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(54) **ANTENNA, ANTENNA MODULE, AND ELECTRONIC DEVICE**

(57) This application provides an antenna, an antenna module, and an electronic device. The antenna includes a tapered slot antenna and a dipole antenna that have same polarization. The tapered slot antenna includes a feeding structure, a first metal structure, and a second metal structure. A tapered slot is formed between the first metal structure and the second metal structure. Two ends of the tapered slot are a narrow-slit end and a wide-mouth end. The feeding structure and the narrow-slit end are coupled to feed the tapered slot antenna, to excite the tapered slot antenna to be a directional antenna. The dipole antenna intersects with the tapered slot, and at an intersection position of the dipole antenna and the tapered slot, coupled feeding is performed on the dipole antenna by using the tapered slot, to excite the dipole antenna to be an omnidirectional antenna. In this application, the tapered slot antenna and the dipole antenna are integrated to implement miniaturization, and the tapered slot antenna feeds the dipole antenna, so that radiation performance of both the dipole antenna and the tapered slot antenna can be met.

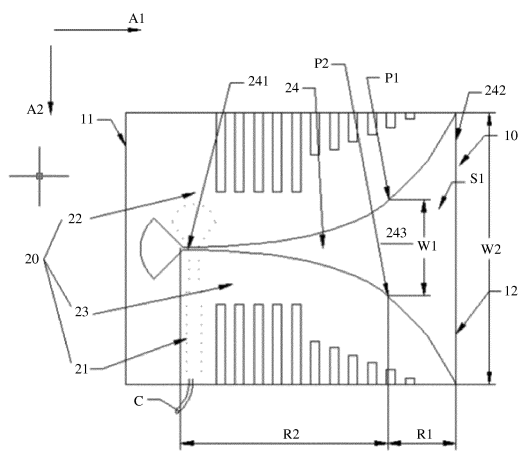


FIG. 6

Description

[0001] This application claims priority to Chinese Patent Application No. 202011193933.9, filed with the China National Intellectual Property Administration on October 30, 2020 and entitled "ANTENNA, ANTENNA MODULE, AND ELECTRONIC DEVICE", which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] This application relates to the field of antenna technologies, and in particular, to an antenna, an antenna module having the antenna, and an electronic device.

BACKGROUND

[0003] With evolution of Wi-Fi protocols, a quantity of spatial streams increases. Currently, a maximum of 16 spatial streams are supported. This means that a built-in product needs a maximum of 16 groups of high-performance antennas, and requires that the antennas have little impact on each other to meet a radiation performance requirement of the product. Due to factors such as appearance, competitiveness, and a use habit in a home scenario, a size and an ID of an existing ONT (Optical network terminal, optical network terminal) built-in product become increasingly small. This means that design space of a MIMO antenna is actually increasingly limited under a condition of improving a product function and performance.

[0004] How to design a directional antenna and an omnidirectional antenna to be integrated to implement miniaturization becomes a research and development direction in the industry.

SUMMARY

[0005] Embodiments of this application provide an antenna and an electronic device. A tapered slot antenna and a dipole antenna are integrated to implement miniaturization of the antenna, and radiation performance of the dipole antenna and the tapered slot antenna can be met.

[0006] According to a first aspect, this application provides an antenna, including a tapered slot antenna and a dipole antenna that have same polarization, where the tapered slot antenna includes a feeding structure, a first metal structure, and a second metal structure, a tapered slot is formed between the first metal structure and the second metal structure, two ends of the tapered slot are a narrow-slit end and a wide-mouth end, and the feeding structure is coupled to the narrow-slit end, to feed the tapered slot antenna and excite the tapered slot antenna to be a directional antenna; and the dipole antenna intersects with the tapered slot, and at an intersection position of the dipole antenna and the tapered slot, coupled feeding is performed on the dipole antenna by using the

tapered slot, to excite the dipole antenna to be an omnidirectional antenna. In this application, the tapered slot antenna and the dipole antenna that have same polarization are integrated, and a same feeding structure is configured to simultaneously excite the tapered slot antenna to be a directional antenna and excite the dipole antenna to be an omnidirectional antenna. It may also be understood that the tapered slot antenna is configured to excite the dipole antenna. This can ensure radiation performance of the dipole antenna and the tapered slot antenna, and facilitate miniaturization configuration of the antenna. This application facilitates a differentiated MIMO antenna design, and implements gain compatibility of omnidirectional coverage and directional enhancement.

[0007] In a possible implementation, a working frequency of the tapered slot antenna is higher than a working frequency of the dipole antenna. It may be understood that, the working frequency of the tapered slot antenna is different from the working frequency of the dipole antenna, so that the antenna provided in this application can have a dual-band feature, and undertake different functions by using different frequencies. In addition, a Wi-Fi coverage capability at different frequencies facilitates the differentiated MIMO antenna design, and implements gain compatibility of omnidirectional coverage and directional enhancement.

[0008] In a possible implementation, the working frequency of the tapered slot is 5 GHz, and the working frequency of the dipole antenna is 2 GHz. This implementation is applicable to a radio field that requires an antenna to transmit or receive an electromagnetic wave signal, and a working frequency of the antenna may be reduced based on a corresponding ratio according to a requirement, to implement an optimal matching design.

[0009] Compared with a conventional single-polarized design of a built-in dual-band small antenna, in this application, a low frequency mode with omnidirectional radiation performance is introduced based on a conventional high-frequency directional antenna, so that applicability of a single antenna is enhanced, a requirement of ONT for a Wi-Fi antenna design can be better matched, a home network Wi-Fi antenna design strategy is met, and a new idea of using a conventional directional antenna for ONT antenna design is opened.

[0010] In a possible implementation, the tapered slot includes a middle position between the narrow-slit end and the wide-mouth end, a part between the narrow-slit end and the middle position is a main feeding area, a part between the middle position and the wide-mouth end is a main radiation area, an intersection position of the dipole antenna and the tapered slot antenna is in the main feeding area, and an included angle is formed between an extension direction of the dipole antenna and an extension direction of the tapered slot. It may be understood that the main radiation area is a part that mainly radiates in the tapered slot antenna, which means that other parts (for example, the main feeding area and a

peripheral area of the tapered slot antenna) of the tapered slot antenna also have a radiation function, and can also affect a radiation signal, but most radiation functions are concentrated in the main radiation area. The main feeding area is mainly configured to feed the main radiation area. The main feeding area may also have a function of radiating a signal. Parameters such as a size and an opening size of the part between the narrow-slit end and the middle position affect radiation of an electromagnetic wave signal. In this implementation, the dipole antenna is disposed in the main feeding area, and the working frequency of the dipole antenna is different from the working frequency of the tapered slot antenna, to be specific, the working frequency of the dipole antenna is outside a working frequency band of the tapered slot antenna, so that the dipole antenna is disposed without affecting a radiation feature of the main radiation area. In other words, in this application, radiation of the dipole antenna can be excited by the tapered slot antenna, and radiation performance of the tapered slot antenna can be ensured.

[0011] In a possible implementation, the extension direction of the dipole antenna and the extension direction of the tapered slot are perpendicular to each other (that is, orthogonal). It may be understood that the dipole antenna is symmetrically distributed on two sides of the tapered slot, so that omnidirectional radiation performance of the dipole antennas is better.

[0012] In a possible implementation, the dipole antenna includes a first radiation section, a second radiation section, and a switch structure electrically connected between the first radiation section and the second radiation section, the switch structure intersects with the tapered slot, the switch structure is electrically connected to a control circuit, and the control circuit controls the switch structure to be turned on or off, to switch the antenna between a first working mode and a second working mode, where the first working mode is that the tapered slot antenna is independently executed, and the second working mode is that the tapered slot antenna and the dipole antenna are simultaneously executed. In this implementation, reconfigurable performance of the antenna is implemented by setting a switch, and the switch may be turned on or off based on a specific requirement, so that the antenna has a plurality of functions.

[0013] Specifically, the switch structure is a diode. The control circuit may be electrically connected to the first radiation section and the second radiation section, to introduce a direct current bias voltage to implement turn-on and turn-off control on the diode. In an implementation, the control circuit is electrically connected to the first radiation section, the first radiation section is connected to a positive electrode of a voltage source, and the second radiation section is grounded, to implement forward bias on the diode. In another implementation, the control circuit is electrically connected to the second radiation section, the second radiation section is connected to a positive electrode of a voltage source, and the first radiation section is grounded, to implement forward bias on the

diode. In this manner, the antenna may have a capability of independently covering a 5 GHz frequency band and a 2 GHz/5 GHz dualfrequency band. In addition, the low frequency band is represented as an omnidirectional radiation feature of a dipole, and the high frequency band maintains a directional radiation feature.

[0014] In a possible implementation, the first radiation section and the second radiation section are symmetrically distributed on two sides of the switch structure. The dipole antenna provided in this implementation is of a symmetric structure, and can meet the omnidirectional radiation feature of the dipole antenna.

[0015] In a possible implementation, the dipole antenna further includes a first patch. The first patch may be understood as a metal sheet structure. A length of a radiation arm is increased in the extension direction of the dipole antenna, and a width of the radiation arm is also increased. The first patch is located at an end that is of the first radiation section and that is away from the second radiation section. The first patch and the first metal structure are disposed in a stacked manner, to increase capacitive coupling of the dipole antenna. In this implementation, the first patch is disposed to ensure an electrical length of the dipole antenna within a limited size range, and facilitates a miniaturization design of the antenna.

[0016] In a possible implementation, the dipole antenna further includes a second patch. The second patch is located at an end that is of the second radiation section and that is away from the first radiation section. The second patch is disposed opposite to the second metal structure, to increase capacitive coupling of the dipole antenna. A design of the second patch is similar to that of the first patch, and beneficial effects are also the same. In this implementation, both the first patch and the second patch are configured. This facilitates symmetric structure arrangement of the dipole antenna, and can better control a polarization direction of the antenna.

[0017] In a possible implementation, the first patch and the first radiation section form an oar form. In this application, the first patch and the second patch are respectively configured at an end of the first radiation section and an end of the second radiation section, that is, positions of the first patch and the second patch are far away from the tapered slot, and specifically, are far away from the narrow-slit end of the tapered slot. In this architecture, impact of the first patch and the second patch on the tapered slot antenna can be minimized. In this way, an omnidirectional radiation mode of the dipole antenna is excited on a premise of ensuring radiation performance of the tapered slot antenna. This application implements an antenna architecture having a dual-band reconfiguration feature.

[0018] Specifically, specific structures of the first patch and the second patch may be described in the following solution. The first patch is used as an example for description. For example, the first patch includes a first part and a second part. The first part is connected to the first radiation section. The second part is connected to an end

that is of the first part and that is away from the first radiation section. The first part is trapezoidal. A size of an end that is of the first part and that is connected to the first radiation section is less than a size of the end that is of the first part and that is connected to the second part. An outer profile of the second part is arc-shaped. A structure form of the second patch may be the same as that of the first patch.

[0019] In a specific implementation, the first patch is symmetrically distributed in an architecture centered on an extension line of the first radiation section. A shape of the first patch may alternatively be other shapes such as a circle, a triangle, a square, or a polygon.

[0020] In a possible implementation, the dipole antenna further includes an extension line, the extension line is connected to the first radiation section and/or the second radiation section, and the extension line is configured to increase an electrical length of the dipole antenna. A specific shape of the extension line may be a winding shape, a snake shape, a sawtooth shape, a wave shape, or the like. A line width of the extension line is less than a line width of the first radiation section.

[0021] In a possible implementation, the dipole antenna includes a radiation line and a first patch and a second patch that are respectively located at two ends of the radiation line, a central position of the radiation line is a feeding part of the dipole antenna, the feeding part intersects with the tapered slot, and the first patch and the second patch are configured to increase capacitive coupling of the dipole antenna.

[0022] In a possible implementation, the dipole antenna includes a strip radiation line and an extension line connected to the strip radiation line, and the extension line is configured to increase an electrical length of the strip radiation line.

[0023] In a possible implementation, the first metal structure includes a first edge facing the second metal structure and a second edge away from the second metal structure, the second metal structure includes a third edge facing the first metal structure and a fourth edge away from the first metal structure, the tapered slot is formed between the first edge and the third edge, a plurality of equal-height first comb teeth distributed along a first direction are disposed on the second edge, a plurality of equal-height second comb teeth distributed along the first direction are disposed on the fourth edge, and the first comb tooth and the second comb tooth are configured to improve a gain of the tapered slot antenna (usually, the gain may be increased by 0.5 dB to 1 dB). Specifically, when the antenna is in a working mode, the tapered slot antenna mainly performs feeding and radiation by using edges of the tapered slot (namely, the first edge of the first metal structure and the third edge of the second metal structure). However, an electromagnetic wave that is not radiated may exist on the outer edges (namely, the second edge and the fourth edge) of the first metal structure and the second metal structure. In other words, current distribution may exist on the outer edges (namely,

the second edge and the fourth edge) of the first metal structure and the second metal structure. Because an extension direction of the first comb tooth and the second comb tooth is a second direction, and electrical lengths of the first comb tooth and the second comb tooth are a quarter wavelength corresponding to a center frequency of the tapered slot antenna, the current may complete electromagnetic wave radiation on the first comb tooth and the second comb tooth, and the electromagnetic wave radiated by using the first comb tooth and the second comb tooth generates a gain on the center frequency of the tapered slot antenna, that is, a signal of the tapered slot antenna can be enhanced, so that directional radiation performance of the tapered slot antenna is better.

[0024] In a possible implementation, both an electrical length of the first comb tooth and an electrical length of the second comb tooth are a quarter wavelength corresponding to a center frequency of the tapered slot antenna. The center frequency may be an intermediate value between a maximum working frequency and a minimum working frequency of the tapered slot antenna. The tapered slot antenna can be excited to work in a high frequency bandwidth. The high frequency bandwidth includes the maximum working frequency and the minimum working frequency, and the center frequency is the intermediate value between the maximum working frequency and the minimum working frequency. Specifically, in this application, the electrical lengths of the first comb tooth and the second comb tooth are close to a quarter wavelength, and have a radiation feature similar to that of a monopole.

[0025] In a possible implementation, a plurality of unequal-height third comb teeth distributed along the first direction are disposed on the second edge, a plurality of unequal-height fourth comb teeth distributed along the first direction are disposed on the fourth edge, electrical lengths of the third comb teeth and electrical lengths of the fourth comb teeth decrease progressively along the first direction, electrical lengths of a third comb tooth and a fourth comb tooth that are close to the wide-mouth end are the smallest, and the third comb teeth and the fourth comb teeth are configured to suppress standing wave current distribution, on the second edge and the fourth edge, of energy that is not radiated by the tapered slot antenna. The third comb tooth and the fourth comb tooth are disposed to reduce a ripple effect caused by the second edge and the fourth edge to a radiation pattern of the tapered slot antenna. A ripple feature herein mainly indicates that a wave-shaped ripple feature is formed because a curved surface of the pattern is not smooth. Specifically, the third comb tooth and the fourth comb tooth are disposed to ensure that the radiation pattern of the tapered slot antenna tends to be smooth, and that the radiation pattern tends to be smooth indicates that radiation performance of the antenna is stable.

[0026] In a specific implementation, the third comb tooth is located between the first comb tooth and the wide-mouth end, and the fourth comb tooth is located

between the second comb tooth and the wide-mouth end. The third comb tooth and the fourth comb tooth are also symmetrically distributed on two sides of the tapered slot.

[0027] In a possible implementation, the tapered slot includes a middle position between the narrow-slit end and the wide-mouth end, a part between the narrow-slit end and the middle position is a main feeding area, a part between the middle position and the wide-mouth end is a main radiation area, an intersection position of the dipole antenna and the tapered slot antenna is in the main feeding area, an included angle (where the included angle may be 90 degrees or close to 90 degrees) is formed between the extension direction of the dipole antenna and the extension direction of the tapered slot, and the first comb tooth and the second comb tooth are symmetrically distributed on two sides of the main feeding area.

[0028] In a possible implementation, the third comb tooth and the fourth comb tooth are symmetrically distributed on two sides of the main radiation region.

[0029] In a possible implementation, a first area is disposed at a periphery of the first metal structure, the first area is at an edge of the first metal structure away from the wide-mouth end, and a first additional antenna is disposed in the first area. In this application, the first additional antenna is disposed in the first area, and the first additional antenna has an independent feeding structure and an independent radiation structure. Because the first additional antenna is disposed in the first area, regardless of a form of the feeding structure and the radiation structure of the first additional antenna, radiation efficiency of the tapered slot antenna and the dipole antenna is not affected.

[0030] In a possible implementation, a second area is disposed at a periphery of the second metal structure, the second area is at an edge of the second metal structure away from the wide-mouth end, and a second additional antenna is disposed in the second area.

[0031] In a possible implementation, the first additional antenna includes a first radiation structure and a first feeding structure. The first radiation structure, the feeding structure of the tapered slot antenna, and the dipole antenna are located on a same layer of a dielectric plate, and are microstrip structures disposed on the dielectric plate. The second additional antenna includes a second radiation structure and a second feeding structure. The second radiation structure, the first metal structure, and the second metal structure are located on a same layer of a dielectric plate, and are also microstrip structures disposed on the dielectric plate.

[0032] In an implementation, the first additional antenna 50 may be a LOOP antenna, and a working frequency of the first additional antenna 50 is 5 GHz. The second additional antenna is an IFA antenna, and a working frequency of the second additional antenna 60 is 2 GHz.

[0033] According to a second aspect, this application provides an electronic device, including a radio frequency circuit and the antenna according to any implementation

of the first aspect, where a feeding structure of the antenna is electrically connected to the radio frequency circuit.

[0034] According to a third aspect, this application further provides an antenna module, including a bracket and an antenna connected to the bracket. The antenna is the antenna provided in any implementation of the first aspect.

10 BRIEF DESCRIPTION OF DRAWINGS

[0035]

FIG. 1 is a schematic diagram of application of an electronic device including an antenna provided in this application as a home gateway in a home gateway system;

FIG. 2 is a schematic diagram of a specific application scenario of an electronic device (home gateway) according to this application;

FIG. 3 is a three-dimensional diagram of an electronic device according to an implementation of this application;

FIG. 4 is a schematic diagram of a state in which a housing of the electronic device shown in FIG. 3 is removed;

FIG. 5 is a schematic diagram of the electronic device shown in FIG. 4 and whose bracket for installing an antenna is removed, and mainly represents a position relationship between the antenna and a board in the electronic device;

FIG. 6 is a schematic diagram of a first surface of an antenna according to an implementation of this application;

FIG. 7 is a schematic diagram of a second surface of an antenna according to an implementation of this application;

FIG. 8 is a schematic side view of an antenna according to an implementation of this application;

FIG. 9 is another schematic side view of an antenna according to an implementation of this application;

FIG. 10 is a schematic diagram of one surface of an antenna according to an implementation of this application;

FIG. 11 is a schematic diagram of one surface of an antenna according to an implementation of this application;

FIG. 12 is a schematic diagram of another surface of an antenna according to an implementation of this application;

FIG. 13 is a schematic diagram of one side surface of an antenna according to an implementation of this application;

FIG. 14 is a schematic diagram of one surface of an antenna according to an implementation of this application;

FIG. 15 is a schematic diagram of a first surface of an antenna according to an implementation of this

application;

FIG. 16 is a schematic diagram of a first surface of an antenna according to an implementation of this application;

FIG. 17 is a schematic diagram of a first surface of an antenna according to an implementation of this application;

FIG. 18 is a schematic diagram of a first surface of an antenna according to an implementation of this application;

FIG. 19 is a schematic sectional diagram of an antenna according to an implementation of this application;

FIG. 20 is a schematic diagram of a first surface of an antenna according to an implementation of this application;

FIG. 21 is a schematic diagram of a first surface of an antenna according to an implementation of this application;

FIG. 22 is a schematic diagram of a first surface of an antenna according to an implementation of this application;

FIG. 23 is a schematic diagram of a first surface of an antenna according to an implementation of this application;

FIG. 24 is a schematic diagram of a first surface of an antenna according to an implementation of this application;

FIG. 25 is a schematic diagram of an S parameter curve of an impedance bandwidth of an antenna according to an implementation of this application;

FIG. 26 is a radiation pattern of an antenna on different frequencies according to an implementation of this application;

FIG. 27A is a current distribution diagram of a conventional antenna including only a tapered slot antenna and not including a dipole antenna;

FIG. 27B is a current distribution diagram of an antenna on a working frequency of a dipole antenna according to an implementation of this application; and

FIG. 27C is a current distribution diagram of an antenna on a working frequency of a tapered slot antenna according to an implementation of this application.

DESCRIPTION OF EMBODIMENTS

[0036] For ease of understanding, the following explains and describes related technical terms used in embodiments of this application.

[0037] Home gateway: A home gateway is one network device located inside a modern home. A function of the home gateway is to enable a home user to be connected to the Internet, so that various intelligent devices located in the home can obtain Internet services, or enable these intelligent devices to communicate with each other. In a word, the home gateway is a bridge that enables various

intelligent devices in a home to be connected to each other and connects a home network to an external network. From a technical perspective, the home gateway implements bridging/routing, protocol conversion, and address management and conversion inside the home and from inside to outside, and functions as a firewall and provides a possible service, for example, VoIP/Video over IP.

[0038] Wireless AP (AP, Access Point, wireless access node, session point, or access bridge): A wireless access point is a widely-used name, and is not only a pure wireless access point (wireless AP), but also a generic term for devices, for example, a wireless router (including a wireless gateway and a wireless bridge). The wireless AP access point supports 2.4 GHz wireless application, and sensitivity complies with the 802.11n standard. The wireless access point uses dual-channel radio frequency output, with a maximum output power of 600 mW for each channel, and can deploy wireless coverage in a large area through a wireless distribution system (point-to-point and point-to-multipoint bridging). The wireless access point is a necessary wireless AP device for wireless network development in hotels.

[0039] A multiple-input multiple-output (Multi-input Multi-output, MIMO) system is an abstract mathematical model for describing a multi-antenna wireless communication system. The multiple-input multiple-output system can use a plurality of antennas of a transmitting end to transmit signals independently, and use a plurality of antennas at a receiving end to receive and restore original information. The technology is first proposed by Marconi in 1908. Marconi uses a plurality of antennas to suppress channel fading (fading). Based on a quantity of antennas of a transmitting end and a receiving end, compared with a common single-input single-output (Single-Input Single-Output, SISO) system, the MIMO multi-antenna technology still includes an early smart antenna, to be specific, a single-input multiple-output (Single-Input Multi-Output, SIMO) system and a multiple-input single-output (Multiple-Input Single-Output, MISO) system.

[0040] An omnidirectional antenna radiates evenly at 360 degrees in a horizontal direction, that is, has no directivity, and has a beam with a specific width in a vertical direction. Usually, a smaller lobe width indicates a larger gain. In a mobile communication system, the omnidirectional antenna is usually used for a station in a suburban area and covers a large area.

[0041] Horizontal polarization indicates that a vibration direction of an electromagnetic wave is horizontal. A polarized wave whose polarization plane is perpendicular to a normal plane of the earth is referred to as a horizontal polarized wave. A direction of an electric field of the wave is parallel to the earth.

[0042] Vertical polarization indicates that an electric field vector vibrates in a specific direction in a specific plane. In this case, the electromagnetic wave is polarized. The plane that contains the electric field vector E is referred to as a polarization plane. Polarization is re-

ferred to as polarization in microwave remote sensing. Polarization can be horizontal or vertical. When an electric field vector of an electromagnetic wave is parallel to an incident plane of a beam, the polarization is called vertical polarization, which is represented by V

[0043] The following describes embodiments of this application with reference to the accompanying drawings in embodiments of this application.

[0044] FIG. 1 is a schematic diagram of application of an electronic device including an antenna provided in this application as a home gateway in a home gateway system. In an implementation shown in FIG. 1, the electronic device provided in this application is a home gateway. The home gateway is connected between an optical line terminal and a terminal device. The optical line terminal is connected to a wide area network (Internet). The optical line terminal obtains a signal from the wide area network (Internet), and transmits the signal to the home gateway. Then, an antenna disposed in the home gateway transmits the signal to each terminal device. The home gateway includes a digital module, a radio frequency module, and an antenna. The digital module is connected between the optical line terminal and the radio frequency module. The radio frequency module is configured to send a radio frequency signal to the antenna. With development of home intelligence, various intelligent terminal devices are configured in a home, and more antennas need to be configured in the home gateway to provide signals for various terminal devices. For example, the antennas may include an antenna 1, an antenna 2, an antenna 3, an antenna 4, and an antenna 5. The antenna 1 may be a low-frequency antenna. For example, the low-frequency antenna may be a 2 GHz antenna or a 3 GHz antenna. The antenna 2, the antenna 3, the antenna 4, and the antenna 5 may be high-frequency antennas. For example, the high-frequency antenna may be a 5 GHz antenna or a 6 GHz antenna. In another implementation, the antennas may be configured in another manner. For example, there may be two or more low-frequency antennas, and there may be one or two or more high-frequency antennas.

[0045] In an implementation, the terminal devices may include a smartphone, a smart home (for example, an air conditioner, an electric fan, a washing machine, or a refrigerator), a smart television, and intelligent security (for example, a camera). The smartphone may be used in a low frequency range, or may be used in a high frequency range. For example, the smartphone may support signals of two frequencies: 2 GHz and 5 GHz. Therefore, as shown in FIG. 1, both the antenna 1 and the antenna 2 provide signals for the smartphone. The antenna 3 provides a signal for the smart home. For the smart home, a user may view and control, by using a smart home gateway system platform, a status of a remote smart home appliance, a lighting system, a power supply system, and the like by using a mobile phone, a PC, and the like. The antenna 4 provides a signal for the smart television, and a user may also remotely control the smart

television by using the terminal device. The smart television may have a function of a web television, or may have a video conference function. The antenna 5 provides a signal for the intelligent security. An intelligent video security system may include functions such as fire prevention, theft prevention, leakage prevention, and remote management. A user can remotely view and configure a home security system by using a mobile phone and the Internet. In addition, the user can remotely monitor a home internal environment. If an exception is detected, the security system can notify the user by making a call, sending a short message, or sending an email.

[0046] In this application, antennas with different working frequencies may be integrated, omnidirectional radiation of a low-frequency antenna can be implemented, and a directional gain of a high-frequency antenna can be implemented. For example, the antenna 1 and the antenna 4 are integrated. The antenna 1 provides a signal for a low working frequency of the smartphone. The smartphone may appear at any location in the home, and the antenna 1 needs omnidirectional radiation. The antenna 4 needs to provide a signal for the smart television. Usually, the smart television is fixed at a specific location in the home, and the antenna 4 needs directional radiation to ensure signal strength.

[0047] FIG. 2 is a schematic diagram of a specific application scenario of an electronic device 100 (home gateway) according to this application. As shown in FIG. 2, in a specific home scenario, different rooms on a same floor need Wi-Fi signals, and different floors also have Wi-Fi signal requirements. The home gateway 100 includes different antennas, so that horizontal omnidirectional radiation can be implemented, to be specific, radiation to different rooms on a same floor can be implemented, to meet Wi-Fi signal requirements of different rooms on a same floor, and vertical through-building radiation can also be implemented, to meet Wi-Fi signal requirements of different floors. In FIG. 2, an ellipse marked as A represents that the antenna has a capability of horizontal polarization omnidirectional radiation, an ellipse marked as B represents that the antenna has a capability of horizontal polarization directional radiation, and an ellipse marked as C represents that the antenna has a capability of vertical polarization radiation and can implement a capability of vertical through-building signal radiation.

[0048] The antenna provided in this application can integrate two antennas, to implement omnidirectional radiation and a directional gain in a same polarization direction, or integrate a plurality of antennas, so that omnidirectional radiation and a directional gain in a same polarization direction can be ensured, and radiation in another polarization direction can also be implemented, for example, omnidirectional radiation and a directional gain in vertical polarization and radiation in horizontal polarization.

[0049] FIG. 3, FIG. 4, and FIG. 5 each are a schematic diagram of an electronic device 100 according to an im-

plementation of this application. The electronic device 100 may be a home gateway, or may be another electronic device, for example, a wireless AP, a home hotspot, or CPE (Customer Premise Equipment, customer premise equipment).

[0050] As shown in FIG. 3, an example in which the electronic device 100 is a home gateway is used. The electronic device 100 includes a housing 1001. The housing 1001 may be in a barrel shape, or may be in another shape, for example, a square box shape or a circular box shape. In this implementation, a top cover 1002 is disposed on the top of the barrel-shaped housing 1001. The top cover 1002 is made of a non-shielding material, for example, plastic. An antenna is disposed inside the top cover 1002. A plurality of through holes 1003 are provided on the top cover 1002. The through holes 1003 are provided to facilitate signal radiation of the antenna in the electronic device 100 and ventilation and heat dissipation inside the electronic device 100.

[0051] With reference to FIG. 3 and FIG. 4, based on FIG. 3, FIG. 4 is a schematic diagram of the electronic device 100 whose housing 1001 is removed according to this application. Aboard 1004 is disposed in the electronic device 100. The antenna 1000 provided in one implementation of this application is disposed on one side of the board 1004. A radio frequency circuit 10041 may be disposed on the board 1004. The radio frequency circuit 10041 is electrically connected to a feeding part of the antenna 1000, and the radio frequency circuit 10041 receives and transmits a signal through the antenna 1000. The board 1004 and the antenna 1000 are disposed inside the housing 1001. To facilitate heat dissipation of the board 1004, the board 1004 is vertically disposed. A base 1005 for securing the board 1004 is disposed in the housing 1001. The board 1004 is connected to the base 1005. A structure 1006 for providing a function of heat conduction and heat dissipation for the board 1004, for example, a metal heat sink, a vapor chamber, a heat pipe, and another heat-conducting structure, may also be disposed on the base 1005, or different types of heat-conducting structures may be combined for use. In this implementation, two boards 1004 are disposed in the electronic device 100. The base 1005 is located at the bottom of the electronic device 100. The heat-conducting and heat-dissipating structure 1006 is upright on the base 1005. The two boards 1004 are respectively located on two opposite sides of the heat-conducting and heat-dissipating structure 1006, that is, the heat-conducting and heat-dissipating structure 1006 is sandwiched between the two boards 1004. In this way, the heat-conducting and heat-dissipating structure 1006 can simultaneously dissipate heat for the two boards 1004, and that the boards are close to the housing 1001 is ensured. This is more convenient for heat dissipation of the boards 1004.

[0052] To ensure radiation performance of the antenna 1000, the antenna 1000 may be disposed on the top of the board 1004. Specifically, as shown in FIG. 4, the an-

tenna 1000 may be installed on a bracket 1007 to form an antenna module R, and then the antenna module R is assembled inside the housing 1001. Another antenna or electronic component may be further disposed on the bracket 1007. An air duct 10071 is disposed on the bracket 1007. The air duct 10071 communicates with the through hole 1003 on the top cover 1002, to implement ventilation and heat dissipation. The antenna module R is located on the top of the board 1004 and the heat-conducting and heat-dissipating structure 1006, that is, in a top area close to the housing 1001, and on an inner side of the top cover 1002. The air duct 10071 and the through hole 1003 are configured to implement ventilation between the heat-conducting and heat-dissipating structure 1006 and the outside of the electronic device 100, to improve a heat dissipation effect. In the implementation shown in FIG. 4, a dielectric plate on which the antenna 1000 (with a tapered slot antenna architecture) is located is placed approximately horizontally. The antenna is horizontally polarized. If a vertically polarized antenna is required in a specific application scenario, the electronic device 100 may be changed from a vertical type to a horizontal type, and an opening of a tapered slot of the tapered slot antenna is provided upward in a vertical direction. In another implementation, the antenna 1000 may alternatively be arranged at another position in the electronic device. As shown in FIG. 5, a vertical bracket is disposed in the electronic device, that is, a part located between the two boards 1004. The antenna 1000 is disposed on the bracket. The opening of the tapered slot of the antenna is provided upward in a vertical direction.

[0053] The housing 1001 may be made of a plastic material as a whole. Alternatively, a part of the housing 1001 is made of a metal material, and a part of the housing 1001 is made of a plastic material (or a non-shielding material). The metal part of the housing 1001 is a part of the housing disposed on a periphery of the board 1004. The metal part of the housing has an advantage of good heat conduction performance. A power device or another heat emitting component is disposed on the board 1004. When the board 1004 works, heat may be conducted to the housing 1001 through the heat-conducting structure. The housing 1001 facilitates heat dissipation, so that heat dissipation can be improved, and a service life of the electronic device 100 is ensured. The plastic (or non-shielding material) part of the housing 1001 is a part of the housing disposed on a periphery of the antenna 1000. The plastic material does not cause signal interference and shielding to the antenna 1000. This helps ensure radiation performance of the antenna 1000.

[0054] In this application, a tapered slot antenna (Tapered slot antenna, TSA) and a dipole antenna (Dipole antenna or doublet) that have same polarization and different working frequencies are integrated into one antenna, and the tapered slot antenna feeds the dipole antenna, so that an application scope of the antenna is extended, and the antenna can implement low-frequency om-

nidirectional radiation of the dipole antenna, and can implement high-frequency directional radiation of the tapered slot antenna. The antenna provided in this application can better match a requirement of an ONT (Optical network terminal, optical network terminal) on a Wi-Fi antenna design (for example, a requirement that more antennas are disposed in limited space, and more areas can be covered), and satisfy a strategy of a home network Wi-Fi antenna design (namely, a high-performance Wi-Fi coverage capability at different frequencies). The antenna provided in this application may be used as one single-band antenna, or may be extended to a dual-band antenna, or may have space for frequency band upgrading, or may implement wide coverage in a large area and high-gain enhanced coverage in a specific area, to implement wide coverage and achieve good experience. In this application, both the tapered slot antenna and the dipole antenna are vertically polarized (where both the tapered slot antenna and the dipole antenna may be horizontally polarized by changing placement angles). The tapered slot antenna is a directional antenna of a first frequency, the dipole antenna is an omnidirectional antenna of a second frequency, and the first frequency is higher than the second frequency.

[0055] In an implementation, as shown in FIG. 6, FIG. 7, FIG. 8, and FIG. 9, the antenna provided in this application is disposed on a dielectric plate 10. The dielectric plate 10 may alternatively be considered as one part of the antenna. In other words, it may be understood that the antenna includes the dielectric plate 10. FIG. 6 is a schematic diagram of antenna distribution on a first surface S1 of the dielectric plate 10. FIG. 7 is a schematic diagram of antenna distribution on a second surface S2 of the dielectric plate 10. FIG. 8 and FIG. 9 are two schematic side views of the dielectric plate 10. The dielectric plate 10 may be any insulating substrate, for example, a ceramic substrate or a PCB. The dielectric plate 10 may be a plate of a single material, or may be a composite plate, for example, include press-fitting plates of two different materials. The dielectric plate 10 may be in a single-layer plate structure, or may be in a two-layer plate structure or a multi-layer plate structure. The first surface S1 and the second surface S2 may be surfaces of the dielectric plate 10. For example, the first surface S1 is a front surface of the dielectric plate 10, and the second surface S2 is a back surface of the dielectric plate 10. The first surface S1 and the second surface S2 may alternatively be layers in the middle of the dielectric plate 10.

[0056] The antenna includes a tapered slot antenna 20 and a dipole antenna 30. In an implementation, the antenna provided in this application is in a microstrip antenna architecture formed on a dielectric plate, and has features of a thin section, a light weight, being conformal to a carrier (the dielectric plate), and easy integration with an active component (for example, a radio frequency circuit, a filter circuit, or a signal amplification circuit). With reference to FIG. 6 and FIG. 7, the tapered slot antenna

20 includes a feeding structure 21 (where a part represented by a dashed line in FIG. 6 represents the feeding structure 21 disposed on the second surface S2), a first metal structure 22, and a second metal structure 23. As shown in FIG. 7, the feeding structure 21 is a microstrip transmission line disposed on the second surface S2 of the dielectric plate, and may be electrically connected to a feeder cable C to feed the tapered slot antenna 20. The first metal structure 22 and the second metal structure 23 are ground layers disposed on the first surface S1 of the dielectric plate 10. An outer conductor of the feeder cable C (for example, a coaxial cable) is welded to the first metal structure 22 or the second metal structure 23. In other words, the outer conductor of the feeder cable C is welded to the ground layer. An inner conductor of the feeder cable C is electrically connected to the feeding structure 21, to form a coaxial cable feeding architecture.

[0057] In another implementation, the tapered slot antenna 20 may alternatively be in a metal plate structure. It may be understood that the tapered slot antenna 20 does not need to be disposed on the dielectric plate, but is designed as a metal plate structure and is fastened in the housing of the electronic device, for example, fastened on the bracket or a surface of another mechanical part.

[0058] In an implementation, a tapered slot 24 is formed between the first metal structure 22 and the second metal structure 23. The tapered slot 24 includes a narrow-slit end 241 and a wide-mouth end 242. Specifically, as shown in FIG. 6, the first metal structure 22 and the second metal structure 23 are disposed on the first surface S1. The dielectric plate 10 includes a first edge 11 and a second edge 12 that are disposed opposite to each other. A direction of extending from the first edge 11 to the second edge 12 is a first direction A1. The narrow-slit end 241 is close to the first edge 11 (where the narrow-slit end 241 may alternatively be located at a position of the first edge 11). The wide-mouth end 242 is located at the second edge 12 or a position close to the second edge 12. It may be understood that a direction of extending from the narrow-slit end 241 to the wide-mouth end 242 is the first direction A1. In another implementation, the first metal structure 22 and the second metal structure 23 may alternatively be located in a middle area of the dielectric plate. In this way, neither the narrow-slit end 241 nor the wide-mouth end 242 may be disposed at an edge position of the dielectric plate 10. However, a direction of extending from the narrow-slit end 241 to the wide-mouth end 242 may still be defined as the first direction A1.

[0059] The tapered slot 24 further includes a middle position 243 located between the narrow-slit end 241 and the wide-mouth end 242. As shown in FIG. 6, a part of the tapered slot 24 between a first point P1 of an edge of the first metal structure 22 and a second point P2 of an edge of the second metal structure 23 is defined as the middle position 243. The "middle position 243" defined herein is a position between the narrow-slit end 241

and the wide-mouth end 242, and a midpoint between the narrow-slit end 241 and the wide-mouth end 242 is not limited. Based on different forms of the tapered slot 24, for example, different sizes of opening angles, a distance between the middle position 243 and the narrow-slit end 241 and a distance between the middle position 243 and the wide-mouth end 242 also change. The distance between the middle position 243 and the narrow-slit end 241 may be greater than the distance between the middle position 243 and the wide-mouth end 242. Alternatively, the distance between the middle position 243 and the narrow-slit end 241 may be less than the distance between the middle position 243 and the wide-mouth end 242.

[0060] A part of the tapered slot 24 between the middle position 243 and the wide-mouth end 242 is a main radiation area R1 of the tapered slot antenna 20. A part between the narrow-slit end 241 and the middle position 243 is a main feeding area R2 of the tapered slot antenna 20. The main feeding area R2 is configured to feed the main radiation area R1. It may be understood that the main radiation area R1 is a part that mainly radiates in the tapered slot antenna 20, which means that other parts (for example, the main feeding area R2 and a peripheral area of the tapered slot antenna 20) of the tapered slot antenna 20 also have a radiation function, and can also affect a radiation signal, but most radiation functions are concentrated in the main radiation area R1. The main feeding area R2 is mainly configured to feed the main radiation area R1. The main feeding area R2 may also have a function of radiating a signal. Parameters such as a size and an opening size of the part between the narrow-slit end 241 and the middle position 243 affect radiation of an electromagnetic wave signal.

[0061] FIG. 8 is a schematic side view in a second direction A2. The second metal structure 23 is displayed on the first surface S1 of the dielectric plate 10. The first metal structure 22 is not displayed in FIG. 8 because the first metal structure 22 is blocked by the second metal structure 23. The feeding structure 21 and the dipole antenna 30 are displayed on the second surface S2 of the dielectric plate. FIG. 9 is a schematic side view in the first direction A1. The first metal structure 22 and the second metal structure 23 are displayed on the first surface S1 of the dielectric plate 10. The feeding structure 21 partially overlaps with the dipole antenna 30 on the second surface S2 of the dielectric plate 10. One end of the feeding structure 21 is located at a left edge of the dielectric plate 10, and the other end of the feeding structure 21 is blocked by the dipole antenna 30 and is displayed as a dashed line. A gap between the first metal structure 22 and the second metal structure 23 is the narrow-slit end 241 of the tapered slot 24 that is formed between the first metal structure 22 and the second metal structure 23.

[0062] A working frequency of the tapered slot antenna 20 can be controlled between a lowest working frequency and a highest working frequency. For example, the working frequency of the tapered slot antenna 20 may range

from 5 GHz to 6.5 GHz. The lowest working frequency of the tapered slot antenna 20 is 5 GHz, and the highest working frequency of the tapered slot antenna 20 is 6.5 GHz. As shown in FIG. 6, on a plane in which the first metal structure 22 is located, a direction perpendicular to the first direction A1 is defined as the second direction A2. A size of the tapered slot 24 in the second direction A2 is defined as a width of the tapered slot 24. From the narrow-slit end 241 to the wide-mouth end 242, widths of the tapered slot 24 at different positions are different. In a possible implementation, a width W1 of the tapered slot 24 at the middle position 243 is a half of a wavelength of the highest working frequency of the tapered slot antenna 20. A width W2 of the tapered slot at the wide-mouth end 242 is a half of a wavelength of the lowest working frequency of the tapered slot antenna 20. In a specific embodiment, the working frequency of the tapered slot antenna 20 may range from 5 GHz to 6 GHz. A width of the tapered slot at the wide-mouth end is 3 cm. A width of the tapered slot at the middle position is 2.5 cm. A larger working frequency span of the tapered slot antenna 20 indicates a larger difference between the width W1 of the tapered slot at the middle position 243 and the width W2 of the tapered slot at the wide-mouth end 242.

[0063] At the wide-mouth end 242, an extension direction of a connection line between the first metal structure 22 and the second metal structure 23 may be the second direction A2 (as shown in FIG. 6), to be specific, a connection line between an endpoint of the first metal structure 22 at the wide-mouth end 242 and an endpoint of the second metal structure 23 at the wide-mouth end 242 may be perpendicular to the first direction A1. In another implementation, as shown in FIG. 10, a connection line between an endpoint P3 of the first metal structure 22 at the wide-mouth end 242 and an endpoint P4 of the second metal structure 23 at the wide-mouth end 242 may alternatively form a non-90-degree included angle (referred to as a wide-mouth included angle A0) with the first direction A1, so that directional radiation of the tapered slot antenna 20 can also be implemented. A polarization direction of the tapered slot antenna 20 may be configured based on a value of the wide-mouth included angle A0.

[0064] As shown in FIG. 10 and FIG. 11, the first metal structure 22 includes a first edge 221 facing the second metal structure 23 and a second edge 222 away from the second metal structure 23. The second metal structure 23 includes a third edge 231 facing the first metal structure 22 and a fourth edge 232 away from the first metal structure 22. The tapered slot 24 is formed between the first edge 221 and the third edge 231. In an implementation, the first edge 221 may be in a smooth curved structure extending from the narrow-slit end 241 to the wide-mouth end 242. The first edge 221 may include a straight line segment and an exponential line. The straight line segment and the exponential line are connected in a smooth transition manner. In another imple-

mentation, the first edge 221 may alternatively be in an architecture extending in a step shape from the narrow-slit end 241 to the wide-mouth end 242. The third edge 231 and the first edge 221 may have a same structure form, or may not be completely the same. In an implementation, the second edge 222 and the fourth edge 232 may be in a straight line shape (for example, the implementation shown in FIG. 10), and both extend along the first direction. It may be understood that the second edge 222 is parallel to the fourth edge 231. In an implementation, as shown in FIG. 11, grooves may be disposed on the second edge 222 and the fourth edge 232, to form comb structures on the first metal structure 22 and the second metal structure 23. Tooth tops of the comb structures are located on the second edge 222 and the fourth edge 232. Tooth roots of the comb structures are located inside the first metal structure 22 and the second metal structure 23, and between the first edge 221 and the second edge 222 and between the third edge 231 and the fourth edge 232.

[0065] Specifically, a plurality of equal-height first comb teeth 223 distributed along the first direction A1 are disposed on the second edge 222. A plurality of equal-height second comb teeth 233 distributed along the first direction A1 are disposed on the fourth edge 232. The first comb tooth 223 and the second comb tooth 233 are configured to improve a gain of the tapered slot antenna 20. For the first comb tooth 223, "equal-height" herein is that electrical lengths of the first comb teeth 223 are the same. In other words, extension sizes in the second direction A2 are the same. Equal heights of the second comb teeth 233 can also be understood in this way. Both an electrical length of the first comb tooth 223 and an electrical length of the second comb tooth 233 are a quarter wavelength corresponding to a center frequency of the tapered slot antenna 20. The center frequency may be an intermediate value between a maximum working frequency and a minimum working frequency of the tapered slot antenna. The first comb tooth 223 and the second comb tooth 233 are symmetrically distributed on two sides of the tapered slot 24.

[0066] When the antenna provided in this application is in a working mode, the tapered slot antenna 20 mainly performs feeding and radiation by using edges of the tapered slot 24 (namely, the first edge 221 of the first metal structure 22 and the third edge 231 of the second metal structure 23). However, an electromagnetic wave that is not radiated may exist on outer edges (namely, the second edge 222 and the fourth edge 232) of the first metal structure 22 and the second metal structure 23. In other words, there may be current distribution on outer edges (namely, the second edge 222 and the fourth edge 232) of the first metal structure 22 and the second metal structure 23. Specifically, for the tapered slot antenna 20, the main feeding area R2 of the tapered slot antenna 20 is close to the narrow-slit end, and is mainly used for feeding, to be specific, transmitting a current. This part of current mainly flows along edges (namely, the first

edge and the third edge) of the tapered slot 24. However, some currents flow to the second edge along a direction of the first metal structure toward the second edge, and some currents flow to the fourth edge along a direction of the second metal structure toward the fourth edge. Therefore, some currents exist on the second edge and the fourth edge. The first comb tooth 223 and the second comb tooth 233 are disposed, so that the currents can be radiated, to improve a gain of the tapered slot antenna 20.

[0067] In the implementation shown in FIG. 10, the outer edges of the first metal structure 22 and the second metal structure 23, to be specific, the second edge 222 and the fourth edge 232, are straight line forms extending along the first direction A1, and cannot participate in electromagnetic wave radiation. However, in the implementation shown in FIG. 11, the outer edges of the first metal structure 22 and the second metal structure 23, to be specific, the second edge 222 and the fourth edge 232, use designs of the first comb tooth 223 and the second comb tooth 233. Because an extension direction of the first comb tooth 223 and the second comb tooth 233 is the second direction A2, and electrical lengths of the first comb tooth 223 and the second comb tooth 233 are a quarter wavelength corresponding to a center frequency of the tapered slot antenna 20, a current may complete electromagnetic wave radiation on the first comb tooth 223 and the second comb tooth 233, and an electromagnetic wave radiated by using the first comb tooth 223 and the second comb tooth 233 generates a gain on the center frequency of the tapered slot antenna 20. In other words, a signal of the tapered slot antenna 20 can be enhanced, so that directional radiation performance of the tapered slot antenna 20 is better. Therefore, in this implementation, the gain of the tapered slot antenna can be increased by using a design of the first comb tooth 223 and the second comb tooth 233 on the outer edges of the first metal structure 22 and the second metal structure 23. Usually, the gain can be increased by 0.5 to 1 dB.

[0068] As shown in FIG. 11, a plurality of unequal-height third comb teeth 224 distributed along the first direction A1 are disposed on the second edge 222. A plurality of unequal-height fourth comb teeth 234 distributed along the first direction A1 are disposed on the fourth edge 232. For the third comb tooth 224, "unequal-height" herein is that electrical lengths of the third comb teeth 224 are unequal. In other words, extension sizes of the third comb teeth 224 in the second direction A2 are unequal. Unequal heights of the fourth comb teeth 234 can also be understood in this way. For the third comb tooth 224, an electrical length of the third comb tooth 224 closer to the wide-mouth end 242 is smaller. The electrical length of the third comb tooth 224 is a size of the third comb tooth 224 in the first direction A1. In other words, along the first direction A1, electrical lengths of the third comb teeth 224 gradually decrease. The fourth comb teeth 234 may also be configured in this way. The third comb tooth 224 and the fourth comb tooth 234 have a

same structure, and are symmetrically distributed on two sides of the tapered slot 24. The third comb tooth 224 and the fourth comb tooth 234 are configured to suppress standing wave current distribution, on the second edge 222 and the fourth edge 232, of energy that is not radiated by the tapered slot antenna 20. The third comb tooth 224 and the fourth comb tooth 234 are disposed to reduce a ripple effect caused by the second edge 222 and the fourth edge 232 to a radiation pattern of the tapered slot antenna 20. A ripple feature herein mainly indicates that a wave-shaped ripple feature is formed because a curved surface of the pattern is not smooth. Specifically, the third comb tooth 224 and the fourth comb tooth 234 are disposed to ensure that the radiation pattern of the tapered slot antenna 20 tends to be smooth, and that the radiation pattern tends to be smooth indicates that radiation performance of the antenna is stable. A principle of suppressing the ripple effect by the third comb tooth 224 and the fourth comb tooth 234 is as follows: In a gap between two adjacent third comb teeth 224, currents are distributed along edges of the third comb teeth 224 corresponding to the gap, and currents on opposite edges of the two third comb teeth 224 on two sides of the gap are distributed in opposite directions. Therefore, opposite currents cancel each other, to suppress the ripple effect.

[0069] In a specific implementation, the third comb tooth 224 is located between the first comb tooth 223 and the wide-mouth end 242, and the fourth comb tooth 234 is located between the second comb tooth 233 and the wide-mouth end. The third comb tooth 224 and the fourth comb tooth 234 are also symmetrically distributed on two sides of the tapered slot 24.

[0070] A width of the second comb tooth 233 may be the same as a width of the first comb tooth 223. A width of the fourth comb tooth 234 may be the same as a width of the third comb tooth 224.

[0071] In an implementation, the second edge and the fourth edge are respectively located at two opposite edges of the dielectric plate. The tapered slot is located in a middle area of the dielectric plate between the two opposite edges.

[0072] As shown in FIG. 11, a matching slot 25 is further disposed between the first metal structure 22 and the second metal structure 23. The matching slot 25 is connected to the tapered slot 24 and is connected to the narrow-slit end 241. The matching slot 25 is located on one side that is of the narrow-slit end 241 and that is away from the wide-mouth end 242. A function of the matching slot 25 is mainly to perform impedance matching for feeding the tapered slot antenna 20. The narrow-slit end 241 is formed between a first slot line 225 of the first metal structure 22 and a second slot line 235 of the second metal structure 23. The first slot line 225 and the second slot line 235 may be understood as some line segments on the first edge 221 and the third edge 231. In an implementation, a shape of the matching slot 25 is a sector. The matching slot 25 includes two straight lines 251 and 252 and one arc line 253. The two straight lines

251 and 252 are respectively located at two ends of the arc line 253. The straight line 251 is connected between the arc line 253 and the first slot line 225. The straight line 252 is connected between the arc line 253 and the second slot line 235. Both the first slot line 225 and the second slot line 235 may be in a straight line segment shape, and extension directions are the first direction A1. The first slot line 225 and the second slot line 235 form a rectangular slot structure. The matching slot 25 is symmetrically distributed by using the rectangular slot structure as a center. It may be understood that an included angle between the straight line 251 of the matching slot 25 and the first slot line 225 is equal to an included angle between the straight line 253 of the matching slot 25 and the second slot line 235. In another implementation, the matching slot 25 may alternatively be in a circular shape or another shape.

[0073] As shown in FIG. 7, the feeding structure 21 is coupled to the narrow-slit end 241 to feed the tapered slot antenna 20. The feeding structure 21 includes a transmission line 211 and a matching part 212. The matching part 212 is connected to one end of the transmission line 211. The other end of the transmission line 211 is configured to connect to a feed source. For example, the transmission line 211 is connected to the feeder cable C, and is connected to the feed source through the feeder cable C. For ease of connection, in an implementation, one end that is of the transmission line 211 and that is connected to the feed source is disposed at an edge position of the dielectric plate 10. The inner conductor of the feeder cable C is welded to the transmission line 211. The outer conductor of the feeder cable C is welded to the first metal structure 22 or the second metal structure 23. The first metal structure 22 or the second metal structure 23 is equivalent to a ground of the tapered slot antenna. That a unit area of the matching part 212 is greater than a unit area of the transmission line 211 may be understood as that the transmission line 211 is a linear metal part, the matching part 212 is a sheet metal part, and a shape of the matching part 212 may be a sector, a circle, or another shape. A main function of the transmission line 211 is to transmit a current, and a main function of the matching part 212 is to form a capacitive structure (an electromagnetic coupling structure) with a metal structure (namely, a joint of the first metal structure 22 or the second metal structure 23) on a rear side of the matching part 212, so that a feed signal transmitted by the microstrip is efficiently coupled and transmitted to the slot. The narrow-slit end 241 is disposed opposite to an area that is on the transmission line 211 and that is adjacent to the matching part 212. The tapered slot antenna 20 is fed by coupling between the transmission line 211 and the narrow-slit slot 241. It may be understood that the transmission line 211 and the narrow-slit slot 241 are disposed in a cross manner. An area in which the transmission line 211 and the narrow-slit slot 241 intersect is a coupled feeding position. The cross position may be a connection position between the transmission line 211

and the matching part 212, or may be any position on the transmission line 211.

[0074] A shape of the transmission line 211 may be a straight line (as shown in FIG. 7), or a shape of the transmission line 211 may be a bent microstrip structure. As shown in FIG. 12, the transmission line 211 includes a first segment 2111 and a second segment 2112. The second segment 2112 is connected between the first segment 2111 and the matching part 212. An extension direction of the second segment 2112 is the second direction A2. The first segment 2111 is connected between the second segment 2112 and one edge of the dielectric plate 10. An included angle is formed between the first segment 2111 and the second segment 2112. In the implementation shown in FIG. 12, the included angle is greater than 90 degrees. It may be understood that a form of the transmission line 211 may be arranged based on a specific architecture of the antenna, and another transmission line (which may be an arc line or a straight line segment) may alternatively be disposed between the first segment 2111 and the second segment 2112. A line width of the transmission line 211 may be understood as a size perpendicular to an extension direction of the transmission line 211. The extension direction of the transmission line 211 is a direction of extending from one end of the transmission line 211 to the other end, in other words, a direction of extending from the feed source to the matching part 212 along the transmission line 211. A width of the transmission line 211 may be a single size, or different positions of the transmission line may have different widths. Parameters such as a shape and a size of the matching part 212 and a width and a length of the transmission line 211 are changed to adjust a bandwidth, a return loss, and the like of the tapered slot antenna 20. This can improve radiation performance of the tapered slot antenna 20.

[0075] In this application, the dipole antenna 30 and the tapered slot antenna 20 are integrated into one antenna, to implement configuration of different frequency bands and different polarization directions. In a specific implementation, the dielectric plate 10 is used as a carrier of the antenna, and the dipole antenna 30 and the tapered slot antenna 20 are disposed on the dielectric plate 10 by using a microstrip. As shown in FIG. 6 and FIG. 7, the dipole antenna 30 and the feeding structure 21 may be located on a same layer (for example, located on the first surface S1) of the dielectric plate 10, and the first metal structure 22 and the second metal structure 23 are located on a same layer (for example, located on the second surface S2) of the dielectric plate 10.

[0076] As shown in FIG. 13, FIG. 14, FIG. 15, and FIG. 16, FIG. 13 is a side view of the dielectric plate 10, and shows an architecture in which the dielectric plate 10 includes two substrate layers and three function layers. FIG. 14, FIG. 15, and FIG. 16 are arrangements of the three function layers on the dielectric plate 10 respectively. As shown in FIG. 13, the dielectric plate 10 includes a first substrate layer 11 and a second substrate layer

12. A side that is of the first substrate layer 11 and that is away from the second substrate layer 12 is a first function layer. The first function layer includes the feeding structure 21 and the dipole antenna 30. FIG. 14 shows an architecture of a plane in which the first function layer is located. A second function layer is between the first substrate layer 11 and the second substrate layer 12. The second function layer includes the first metal structure 22. FIG. 15 shows an architecture of a plane in which the second function layer is located. A side that is of the second substrate layer 12 and that is away from the first substrate layer 11 is a third function layer. The third function layer includes the second metal structure 23. FIG. 16 shows an architecture of a plane in which the third function layer is located. In summary, for the antenna provided in this application, the first metal structure 22 and the second metal structure 23 may be separately disposed on different layers of the dielectric plate 10, and the dipole antenna 30 and the feeding structure 21 may also be located on different layers of the dielectric plate.

[0077] The first metal structure 22 and the second metal structure 23 are equivalent to ground layers of the antenna.

[0078] As shown in FIG. 11, when the first metal structure 22 and the second metal structure 23 are located at a same layer, a part of the first metal structure 22 and a part of the second metal structure 23 are connected as a whole, and a connection position is located on a side that is of the matching slot 25 and that is away from the narrow-slit end 241. It may be understood that, in a manufacturing process, a complete copper layer is disposed on the dielectric plate 10, and the tapered slot 24 and the matching slot 25 are manufactured on the copper layer in an etching manner. However, the etched copper layer is still in an integrated structure, and the etched copper layer is divided into the first metal structure 22 and the second metal structure 23 by the tapered slot 24 and the matching slot 25.

[0079] FIG. 17 shows that the first metal structure 22 and the second metal structure 23 are located at different layers of the dielectric plate. The first metal structure 22 is represented by a solid line. The second metal structure 23 is represented by a dashed line. It may be understood that the first metal structure 22 is located at a visible surface layer, and the second metal structure 23 is located at an intermediate layer of the dielectric plate and is blocked. When the first metal structure 22 and the second metal structure 23 are located at different layers, the first metal structure 22 and the second metal structure 23 may have a partially overlapping area S. In the implementation shown in FIG. 17, the partially overlapping area S is a rectangular area. The partially overlapping area S is located on a side that is of the matching slot 25 and that is away from the narrow-slit end 241. In the overlapping area S, the first metal structure 22 and the second metal structure 23 may be electrically connected through a metal hole 13 on the dielectric plate 10.

[0080] In another implementation, FIG. 18 shows that

the first metal structure 22 and the second metal structure 23 are located at different layers of the dielectric plate. The first metal structure 22 is represented by a solid line. The second metal structure 23 is represented by a dashed line. There is no overlapping area between the first metal structure 22 and the second metal structure 23. The first metal structure 22 and the second metal structure 23 are electrically connected through a metal hole 13 between different layers of the dielectric plate 10. As shown in FIG. 19, the metal hole 13 between the first metal structure 22 and the second metal structure 23 that do not overlap may be disposed in an oblique manner at different layers of the dielectric plate 10. "An oblique manner" is that a relationship between the metal hole 13 and the dielectric plate 10 is not perpendicular. One end of the metal hole 13 is located on the first metal structure 22. The other end of the metal hole 13 is located on the second metal structure 23. In the substrate layer of the dielectric plate 10, the metal hole 13 extends in an oblique manner.

[0081] As shown in FIG. 7 and FIG. 12, the dipole antenna 30 intersects with the tapered slot 24 of the tapered slot antenna 20, and at an intersection position of the dipole antenna 30 and the tapered slot 24, coupled feeding is performed on the dipole antenna 30 by using the tapered slot 24, to excite the dipole antenna 30. A working frequency of the dipole antenna 30 is a second frequency. The dipole antenna 30 is an omnidirectional antenna. The second frequency is lower than a first frequency. For example, the second frequency is a working frequency that ranges from 2 GHz to 3 GHz, and the first frequency is a working frequency that ranges from 5 GHz to 7 GHz. The intersection position of the dipole antenna 30 and the tapered slot 24 is in the main feeding area R2 of the tapered slot antenna 20. An included angle is formed between an extension direction of the dipole antenna 30 and an extension direction of the tapered slot 24. In a specific implementation, the extension direction of the dipole antenna 30 is perpendicular to the extension direction of the tapered slot 24. In other words, the extension direction of the dipole antenna 30 is the second direction A2, and the extension direction of the tapered slot 24 is the first direction A1. In another implementation, the extension direction of the dipole antenna 30 may alternatively be deflected relative to the second direction A2. For example, a preset included angle may be formed between the extension direction of the dipole antenna 30 and the first direction A1 (where a specific value of the included angle is not limited, and may be 80 degrees, 70 degrees, or 60 degrees, or may be some angles close to 90 degrees, for example, 83 degrees and 89 degrees).

[0082] In this implementation, the dipole antenna is disposed in the main feeding area, and the working frequency of the dipole antenna is different from the working frequency of the tapered slot antenna, to be specific, the working frequency of the dipole antenna is outside a working frequency band of the tapered slot antenna, so that the dipole antenna is disposed without affecting a

radiation feature of the main radiation area. In other words, in this application, radiation of the dipole antenna can be excited by the tapered slot antenna, and radiation performance of the tapered slot antenna can be ensured.

[0083] As shown in FIG. 12, in a specific implementation, the dipole antenna 30 includes a first radiation section 31, a second radiation section 32, and a switch structure 33 electrically connected between the first radiation section 31 and the second radiation section 32. The switch structure 33 intersects with the tapered slot 24. The switch structure 33 is electrically connected to a control circuit 100. The control circuit 100 controls the switch structure 33 to be turned on or off, to switch the antenna between a first working mode and a second working mode. The first working mode is a mode in which the switch structure 33 is turned off. In this mode, the antenna executes only the tapered slot antenna 20. The second working mode is a mode in which the switch structure 33 is turned on. In this mode, the antenna simultaneously executes the tapered slot antenna 20 and the dipole antenna 30.

[0084] The control circuit 100 may be a circuit structure disposed on a circuit board in the electronic device or an independent driving component. Alternatively, the control circuit 100 may be integrated into the dielectric board as one part of the antenna provided in this application.

[0085] Specifically, the switch structure 33 may be a diode. The control circuit 100 may perform turn-on and turn-off control on the switch structure 33 by introducing a direct current bias voltage into the first radiation section 31 and the second radiation section 32. The first radiation section 31 may be connected to a positive electrode of a voltage source, and the second radiation section 32 may be grounded. Alternatively, in an opposite configuration, the first radiation section 31 is grounded, and the second radiation section 32 is connected to a negative voltage. Finally, forward bias on the switch structure 33 is implemented.

[0086] The first radiation section 31 and the second radiation section 32 are symmetrically distributed on two sides of the switch structure 33. The switch structure 33 crosses the narrow-slit end 241. A joint P5 between the switch structure 33 and the first radiation section 31 is located in a range of the first metal structure 22. A joint P6 between the switch structure 33 and the second radiation section 32 is located in a range of the second metal structure 23. In this architecture, positions at which the switch structure 33 is connected to the first radiation section 31 and the second radiation section 32 overlap the first metal structure 22 and the second metal structure 23, and are not located in a range of the tapered slot 24. Current transmission of the tapered slot 24 is not affected, and signal radiation performance of the tapered slot antenna 20 can be ensured.

[0087] As shown in FIG. 20, in a specific implementation, the dipole antenna 30 further includes a first patch 34 and a second patch 35. The first patch 34 and the second patch 35 may be understood as metal sheet

structures. A length of a radiation arm is increased in the extension direction of the dipole antenna 30, and a width of the radiation arm is also increased. The first patch 34 is located at an end that is of the first radiation section 31 and that is away from the second radiation section 32. The first patch 34 is disposed opposite to the first metal structure 22, to increase capacitive coupling of the dipole antenna 30. The second patch 35 is located at an end that is of the second radiation section 32 and that is away from the first radiation section 31. The second patch 35 is disposed opposite to the second metal structure 23, to increase capacitive coupling of the dipole antenna 30. The first patch 34 and the second patch 35 may co-exist, or only one of the first patch 34 and the second patch 35 may be disposed. In this implementation, the first patch 34 and the second patch 35 are disposed to ensure an electrical length of the dipole antenna 30 within a limited size range, and facilitate a miniaturization design of the antenna. In an implementation shown in FIG. 20, the dipole antenna 30 simultaneously includes the first radiation section 31, the second radiation section 32, the switch structure 33, the first patch 34, and the second patch 35.

[0088] The first patch 34 is disposed at an end of the first radiation section 31. The second patch 35 is disposed at an end of the second radiation section 32. A small size of the dipole antenna 30 is implemented by a capacitive coupling design at the end. It may be understood as that a function of the first patch 34 and the second patch 35 is to generate capacitive coupling between the dipole antenna 30 and the first metal structure 22 and the second metal structure 23 of the tapered slot antenna 20. Based on capacitive coupling, it can be ensured that the dipole antenna 30 can still implement a working frequency of the dipole antenna 30 in a small-sized mode. The first patch is symmetrically distributed in an architecture centered on an extension line of the first radiation section. A shape of the first patch may alternatively be other shapes such as a circle, a triangle, a square, or a polygon. In a specific implementation, the first patch 34 and the first radiation section 31 form an oar form. In this application, the first patch 34 and the second patch 35 are respectively configured at an end of the first radiation section 31 and an end of the second radiation section 32, that is, positions of the first patch 34 and the second patch 35 are far away from the tapered slot 24, and specifically, are far away from the narrow-slit end 241 of the tapered slot 24. In this architecture, impact of the first patch 34 and the second patch 35 on the tapered slot antenna 20 can be minimized. In this way, an omnidirectional radiation mode of the dipole antenna is excited on a premise of ensuring radiation performance of the tapered slot antenna. This application implements an antenna architecture having a dual-band reconfiguration feature.

[0089] As shown in FIG. 20, specifically, the first patch 34 includes a first part 341 and a second part 342. The first part 341 is connected to the first radiation section

31. The second part 342 is connected to an end that is of the first part 341 and that is far away from the first radiation section 31. The first part 341 is trapezoidal. A size of an end that is of the first part 341 and that is connected to the first radiation section 31 is less than a size of the end that is of the first part 341 and that is connected to the second part 342. An outer profile of the second part 342 is arc-shaped. The second patch 35 includes a first part 351 and a second part 352. Specific structures of the first part 351 and the second part 352 of the second patch 35 are the same as those of the first part 341 and the second part 342 of the first patch 34. Details are not described again.

[0090] In another implementation, the dipole antenna 30 may not include the switch structure 33. It may be understood that the first radiation section 31 is directly connected to the second radiation section 32. As shown in FIG. 7, the dipole antenna 30 includes a middle radiation line 310 (equivalent to the first radiation section 31 and the second radiation section 32 in the implementation shown in FIG. 20) and the first patch 34 and the second patch 35 (equivalent to the first patch and the second patch in the implementation shown in FIG. 20) that are located at two ends of the radiation line 310. In this implementation, the tapered slot antenna 20 and the dipole antenna 30 can only be simultaneously activated, and a function of separately exciting the tapered slot antenna 20 cannot be implemented.

[0091] As shown in FIG. 21, based on the implementation shown in FIG. 20, in this implementation, the dipole antenna 30 further includes extension lines 36 and 37. The extension line 36 is connected to the first radiation section 31. The extension line 37 is connected to the second radiation section 32. The extension lines 36 and 37 are configured to increase an electrical length of the dipole antenna 30. Specific shapes of the extension lines 36 and 37 may be a winding shape, a snake shape, a sawtooth shape, a wave shape, or the like. Line widths of the extension lines 36 and 37 are less than a line width of the first radiation section 31. The dipole antenna 30 may include two extension lines 36 and 37. In other words, one extension line is configured for each of the first radiation section 31 and the second radiation section 32. It may be understood that the dipole antenna 30 may alternatively include only one extension line. For example, only one extension line 36 is disposed on the first radiation section 31, and no extension line is disposed on the second radiation section 32. In this way, the electrical length of the dipole antenna 30 may also be changed.

[0092] As shown in FIG. 22, in this implementation, the dipole antenna 30 includes a strip radiation line 38 and an extension line 39 connected to the strip radiation line. There may be one, two, or more extension lines 39. In the implementation shown in FIG. 22, the dipole antenna 30 includes two extension lines 39. The extension line 39 is configured to increase an electrical length of the strip radiation line 38.

[0093] In conclusion, the tapered slot 24 in the tapered slot antenna 20 provided in this application has a topdown symmetric form. The narrow-slit end 241 (a feeding position) of the tapered slot 24 is a long narrow-slit. The tapered slot 24 is gradually opened from the narrow-slit end 241 to the wide-mouth end 242, which is similar to a horn. A part (which may be understood as a narrow slot close to a feeding end) between the narrow-slit end 241 and the middle position 243 may be considered as an energy conduction part, to guide radio frequency energy to be transferred from the feeding structure to a part of the wide-mouth end 242. The energy conduction part is concentrated in the main feeding area R2, and completes conduction of energy from the feeding structure to a radiation slot. As a tension angle increases, and when the tension angle reaches a half wavelength, radiation starts to be performed to the outside, and the main radiation area R1 (mainly located in a right half part of the tapered slot 24) is formed. Therefore, the main feeding area R2 may be considered as a feeding network of the main radiation area R1. Design of the main feeding area R2 does not affect a radiation feature of the main radiation area R1, especially when an added design part is outside a working frequency band of the right half radiator. Therefore, the dipole antenna 30 (for example, an oar conductor architecture with a symmetric upper and lower structure) is introduced to a back of the main feeding area R2. A size of the dipole antenna 30 is approximately equal to a half wavelength of a working frequency band corresponding to a Wi-Fi low frequency 2 GHz. A dipole antenna covering a Wi-Fi low frequency vertical polarization feature is implemented, and feeding is implemented by using a coupling function of a tapered slot.

[0094] As shown in FIG. 23 and FIG. 24, the antenna provided in this application further includes a first additional antenna 50 and a second additional antenna 60. The first additional antenna 50 and the second additional antenna 60 are also disposed on the dielectric plate 10. In addition, the first additional antenna 50 is disposed on a periphery of the first metal structure 22, and is located at an edge that is of the first metal structure 22 and that is away from the wide-mouth end 242, that is, a position of the first additional antenna 50 is adjacent to the first metal structure 22. The second additional antenna 60 is disposed on a periphery of the second metal structure 23. Similarly, the second additional antenna 60 is located at an edge that is of the second metal structure 23 and that is away from the wide-mouth end 242, and the second additional antenna 60 is adjacent to the second metal structure 23. It may be understood that, in an implementation, the antenna provided in this application may simultaneously include the tapered slot antenna 20, the dipole antenna 30, the first additional antenna 50, and the second additional antenna 60. In another implementation, the antenna provided in this application may include the tapered slot antenna 20, the dipole antenna 30, and the first additional antenna 50 (or the second additional antenna 60), that is, only one of the first addi-

tional antenna 50 and the second additional antenna 60 may be disposed.

[0095] Specifically, a first area R3 is disposed on the dielectric plate 10. The first area R3 is located at a corner position of the first metal structure 22, and the first area R3 is at an edge that is of the first metal structure 22 and that is away from the wide-mouth end 242. It may be understood as that the wide-mouth end 242 is located at the second edge 12 of the dielectric plate, the first area R3 is close to the first edge 11 of the dielectric plate 10, and the first edge 11 and the second edge 12 are disposed opposite to each other. For the tapered slot antenna 20 and the dipole antenna 30, the first area R3 is an area with less current distribution or no current distribution. Therefore, another antenna disposed in the first area R3 does not affect radiation efficiency of the tapered slot antenna and the dipole antenna. Therefore, in this application, the first additional antenna 50 is disposed in the first area R3, and the first additional antenna 50 has an independent feeding structure and an independent radiation structure. Because the first additional antenna 50 is disposed in the first area R3, regardless of a form of the feeding structure and the radiation structure of the first additional antenna 50, radiation efficiency of the tapered slot antenna 20 and the dipole antenna 30 is not affected. Similarly, a second area R4 also exists at a corner position of the second metal structure 23. A position of the second area R4 is similar to the position of the first area R3, and is an edge position that is of the second metal structure 23 and that is away from the wide-mouth end 242. In a working mode of the tapered slot antenna 20 and the dipole antenna 30, the second area R4 has less current distribution or no current distribution.

[0096] As shown in FIG. 23 and FIG. 24, the first area R3 is located at a position of an upper left corner of the dielectric plate 10, and the second area R4 is located at a position of a lower left corner of the dielectric plate 10. As shown in FIG. 24, the first additional antenna 50 includes a first radiation structure 51 and a first feeding structure 52. The first radiation structure 51, the feeding structure 21 of the tapered slot antenna 20, and the dipole antenna 30 are located at a same layer of the dielectric plate 10, and are microstrip structures disposed on the dielectric plate 10. In an implementation, the first additional antenna 50 may be a LOOP antenna, and a working frequency of the first additional antenna 50 is 5 GHz. As shown in FIG. 23, the second additional antenna 60 includes a second radiation structure 61 and a second feeding structure 62. The second radiation structure 61, the first metal structure 22, and the second metal structure 23 are located at a same layer of the dielectric plate 10, and are microstrip structures disposed on the dielectric plate 10. In an implementation, the second additional antenna 60 is an IFA antenna, and a working frequency of the second additional antenna 60 is 2 GHz.

[0097] FIG. 25 is a schematic diagram of an S parameter curve of an impedance bandwidth of an antenna according to an implementation of this application. A ver-

tical axis is a return loss scale, and -10 dB is an industry-accepted threshold for measuring port matching. A horizontal axis indicates a frequency, 1 to 2 indicate a specific frequency band range that is low-frequency omnidirectional, and 3 to 4 indicate a working range in a high frequency band. It can be learned from FIG. 25 that the antenna provided in this application combines a tapered slot antenna whose working frequency ranges from 5 GHz to 6 GHz and a dipole antenna whose working frequency ranges from 2 GHz to 3 GHz, so that radiation performance of both the tapered slot antenna and the dipole antenna can be met.

[0098] FIG. 26 is a radiation pattern of an antenna on different frequencies according to an implementation of this application. A left diagram is a radiation pattern of a dipole antenna, and a right diagram is a radiation pattern of a tapered slot antenna. It can be learned that the dipole antenna is an omnidirectional antenna and the tapered slot antenna is a directional antenna.

[0099] FIG. 27A is a current distribution diagram of an antenna that is provided in this application and that includes only a tapered slot antenna and does not include a dipole antenna. In this case, only the tapered slot antenna is excited, and a working frequency is 5.5 GHz. Currents are mainly distributed at edges of a tapered slot, to be specific, edges that are of a first metal structure and a second metal structure and that face the tapered slot.

[0100] FIG. 27B is a current distribution diagram of an antenna on a working frequency of a dipole antenna according to an implementation of this application. In this case, only the dipole antenna is excited. A current is mainly distributed on the dipole antenna. The working frequency is 2 GHz.

[0101] FIG. 27C is a current distribution diagram of an antenna on a working frequency of a tapered slot antenna according to an implementation of this application. In this case, only the tapered slot antenna is excited. The working frequency is 5.5 GHz. A current is mainly distributed at an edge of a tapered slot.

[0102] The foregoing descriptions are merely specific implementations of this application, but are not intended to limit the protection scope of this application. Any variation or replacement readily figured out by a person skilled in the art within the technical scope disclosed in this application shall fall within the protection scope of this application. Therefore, the protection scope of this application shall be subject to the protection scope of the claims.

Claims

1. An antenna, comprising a tapered slot antenna and a dipole antenna that have same polarization, wherein

the tapered slot antenna comprises a feeding

structure, a first metal structure, and a second metal structure, a tapered slot is formed between the first metal structure and the second metal structure, two ends of the tapered slot are a narrow-slit end and a wide-mouth end, and the feeding structure is coupled to the narrow-slit end, to excite the tapered slot antenna to be a directional antenna; and

the dipole antenna intersects with the tapered slot, and at an intersection position of the dipole antenna and the tapered slot, coupled feeding is performed on the dipole antenna by using the tapered slot, to excite the dipole antenna to be an omnidirectional antenna.

2. The antenna according to claim 1, wherein a working frequency of the tapered slot antenna is higher than a working frequency of the dipole antenna.
3. The antenna according to claim 1 or 2, wherein the tapered slot comprises a middle position between the narrow-slit end and the wide-mouth end, a part between the narrow-slit end and the middle position is a main feeding area, a part between the middle position and the wide-mouth end is a main radiation area, an intersection position of the dipole antenna and the tapered slot antenna is in the main feeding area, and an extension direction of the dipole antenna intersects with an extension direction of the tapered slot.
4. The antenna according to claim 3, wherein the extension direction of the dipole antenna is orthogonal to the extension direction of the tapered slot.
5. The antenna according to claim 1 or 2, wherein the dipole antenna comprises a first radiation section, a second radiation section, and a switch structure electrically connected between the first radiation section and the second radiation section, the switch structure intersects with the tapered slot, the switch structure is electrically connected to a control circuit, and the control circuit controls the switch structure to be turned on or off, to switch the antenna between a first working mode and a second working mode, wherein the first working mode is that the tapered slot antenna is independently executed, and the second working mode is that functions of the tapered slot antenna and the dipole antenna are simultaneously executed.
6. The antenna according to claim 5, wherein the first radiation section and the second radiation section are symmetrically distributed on two sides of the switch structure.
7. The antenna according to claim 5, wherein the dipole antenna further comprises a first patch, the first patch

is located at an end that is of the first radiation section and that is away from the second radiation section, and the first patch and the first metal structure are disposed in a stacked manner.

8. The antenna according to claim 7, wherein the dipole antenna further comprises a second patch, the second patch is located at an end that is of the second radiation section and that is away from the first radiation section, and the second patch and the second metal structure are disposed in a stacked manner.
9. The antenna according to claim 5, wherein the dipole antenna further comprises an extension line, the extension line is connected to the first radiation section and/or the second radiation section, and the extension line is configured to increase an electrical length of the dipole antenna.
10. The antenna according to claim 1 or 3, wherein the dipole antenna comprises a radiation line and a first patch and a second patch that are respectively located at two ends of the radiation line, a central position of the radiation line is a feeding part of the dipole antenna, the feeding part intersects with the tapered slot, and the first patch and the second patch are configured to increase capacitive coupling of the dipole antenna.
11. The antenna according to claim 1 or 2, wherein the dipole antenna comprises a strip radiation line and an extension line connected to the strip radiation line, and the extension line is configured to increase an electrical length of the strip radiation line.
12. The antenna according to claim 1 or 2, wherein the first metal structure comprises a first edge facing the second metal structure and a second edge away from the second metal structure, the second metal structure comprises a third edge facing the first metal structure and a fourth edge away from the first metal structure, the tapered slot is formed between the first edge and the third edge, a plurality of equal-height first comb teeth distributed along a first direction are disposed on the second edge, a plurality of equal-height second comb teeth distributed along the first direction are disposed on the fourth edge, and the first comb tooth and the second comb tooth are configured to improve a gain of the tapered slot antenna.
13. The antenna according to claim 12, wherein both an electrical length of the first comb tooth and an electrical length of the second comb tooth are a quarter wavelength corresponding to a center frequency of the tapered slot antenna, the tapered slot antenna can be excited to work in a high frequency bandwidth, the high frequency bandwidth comprises a maximum working frequency and a minimum working frequen-

cy, and the center frequency is an intermediate value between the maximum working frequency and the minimum working frequency.

14. The antenna according to claim 12, wherein a plurality of unequal-height third comb teeth distributed along the first direction are disposed on the second edge, a plurality of unequal-height fourth comb teeth distributed along the first direction are disposed on the fourth edge, electrical lengths of the third comb teeth and electrical lengths of the fourth comb teeth decrease progressively along the first direction, electrical lengths of a third comb tooth and a fourth comb tooth that are close to the wide-mouth end are the smallest, and the third comb teeth and the fourth comb teeth are configured to suppress standing wave current distribution, on the second edge and the fourth edge, of energy that is not radiated by the tapered slot antenna.
15. The antenna according to claim 14, wherein the tapered slot comprises a middle position between the narrow-slit end and the wide-mouth end, a part between the narrow-slit end and the middle position is a main feeding area, a part between the middle position and the wide-mouth end is a main radiation area, an intersection position of the dipole antenna and the tapered slot antenna is in the main feeding area, and the first comb tooth and the second comb tooth are symmetrically distributed on two sides of the main feeding area.
16. The antenna according to claim 15, wherein the third comb tooth and the fourth comb tooth are symmetrically distributed on two sides of the main radiation area.
17. The antenna according to claim 1 or 2, wherein a first area is disposed at a periphery of the first metal structure, the first area is at an edge of the first metal structure away from the wide-mouth end, and a first additional antenna is disposed in the first area.
18. The antenna according to claim 17, wherein a second area is disposed at a periphery of the second metal structure, the second area is at an edge of the second metal structure away from the wide-mouth end, and a second additional antenna is disposed in the second area.
19. An electronic device, comprising a radio frequency circuit and the antenna according to any one of claims 1 to 18, wherein a feeding structure of the antenna is electrically connected to the radio frequency circuit.
20. An antenna module, comprising a bracket and the antenna according to any one of claims 1 to 18 that

is connected to the bracket.

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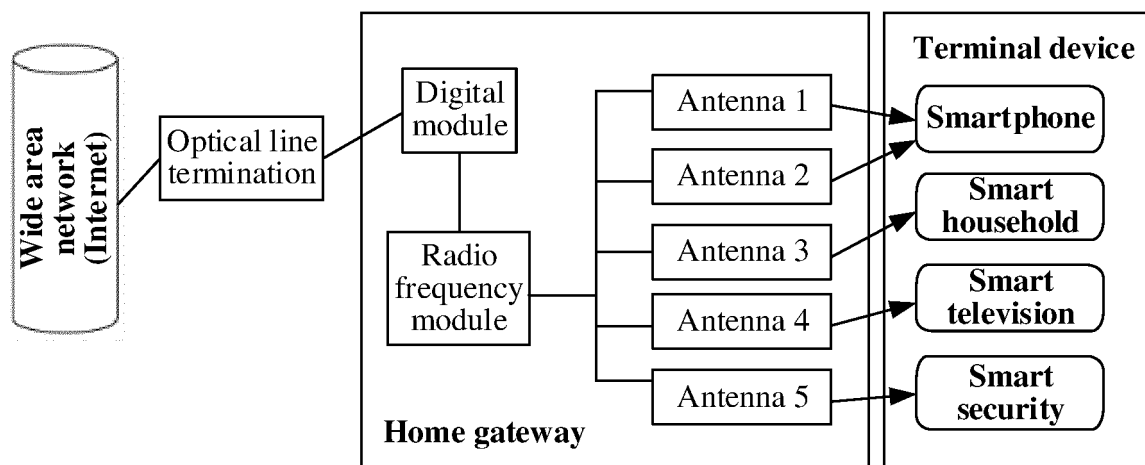


FIG. 1

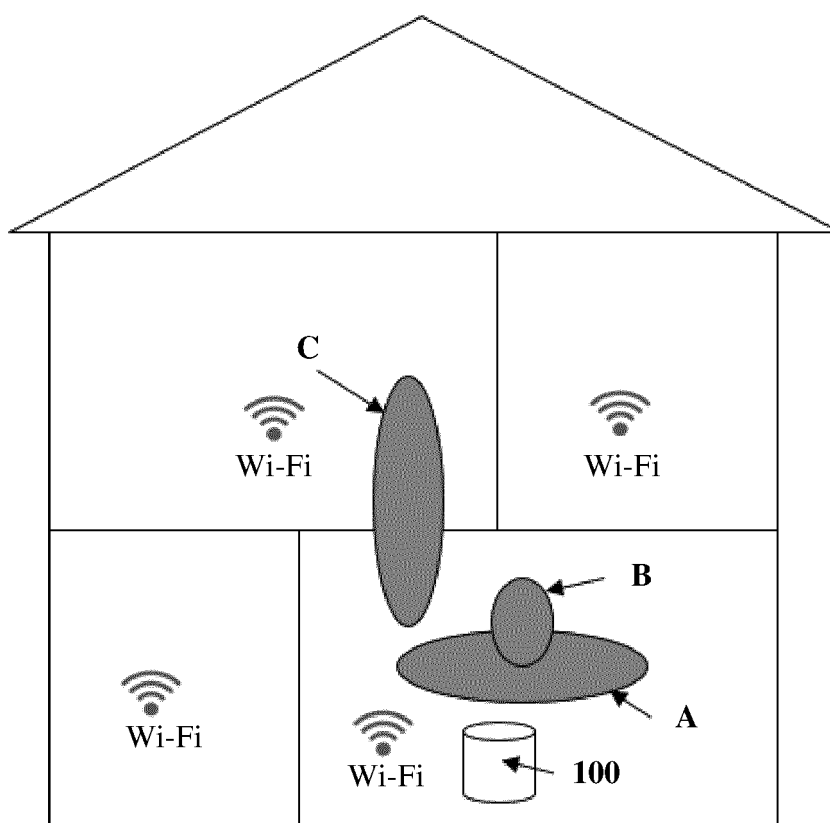


FIG. 2

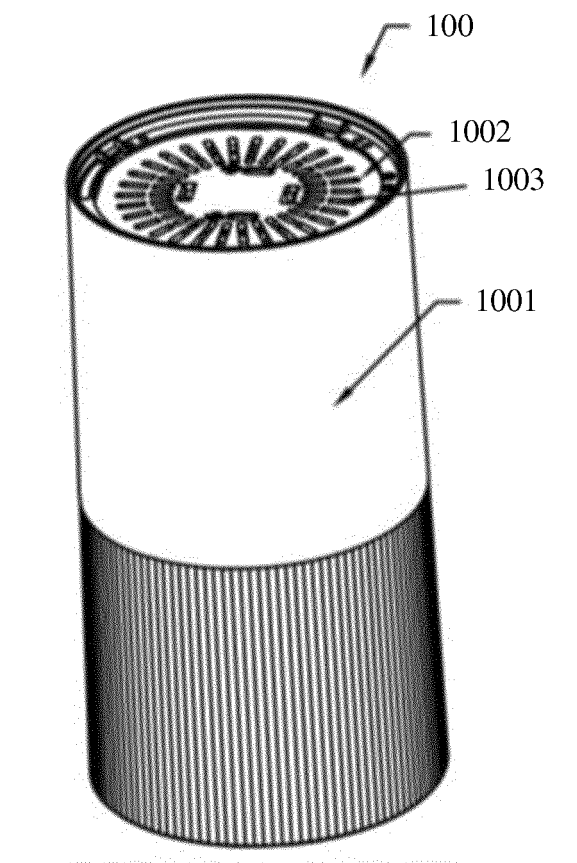


FIG. 3

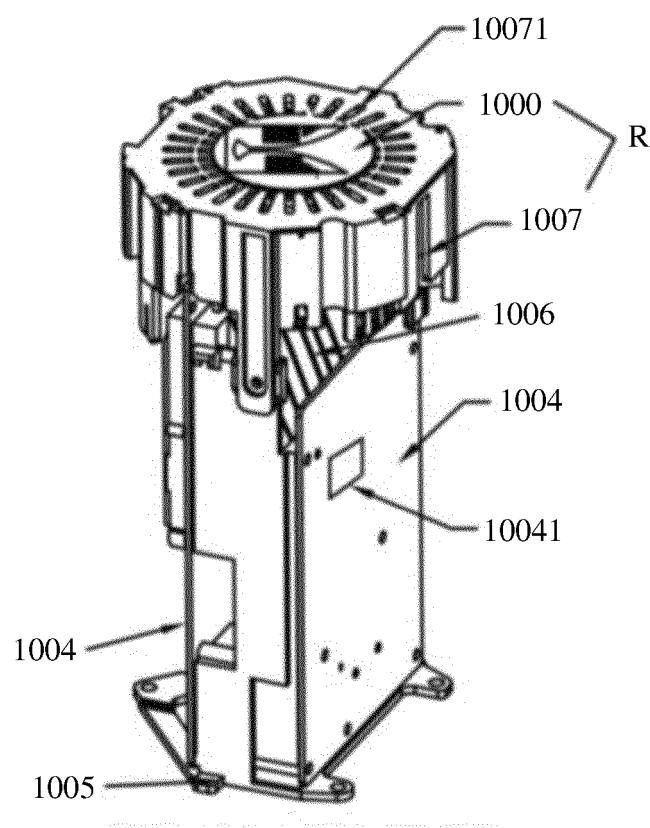


FIG. 4

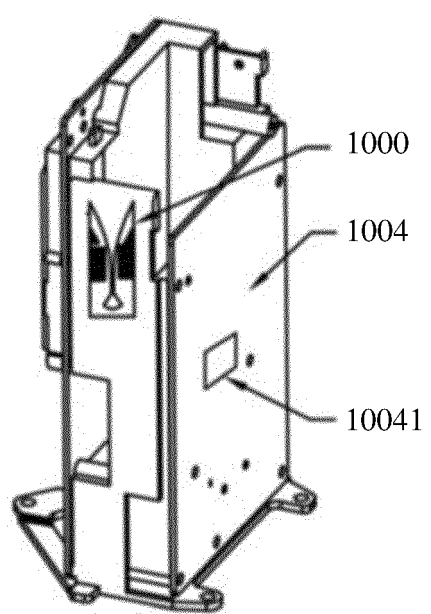


FIG. 5

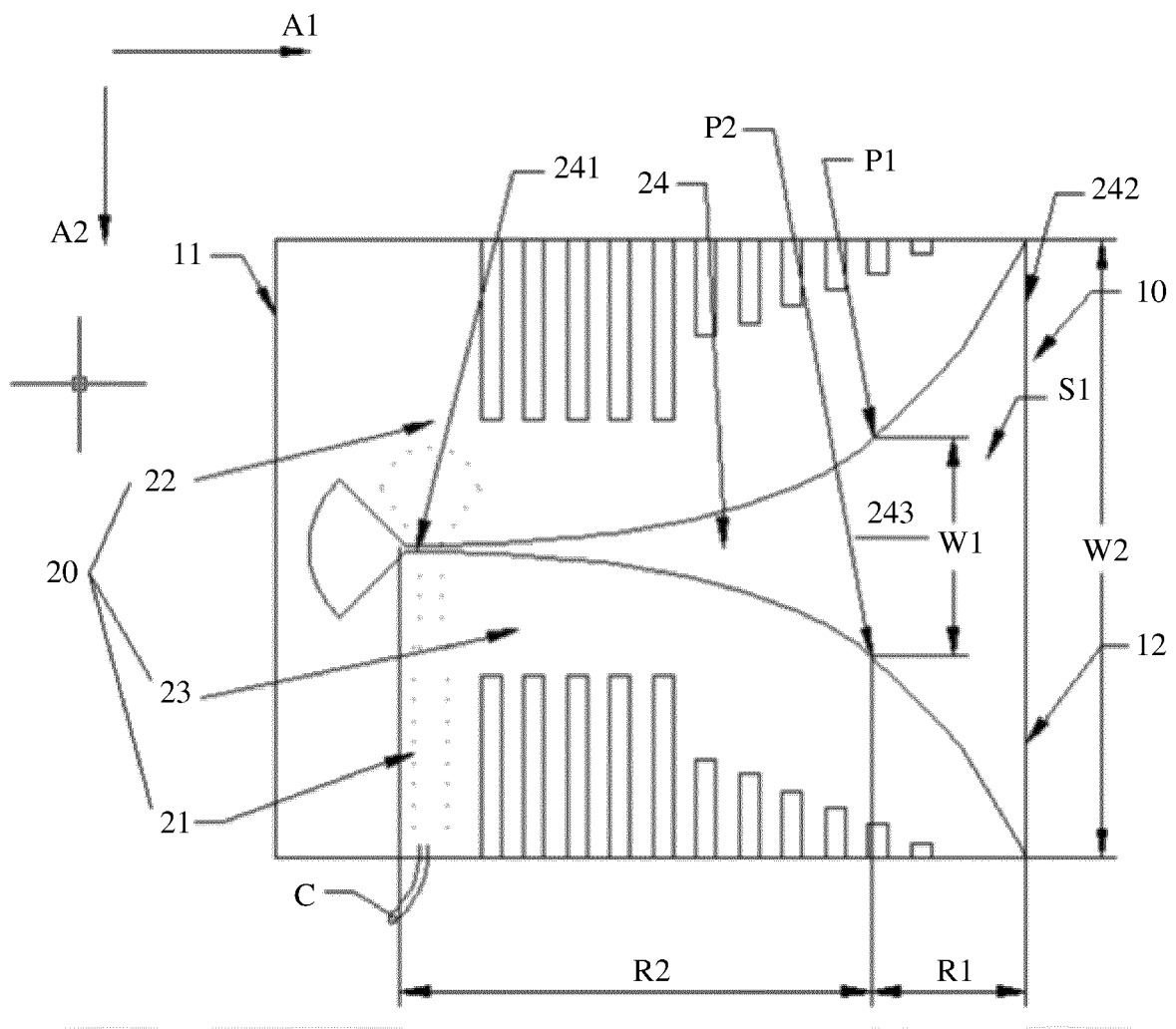


FIG. 6

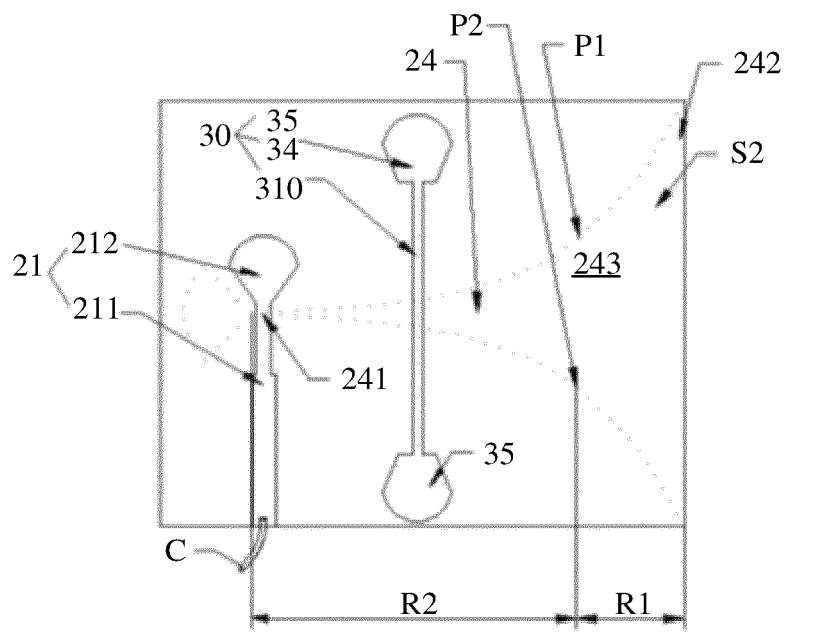


FIG. 7

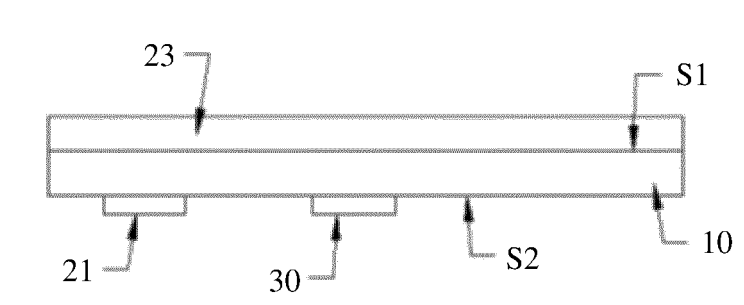


FIG. 8

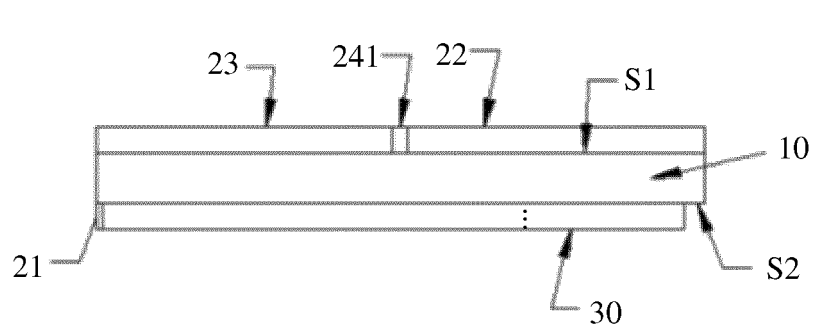


FIG. 9

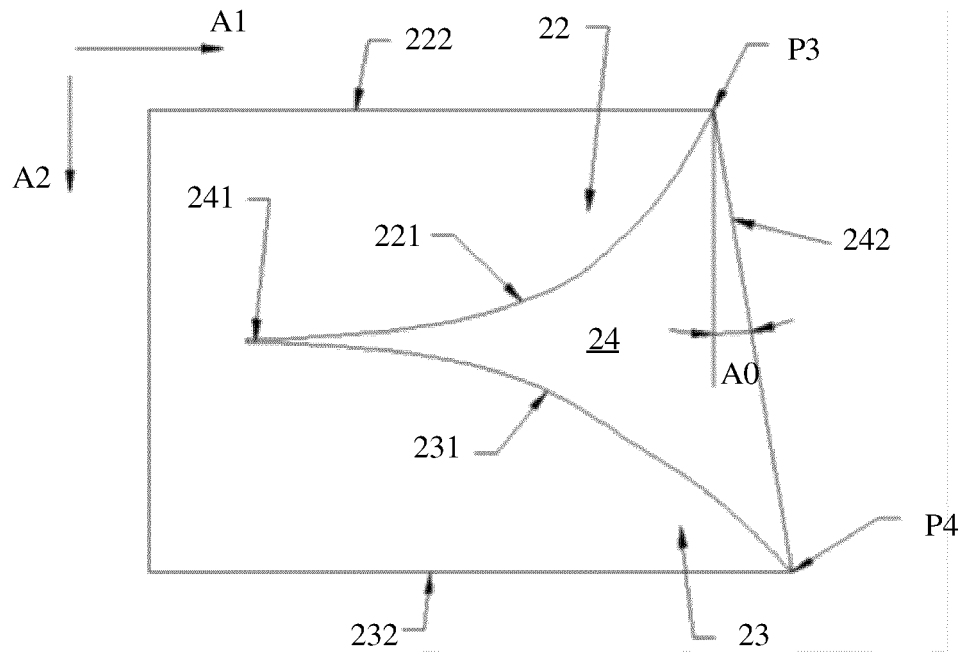


FIG. 10

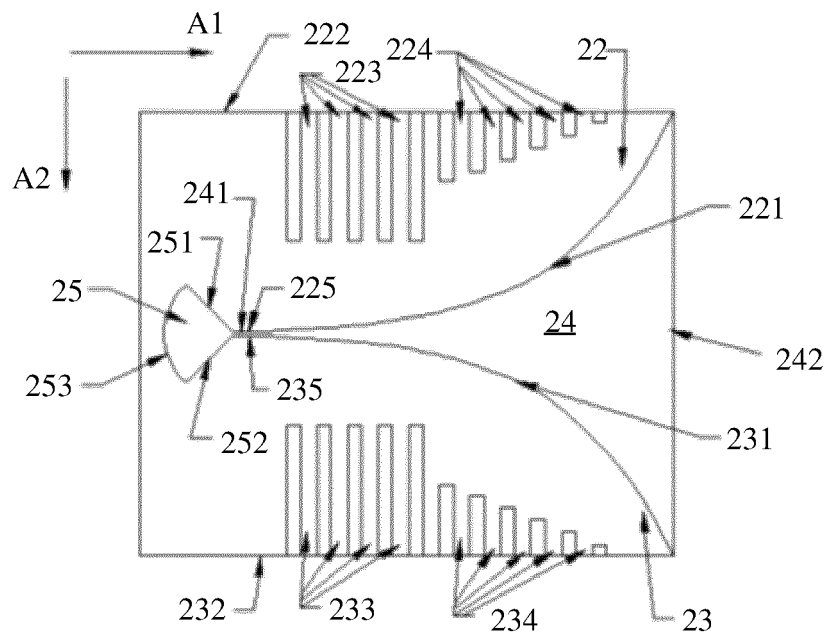


FIG. 11

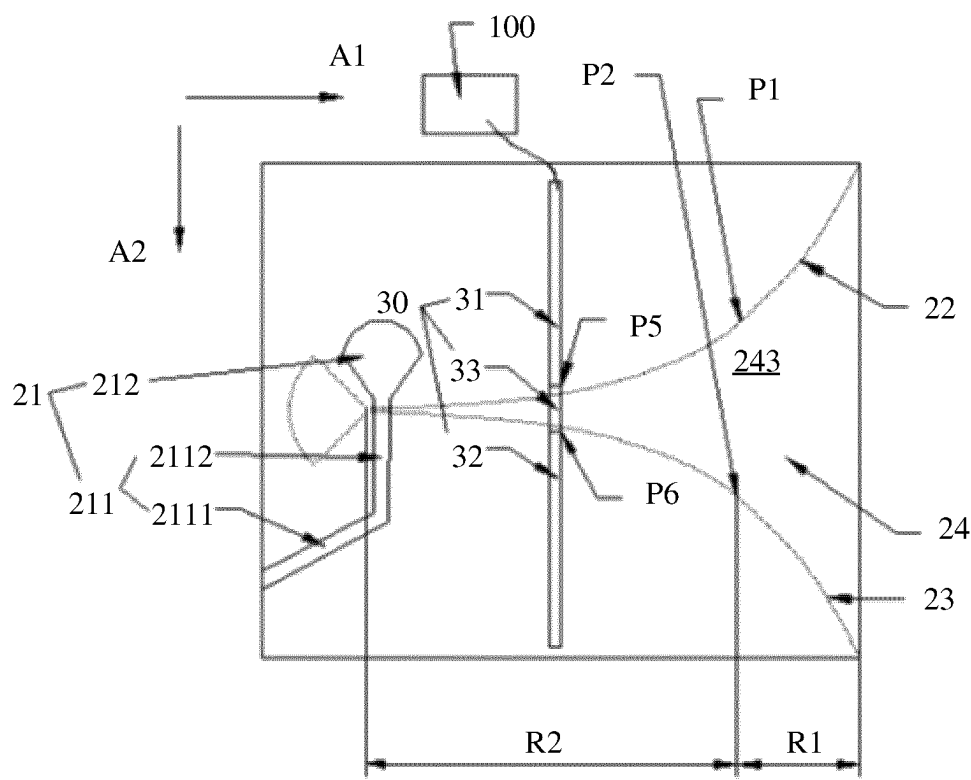


FIG. 12

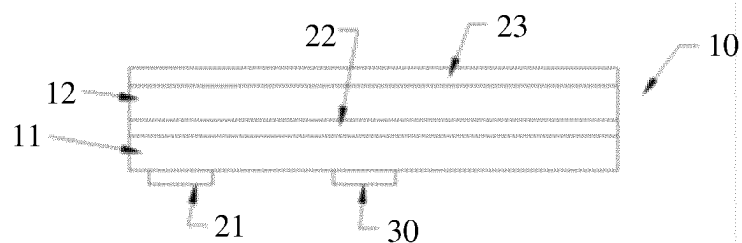


FIG. 13

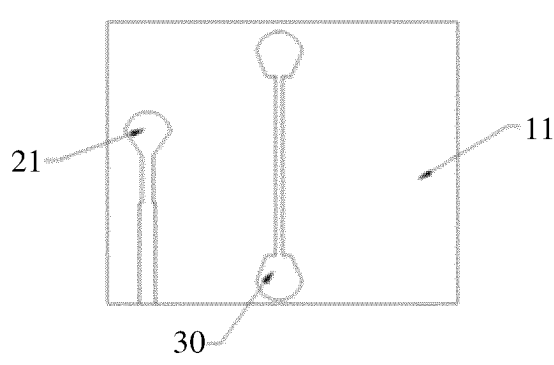


FIG. 14

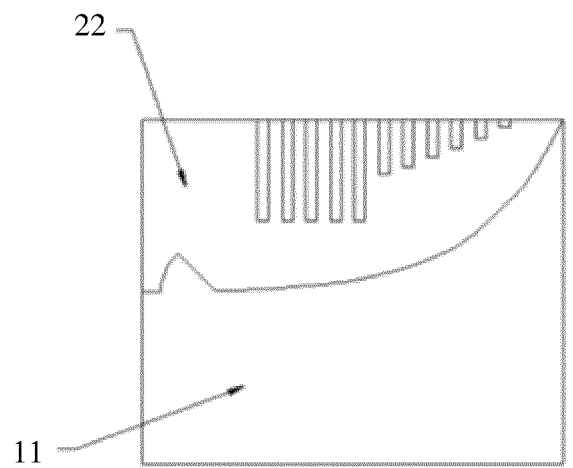


FIG. 15

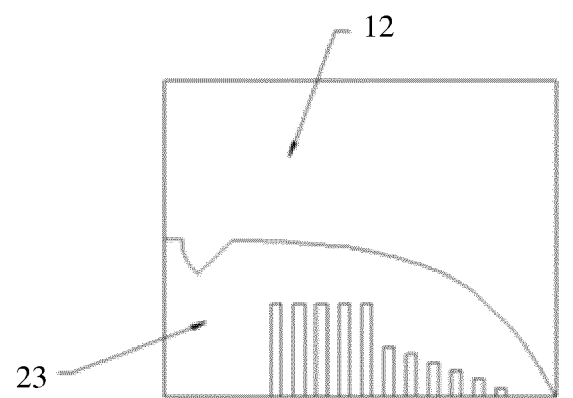


FIG. 16

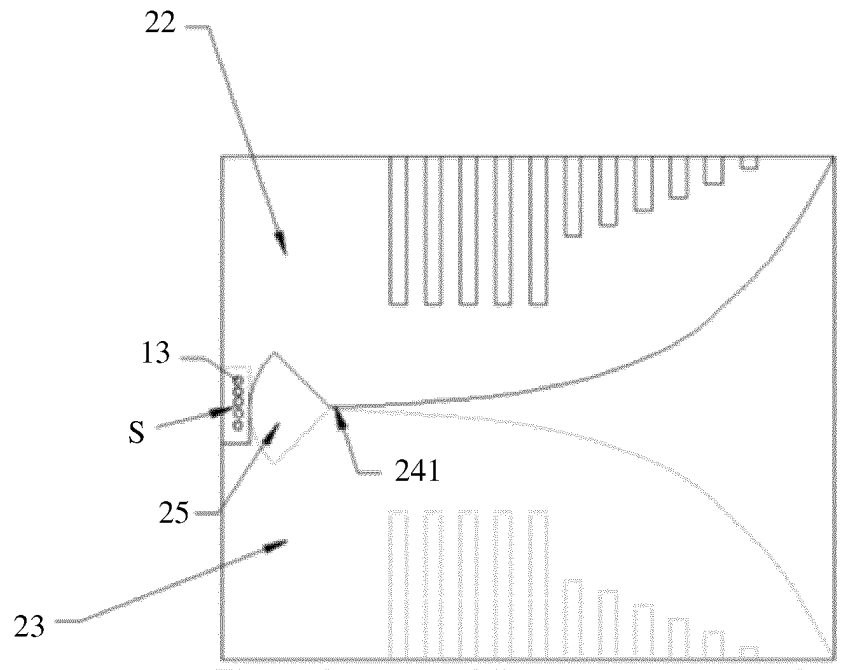


FIG. 17

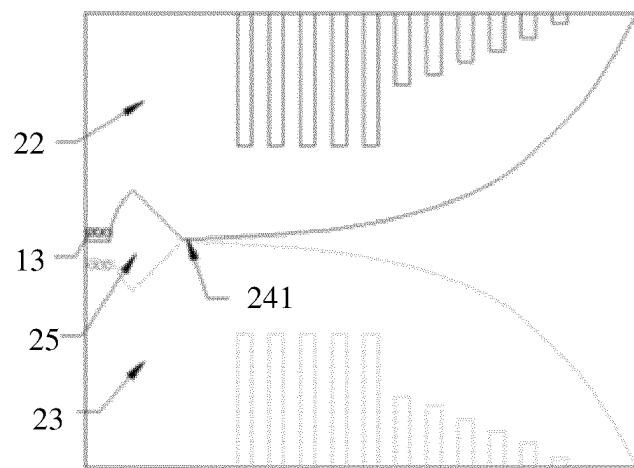


FIG. 18

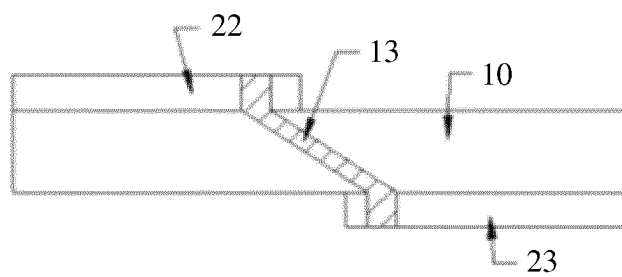


FIG. 19

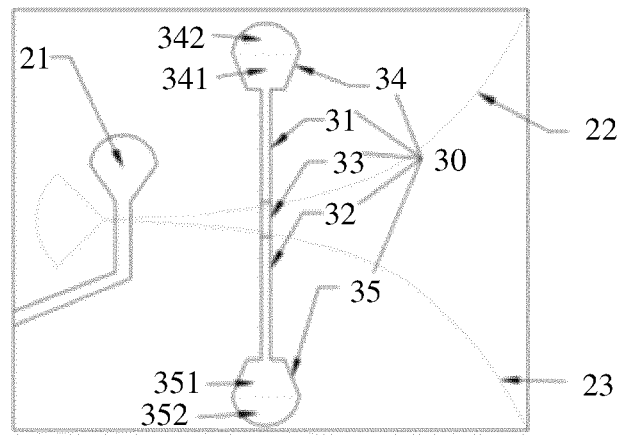


FIG. 20

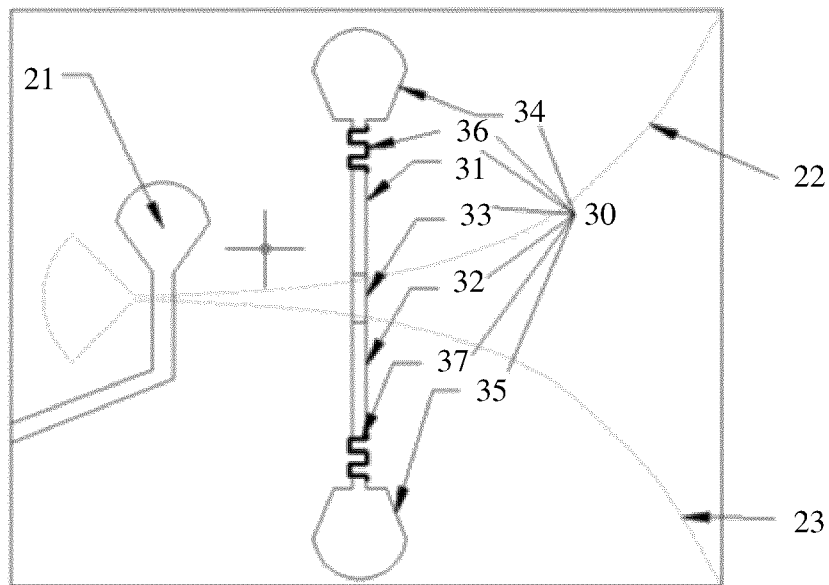


FIG. 21

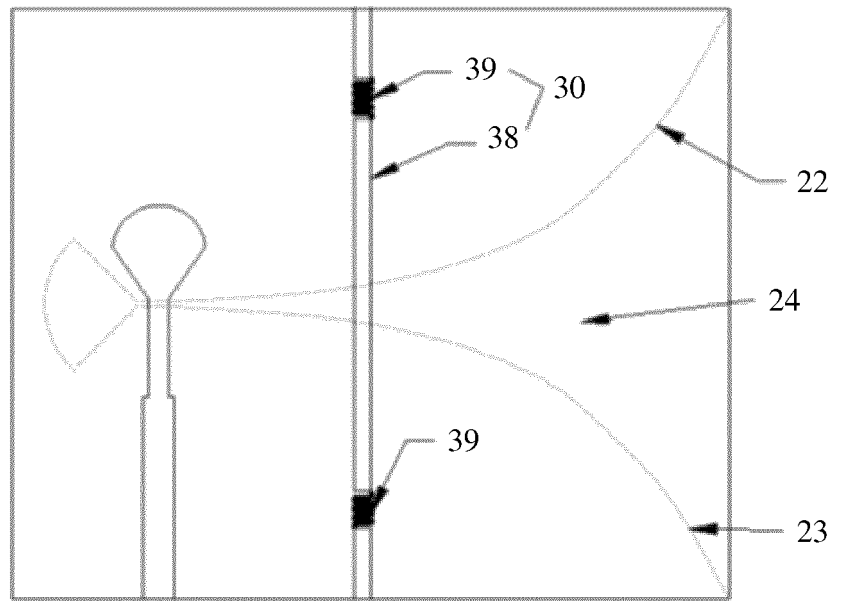


FIG. 22

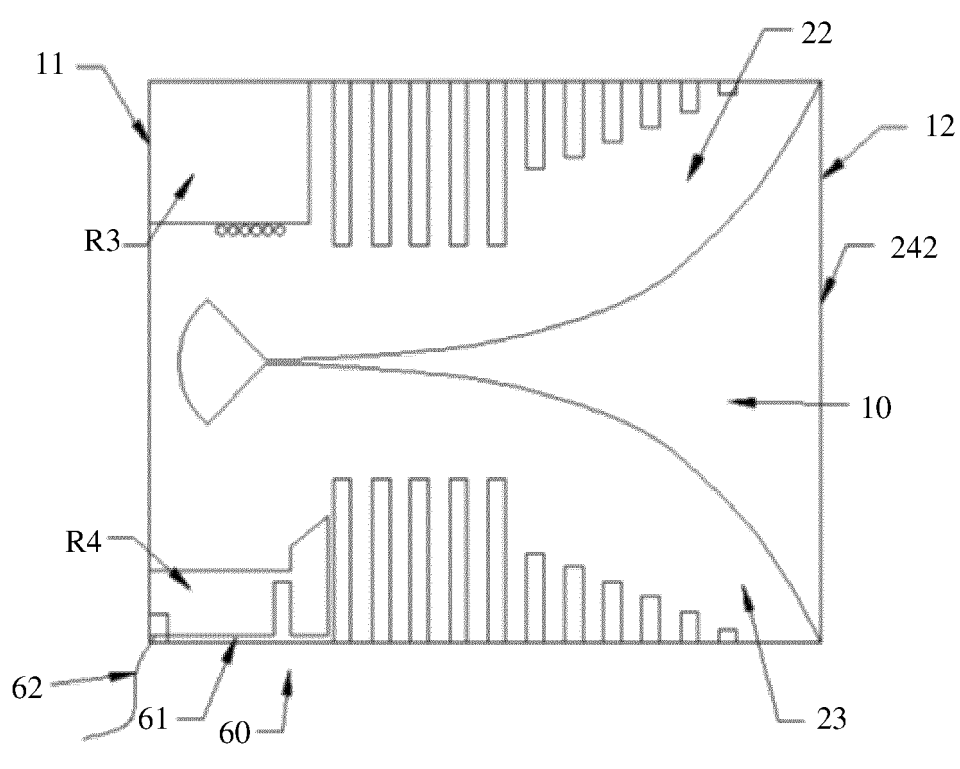


FIG. 23

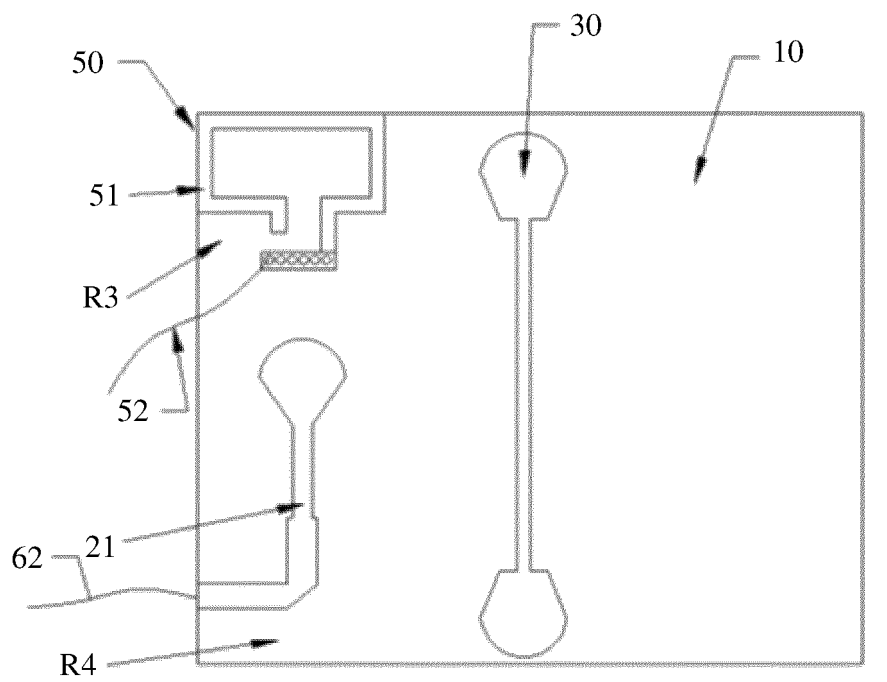


FIG. 24

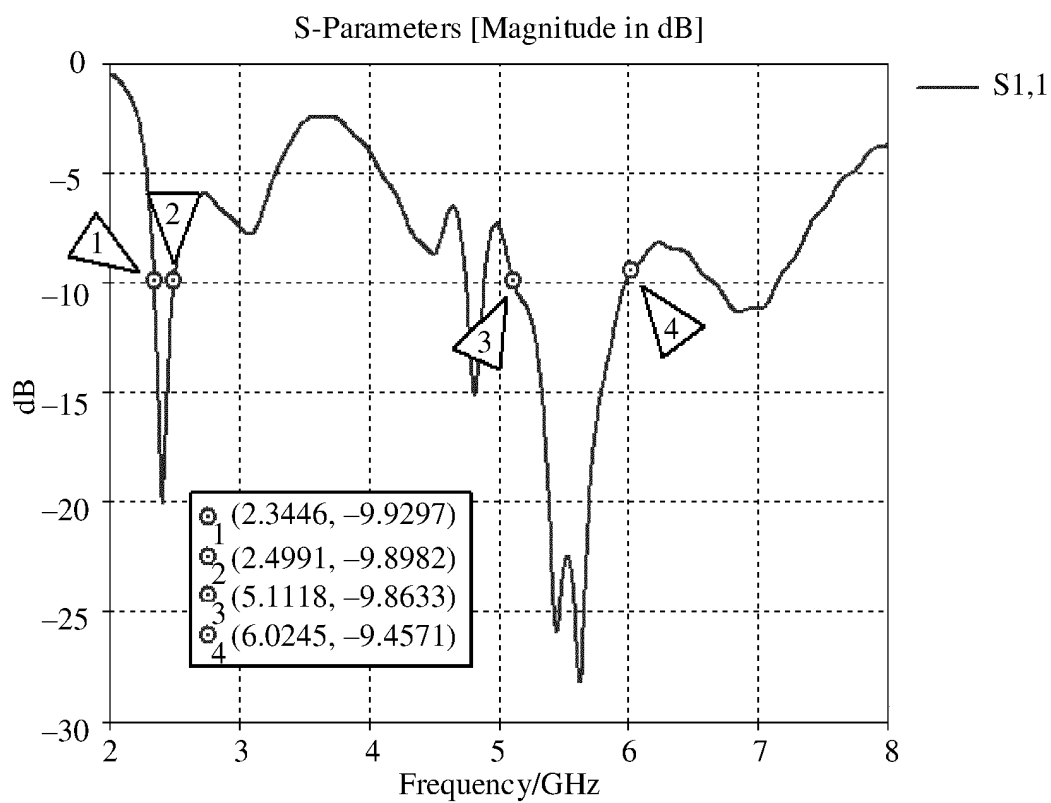


FIG. 25

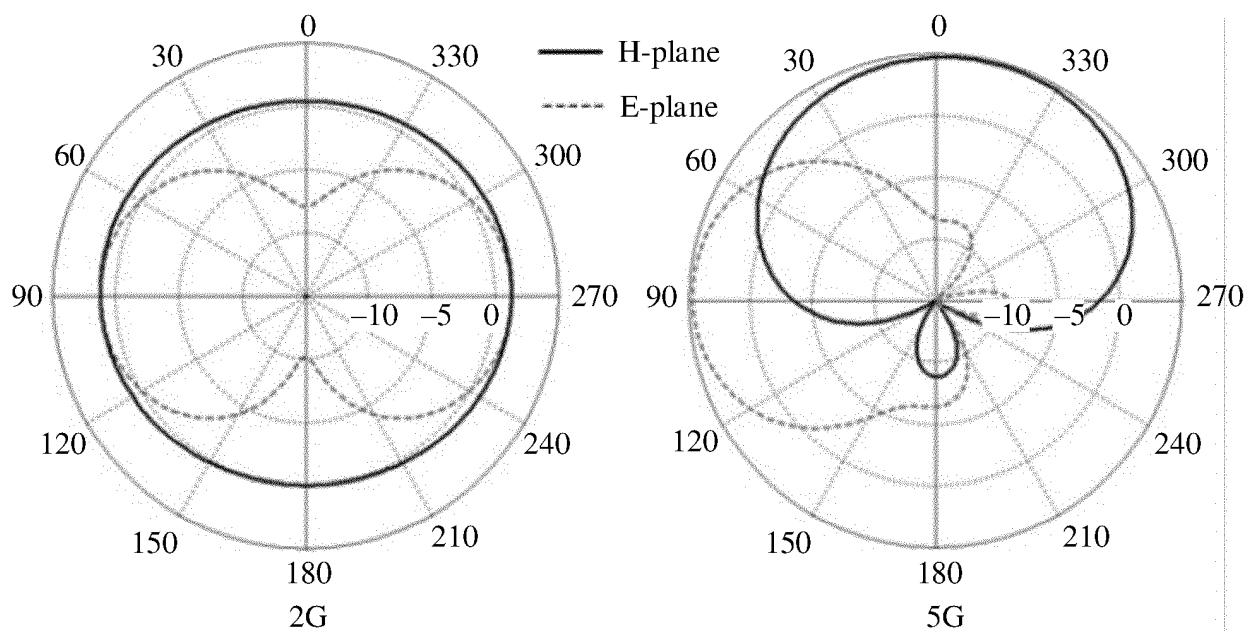


FIG. 26

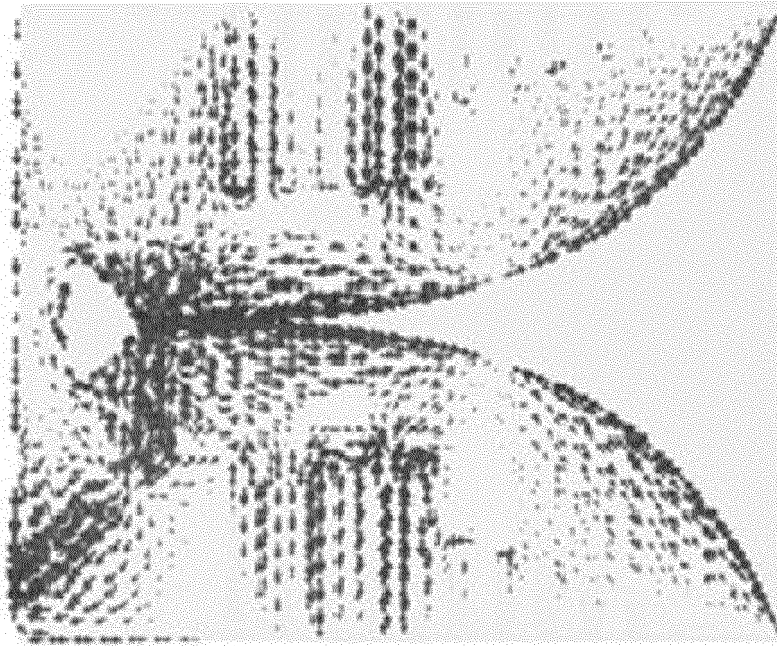


FIG. 27A

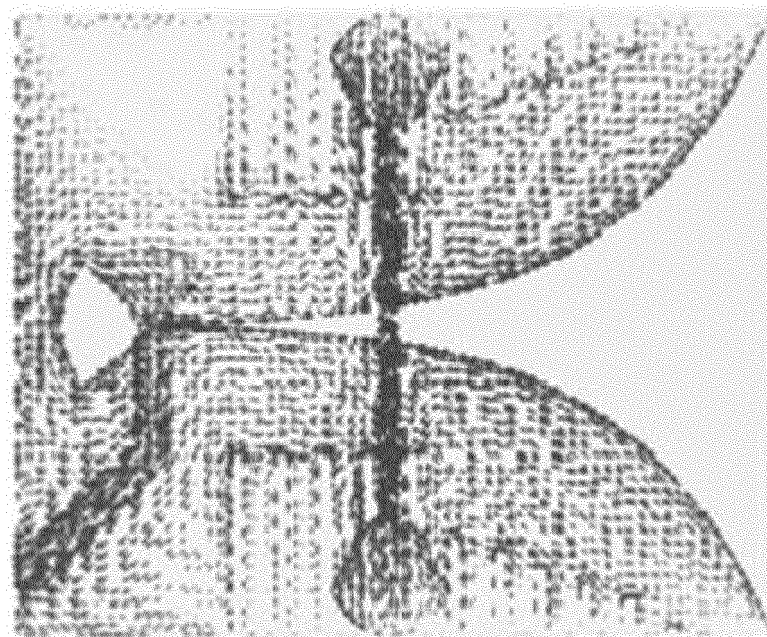


FIG. 27B

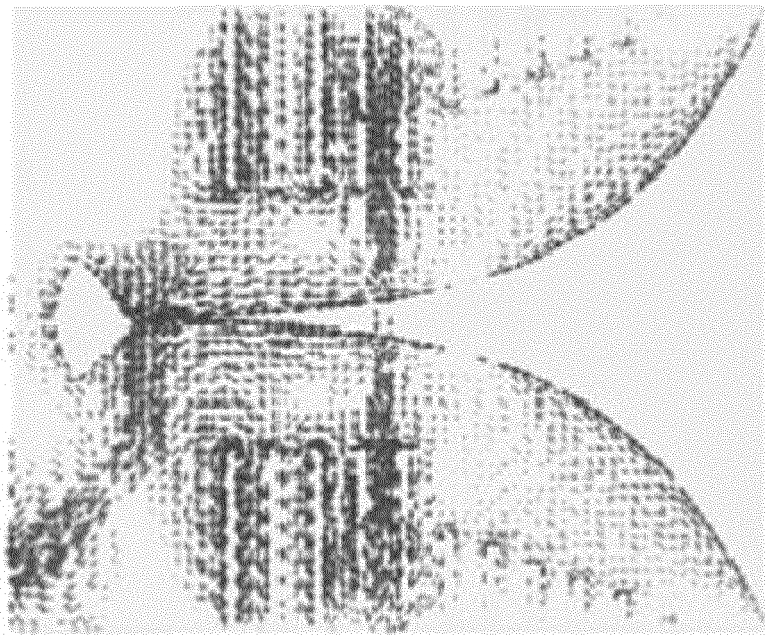


FIG. 27C

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2021/113438

A. CLASSIFICATION OF SUBJECT MATTER

H01Q 21/06(2006.01)i; H01Q 1/22(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)

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)

CNABS; CNTXT; VEN; USTXT; WOTXT; EPTXT; CNKI; IEEE; 渐变, 锥形, 锥削, 维瓦尔第, 天线, 偶极, 半波振子, 蜿蜒线, 弯折线, 延伸线, 开关, 切换, 相交, 耦合, 切口, 开口, 缝, 槽, TSA, vivaldi, tapered slot, slit?, groov+, aperture?, opening +, meander+, dipole?, antenna?, aerial?, switch+, coupl+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 101901960 A (SHANGHAI INSTITUTE OF MICROSYSTEM AND INFORMATION TECHNOLOGY, CHINESE ACADEMY OF SCIENCES) 01 December 2010 (2010-12-01) description, paragraphs [0015]-[0024], and figures 1 and 2	1-4, 17-20
X	Peng Zhang et al. "Gain Enhancement of Tapered Slot-line Antenna with Directive Grating" (<i>2008 Asia-Pacific Microwave Conference</i>), 26 May 2009 (2009-05-26), pages 1-3, figures 1, 2	1-4, 17-20
Y	CN 101901960 A (SHANGHAI INSTITUTE OF MICROSYSTEM AND INFORMATION TECHNOLOGY, CHINESE ACADEMY OF SCIENCES) 01 December 2010 (2010-12-01) description, paragraphs [0015]-[0024], and figures 1 and 2	10-16, 19, 20
Y	Peng Zhang et al. "Gain Enhancement of Tapered Slot-line Antenna with Directive Grating" (<i>2008 Asia-Pacific Microwave Conference</i>), 26 May 2009 (2009-05-26), pages 1-3, figures 1, 2	10-16, 19, 20
Y	US 2006170605 A1 (Chia-Lun Tang et al.) 03 August 2006 (2006-08-03) description paragraphs [0023]-[0029], figures 2A, 8	10, 11, 19, 20

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

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Date of the actual completion of the international search

15 September 2021

Date of mailing of the international search report

27 September 2021

Name and mailing address of the ISA/CN

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Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No. PCT/CN2021/113438

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	V, Mikhnev et al. "A Tapered-slot Antenna with Emulated Continuous Resistive Loading" <i>«The Second European Conference on Antennas and Propagation, EuCAP 2007»</i> , 26 February 2008 (2008-02-26), pages 1-3, figure 1	12-16, 19, 20
A	GB 2508428 A (EADS SINGAPORE PTE LTD.) 04 June 2014 (2014-06-04) entire document	1-20

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2021/113438

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	101901960	A	01 December 2010	None			
US	2006170605	A1	03 August 2006	TW	200629654	A	16 August 2006
				US	7463209	B2	09 December 2008
				TW	I261387	B	01 September 2006
GB	2508428	A	04 June 2014	None			

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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- CN 202011193933 [0001]