in Figure 1 to Figure 10, the shape of the resonant slot 11 is not limited, so long as the resonant frequency of the resonant slot 11 matches the operating frequency of the dipole antenna 2, and the direction of polarization of the resonant slot 11 is at a preset angle to the direction of polarization of the dipole antenna 2. In order to achieve a better result in solving the reflection effect of the metal panel 1, and thereby increase the bandwidth and radiation efficiency of the dipole antenna 2, any one or more of the following requirements may be met for the resonant slot 11:

In some embodiments of the invention, the resonant frequency of the resonant slot 11 matches the operating frequency of the dipole antenna 2, effectively adjusting the impedance characteristics of the dipole antenna 2. Preferably, the resonant frequency of the resonant slot 11 may be the same as the operating frequency of the dipole antenna 2, providing a better impedance matching between the metal panel 1 and the dipole antenna 2.

The angle between the orientation of the resonant slot 11 and the orientation of the dipole antenna 2 affects the bandwidth and radiation efficiency of the dipole antenna. This angle is the angle between the direction of polarization of the resonant slot 11 and the direction of polarization of the dipole antenna 2.

In some embodiments of the invention, the angle between the direction of polarization of the resonant slot 11 and the direction of polarization of the dipole antenna 2 ranges from -30 ° to +30 °, providing a better result in increasing the bandwidth and radiation efficiency of the dipole antenna 2.

Preferably, the angle between the direction of polarization of the resonant slot 11 and the direction of polarization of the dipole antenna 2 is 0 °.

Preferably, the resonant slot 11 is in the middle of the metal panel 1.

In some embodiments of the invention, the length of the resonant slot 11 affects the radiation efficiency of the dipole antenna 2, and the width of the resonant slot 11 affects the bandwidth of the dipole antenna 2.

Preferably, the length of the resonant slot 11 is (1/2)λg, where λg denotes the wavelength of the dipole antenna 2, e.g., a wavelength corresponding to an operating frequency ranging from 2.40GHz to 2.50GHz. Preferably, the width of the resonant slot 11 ranges from 1mm to 5mm.

It shall be understood that the relative position of the metal panel 1 to the dipole antenna 2 in the space is arbitrary. The metal panel 1 being parallel to the dipole antenna 2 in the space as shown in Figure 1 to Figure 10 is merely an example for the convenience of illustration.

As can be seen from the above, the present invention may include a metal panel 1 and a dipole antenna 2, wherein the metal panel 1 is provided with a resonant slot 11; the resonant slot 11 has a resonant frequency that matches an operating frequency of the dipole antenna 2; and the direction of polarization of the resonant slot 11 is at a preset angle to the direction of polarization of the dipole antenna 2. The embodiment adds a resonant slot 11 onto the metal panel 1, and can adjust the impedance characteristics of the dipole antenna 2 by adjusting the angle between the direction of polarization of the resonant slot 11 and the direction of polarization of the dipole antenna 2 as well as the resonant frequency of the resonant slot 11, thereby realizing impedance matching and effectively solving the reflection effect of the metal panel 1, so that electromagnet power of the dipole antenna 2 is not significantly reflected by the metal panel 1, and the bandwidth and radiation efficiency of the dipole antenna 2 in the applications with a metal panel are increased.

An antenna device provided by the present invention is described in detail above. Specific examples are used in describing the principle and embodiments of the

invention. The description of the embodiments is merely for a better understanding of the method and the spirit of the invention. Various modifications can be made to the specific embodiments and the application ranges by those skilled in the art based on the ideas illustrated by the embodiments herein. Therefore, the disclosure in the specification shall not be interpreted as limiting the scope of the invention.

We Claim:

1. An antenna device, comprising:

a metal panel (1) and a dipole antenna (2), wherein the metal panel (1) is provided with a resonant slot (11) thereon; the resonant slot (11) has a resonant frequency that matches an operating frequency of the dipole antenna (2); and a direction of polarization of the resonant slot (11) is at a preset angle to a direction of polarization of the dipole antenna (2).

2. The antenna device according to claim 1, wherein,

the resonance frequency of the resonant slot (11) is the same as the operating frequency of the dipole antenna (2).

3. The antenna device according to claim 1 or claim 2, wherein,

the angle between the direction of polarization of the resonant slot (11) and the direction of polarization of the dipole antenna (2) ranges from -30 ° to +30 °.

4. The antenna device according to claim 3, wherein,

the angle between the direction of polarization of the resonant slot (11) and the direction of polarization of the dipole antenna (2) is 0 °.

5. The antenna device according to claim 1 or claim 2, wherein,

the resonant slot (11) is λg/2 long, where λg denotes a wavelength of the dipole antenna (2).

6. The antenna device according to claim 1 or claim 2, wherein,

a width of the resonant slot (11) ranges from 1mm to 5mm.

7. The antenna device according to claim 1 or claim 2, wherein,

the resonant slot (11) is in the middle of the metal panel (1).

Dated this 27th day of December, 2013

MOHAN DEWAN

Of R. K. DEWAN & CO.

APPLICANTS' PATENT ATTORNEY

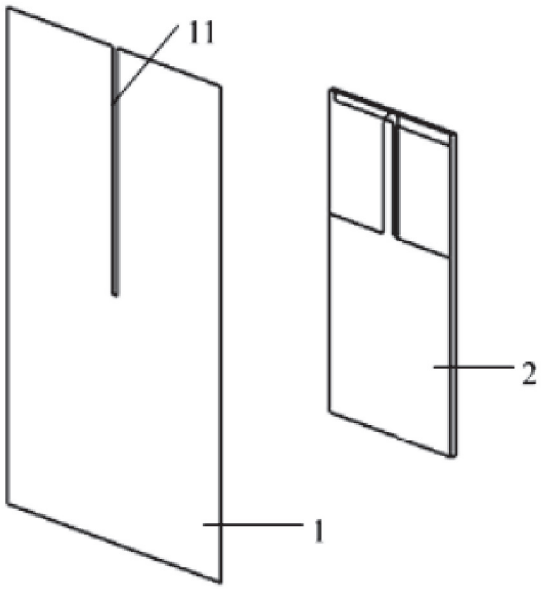


FIG. 1

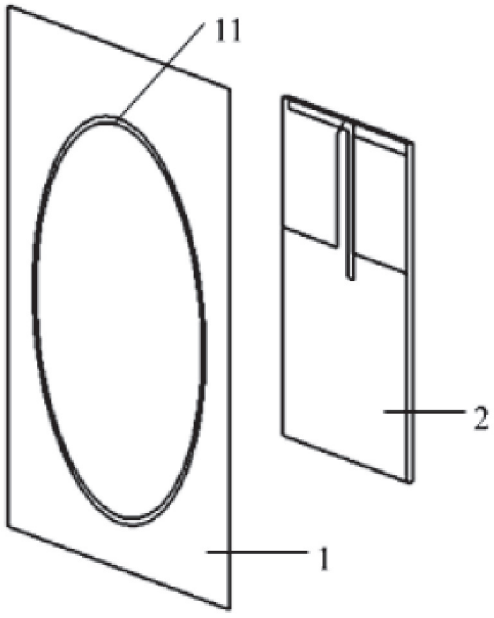


FIG. 2

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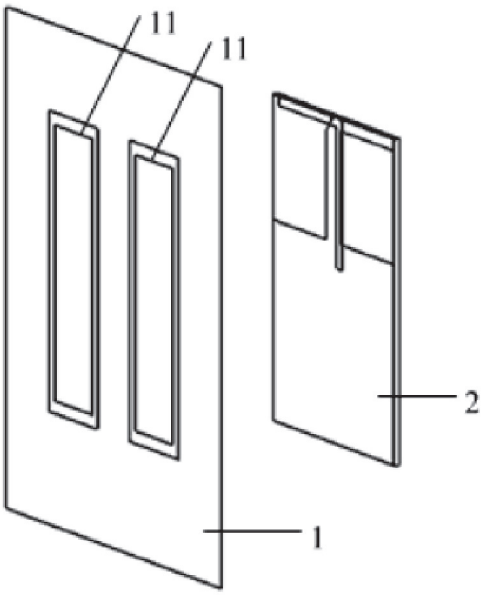


FIG. 3

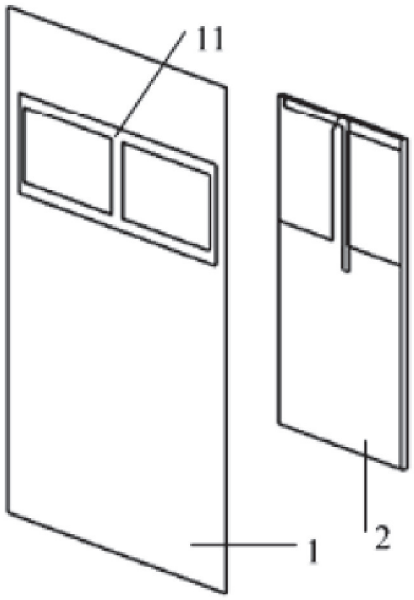


FIG. 4

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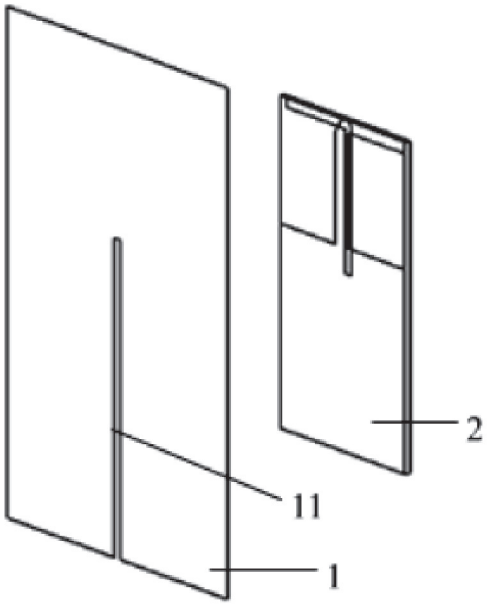


FIG. 5

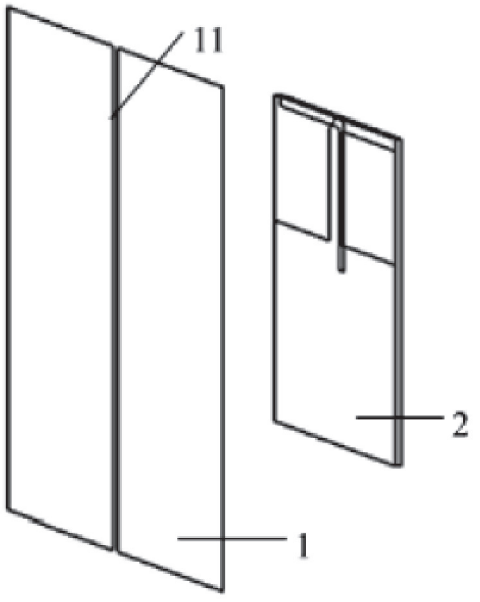


FIG. 6

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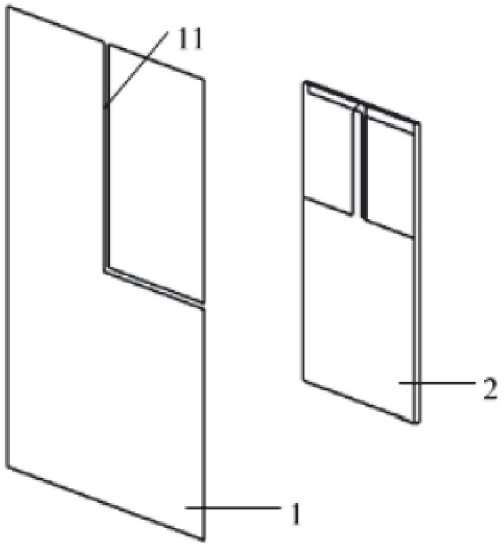


FIG. 7

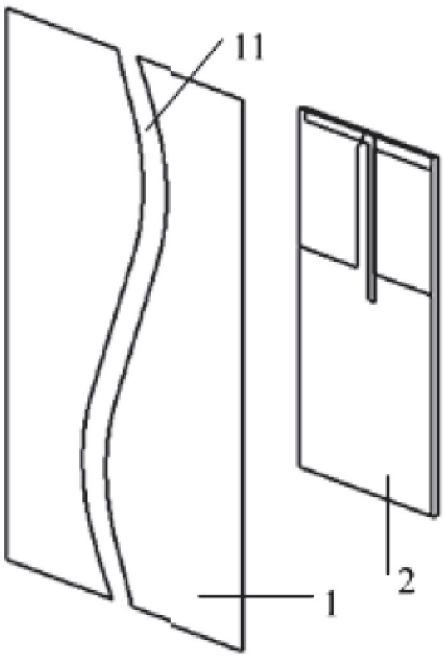


FIG. 8

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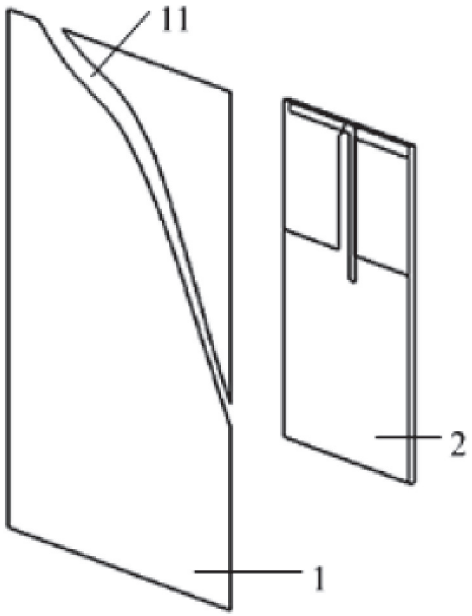


FIG. 9

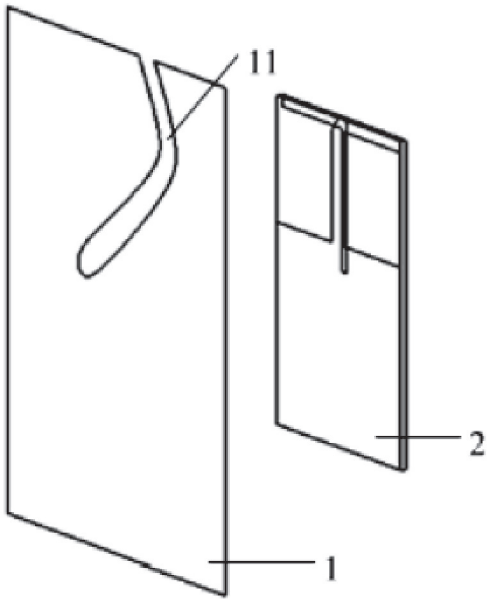


FIG. 10

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