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(54) **FEED SYSTEM, ARRAY ANTENNA, AND BASE STATION**

(57) Embodiments of this application relate to the field of mobile communications technologies, and provide a feed system, an array antenna, and a base station, to provide a phase-shift feed system having a simple structure. The feed system is located on a back surface of a metal plate. The feed system includes a plurality of first feed chambers and a plurality of first feed striplines suspended in the plurality of first feed chambers. Each of the plurality of first feed striplines includes a plurality of output ports. The plurality of first feed chambers and

a ground plane of the metal plate share a metal surface. The metal surface has a plurality of openings corresponding to a plurality of first radiating elements located on a front surface of the metal plate. The plurality of output ports of each first feed stripline are connected, in a one-to-one manner, to the plurality of first radiating elements through the plurality of openings. The plurality of first feed striplines are used to provide transmission signals for the plurality of first radiating elements.

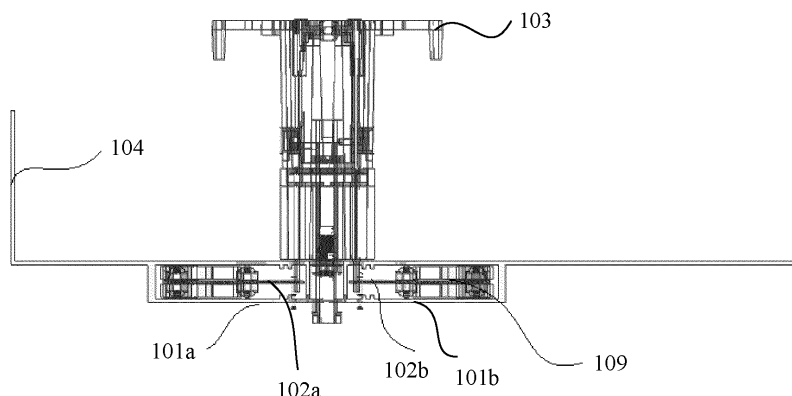


FIG. 3

Description

[0001] This application claims priority to Chinese Patent Application No. 201811637333.X, filed with the China National Intellectual Property Administration on December 29, 2018 and entitled "FEED SYSTEM, ARRAY ANTENNA, AND BASE STATION", which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] Embodiments of this application relate to the field of mobile communications technologies, and in particular, to a feed system, an array antenna, and a base station.

BACKGROUND

[0003] With multi-band and multi-system development of mobile communications systems, base stations require multi-band and multi-polarized antennas. However, when a multi-band antenna is designed, the connection of a feed network is very complex due to a large quantity of frequency bands. Production of conventional components and cables is time-consuming, assembly is difficult, and a loss of the whole system is high.

[0004] As shown in FIG. 1, an antenna feed network includes at least one feeder. Each feeder is a coaxial cable and includes an inner conductor and an outer conductor. The outer conductor uses a stretched profile tube, and the profile tube has a slit along a stretching direction (that is, the outer conductor is parallel to the stretching direction). The inner conductor is suspended in a chamber formed by the outer conductor and is supported by a medium. A size of the slit on the outer conductor ensures that the inner conductor can be supported by the medium to reach the chamber of the coaxial cable. However, the antenna feed network shown in FIG. 1 cannot support miniaturization of an antenna. Especially for a multi-band antenna, its large volume results in inconvenient production and assembly, and a large width is occupied. Even though single-band antennas can be deployed, it is difficult to deploy multi-band antennas for an entire multi-band network.

SUMMARY

[0005] Embodiments of this application provide a feed system, an array antenna, and a base station, to provide a phase-shift feed system having a simple structure.

[0006] To resolve the foregoing technical problem, the embodiments of this application provide the following technical solutions.

[0007] According to a first aspect, an embodiment of this application provides a feed system. The feed system is located on a back surface of a metal plate. The feed system includes a plurality of first feed chambers and a plurality of first feed striplines suspended in the plurality

of first feed chambers. Each of the plurality of first feed striplines includes a plurality of output ports. The plurality of first feed chambers and a ground plane of the metal plate share a metal surface. The metal surface has a plurality of openings corresponding to a plurality of first radiating elements located on a front surface of the metal plate. The plurality of output ports of each first feed stripline are connected, in a one-to-one manner, to the plurality of first radiating elements through the plurality of openings. The plurality of first feed striplines are used to provide transmission signals for the plurality of first radiating elements.

[0008] Based on the feed system provided in this embodiment of this application, the plurality of output ports of each first feed stripline are connected, in a one-to-one manner, to the plurality of first radiating elements through the plurality of openings. In this way, each first feed stripline may provide transmission signals for the plurality of first radiating elements connected to the first feed stripline, without using a cable or another conductor, so that cable-free efficient feeding of an entire network can be implemented. In addition, the first feed stripline and the plurality of first radiating elements are simply connected, which is easy for assembly, so that automatic assembly of a multi-band antenna is possible.

[0009] In a possible implementation, a distance between any first feed stripline and an upper wall of a first feed chamber in which the first feed stripline is located is equal to a distance between the first feed stripline and a lower wall of the first feed chamber in which the first feed stripline is located.

[0010] In a possible implementation, the first feed stripline is covered with a sliding medium. The sliding medium is used to change a phase value of the first feed stripline from an input port to the output port.

[0011] In a possible implementation, the plurality of first feed striplines are used to provide transmission signals with a same phase value for the plurality of first radiating elements.

[0012] In a possible implementation, the plurality of first feed chambers and the metal plate are integrally formed. Alternatively, the plurality of first feed chambers are coupled or electrically connected to the metal plate into a whole. In an optional implementation, the plurality of first feed chambers may be integrally formed. Alternatively, the plurality of first feed chambers may be separately formed and coupled or directly connected.

[0013] In a possible implementation, the feed system further includes a plurality of second feed chambers and a plurality of second feed striplines suspended in each of the plurality of second feed chambers. The plurality of second feed striplines pass through the plurality of second feed chambers and are connected to a plurality of second radiating elements located on the front surface of the metal plate. The second feed striplines are used to provide transmission signals for the plurality of second radiating elements, and the plurality of second feed chambers are perpendicular to or parallel to the plurality

of first feed chambers.

[0014] In a possible implementation, the plurality of first feed chambers include a first chamber and a second chamber that are disposed in parallel on the back surface of the metal plate, and there is an isolation chamber or a gap between the first chamber and the second chamber. The plurality of second feed chambers include a third chamber and a fourth chamber that are disposed in parallel, and the third chamber and the fourth chamber are perpendicular to the metal plate. The first chamber and the second chamber are located between the third chamber and the fourth chamber, the first chamber is vertically connected to the third chamber, and the second chamber is vertically connected to the fourth chamber.

[0015] In a possible implementation, the plurality of first feed chambers include a first chamber and a second chamber that are disposed in parallel, and each of the first chamber and the second chamber is vertically connected to the metal plate. The plurality of second feed chambers include a third chamber and a fourth chamber that are disposed in parallel on the back surface of the metal plate, the first chamber and the second chamber are located between the third chamber and the fourth chamber, the first chamber is vertically connected to the third chamber, and the second chamber is vertically connected to the fourth chamber.

[0016] In a possible implementation, the plurality of first feed chambers include a first chamber and a second chamber that are disposed in parallel, and each of the first chamber and the second chamber is vertically connected to the metal plate. The second feed chambers include a third chamber and a fourth chamber that are disposed in parallel, the third chamber and the fourth chamber are vertically connected to the metal plate, the first chamber and the second chamber are located between the third chamber and the fourth chamber, the first chamber is in contact with the third chamber, and the fourth chamber is in contact with the second chamber.

[0017] In a possible implementation, there is a gap between the first chamber and the second chamber.

[0018] In a possible implementation, the first feed striplines include a power division phase-shift stripline.

[0019] In a possible implementation, in this embodiment of this application, the radiating element uses a dual-polarized radiating half-wave dipole.

[0020] In a possible implementation, in this embodiment of this application, the feed stripline may be a metal carrier for any transmission signal.

[0021] According to a second aspect, an embodiment of this application provides an array antenna, including a metal plate and a plurality of columns of antennas disposed on the metal plate. The antenna includes the feed system described in any one of the first aspect and the possible implementations of the first aspect, a plurality of first radiating elements located on a front surface of the metal plate, and/or a plurality of second radiating elements located on the front surface of the metal plate. The plurality of first radiating elements and the plurality

of second radiating elements are electrically connected to a ground plane of the metal plate. The feed system is configured to provide transmission signals for the plurality of first radiating elements and/or the plurality of second radiating elements.

[0022] According to a third aspect, an embodiment of this application provides a base station, including the array antenna described in the second aspect.

BRIEF DESCRIPTION OF DRAWINGS

[0023]

FIG. 1 is a schematic diagram of a structure of a feed system in the conventional technology;

FIG. 2 is a first schematic diagram of a structure of a feed system according to an embodiment of this application;

FIG. 3 is a second schematic diagram of a structure of a feed system according to an embodiment of this application;

FIG. 4 is a third schematic diagram of a structure of a feed system according to an embodiment of this application;

FIG. 5 is a fourth schematic diagram of a structure of a feed system according to an embodiment of this application;

FIG. 6 is a fifth schematic diagram of a structure of a feed system according to an embodiment of this application;

FIG. 7 is a sixth schematic diagram of a structure of a feed system according to an embodiment of this application;

FIG. 8 is a seventh schematic diagram of a structure of a feed system according to an embodiment of this application;

FIG. 9 is a schematic diagram of a structure of an array antenna according to an embodiment of this application; and

FIG. 10 is a schematic diagram of a structure of another array antenna according to an embodiment of this application.

DESCRIPTION OF EMBODIMENTS

[0024] Before the embodiments of this application are described, related terms in the embodiments of this application are first explained.

(1) Coupling connection (or coupling grounding)

[0025] A capacitive effect exists between two pieces of metal that are close to each other and have a coupling area. When a capacitance value is appropriate, radio frequency signals can be transmitted between the two pieces of non-contacting metal.

(2) Direct connection (or direct grounding)

[0026] Direct contact between pieces of metal allows radio frequency signals or direct current signals to be transmitted between the pieces of metal.

(3) Polarization path

[0027] A feed system that feeds radiating elements needs to feed radiating elements separately based on polarization of the radiating elements. Therefore, all channels of the feed system for one polarization direction of the radiating elements are referred to as polarization paths.

(4) Array antenna

[0028] An array antenna is an antenna system in which several identical dipoles are arranged according to a specific geometrical rule and operate by using a common feed system.

(5) Half-wave dipole

[0029] A half-wave dipole is a radiation structure including two metal arms that have approximately equal lengths. A length of each metal arm is approximately 1/4 of a radiation wavelength (a total length is half a wavelength, and therefore the radiation structure is referred to as the half-wave dipole). The radiation structure is excited by using adjacent ends of the metal arms.

[0030] In the embodiments of this application, terms such as "first" and "second" are used to distinguish between same or similar items that have basically same functions and purposes, to clearly describe the technical solutions in the embodiments of this application. For example, a first radiating element and a second radiating element are merely used to distinguish from different radiating elements, and are not intended to limit a sequence thereof. A person skilled in the art may understand that the terms such as "first" and "second" do not limit a quantity or an execution sequence, and the terms such as "first" and "second" do not indicate a definite difference.

[0031] It should be noted that, in this application, the word "example" or "for example" is used to represent giving an example, an illustration, or a description. Any embodiment or design scheme described as an "example" or after "for example" in this application should not be explained as being more preferred or having more advantages than another embodiment or design scheme. Exactly, use of the words such as "example" or "for example" is intended to present a relative concept in a specific manner.

[0032] In this application, "at least one" means one or more, and "a plurality of" means two or more. The term "and/or" describes an association relationship of associated objects and represents that three relationships may exist. For example, A and/or B may represent

the following cases: Only A exists, both A and B exist, and only B exists. A and B may be singular or plural. The character "/" generally indicates an "or" relationship between the associated objects. "At least one of the following" or a similar expression thereof indicates any combination of the following, and includes any combination of one or more of the following. For example, at least one of a, b, or c may indicate: a, b, c, a and b, a and c, b and c, or a, b, and c, where a, b, and c may be singular or plural.

[0033] FIG. 2 and FIG. 3 each are a schematic diagram of a structure of a feed system according to an embodiment of this application. The feed system is located on a back surface of a metal plate 104. The feed system includes a plurality of first feed chambers 101 (for example, a first feed chamber 101a and a first feed chamber 101b in FIG. 3) and a plurality of first feed striplines (suspended striplines, SSLs) 102 (for example, a feed stripline 102a and a feed stripline 102b in FIG. 3) suspended in the plurality of first feed chambers 101. Each of the plurality of first feed striplines 102 includes a plurality of output ports. The plurality of first feed chambers 101 and a ground plane of the metal plate 104 share a metal surface.

[0034] The metal surface has a plurality of openings corresponding to a plurality of first radiating elements (radiators) 103 (for example, a radiating element 103-1, a radiating element 103-2, a radiating element 103-3, and a radiating element 103-4 shown in FIG. 2) located on a front surface of the metal plate 104. The plurality of output ports of each first feed stripline 102 are connected, in a one-to-one manner, to the plurality of first radiating elements 103 through the plurality of openings. The plurality of first feed striplines 102 are used to provide transmission signals for the plurality of first radiating elements 103.

[0035] Based on the feed system provided in the embodiments of this application, the plurality of output ports of each first feed stripline are connected, in a one-to-one manner, to the plurality of first radiating elements through the plurality of openings. In this way, each first feed stripline may provide transmission signals for the plurality of first radiating elements connected to the first feed stripline, without using a cable or another conductor, so that cable-free efficient feeding of an entire network can be implemented. In addition, the first feed stripline and the plurality of first radiating elements are simply connected, which is easy for assembly, so that automatic assembly of a multi-band antenna is possible.

[0036] In the embodiments of this application, the back surface of the metal plate 104 is a surface opposite to the front surface of the metal plate 104. The plurality of first radiating elements 103 may be disposed at intervals on the front surface of the metal plate 104. The plurality of first feed chambers 101 may be disposed on the back surface of the metal plate 104.

[0037] It should be understood that a quantity of the plurality of first radiating elements 103 located on the

front surface of the metal plate 104 is not limited in the embodiments of this application. FIG. 2 only shows an example in which there are five radiating elements. In practice, there may be more or fewer radiating elements than those shown in FIG. 2. In addition, the plurality of first radiating elements 103 belong to a same antenna array. As shown in FIG. 2, the plurality of first radiating elements 103 belong to an array 2.

[0038] For example, in the embodiments of this application, the plurality of first feed striplines 102 are used to provide transmission signals in a first frequency band for the plurality of first radiating elements 103. For example, the first frequency band may be a high frequency band.

[0039] For example, in the embodiments of this application, the plurality of first feed chambers 101 and the metal plate 104 may be integrally formed, or may be separately formed and connected into a whole by using another process. This is not limited in the embodiments of this application. The plurality of first feed chambers 101 are also integrally formed, and one feed chamber corresponds to one polarization direction, without connection of a plurality of feed chambers.

[0040] In the embodiments of this application, that the plurality of first feed chambers 101 and a ground plane of the metal plate 104 share a metal surface means that an upper surface of the plurality of first feed chambers 101 is the ground plane of the metal plate 104 or the ground plane of the metal plate 104 is an upper surface of the plurality of first feed chambers 101. For example, first openings may be provided at positions that are on a bottom surface of the metal plate 104 and that are opposite to the plurality of first feed chambers 101, and the upper surface of the plurality of first feed chambers 101 is used to compensate for the first openings, so that the metal plate 104 becomes a complete metal plate. That is, the metal surface belongs to the plurality of first feed chambers 101, and the metal surface is shared by the metal plate 104.

[0041] For example, the feed stripline in the embodiments of this application may be a metal carrier for any transmission signal.

[0042] It should be understood that, in the embodiments of this application, one first feed stripline 102 is suspended in each of the plurality of first feed chambers 101. Therefore, the plurality of first feed striplines 102 are suspended in the plurality of first feed chambers 101. Each of the plurality of first feed striplines 102 is connected to one first radiating element 103. One first feed stripline 102 is connected to one feed probe in the plurality of first radiating elements 103.

[0043] In an optional implementation, in the embodiments of this application, a spacing between any two of the plurality of openings on the metal surface is equal to a spacing between first radiating elements corresponding to the two openings.

[0044] For example, if an opening 1 corresponds to the radiating element 103-1 and an opening 2 corresponds

to the radiating element 103-2, a spacing between the opening 1 and the opening 2 is equal to a spacing between the radiating element 103-1 and the radiating element 103-2.

[0045] In the embodiments of this application, a quantity of output ports of each first feed stripline 102 is not limited. Specifically, a quantity of output ports of one first feed stripline 102 may be determined by a quantity of first radiating elements 103 for which the first feed stripline 102 provides transmission signals.

[0046] In the embodiments of this application, the plurality of first feed chambers 101 may be placed in parallel on the back surface of the metal plate 104, or may be placed vertically on the back surface of the metal plate 104, to match different first radiating elements.

[0047] For example, FIG. 4 is a path diagram of a feed system for one polarization direction. For example, the plurality of output ports include an output port 102a, an output port 102b, an output port 102c, and an output port 102d. In this case, the first feed stripline 102 provides a transmission signal for the radiating element 103-1 through the output port 102a. The first feed stripline 102 provides a transmission signal for the radiating element 103-2 through the output port 102b. The first feed stripline 102 provides a transmission signal for the radiating element 103-3 through the output port 102c. The first feed stripline 102 provides a transmission signal for the radiating element 103-4 through the output port 102d.

[0048] It should be understood that, in the embodiments of this application, phase values of transmission signals that are provided by one first feed stripline for a plurality of first radiating elements 103 connected to the first feed stripline are the same. Alternatively, phase values of transmission signals that are provided by one first feed stripline for different first radiating elements 103 in a plurality of first radiating elements 103 connected to the first feed stripline meet a design requirement.

[0049] Optionally, in the embodiments of this application, the radiating element uses a dual-polarized radiating half-wave dipole.

[0050] Generally, one feed system may provide a transmission signal in the first frequency band, or may provide a transmission signal in a second frequency band (for example, a low frequency band). The plurality of first feed chambers 101 and the plurality of first feed striplines 102 suspended in the plurality of first feed chambers 101 may be referred to as a first feed system, configured to provide transmission signals in the first frequency band for the plurality of first radiating elements 103. In addition, the feed system may further include a second feed system, configured to provide transmission signals in the second frequency band for a plurality of second radiating elements 105. The following separately describes a specific structure of the second feed system.

[0051] In an optional embodiment, the feed system in the embodiments of this application may further include the second feed system. The second feed system is configured to provide transmission signals in the second fre-

quency band for the plurality of second radiating elements 105 located on the front surface of the metal plate. The first frequency band is lower than the second frequency band.

[0052] For example, the first frequency band is 400 MHz to 960 MHz. The second frequency band is 1350 MHz to 6000 MHz.

[0053] In a first possible implementation, the second feed system includes a plurality of second feed striplines. The plurality of second feed striplines pass through the feed chambers of the first feed system and are configured to provide transmission signals in the second frequency band for the plurality of second radiating elements 105.

[0054] It may also be understood that the plurality of second feed striplines pass through the feed chambers of the first feed system to divide the feed chambers of the first feed system into the plurality of first feed chambers 101.

[0055] It should be understood that, in the embodiments of this application, each second feed stripline also includes a plurality of output ports. A plurality of output ports of one second feed stripline are in a one-to-one correspondence with a plurality of second radiating elements.

[0056] For example, as shown in FIG. 5, the plurality of first feed chambers 101 include the first feed chamber 101a and the first feed chamber 101b, the plurality of first feed striplines 102 include the first feed stripline 102a and the first feed stripline 102b, and a chamber through which the second feed stripline 106 passes is a chamber 101c. For example, the first feed stripline 102a is suspended in the first feed chamber 101a, and the first feed stripline 102a and the first radiating element 103 are directly connected by using a feed probe 103-2 of the first radiating element 103. The first feed stripline 102b is suspended in the first feed chamber 101b, and the first feed stripline 102b and the first radiating element 103 are directly connected by using a feed probe 103-1 of the first radiating element 103. The second feed stripline 106 passes through the chamber 101c, and then feeds the second radiating element 105. It should be understood that, the second feed stripline 106 passes through the chamber 101c, and then is directly connected to a feed probe of the second radiating element 105.

[0057] In the embodiments of this application, the first feed stripline 102 is directly welded with the feed probe of the first radiating element 103.

[0058] In the first possible implementation, the second feed system includes a plurality of second feed chambers 107 (for example, a third chamber 107-1 and a fourth chamber 107-2 in FIG. 6) and a plurality of second feed striplines 106 (for example, a feed stripline 106-1 and a feed stripline 106-2) suspended in the plurality of second feed chambers 107. Each second feed chamber 107 for the plurality of second feed striplines 106 is connected to the plurality of second radiating elements 105 located on the front surface of the metal plate 104.

[0059] Each second feed stripline 106 is used to pro-

vide transmission signals for the plurality of second radiating elements 105 connected to the second feed stripline 106, and the plurality of second feed chambers 107 are perpendicular to or parallel to the plurality of first feed chambers 101.

[0060] In the embodiments of this application, that the second feed stripline 106 is connected to the plurality of second radiating elements 105 includes: The second feed stripline 106 is directly connected to feed probes of the plurality of second radiating elements 105.

[0061] It should be understood that, the plurality of second feed striplines 106 suspended in the plurality of second feed chambers 107 mean that a second feed stripline 106 connected to one or more second radiating elements 105 is suspended in each of the plurality of second feed chambers 107. Therefore, the plurality of second feed striplines 106 may be suspended in the plurality of second feed chambers 107.

[0062] Specifically, in a structure shown in FIG. 6, the plurality of second feed striplines 106 pass through the second feed chambers 107 in which the plurality of second feed striplines 106 are respectively located and are connected to the plurality of second radiating elements 105 located on the front surface of the metal plate 104.

[0063] For example, as shown in FIG. 6, the feed stripline 106-1 is suspended in the third chamber 107-1. Therefore, the feed stripline 106-1 passes through the third chamber 107-1 and is connected to a feed probe 105-1 of the second radiating element 105. The feed stripline 106-2 is suspended in the fourth chamber 107-2. The feed stripline 106-2 passes through the fourth chamber 107-2 and is connected to a feed probe 105-2 of the second radiating element 105. For a connection relationship in the first feed system in FIG. 6, refer to the descriptions of FIG. 5. Details are not described herein again.

[0064] Specifically, in the structure shown in FIG. 6, each feed probe of one first radiating element 103 passes through the opening on the metal surface and is connected to a corresponding first feed stripline. For example, in FIG. 6, the feed probe 103-1 of the first radiating element 103 passes through the opening and is directly connected to a feed stripline 102-1. The feed probe 103-2 of the first radiating element 103 passes through the opening and is directly connected to a feed stripline 102-2.

[0065] For example, in the embodiments of this application, the plurality of second feed chambers 107 and the plurality of first feed chambers 101 are integrally formed. Alternatively, the plurality of second feed chambers 107 are integrally formed, and the plurality of first feed chambers 101 are integrally formed. Then the plurality of second feed chambers 107 and the plurality of first feed chambers 101 are connected together.

[0066] In the embodiments of this application, each second feed stripline has a plurality of output ports. In the embodiments of this application, phase values of transmission signals provided by any second feed stripline for a plurality of second radiating elements 105 connected to the second feed stripline are the same, or phas-

es of transmission signals provided by any second feed stripline for different second radiating elements 105 in a plurality of second radiating elements 105 connected to the second feed stripline meet a design requirement.

[0067] In the embodiments of this application, the plurality of second feed chambers 107 and the metal plate 104 may be integrally formed, or may be separately formed and then directly connected or coupled.

[0068] The following separately describes a position relationship between the plurality of second feed chambers 107 and the plurality of first feed chambers 101 with reference to FIG. 6 to FIG. 8.

[0069] In a possible implementation, as shown in FIG. 6, the plurality of first feed chambers 101 include a first chamber 101-1 and a second chamber 101-2 that are disposed in parallel on the back surface of the metal plate. There is an isolation chamber 101-1 or a gap between the first chamber 101-1 and the second chamber 101-2. The plurality of second feed chambers 107 include the third chamber 107-1 and the fourth chamber 107-2 that are disposed in parallel, and the third chamber 107-1 and the fourth chamber 107-2 are perpendicular to the metal plate 104. The first chamber 101-1 and the second chamber 101-2 are located between the third chamber 107-1 and the fourth chamber 107-2, the first chamber 101-1 is vertically connected to the third chamber 107-1, and the second chamber 101-2 is vertically connected to the fourth chamber 107-2.

[0070] It should be understood that the first chamber 101-1 and the second chamber 101-2 are separated by the isolation chamber 101-1 or the gap.

[0071] It should be understood that, in the structure described in FIG. 6, a distance between a second feed stripline 106 in any second feed chamber and a left side of the second feed chamber is equal to a distance between the second feed stripline 106 and a right side of the second feed chamber. In the embodiments of this application, a surface on which the second feed chamber is connected to the metal plate 104 may be used as an upper part. Therefore, the left side of the second feed chamber and the right side of the second feed chamber may be determined based on the upper part of the second feed chamber.

[0072] In another possible implementation, as shown in FIG. 7, the plurality of first feed chambers 101 include a first chamber 101-1 and a second chamber 101-2 that are disposed in parallel, and each of the first chamber 101-1 and the second chamber 101-2 is vertically connected to the metal plate 104. The plurality of second feed chambers 107 include the third chamber 107-1 and the fourth chamber 107-2 that are disposed in parallel on the back surface of the metal plate 104. The first chamber 101-1 and the second chamber 101-2 are located between the third chamber 107-1 and the fourth chamber 107-2, the first chamber 101-1 is vertically connected to the third chamber 107-1, and the second chamber 101-2 is vertically connected to the fourth chamber 107-2.

[0073] Specifically, in a structure shown in FIG. 7, each

feed probe of one second radiating element 105 passes through a corresponding second feed chamber and is connected to a second feed stripline 106 suspended in the second feed chamber 107. For example, the feed probe 105-1 of the second radiating element 105 passes through the third chamber 107-1 and is connected to the feed stripline 106-1 suspended in the third chamber 107-1. The feed probe 105-2 of the second radiating element 105 passes through the fourth chamber 107-2 and is connected to the feed stripline 106-2 suspended in the fourth chamber 107-2.

[0074] Specifically, in the structure shown in FIG. 7, a distance between a second feed stripline 106 suspended in any second feed chamber 107 and an upper part of the second feed chamber 107 is equal to a distance between the second feed stripline 106 and a lower part of the second feed chamber 107.

[0075] Specifically, in the structure shown in FIG. 7, each feed probe of one first radiating element 103 passes through the opening on the metal surface and is connected to a corresponding first feed stripline 102. For example, in FIG. 7, the feed probe 103-1 of the first radiating element 103 passes through the opening and is directly connected to the feed stripline 102-1. The feed probe 103-2 of the first radiating element 103 passes through the opening and is directly connected to the feed stripline 102-2. Alternatively, any first feed stripline 102 passes through the opening on the metal surface and is connected to one feed probe in a plurality of corresponding first radiating elements 103.

[0076] In still another possible implementation, the plurality of first feed chambers 101 include a first chamber 101-1 and a second chamber 101-2 that are disposed in parallel. Each of the first chamber 101-1 and the second chamber 101-2 is vertically connected to the metal plate 104. The second feed chambers 107 include the third chamber 107-1 and the fourth chamber 107-2 that are disposed in parallel. The third chamber 107-1 and the fourth chamber 107-2 are vertically connected to the metal plate 104. The first chamber 101-1 and the second chamber 101-2 are located between the third chamber 107-1 and the fourth chamber 107-2.

[0077] Optionally, an example in which the first chamber 101-1 is in contact with the third chamber 107-1 and the fourth chamber 107-2 is in contact with the second chamber 101-2 is used in FIG. 8. Certainly, the first chamber 101-1 may not be in contact with the third chamber 107-1. The fourth chamber 107-2 may not be in contact with the second chamber 101-2.

[0078] Optionally, in structures shown in FIG. 7 and FIG. 8, there is a gap 108 between the first chamber 101-1 and the second chamber 101-2. It should be understood that, the gap 108 may or may not exist, and is used to match different first radiating elements. The first feed stripline and the first radiating element shown in FIG. 7 and FIG. 8 are also directly connected without adding a pin for connection, but there may be a PCB or another carrier for connection, to not increase a quantity

of solder joints. The second feed stripline and the second radiating element are also directly connected without adding a pin for connection, but there may be a PCB or another carrier for connection, to not increase a quantity of solder joints.

[0079] Optionally, in the embodiments of this application, the first feed striplines include a power division phase-shift stripline.

[0080] Optionally, as shown in FIG. 3, in the embodiments of this application, each first feed stripline is further provided with a sliding medium 109. The sliding medium is used to change a phase value of the first feed stripline from an input port to the output port.

[0081] For example, the sliding medium 109 is a movable medium covering the first feed stripline, and the phase value of the first feed stripline from the input port to the output port is adjusted by changing an area covering the stripline.

[0082] In another embodiment, the array antenna provided in the embodiments of this application includes a metal plate 104 and a plurality of columns of antennas disposed on the metal plate. The antenna includes the feed system described in any one of FIG. 2 to FIG. 7, a plurality of first radiating elements 103 located on a front surface of the metal plate 104, and/or a plurality of second radiating elements 105 located on the front surface of the metal plate 104. The plurality of first radiating elements 103 and the plurality of second radiating elements 105 are electrically connected to a ground plane of the metal plate 104. The feed system is configured to provide transmission signals for the plurality of first radiating elements 103 and/or the plurality of second radiating elements 105.

[0083] It should be understood that the array antenna may include only a plurality of columns of first feed systems, and each column of first feed systems in the plurality of columns of first feed systems is configured to provide transmission signals for a plurality of first radiating elements 103 in the column. In this case, the array antenna is configured to provide a signal in a first frequency band.

[0084] It should be understood that the array antenna may include a plurality of columns of first feed systems and a plurality of columns of second feed systems. Each column of first feed systems in the plurality of columns of first feed systems is configured to provide transmission signals for a plurality of first radiating elements 103 in the column. Each column of second feed systems in the plurality of columns of second feed systems is configured to provide transmission signals for a plurality of second radiating elements 105 in the column. In this case, the array antenna is configured to provide signals in a first frequency band and a second frequency band.

[0085] For example, as shown in FIG. 9, the array antenna shown in FIG. 9 includes an array 1 and an array 2. Structures of the array 1 and the array 2 are symmetrically disposed. In FIG. 9, an example in which first feed systems and second feed systems in the array 1 and the

array 2 use the structure shown in FIG. 5 is used.

[0086] It should be noted that the plurality of columns of antennas are disposed at intervals. Specifically, a baffle 110 used to separate the columns of antennas is disposed on the metal plate 104.

[0087] For example, as shown in FIG. 10, the array antenna shown in FIG. 10 includes an array 1 and an array 2. Structures of the array 1 and the array 2 are symmetrically disposed. In FIG. 9, an example in which first feed systems and second feed systems in the array 1 and the array 2 use the structure shown in FIG. 6 is used.

[0088] It may be understood that the array antenna may alternatively use the feed system shown in FIG. 7 or FIG. 8.

[0089] 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. A feed system, wherein the feed system is located on a back surface of a metal plate, and the feed system comprises a plurality of first feed chambers and a plurality of first feed striplines suspended in the plurality of first feed chambers;

each of the plurality of first feed striplines comprises a plurality of output ports, and the plurality of first feed chambers and a ground plane of the metal plate share a metal surface; and the metal surface has a plurality of openings corresponding to a plurality of first radiating elements located on a front surface of the metal plate, the plurality of output ports of each first feed stripline are connected, in a one-to-one manner, to the plurality of first radiating elements through the plurality of openings, and the plurality of first feed striplines are used to provide transmission signals for the plurality of first radiating elements.

2. The feed system according to claim 1, wherein the feed system further comprises:

a plurality of second feed chambers and a plurality of second feed striplines suspended in the plurality of second feed chambers; each of the plurality of second feed striplines is connected to a plurality of second radiating elements located on the front surface of the metal

- plate; and
each second feed stripline is used to provide transmission signals for the plurality of second radiating elements connected to the second feed stripline, and the plurality of second feed chambers are perpendicular to or parallel to the plurality of first feed chambers.
3. The feed system according to claim 2, wherein the plurality of first feed chambers comprise a first chamber and a second chamber that are disposed in parallel on the back surface of the metal plate, and there is an isolation chamber or a gap between the first chamber and the second chamber;
- the plurality of second feed chambers comprise a third chamber and a fourth chamber that are disposed in parallel, and the third chamber and the fourth chamber are perpendicular to the metal plate; and
the first chamber and the second chamber are located between the third chamber and the fourth chamber, the first chamber is vertically connected to the third chamber, and the second chamber is vertically connected to the fourth chamber.
4. The feed system according to claim 2, wherein the plurality of first feed chambers comprise a first chamber and a second chamber that are disposed in parallel, and each of the first chamber and the second chamber is vertically connected to the metal plate; and
the plurality of second feed chambers comprise a third chamber and a fourth chamber that are disposed in parallel on the back surface of the metal plate, the first chamber and the second chamber are located between the third chamber and the fourth chamber, the first chamber is vertically connected to the third chamber, and the second chamber is vertically connected to the fourth chamber.
5. The feed system according to claim 2, wherein the plurality of first feed chambers comprise a first chamber and a second chamber that are disposed in parallel, and each of the first chamber and the second chamber is vertically connected to the metal plate;
- the second feed chambers comprise a third chamber and a fourth chamber that are disposed in parallel, and the third chamber and the fourth chamber are vertically connected to the metal plate; and
the first chamber and the second chamber are located between the third chamber and the fourth chamber, the first chamber is in contact with the third chamber, and the fourth chamber is in contact with the second chamber.
6. The feed system according to claim 4 or 5, wherein there is a gap between the first chamber and the second chamber.
7. The feed system according to any one of claims 1 to 6, wherein the first feed striplines comprise a power division phase-shift stripline.
8. An array antenna, comprising a metal plate and a plurality of columns of antennas disposed on the metal plate, wherein the antenna comprises the feed system according to any one of claims 1 to 7 that is located on a back surface of the metal plate, a plurality of first radiating elements located on a front surface of the metal plate, and/or a plurality of second radiating elements located on the front surface of the metal plate; the plurality of first radiating elements and the plurality of second radiating elements are electrically connected to a ground plane of the metal plate; and the feed system is configured to provide transmission signals for the plurality of first radiating elements and/or the plurality of second radiating elements.
9. A base station, comprising the array antenna according to claim 8.

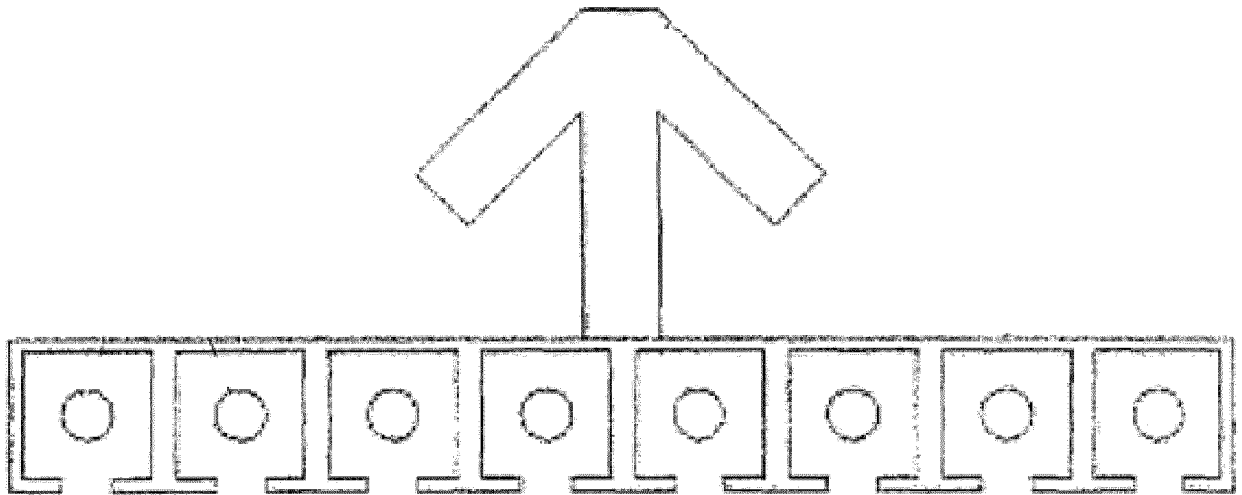


FIG. 1

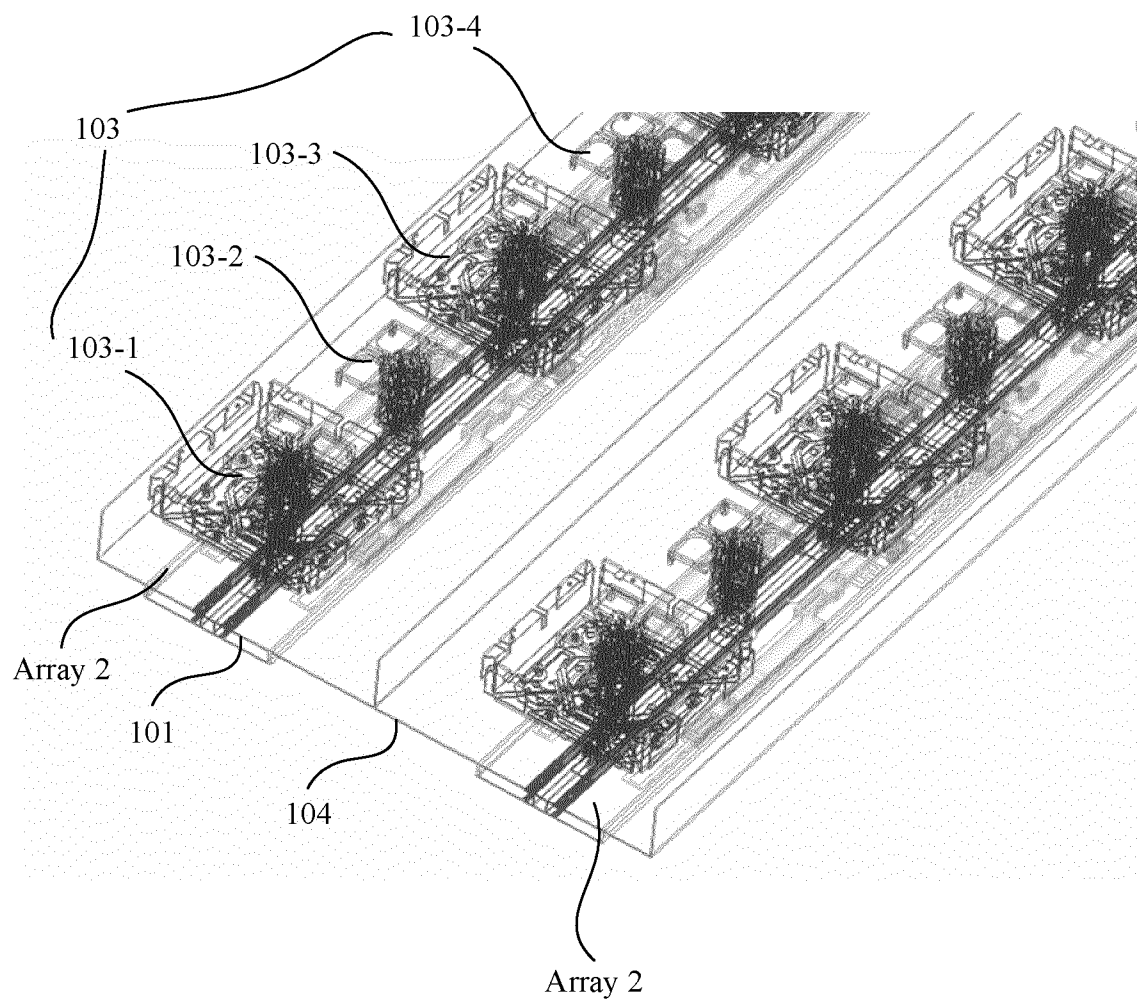


FIG. 2

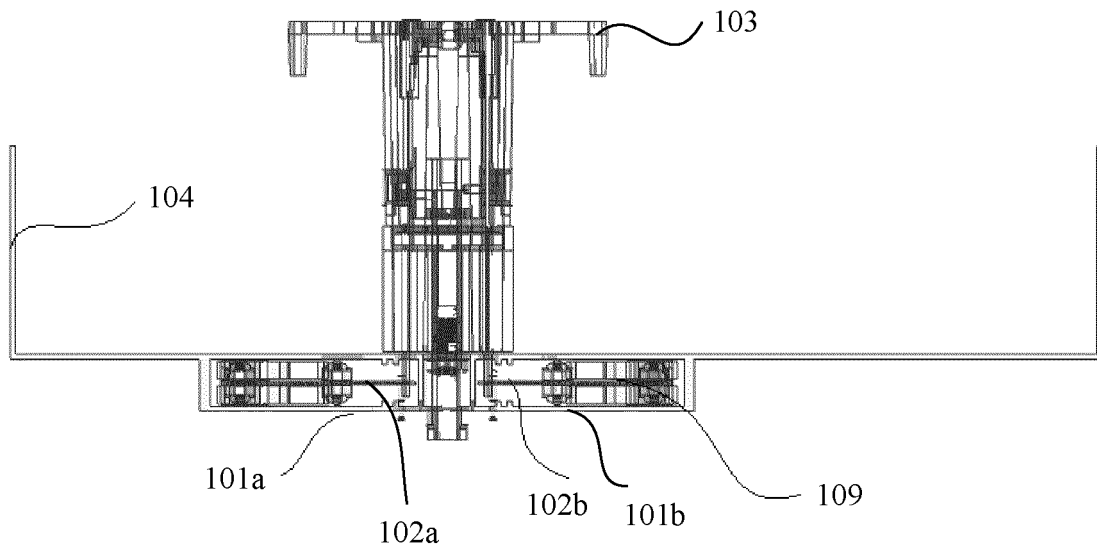


FIG. 3

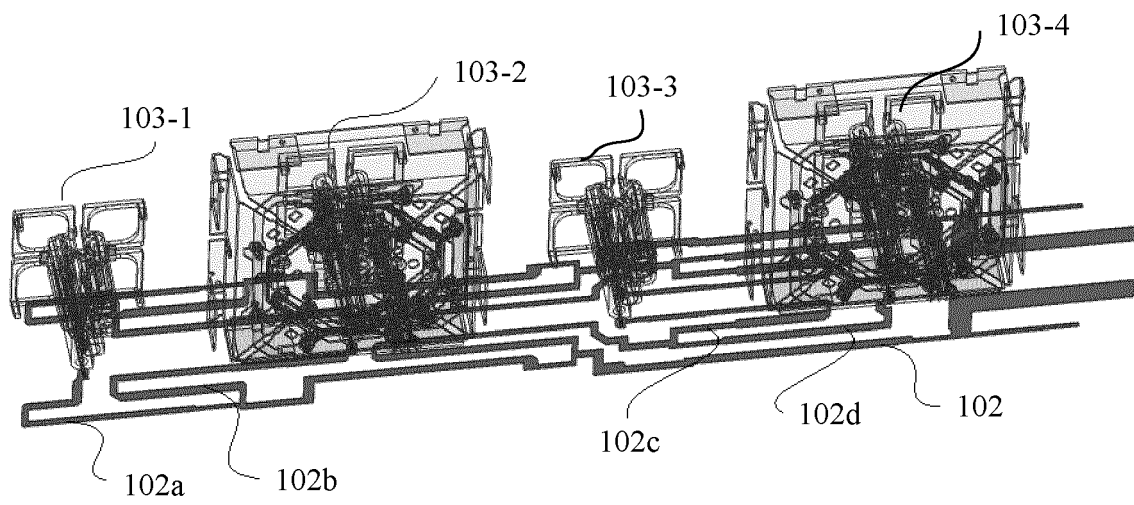


FIG. 4

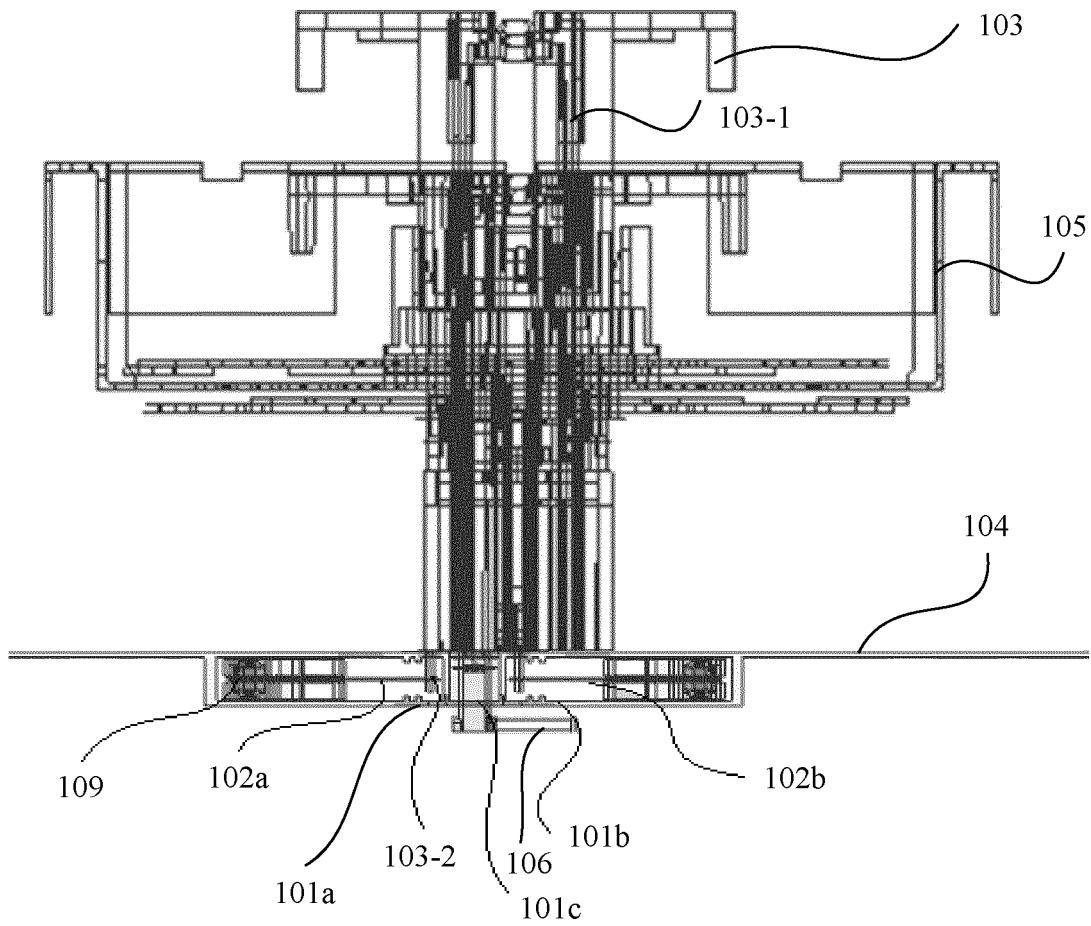


FIG. 5

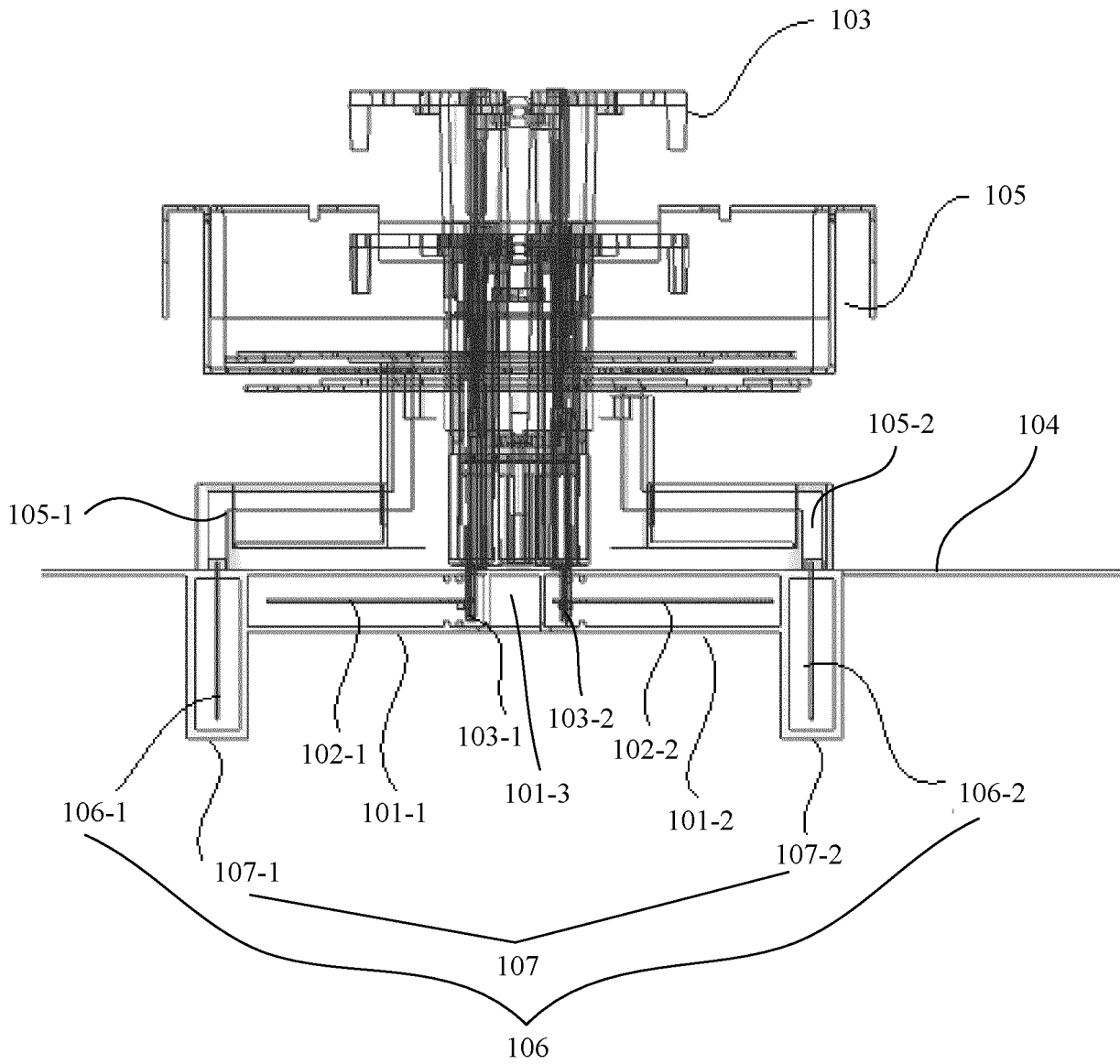


FIG. 6

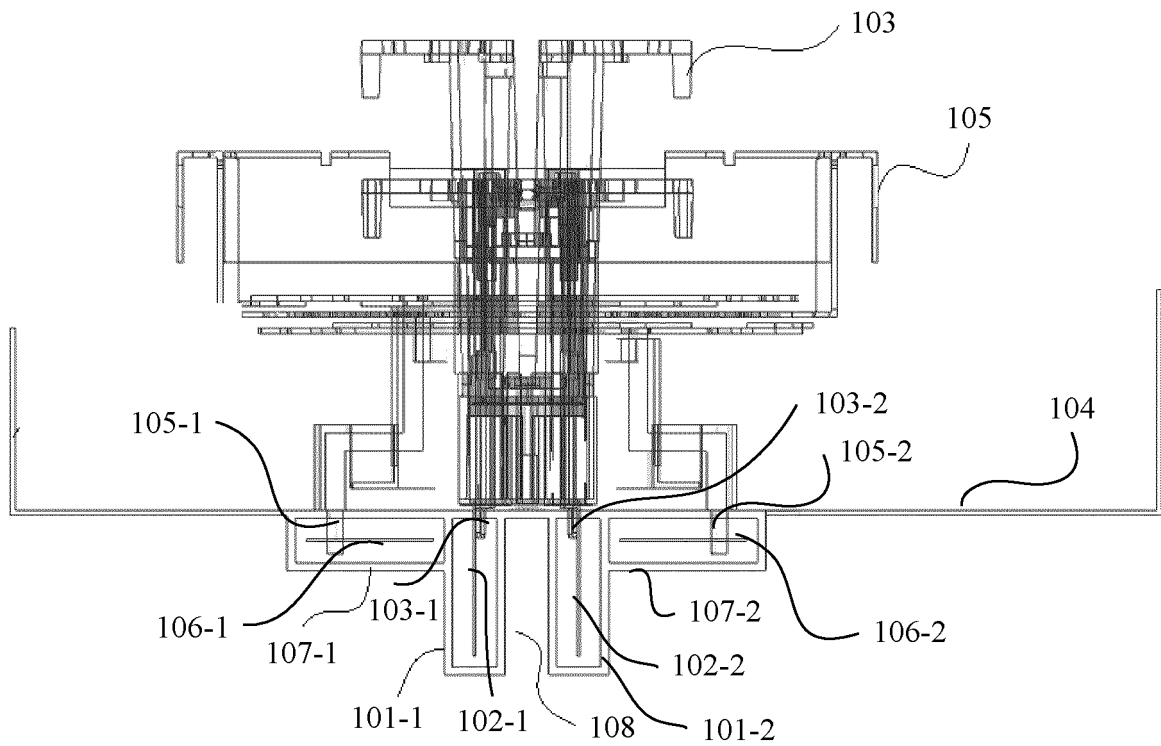


FIG. 7

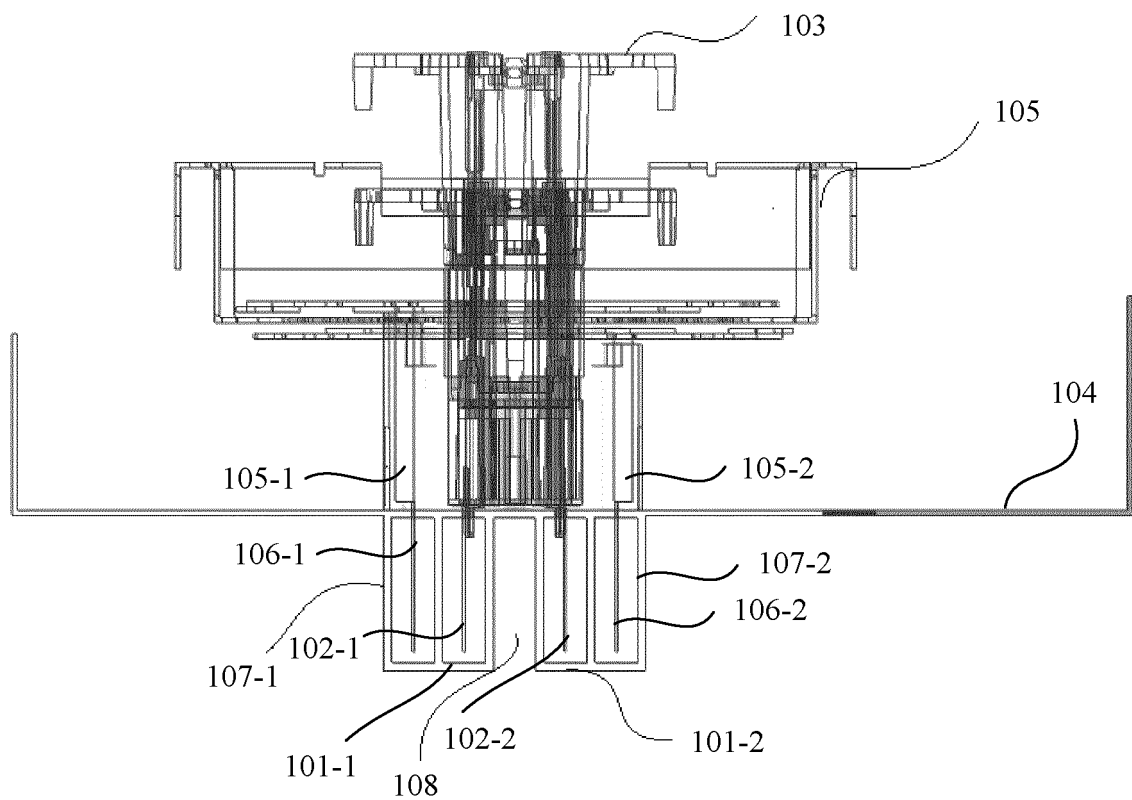


FIG. 8

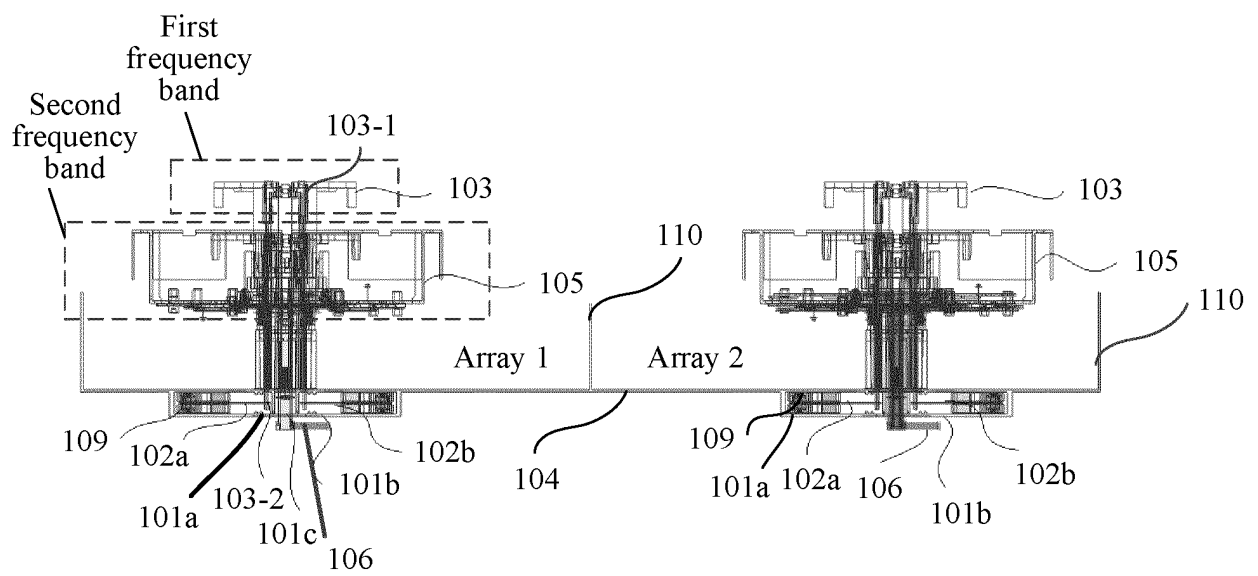


FIG. 9

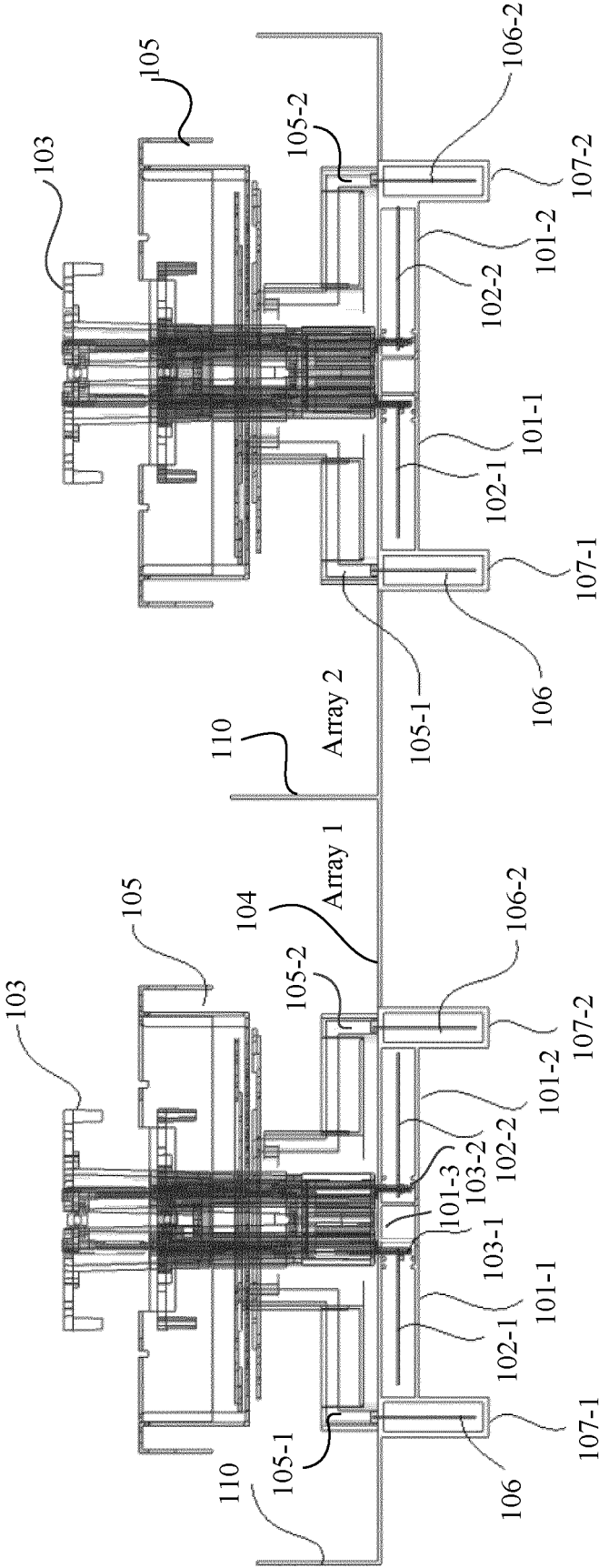


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2019/128466

A. CLASSIFICATION OF SUBJECT MATTER

H01Q 21/00(2006.01)i; H01Q 21/08(2006.01)i; H01Q 1/36(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)

EPTXT; USTXT; VEN; WOTXT; JPTXT; CNABS; CNTXT; CNKI: 腔, 孔, 通孔, 开孔, 贯孔, 贯穿, 馈电, 辐射, 带状线, 微带线, 正交, 垂直, 平行, cavum, line, house, cavity, hole, plump, aperture, feed, radiat+, stripline, strip, parallel, perpendicularity, orthogonal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 107819198 A (SHANGHAI HUAWEI TECHNOLOGIES CO., LTD.) 20 March 2018 (2018-03-20) description, paragraphs [0053]-[0093], and figures 1-24	1-9
X	CN 101707277 A (CHINA ELECTRONIC TECHNOLOGY GROUP CORPORATION NO.10 RESEARCH INSTITUTE) 12 May 2010 (2010-05-12) description, paragraphs [0023]-[0043], and figures 1-6	1, 8, 9
X	US 2014035698 A1 (DIELECTRIC, LLC) 06 February 2014 (2014-02-06) description, paragraphs [0021]-[0113], and figures 1-8	1, 8, 9
X	CN 2487123 Y (ELECTRONIC NO.54 INST., MINISTRY OF INFORMATION INDUSTRY) 17 April 2002 (2002-04-17) description, page 3, the last paragraph to page 6, paragraph 2, and figures 1-3	1, 8, 9
X	CN 104409870 A (ZHAO, Bing) 11 March 2015 (2015-03-11) description, paragraphs [0023]-[0043], and figures 1-6	1, 8, 9
X	US 2014035792 A1 (DIELECTRIC, LLC) 06 February 2014 (2014-02-06) description, paragraphs [0016]-[0064], and figures 1-3	1, 8, 9

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

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“P” document published prior to the international filing date but later than the priority date claimed

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“&” document member of the same patent family

Date of the actual completion of the international search

05 March 2020

Date of mailing of the international search report

13 March 2020

Name and mailing address of the ISA/CN

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Facsimile No. (86-10)62019451

Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No. PCT/CN2019/128466

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C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 208111666 U (GUANGDONG SINAN COMMUNICATION TECHNOLOGY CO., LTD.) 16 November 2018 (2018-11-16) entire document	1-9

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2019/128466

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CN	107819198	A	20 March 2018	WO	2019056905	A1	28 March 2019
CN	101707277	A	12 May 2010	CN	101707277	B	19 June 2013
US	2014035698	A1	06 February 2014	None			
CN	2487123	Y	17 April 2002	None			
CN	104409870	A	11 March 2015	CN	105305036	A	03 February 2016
US	2014035792	A1	06 February 2014	None			
CN	208111666	U	16 November 2018	None			

REFERENCES CITED IN THE DESCRIPTION

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