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(54) **MICROWAVE DEVICE AND MICROWAVE COMMUNICATION SITE**

(57) This application relates to a microwave apparatus, including a bracket, and a Luneberg lens antenna and a radio frequency module that are fastened to the bracket. The radio frequency module includes a waveguide assembly, at least two fixing parts are disposed on the bracket, and the waveguide assembly is installed at any one of the fixing parts and can be switched between different fixing parts. When waveguide assemblies are located on different fixing parts, the waveguide assemblies all extend in a direction close to a geometric center of the Luneberg lens antenna, and distances between the waveguide assemblies and the Luneberg lens antenna are all within a preset first range. The radio frequency module implements receiving and sending functions of a radio frequency signal by using a path formed by the waveguide assembly and the Luneberg lens antenna. In this application, because a plurality of fixing parts are disposed on the microwave apparatus, the radio frequency module can adjust a radio frequency direction. In addition, because the distance between the waveguide assembly and the geometric center of the Luneberg lens antenna is within the first range, it can be ensured that the radio frequency module works reliably on any fixing

part. This application further relates to a microwave communication site equipped with the foregoing microwave apparatus.

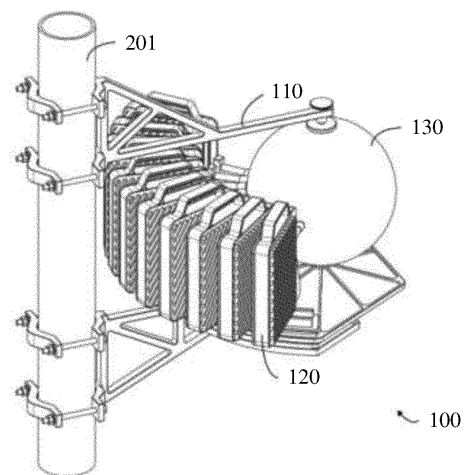


FIG. 3

## Description

### TECHNICAL FIELD

[0001] This application relates to the field of antenna technologies, and in particular, to a microwave apparatus, and a microwave communication site equipped with the microwave apparatus.

### BACKGROUND

[0002] With rapid development of wireless communication technologies, base station traffic and a quantity of sites keep increasing. Microwave communication sites that are interconnected with base stations gradually evolve from tree networking to star networking. The microwave communication site communicates with each base station by using a microwave apparatus, and the microwave communication site gradually evolves from a single-direction small site to a multi-directional large-capacity convergence site.

[0003] Existing microwave apparatuses mostly use a parabolic antenna point-to-point backhaul solution, and bands and directions of the microwave apparatuses are relatively fixed. As a result, when a microwave communication site needs to implement a multi-direction large-capacity function, only a quantity of microwave apparatuses can be increased, causing many problems such as high tower installation density, increased load bearing, and wind resistance of the microwave communication site. In addition, an increase in the quantity of microwave apparatuses also increases tower rent costs.

### SUMMARY

[0004] In view of disadvantages in the conventional technology, objectives of the present invention are to provide a microwave apparatus with a small size, implement multi-directional receiving and sending functions of a radio frequency signal, and further provide a microwave communication site equipped with the microwave apparatus. This application specifically includes the following technical solutions.

[0005] A microwave apparatus is provided, and includes a bracket, and a Luneberg lens antenna and a radio frequency module that are fastened to the bracket. The radio frequency module includes a waveguide assembly, at least two fixing parts are disposed on the bracket, and the waveguide assembly is installed at any one of the fixing parts and can be switched between different fixing parts. When waveguide assemblies are located at different fixing parts, the waveguide assemblies all extend in a direction close to a geometric center of the Luneberg lens antenna, and distances between the waveguide assemblies and the Luneberg lens antenna are all within a preset first range; and the radio frequency module implements receiving and sending functions of a radio frequency signal by using a path formed by the

waveguide assembly and the Luneberg lens antenna.

[0006] In this application, the microwave apparatus receives and sends a radio frequency signal by using the radio frequency module, and forms a signal receiving and sending path of the radio frequency module by using the waveguide assembly of the radio frequency module and the Luneberg lens antenna. Because a plurality of fixing parts are disposed, the waveguide assemblies may be installed at different fixing parts, so that fitting between the waveguide assembly and the Luneberg lens antenna can be implemented at different angles, and a direction of the radio frequency signal can be adjusted. In addition, when the waveguide assemblies are located at the fixing parts, distances between the waveguide assemblies and the geometric center of the Luneberg lens antenna are equal. Therefore, fitting between the waveguide assembly and the Luneberg lens antenna can be ensured, so that the waveguide assembly can work reliably at any fixing part.

[0007] In a possible implementation, each fixing part is located on a first plane.

[0008] In this implementation, each fixing part is located on the first plane, so that an angle of the waveguide assembly can be adjusted in a direction parallel to the first plane.

[0009] In a possible implementation, a distance between each fixing part and the geometric center of the Luneberg lens antenna is within a preset second range.

[0010] In this implementation, when the waveguide assemblies have a consistent appearance structure, the preset second range is controlled, so that a distance between the waveguide assembly of the radio frequency module and the Luneberg lens antenna can be indirectly controlled to fall within the first range.

[0011] In a possible implementation, the waveguide assembly includes a fixed segment and a sliding segment, the sliding segment is located between the fixed segment and the Luneberg lens antenna, the sliding segment is slidably connected to the fixed segment, and has at least two fitting positions relative to the Luneberg lens antenna, the at least two fitting positions are all located on a second plane, and the second plane intersects with the first plane.

[0012] In this implementation, the fixed segment and the sliding segment cooperate with each other, so that the waveguide assembly can form at least two fitting positions in a direction of the second plane relative to the Luneberg lens antenna. In addition, the second plane intersects with the first plane, and adjustment of the fitting positions can further expand a direction adjustment range of the radio frequency module.

[0013] In a possible implementation, the second plane and the first plane are perpendicular to each other.

[0014] In a possible implementation, the first plane is a horizontal plane, and the second plane is a vertical plane.

[0015] In a possible implementation, a track of sliding of the sliding segment relative to the fixed segment is

arc-shaped, and a center of the sliding track coincides with the geometric center of the Luneberg lens antenna.

[0016] In this implementation, the sliding track of the sliding segment is arc-shaped, and a track center of the sliding segment coincides with the geometric center of the Luneberg lens antenna, so that the sliding segment can always maintain a distance from the Luneberg lens antenna on the sliding track of the sliding segment, thereby forming a plurality of fitting positions, and improving a direction adjustment capability of the radio frequency module.

[0017] In a possible implementation, there are two fixed segments, the two fixed segments are disposed at an interval, and the sliding segment is located between the two fixed segments and slides relative to the two fixed segments at the same time.

[0018] In this implementation, two opposite ends of the sliding segment each cooperate with one fixed segment to slide, and a sliding track of the sliding segment is more stable, so that a relative distance between the sliding segment and the Luneberg lens antenna can be ensured.

[0019] In a possible implementation, the two fixed segments separately transmit signals to the sliding segment, and transmit a combined signal to the Luneberg lens antenna after the signals are combined on the sliding segment.

[0020] In this implementation, the two fixed segments separately transmit the signals to the sliding segment, and transmit the combined signal, so that bandwidth or traffic of the radio frequency signal can be expanded.

[0021] In a possible implementation, the signals separately transmitted by the two fixed segments to the sliding segment are located in a same band.

[0022] In a possible implementation, the signals separately transmitted by the two fixed segments to the sliding segment have a same polarization direction and different frequencies.

[0023] In this implementation, two signals with different frequencies can expand bandwidth of the radio frequency signal.

[0024] In a possible implementation, the signals separately transmitted by the two fixed segments to the sliding segment have a same frequency and different polarization directions.

[0025] In this implementation, two signals with different polarization directions can expand traffic of the radio frequency signal.

[0026] In a possible implementation, the radio frequency module includes a first motor and a transmission mechanism, the first motor is fastened to the fixed segment, the transmission mechanism is connected between the first motor and the sliding segment in a transmission manner, and the first motor drives, by using the transmission mechanism, the sliding segment to slide relative to the fixed segment.

[0027] In this implementation, the first motor drives a sliding action of the sliding segment, so that a direction of the radio frequency signal can be automatically ad-

justed.

[0028] In a possible implementation, the radio frequency module includes a switch and a transceiver assembly, the transceiver assembly is configured to receive or transmit a radio frequency signal, and the switch is configured to control turn-on and turn-off of the transceiver assembly.

[0029] In a possible implementation, the transceiver assembly includes a signal processing unit, a frequency conversion unit, an amplification unit, and a filtering unit. When the radio frequency module sends a signal, the signal processing unit generates a radio frequency signal. After the frequency conversion unit performs up-conversion on the radio frequency signal, the amplification unit amplifies the radio frequency signal and the filtering unit filters the radio frequency signal to form a radio frequency signal. Then, the radio frequency signal is transmitted to the waveguide assembly. When the radio frequency module receives a signal, the filtering unit filters the signal, the amplification unit amplifies the signal, and the frequency conversion unit performs down-conversion on the signal. Then, the radio frequency signal is transmitted to the signal processing unit for processing.

[0030] In a possible implementation, the frequency conversion unit includes an up-conversion unit and a down-conversion unit.

[0031] In this embodiment, the up-conversion unit is configured to perform frequency increase on a transmitted radio frequency signal, and the down-conversion unit is configured to perform frequency decrease on a received radio frequency signal.

[0032] In a possible implementation, the amplification unit includes a power amplifier and a low noise amplifier.

[0033] In this embodiment, the power amplifier is configured to amplify a transmitted radio frequency signal, and the low noise amplifier is configured to amplify a received radio frequency signal.

[0034] In a possible implementation, both the transceiver assembly and the waveguide assembly are located at the fixing part.

[0035] In a possible implementation, the transceiver assembly is fastened to the bracket, the waveguide assembly is located at the fixing part, and the transceiver assembly and the waveguide assembly are communicatively connected by using a transmission line.

[0036] In a possible implementation, there are a plurality of radio frequency modules, a quantity of radio frequency modules is less than or equal to a quantity of fixing parts, and waveguide assemblies of the plurality of radio frequency modules are respectively installed at different fixing parts.

[0037] In this implementation, the plurality of radio frequency modules are disposed, and the waveguide assemblies of the radio frequency modules may be respectively disposed on the plurality of fixing parts, so as to implement multi-directional receiving and sending functions of a radio frequency signal.

[0038] In a possible implementation, the plurality of ra-

radio frequency modules include a first radio frequency module and a second radio frequency module, and a band covered by the first radio frequency module is different from a band covered by the second radio frequency module.

[0039] In a possible implementation, bands of the plurality of radio frequency modules are different.

[0040] In a possible implementation, a maximum included angle between the plurality of fixing parts is less than or equal to  $175^\circ$ .

[0041] In this implementation, due to a principle limitation of the Luneberg lens antenna, it needs to be ensured that the angle between the plurality of fixing parts is controlled to fall within  $175^\circ$ .

[0042] In a possible implementation, a maximum included angle between the plurality of fixing parts is less than or equal to  $90^\circ$ .

[0043] In this implementation, the angle between the plurality of fixing parts is set to fall within  $90^\circ$ , so that receiving and sending quality of the radio frequency signal can be ensured, and mutual interference between signals can be avoided.

[0044] In a possible implementation, the bracket includes a fixing plate, the fixing plate is fixedly connected to the Luneberg lens antenna, and the first plane is constructed as an outer surface of the fixing plate close to the Luneberg lens antenna.

[0045] In this implementation, it can be ensured, by using an outer surface structure of the fixing plate, that each fixing part is located in the first plane.

[0046] In a possible implementation, the bracket includes a positioning assembly, the fixing plate is provided with an arc-shaped groove, projection of the geometric center of the Luneberg lens antenna on the first plane coincides with a center of the arc-shaped groove, and the positioning assembly is connected between the arc-shaped groove and the waveguide assembly to form the fixing part.

[0047] In this implementation, the center of the arc-shaped groove is set corresponding to the geometric center of the Luneberg lens antenna, so as to ensure that distances between all positions of the arc-shaped groove and the Luneberg lens antenna are equal. A distance between the waveguide assembly and the geometric center of the Luneberg lens antenna is also ensured by using the positioning assembly fastened to the arc-shaped groove.

[0048] In a possible implementation, the positioning assembly is slidably installed in the arc-shaped groove.

[0049] In this implementation, the positioning assembly slides relative to the arc-shaped groove, so that a signal transmission direction of the radio frequency module can be randomly adjusted, thereby facilitating adjustment of an included angle between a plurality of radio frequency modules.

[0050] In a possible implementation, the waveguide assembly is plate-shaped, and the waveguide assembly is disposed parallel to the second plane, so that the mi-

crowave apparatus can accommodate more waveguide assemblies.

[0051] In this implementation, the bracket further includes a second motor, and the second motor is configured to drive the positioning assembly to slide relative to the arc-shaped groove.

[0052] In this implementation, the second motor drives the positioning assembly to slide, so that the waveguide assembly can be driven to rotate relative to the Luneberg lens antenna, thereby automatically adjusting a direction of the radio frequency signal.

[0053] This application further provides a microwave communication site. The microwave communication site includes a column and the foregoing microwave apparatus, and the microwave apparatus is fastened on the column and is configured to receive and send a signal.

[0054] In a possible implementation, the microwave communication site further includes a tower and an indoor microwave apparatus. The column is disposed on the tower, and the indoor microwave device is communicatively connected to the microwave apparatus.

[0055] It may be understood that, because the microwave communication site is equipped with the foregoing microwave apparatus, the microwave communication site has beneficial effects similar to those of the foregoing microwave apparatus. That is, a transmit angle of the radio frequency signal in the microwave apparatus can be adjusted, and functions such as single-band large-area coverage and multi-band simultaneous receiving and sending can be implemented.

## BRIEF DESCRIPTION OF DRAWINGS

[0056]

FIG. 1 is a diagram of a working scenario of a microwave communication site according to an embodiment of this application;

FIG. 2 is a diagram of a working scenario of a microwave communication site in which a plurality of base stations communicate according to an embodiment of this application;

FIG. 3 is a diagram of a structure of a microwave apparatus according to an embodiment of this application;

FIG. 4 is a diagram of an exploded structure of a microwave apparatus according to an embodiment of this application;

FIG. 5 is a diagram of a structure of fixing between a Luneberg lens antenna and a bracket in a microwave apparatus according to an embodiment of this application;

FIG. 5a is a diagram of a local structure of fixing between a Luneberg lens antenna and an upper bracket in a microwave apparatus according to an embodiment of this application;

FIG. 6 is a diagram of a structure of fixing between a radio frequency module and a bracket in a micro-

wave apparatus according to an embodiment of this application;

FIG. 7 is a diagram of a structure of a radio frequency module in a microwave apparatus according to an embodiment of this application;

FIG. 8 is a diagram of a lateral orientation of a structure of fixing between a radio frequency module and a bracket in a microwave apparatus according to an embodiment of this application;

FIG. 9 is a diagram of a structure of fitting between a radio frequency module and a Luneberg lens antenna in a microwave apparatus according to an embodiment of this application;

FIG. 10 is a diagram of a frame structure of an internal assembly in a radio frequency module in a microwave apparatus according to an embodiment of this application;

FIG. 11 is a diagram of a frame structure of a frequency conversion unit and an amplification unit in a radio frequency module in a microwave apparatus according to an embodiment of this application;

FIG. 12 is a diagram of a structure of a microwave apparatus according to another embodiment of this application;

FIG. 13 is a diagram of a structure of a waveguide assembly in a radio frequency module in a microwave apparatus according to another embodiment of this application;

FIG. 14 is a diagram of a structure of fitting between a radio frequency module and a Luneberg lens antenna in a microwave apparatus according to another embodiment of this application;

FIG. 15 is a diagram of a structure of fitting between a radio frequency module and a Luneberg lens antenna in a microwave apparatus according to still another embodiment of this application;

FIG. 16 is a diagram of a structure of a radio frequency module in a microwave apparatus according to another embodiment of this application;

FIG. 17 is a diagram of a structure of a waveguide assembly in a radio frequency module in a microwave apparatus according to another embodiment of this application;

FIG. 18 is a diagram of a planar structure of a fixing plate in a microwave apparatus according to an embodiment of this application;

FIG. 19 is a diagram of a local cross-sectional structure of a radio frequency module and a bracket in a microwave apparatus according to another embodiment of this application;

FIG. 20 is a diagram of a planar structure in which radio frequency modules in a microwave apparatus are respectively disposed on two fixing parts according to an embodiment of this application;

FIG. 21 is a diagram of a radio frequency signal radiation direction in which radio frequency modules in a microwave apparatus are respectively disposed on two fixing parts according to an embodiment of

this application;

FIG. 22 is a diagram of a planar structure in which two radio frequency modules in a microwave apparatus are respectively disposed on fixing plates according to another embodiment of this application;

FIG. 23 is a diagram of a radio frequency signal radiation direction in which two radio frequency modules in a microwave apparatus are respectively disposed on fixing plates according to another embodiment of this application;

FIG. 24 is a diagram of a structure in which a microwave apparatus includes a plurality of radio frequency modules according to another embodiment of this application;

FIG. 25 is a diagram of a structure in which a plurality of radio frequency modules in a microwave apparatus are simultaneously fastened to fixing plates according to another embodiment of this application;

FIG. 26 is a diagram of a radio frequency signal radiation direction in which a plurality of radio frequency modules in a microwave apparatus are simultaneously fastened to fixing plates according to another embodiment of this application; and

FIG. 27 is a diagram of a structure in which a radio frequency module is newly disposed in a microwave apparatus according to another embodiment of this application.

## DESCRIPTION OF EMBODIMENTS

**[0057]** The following describes technical solutions in embodiments of this application with reference to accompanying drawings in embodiments of this application. It is clear that the described embodiments are merely some but not all of embodiments of this application. All other embodiments obtained by a person of ordinary skill in the art based on embodiments of this application without creative efforts shall fall within the protection scope of this application.

**[0058]** FIG. 1 is a diagram of a working scenario of a microwave communication site 200 according to an embodiment of this application.

**[0059]** The microwave communication site 200 in this application includes an indoor microwave apparatus 210, a tower 220, and a microwave apparatus 100 provided in this application. The tower 220 is provided with a column 201, and the microwave apparatus 100 may be installed on the column 201. Alternatively, the microwave apparatus 100 may be directly installed on the tower 220. In some embodiments, the separate column 201 may alternatively replace a structure of the tower 220, and is used to fix the microwave apparatus 100.

**[0060]** The microwave apparatus 100 is communicatively connected to the indoor microwave apparatus 210. Generally, the microwave apparatus 100 and the indoor microwave apparatus 210 are connected by using a cable (for example, an intermediate frequency cable) to transmit a signal. The indoor microwave apparatus 210

may be further connected to a core network 9 by using a router 8, to receive a signal sent by the core network 9, and transfer the signal to the microwave apparatus 100 for transmission; or transfer a signal received by the microwave apparatus 100 to the core network 9. In some embodiments, communication between the indoor microwave apparatus 210 and the router 8 and communication between the router 8 and the core network 9 may be implemented by using an optical fiber.

**[0061]** The microwave apparatus 100 is generally communicatively connected to a base station. A signal obtained by the microwave apparatus 100 from the core network 9 may be sent to the base station, or a signal received by the base station may be transferred to the core network 9. Specifically, a microwave antenna 6 is disposed in the base station, and a signal is transmitted between the microwave antenna 6 and the microwave apparatus 100 in this application in a microwave manner, that is, in a wireless manner. A base station antenna 3 is further disposed in the base station, and both the base station antenna 3 and the microwave antenna 6 may be disposed on an antenna rack 7 of the base station. The antenna rack 7 may be a structure of the tower 220, or may be a structure of the separate column 201.

**[0062]** A base station indoor unit 4 and a microwave indoor unit 5 are further disposed in the base station. The base station indoor unit 4 and the microwave indoor unit 5 may communicate with each other by using a base station service fiber. The base station indoor unit 4 is communicatively connected to the base station antenna 3, and sends a signal to a terminal (a terminal 2 shown in FIG. 1) or receives a signal of a terminal (a terminal 1 shown in FIG. 1) by using the base station antenna 3. The microwave indoor unit 5 is connected to the microwave antenna 6, to send, to the microwave apparatus 100 in a microwave manner, a signal transmitted by the base station indoor unit 4, or receive a signal transmitted by the microwave apparatus 100 and send the signal to the base station indoor unit 4.

**[0063]** Therefore, the microwave communication site 200 in this application serving as a part on a transmission path from the core network 9 to the terminal can implement a function of communication between the router 8 and the microwave antenna 6 of the base station. The microwave apparatus 100 may be configured to receive or send a radio frequency signal. The radio frequency signal may cover an MHB band, an NR band, an LB band, a Wi-Fi 6E band, a 5G band, a UWB band, a millimeter-wave band, or the like.

**[0064]** FIG. 2 is a diagram of a working scenario of a microwave communication site 200. A plurality of base stations may be disposed around the microwave communication site 200, and the microwave antenna 6 configured to communicate with the microwave apparatus 100 is disposed in each base station. Microwave antennas 6 of different base stations send radio frequency signals to the microwave communication site 200 from different directions, and these signals are generally signals

of different bands, so as to avoid mutual interference. The microwave apparatus 100 disposed on the microwave communication site 200 is configured to receive signals, to combine the signals sent by the base stations into the core network 9, or distribute signals from the core network 9 to the base stations.

**[0065]** Because orientations of the base stations relative to the microwave communication site 200 are different, the microwave apparatus 100 of the microwave communication site 200 needs to receive and send signals in different directions, and bands of the signals in the different directions may also be different.

**[0066]** FIG. 3 shows an external structure of an embodiment of the microwave apparatus 100 provided in this application. FIG. 4 shows an exploded structure of the microwave apparatus 100 shown in FIG. 3.

**[0067]** The microwave apparatus 100 in this application includes a bracket 110, a radio frequency module 120, and a Luneberg lens antenna 130. The bracket 110 is configured to be fitted with the tower 220 or the column 201, to fix the microwave apparatus 100 on the tower 220 or the column 201. The radio frequency module 120 and the Luneberg lens antenna 130 are fastened to the bracket 110, and the radio frequency module 120 is fitted with the Luneberg lens antenna 130 to implement receiving and sending functions of a radio frequency signal of the microwave apparatus 100.

**[0068]** In the diagrams of FIG. 3 and FIG. 4, the bracket 110 includes an upper bracket 111, a lower bracket 112, and a fixing plate 113 located between the upper bracket 111 and the lower bracket 112. The fixing plate 113 is fastened to the lower bracket 112, and is configured to bear the radio frequency module 120 and the Luneberg lens antenna 130. In this case, the radio frequency module 120 and the Luneberg lens antenna 130 are also located between the upper bracket 111 and the lower bracket 112. In some other embodiments, the bracket 110 may include only the upper bracket 111 and the fixing plate 113, or may include only the lower bracket 112 and the fixing plate 113. This does not affect solution implementation of the microwave apparatus 100 in this application. In addition, in some embodiments, the fixing plate 113 may alternatively be fastened to one side of the upper bracket 111, and the radio frequency module 120 and the Luneberg lens antenna 130 are suspended below the fixing plate 113.

**[0069]** Refer to FIG. 5. The upper bracket 111 and the lower bracket 112 are disposed at an interval along a length direction of the column 201, and the Luneberg lens antenna 130 is separately fastened to the upper bracket 111 and the lower bracket 112. A side of the Luneberg lens antenna 130 close to the lower bracket 112 is fastened to the fixing plate 113, and a side of the Luneberg lens antenna 130 close to the upper bracket 111 is abutted and fixed by using a compression part 114. The Luneberg lens antenna 130 is spherical. When the Luneberg lens antenna 130 is borne on the fixing plate 113, the compression part 114 may be located at

the other end of the fixing plate 113 relative to a geometric center (that is, a spherical center) A of the Luneberg lens antenna 130, and abuts the Luneberg lens antenna 130 at two opposite ends along the length direction of the column 201 (refer to FIG. 5a), to fix the Luneberg lens antenna 130.

**[0070]** As shown in FIG. 6, in the microwave apparatus 100 in this application, the radio frequency module 120 may alternatively be fastened to the fixing plate 113. Specifically, a plurality of fixing parts 141 configured to bear and fix the radio frequency module 120 are disposed on the bracket 110 (the fixing plate 113 in this embodiment). In addition, as shown in FIG. 6, the fixing parts 141 are all located on a same plane (defined as a first plane 151 in this embodiment). Further, an outer surface 1131 of the fixing plate 113 is constructed as the first plane 151, and the plurality of fixing parts 141 are all located on the outer surface 1131. When the radio frequency module 120 is fastened to the bracket 110, the radio frequency module 120 needs to be correspondingly disposed on the fixing part 141, to ensure a relative position between the radio frequency module 120 and the Luneberg lens antenna 130. It may be understood that, in some other embodiments, the fixing parts 141 may alternatively be located on different planes, and a relative position between the radio frequency module 120 and the Luneberg lens antenna 130 can also meet a preset requirement. For details, refer to a diagram of a structure of the radio frequency module 120 shown in FIG. 7.

**[0071]** In this embodiment, the radio frequency module 120 includes a main part 121 and a waveguide assembly 122, and the main part 121 and the waveguide assembly 122 are of an integrated structure, which is also described as that the main part 121 and the waveguide assembly 122 are mutually fixed. A position between the fixing part 141 and the radio frequency module 120 is set, so that a relative position between the waveguide assembly 122 and the fixing part 141 is fixed. In other words, in the microwave apparatus 100 in this application, the fixing part 141 is configured to control a position of the waveguide assembly 122. The main part 121 bears a component, which is configured to implement receiving and sending functions of a radio frequency signal. The main part 121 and the waveguide assembly 122 each are fastened to the fixing part 141 (refer to FIG. 8), and are spaced from the Luneberg lens antenna 130. The waveguide assembly 122 is located between the main part 121 and the Luneberg lens antenna 130. That is, the waveguide assembly 122 extends from the main part 121 to the Luneberg lens antenna 130, and forms abutting fitting or forms small-gap fitting with the Luneberg lens antenna 130 (refer to FIG. 9). The abutting fitting or the small-gap fitting herein is a limitation on a first range. In the microwave apparatus 100 in this application, the waveguide assembly 122 is configured to transmit a radio frequency signal formed by the main part 121 of the radio frequency module 120 to the Luneberg lens antenna 130 to implement a sending function, and is also configured

to transmit a radio frequency signal received from the Luneberg lens antenna 130 back to the main part 121 to implement a receiving function.

**[0072]** The Luneberg lens antenna 130 may be understood as a spherical layered dielectric lens antenna, and can convert a spherical wave or a cylindrical wave of a point source or a line source into a plane wave by using an electromagnetic wave, to obtain an antenna of a pen-shaped, sector-shaped, or another-shaped beam, so as to transmit a radio frequency signal output by the radio frequency module 120 to space in an input direction of the waveguide assembly 122, receive a spatial signal in a corresponding direction of the waveguide assembly 122 and converge the signal to a position of the waveguide assembly, and input the signal to the radio frequency module 120 for processing.

**[0073]** The waveguide assembly 122 may be understood as a section of radio frequency signal transmission line, and is constructed in a shape of a hollow metal tube with two ends fitted flange plates. Based on different cross-sectional geometric shapes of the hollow metal tube, the waveguide assembly 122 may be of different structures such as a rectangular waveguide, a circular waveguide, an elliptical waveguide, a single-ridge waveguide, and a double-ridge waveguide. Therefore, in the microwave apparatus 100 in this application, the Luneberg lens antenna 130 and the waveguide assembly 122 jointly form a signal receiving and sending path of the radio frequency module 120. The radio frequency module 120 may implement a signal receiving and sending function by using the receiving and sending path formed by the Luneberg lens antenna 130 and the waveguide assembly 122.

**[0074]** FIG. 10 is a frame diagram of an internal structure of the main part 121 of the radio frequency module 120.

**[0075]** A switch 123 and a transceiver assembly 124 are disposed in the main part 121 of the radio frequency module 120. The switch 123 is connected in series to the transceiver assembly 124, and the switch 123 is configured to control turn-on and turn-off (sleep) of the transceiver assembly 124. The transceiver assembly 124 is configured to send a radio frequency signal, or receive a radio frequency signal. Specifically, the transceiver assembly 124 may be an intermediate-frequency transceiver combination processing component, and may receive and send intermediate-frequency signals simultaneously through a cable. In an embodiment, the transceiver assembly 124 includes a signal processing unit 1241, a frequency conversion unit 1242, an amplification unit 1243, and a filtering unit 1244. When the radio frequency module 120 sends a signal, the signal processing unit 1241 forms a radio frequency signal. The radio frequency signal is up-converted by the frequency conversion unit 1242, then amplified by the amplification unit 1243, and finally filtered by the filtering unit 1244, to transmit a finally transmitted radio frequency signal to the waveguide assembly 122 for transmission on a transmission path

formed by the waveguide assembly 122 and the Luneberg lens antenna 130.

**[0076]** When the radio frequency module 120 receives a signal, a radio frequency signal received by using the Luneberg lens antenna 130 and the waveguide assembly 122 is first transmitted to the filtering unit 1244 for filtering, then amplified by the amplification unit 1243, and after being down-converted by the frequency conversion unit 1242, transmitted to the signal processing unit 1241 for processing and receiving. In an embodiment, the signal processing unit 1241 is an intermediate-frequency processing unit. In a transmission process, a radio frequency signal usually needs to be transmitted after up-conversion, to avoid power consumption loss. Therefore, when sending or receiving a radio frequency signal, the frequency conversion unit 1242 needs to perform up-conversion or down-conversion on the radio frequency signal.

**[0077]** In an embodiment, as shown in FIG. 11, the frequency conversion unit 1242 includes an up-conversion unit 1242a, and the amplification unit 1243 includes a power amplifier 1243a. The up-conversion unit 1242a is electrically connected to the power amplifier 1243a. When the radio frequency module 120 sends a signal, the up-conversion unit 1242a is configured to perform up-conversion on the radio frequency signal, and the power amplifier 1243a is configured to amplify the radio frequency signal. In some embodiments, the frequency conversion unit 1242 includes a down-conversion unit 1242b, and the amplification unit 1243 includes a low noise amplifier 1243b. The down-conversion unit 1242b is electrically connected to the low noise amplifier 1243b. When the radio frequency module 120 receives a signal, the low noise amplifier 1243b is configured to amplify the received radio frequency signal, and the down-conversion unit 1242b is configured to perform down-conversion on the received radio frequency signal.

**[0078]** FIG. 12 shows some embodiments of the microwave apparatus 100 in this application. In these embodiments, a structure of the main part 121 of the radio frequency module 120, together with the switch 123 and the transceiver assembly 124 that are accommodated by the main part 121, may be fastened to the tower 220 or the column 201. The main part 121 and the waveguide assembly 122 are of a separate structure, and the radio frequency module 120 fixes the waveguide assembly 122 only on the fixing part 141 of the bracket 120, to ensure a relative position between the waveguide assembly 122 and the Luneberg lens antenna 130. The switch 123 and the transceiver assembly 124 may alternatively be disposed outside the bracket 110, and are fastened to the bracket 110. The transceiver assembly 124 may be electrically connected to the waveguide assembly 122 by using a transmission line, and implement a bidirectional transmission function of a radio frequency signal. In these embodiments, a radio frequency component in the microwave communication site 200 may be reused, that is, an inherent radio frequency component in the microwave

communication site 200 may be used to connect a signal to the waveguide assembly 122 of the microwave apparatus 100 in this application by using a transmission line, and transmit and receive the signal by using the structure of the microwave apparatus 100 in this application. A size of the waveguide assembly 122 is smaller than that of the radio frequency module 120 (as shown in FIG. 13). In addition, in these embodiments, overall costs of the microwave apparatus 100 are reduced, and the size of the radio frequency module 120 is correspondingly reduced.

**[0079]** It should be noted that the fixing part 141 is correspondingly disposed on the microwave apparatus 100 in this application with the waveguide assembly 122, that is, the fixing part 141 is configured to fix a relative position between the waveguide assembly 122 and the Luneberg lens antenna 130. Therefore, the embodiments in which the main part 121 and the waveguide assembly 122 of the radio frequency module 120 are disposed separately shown in FIG. 12 and FIG. 13 may be compatible. However, in an embodiment in which the main part 121 and the waveguide assembly 122 of the radio frequency module 120 are of an integrated structure, a position between the radio frequency module 120 and the fixing part 141 may be controlled, to indirectly control a position between the waveguide assembly 122 and the fixing part 141, and ensure a relative position between the waveguide assembly 122 and the Luneberg lens antenna 130.

**[0080]** It may be understood that, in some embodiments, the main part 121 and the waveguide assembly 122 that are included in the radio frequency module 120 are of an integrated structure or a separate structure. That is, in some scenarios, the radio frequency module 120 in the microwave apparatus 100 includes both a newly disposed radio frequency module 120 and a reused and reconstructed radio frequency module 120. In these scenarios, the fixing part 141 is still configured to control a distance between the waveguide assembly 122 of the radio frequency module 120 and the Luneberg lens antenna 130 to fall within a first preset range. That is, some fixing parts 141 are configured to be directly connected to the waveguide assembly 122, and fix the waveguide assembly 122; and the other fixing parts 141 are connected to the main part 121 to indirectly fix the waveguide assembly 122.

**[0081]** As shown in FIG. 6 and FIG. 8, in embodiments provided in this application, the radio frequency module 120 is plate-shaped. When the radio frequency module 120 is connected to the fixing part 141 of the fixing plate 113, an included angle exists between the plate-shaped radio frequency module 120 and the outer surface 1131 of the fixing plate 113. However, as shown in FIG. 7, the main part 121 of the radio frequency module 120 is approximately rectangular, and the waveguide assembly 122 is located on one side of the main part 121. Specifically, the waveguide assembly 122 includes a fixed segment 1221 and a sliding segment 1222. The fixed segment 1221 is fixedly connected to the main part 121 of

the radio frequency module 120, and the sliding segment 1222 is slidably connected to the fixed segment 1221. Further, the sliding segment 1222 is located between the fixed segment 1221 and the Luneberg lens antenna 130.

**[0082]** Specifically, the sliding segment 1222 includes a sliding end 1223 and a pointing end 1224. The sliding end 1223 is slidably connected to the fixed segment 1221, and the pointing end 1224 extends toward the Luneberg lens antenna 130, and is configured to form abutting fitting or small-gap fitting with the Luneberg lens antenna 130. The waveguide assembly 122 implements a function of signal transmission between the waveguide assembly 122 and the Luneberg lens antenna 130 through fitting between the pointing end 1224 and the Luneberg lens antenna 130. That is, the pointing end 1224 of the sliding segment 1222 is located between the sliding end 1223 and the Luneberg lens antenna 130. It should be noted that, that the sliding segment 1222 is located between the fixed segment 1221 and the Luneberg lens antenna 130, and the pointing end 1224 is located between the sliding end 1223 and the Luneberg lens antenna 130 is defined based on a signal transmission path of the waveguide assembly 122. However, it does not mean that an actual appearance structure and position relationship of the waveguide assembly 122 strictly complies with the foregoing relationship.

**[0083]** For the microwave apparatus 100 in this application, when the sliding segment 1222 of the waveguide assembly 122 may slide relative to the fixed segment 1221, and fitting between the sliding segment 1222 and the Luneberg lens antenna 130 meets a preset requirement, that is, when the sliding segment 1222 and the Luneberg lens antenna 130 form abutting fitting or small-gap fitting, it is defined that a fitting position 142 is formed between the sliding segment 1222 and the Luneberg lens antenna 130. As shown in FIG. 9, when the sliding segment 1222 is located at the fitting position 142, the pointing end 1224 of the sliding segment 1222 points to the geometric center A of the Luneberg lens antenna 130, and a distance between the pointing end 1224 and the Luneberg lens antenna 130 may be within the preset first range, to ensure reliable fitting between the waveguide assembly 122 and the Luneberg lens 130, and form an ideal radiation waveform by using the Luneberg lens antenna 130.

**[0084]** The sliding segment 1222 may slide relative to the fixed segment 1221. Therefore, in some embodiments, in a process in which the sliding segment 1222 slides relative to the fixed segment 1221, two or more fitting positions 142 may be formed. Preset fitting can be formed between the sliding segment 1222 and the Luneberg lens antenna 130 at the two or more fitting positions 142, to ensure that the pointing end 1224 points to the geometric center A of the Luneberg lens antenna. It may be understood that, when the pointing end 1224 transmits signals to the Luneberg lens antenna 130 from different fitting positions 142, a radiation wave direction formed by the transmitted signals changes accordingly.

Therefore, the microwave apparatus 100 in this application can change a radiation angle by using the foregoing structure.

**[0085]** A process in which different fitting positions 142 are formed between the waveguide assembly 122 and the Luneberg lens antenna 130 is implemented through sliding of the sliding segment 1222 relative to the fixed segment 1221. Therefore, it may also be understood that a radiation angle of the microwave apparatus 100 in this application changes along a sliding direction of the sliding segment 1222 relative to the fixed segment 1221. Because the Luneberg lens antenna 130 is spherical, to form a preset fitting relationship between the sliding segment 1222 and the Luneberg lens antenna 130 at the fitting position 142, it needs to be ensured that distances between various fitting positions 142 and the geometric center A of the Luneberg lens antenna 130 are equal, or an offset to a preset value is less than the first range. Therefore, in embodiments, the sliding direction of the sliding segment 1222 relative to the fixed segment 1221 should be set to be arc-shaped, and a center of the arc coincides with the geometric center A of the Luneberg lens antenna 130. That is, a track of sliding of the sliding segment 1222 relative to the fixed segment 1221 is an arc, and a center of the sliding track coincides with the geometric center A of the Luneberg lens antenna 130. Therefore, distances between all positions of the sliding segment 1222 on the sliding track of the sliding segment 1222 and the Luneberg lens antenna 130 can always be equal, or fall within the preset first range, so that a plurality of fitting positions 142 can be formed, and a plurality of angle fitting relationships can be formed between the waveguide assembly 122 and the Luneberg lens antenna 130, thereby improving a direction adjustment range of the radio frequency module 120.

**[0086]** When the track of sliding of the sliding segment 1222 relative to the fixed segment 1221 is arc-shaped, the arc-shaped track may form a plane. In embodiments, the plane formed by the arc-shaped track may be defined as a second plane 152 (refer to FIG. 6). The plurality of fitting positions 142 formed between the sliding segment 1222 and the Luneberg lens antenna 130 are all located on the second plane 152. It may be understood that the second plane 152 may further pass through the geometric center A of the Luneberg lens antenna 130. As mentioned above, the main part 121 of the radio frequency module 120 provided in embodiments of this application may be set to be plate-shaped. Therefore, the second plane 152 may be further set in a direction of a plate plane parallel to the main part 121. Therefore, the sliding segment 1222 slides in the plate plane parallel to the main part 121, so that a size occupied by the radio frequency module 120 in the microwave apparatus 100 can be reduced.

**[0087]** As mentioned above, the included angle exists between the plate-shaped radio frequency module 120 and the outer surface 1131 of the fixing plate 113. The first plane 151 of the microwave apparatus 100 in this

application is provided on the outer surface 1131, and therefore the second plane 152 also intersects with the first plane 151 and an included angle exists between the second plane 152 and the first plane 151. In an embodiment, the second plane 152 and the first plane 151 may be set to be perpendicular to each other. In this case, an angle adjustment direction of the waveguide assembly 122 relative to the Luneberg lens antenna 130 may be perpendicular to the outer surface 1131 of the fixing plate 113. Further, the first plane 151 may be set as a horizontal plane. In this case, the second plane 152 is a vertical plane. Angle adjustment of the waveguide assembly 122 relative to the Luneberg lens antenna 130 is angle adjustment in a tilt direction.

**[0088]** Refer to FIG. 9, FIG. 14, and FIG. 15. As shown in FIG. 9, when the waveguide assembly 122 is located at a fitting position 142 with the Luneberg lens antenna 130, and the waveguide assembly 122 is located at the fitting position 142 shown in FIG. 9, the pointing end 1224 sends a radio frequency signal to the Luneberg lens antenna 130 along a horizontal direction. However, as shown in FIG. 14, the sliding segment 1222 of the waveguide assembly 122 slides toward a direction close to the fixed segment 1221, and stops at a fitting position 142. The fitting position 142 is lower than the geometric center A of the Luneberg lens antenna 130. In this case, an included angle is formed between the pointing end 1224 and the horizontal direction, and a signal input point of the pointing end 1224 is also lower than the geometric center A of the Luneberg lens antenna 130. Therefore, the radio frequency signal transmitted by the waveguide assembly 122 to the Luneberg lens antenna 130 is propagated upwards in a tilt direction after passing through the Luneberg lens antenna 130. However, as shown in FIG. 15, the sliding segment 1222 of the waveguide assembly 122 slides toward a direction away from the fixed segment 1221, and stops at another fitting position 142. The fitting position 142 is higher than the geometric center A of the Luneberg lens antenna 130. In this case, an included angle is also formed between the pointing end 1224 and the horizontal direction, and a signal input point of the pointing end 1224 is also higher than the geometric center A of the Luneberg lens antenna 130. Therefore, the radio frequency signal transmitted by the waveguide assembly 122 to the Luneberg lens antenna 130 is propagated downwards in a tilt direction after passing through the Luneberg lens antenna 130.

**[0089]** It may be understood that, in some embodiments, when the first plane 151 is set to a vertical plane, angle adjustment of the waveguide assembly 122 relative to the Luneberg lens antenna 130 may be angle adjustment in a horizontal direction. However, in some other embodiments, the first plane 151 may be set to form an included angle with the horizontal plane, which does not affect an angle change of the waveguide assembly 122 relative to the Luneberg lens antenna 130. Based on different positions of base stations with which the waveguide assembly 122 needs to communicate, the

waveguide assembly 122 may be adaptively adjusted within a preset angle range.

**[0090]** In an embodiment, a first motor (not shown in the figure) and a transmission mechanism (not shown in the figure) may be further disposed in the radio frequency module 120. The first motor is fastened to the main part 121 of the radio frequency module 120, the transmission mechanism is connected between the first motor and the sliding segment 1222 in a transmission manner, and the first motor may drive, by using the transmission mechanism, the sliding segment 1222 to slide relative to the fixed segment 1221. Therefore, automatic adjustment of a radio frequency signal direction of the microwave apparatus 100 in this application can be implemented under the drive of the first motor. However, in an embodiment in which the main part 121 and the waveguide assembly 122 are separately disposed, the first motor is fastened to the fixed segment 1221 of the waveguide assembly 122, or may be fitted with the transmission mechanism to implement sliding of the sliding segment 1222 relative to the fixed segment 1221.

**[0091]** For an embodiment, refer to FIG. 16. In this embodiment, there are two fixed segments 1221, and the two fixed segments 1221 are disposed at an interval, and are separately fastened to the main part 121 of the radio frequency module 120. The sliding segment 1222 is located between the two fixed segments 1221, and the sliding segment 1222 may simultaneously slide relative to the two fixed segments 1221. Specifically, the two fixed segments 1221 are respectively located at two ends of the sliding track of the sliding segment 1222, and the sliding segment 1222 is constructed as a "T"-shaped structure, so that the sliding segment 1222 is separately connected to the two fixed segments 1221 slidably. The sliding segment 1222 slides between the two fixed segments 1221, and because two opposite ends of the sliding segment 1222 are separately fitted with one fixed segment 1221 to slide, the sliding track of the sliding segment 1222 is more stable, so as to ensure that a relative distance between the sliding segment 1222 and the Luneberg lens antenna 130 meets a preset requirement. It may be understood that, in the embodiment in which there are two fixed segments 1221 shown in FIG. 16, a function of adjusting a radiation angle of the waveguide assembly 122 relative to the Luneberg lens antenna 130 may also be implemented through sliding of the sliding segment 1222 between the two fixed segments 1221.

**[0092]** FIG. 17 shows a structure in which the waveguide assembly 122 is provided with two fixed segments 1221 in an embodiment in which the main part 121 and the waveguide assembly 122 of the radio frequency module 120 are disposed separately. In the diagram shown in the figure, the sliding segment 1222 is also slidably disposed between the two fixed segments 1221, and may slide relative to the two fixed segments 1221 at the same time.

**[0093]** In the foregoing embodiment in which the radio frequency module 120 is provided with one fixed segment

1221, the radio frequency module 120 transmits a radio frequency signal to the sliding segment 1222 by using the single fixed segment 1221. However, in the embodiments in which the radio frequency module 120 shown in FIG. 16 and FIG. 17 includes two fixed segments 1221, the radio frequency module 120 may separately transmit signals to the sliding segment 1222 by using the two fixed segments 1221. After the two signals are combined on the sliding segment 1222, a combined signal is transmitted to the Luneberg lens antenna 130 for sending. In such a setting, the signals that are separately transmitted by the two fixed segments 1221 to the sliding segment 1222 may be set differently, so that the combined radio frequency signal on the sliding segment 1222 has wider bandwidth or larger traffic.

**[0094]** In an embodiment, the signals separately transmitted by the two fixed segments 1221 to the sliding segment 1222 are located in a same band. Therefore, the combined radio frequency signal on the sliding segment 1222 is also a signal in a same band, so that the signal transmitted by the Luneberg lens antenna 130 can correspondingly cover a preset band. Further, in an embodiment, the signals separately transmitted by the two fixed segments 1221 to the sliding segment 1222 have a same polarization direction and different frequencies. For example, the radio frequency module 120 is configured to transmit a signal of an 18 GHz band. In this case, a frequency of the signal transmitted by one fixed segment 1221 to the sliding segment 1222 is 18.03 GHz, and a frequency of the signal transmitted by the other fixed segment 1221 to the sliding segment 1222 is 18.58 GHz. Because signals tend to correspond to consistent frequency bandwidth, a radio frequency signal formed by combining two radio frequency signals having different frequencies has wider bandwidth than a radio frequency signal having a single frequency.

**[0095]** However, in some other embodiments, the signals separately transmitted by the two fixed segments 1221 to the sliding segment 1222 have a same frequency and different polarization directions. In this case, the sliding segment 1222 is formed as a Orthogonal Mode Transducer (Orthogonal Mode Transducer, OMT). After two radio frequency signals having different polarization directions are combined by the polarization combiner, traffic of a combined radio frequency signal increases. It may be understood that, when the polarization directions of the two radio frequency signals are perpendicular to each other, the traffic of the radio frequency signal formed by combining the two radio frequency signals is doubled compared with traffic of a single radio frequency signal.

**[0096]** For an embodiment, refer to FIG. 18. FIG. 18 shows a planar structure of the fixing plate 113.

**[0097]** In this embodiment, the fixing plate 113 includes a bearing base 115 and an arc-shaped groove 116. The bearing base 115 is located on the outer surface 1131, and may be flush, protruding, or concave relative to the outer surface 1131. The bearing base 115 is configured to bear the Luneberg lens antenna 130. It may be under-

stood that the bearing base 115 and the compression par 114 of the upper bracket 111 jointly function, and are configured to bear and fix the Luneberg lens antenna 130. Because of a spherical feature of the Luneberg lens antenna 130, the bearing base 115 and the compression par 114 should be symmetrically disposed relative to the geometric center A of the Luneberg lens antenna 130, so as to form reliable fixing for the Luneberg lens antenna 130. In some embodiments, when the fixing plate 113 is disposed horizontally, a vertical projection position of the geometric center A of the Luneberg lens antenna 130 on the outer surface 1131 is defined as a point B, and the bearing base 115 may be disposed corresponding to the point B.

**[0098]** The arc-shaped groove 116 is disposed on a periphery of the bearing base 115, and a center of the arc-shaped groove 116 may coincide with the point B. In this case, distances from all positions of the arc-shaped groove 116 to the point B are equal. Alternatively, in some embodiments, distances from all positions of the arc-shaped groove 116 to the point B is controlled to fall within a second range. Refer to FIG. 19. The bracket 110 further includes a positioning assembly 117. The positioning assembly 117 is connected between the radio frequency module 120 and the arc-shaped groove 116, and is configured to implement positioning of the radio frequency module 120 relative to the arc-shaped groove 116. That is, the positioning assembly 117 is configured to form the foregoing fixing part 141, and implement fixing of the radio frequency module 120 on the fixing plate 113 through fitting with the radio frequency module 120.

**[0099]** Specifically, as shown in FIG. 19, the arc-shaped groove 116 runs through the fixing plate 113. The positioning assembly 117 includes a first bolt 1171, a second bolt 1172, and an adapter plate 1173. The first bolt 1171 runs through the arc-shaped groove 116 to implement fixing between the adapter plate 1173 and the fixing plate 113, and the second bolt 1172 runs through the adapter plate 1173 and is fixedly connected to the main part 121 of the radio frequency module 120. It may be understood that, in some other embodiments, the first bolt 1171 may alternatively be directly fixedly connected to the main part 121 of the radio frequency module 120, to fix the radio frequency module 120 on the fixing plate 113.

**[0100]** Because the center of the arc-shaped groove 116 is disposed corresponding to the point B, when the positioning assembly 117 is fastened to any position on the arc-shaped groove 116, distances between all positions and a position of the point B are equal. The distance may be understood as the foregoing second range. Therefore, distances between all radio frequency modules 120 connected to fixing plates 113 by using positioning assemblies 117 and the position of the point B are also equal. It may be understood that, because the point B is projection of the geometric center A of the Luneberg lens antenna 130 on the outer surface 1131, when the radio frequency modules 120 are fastened to

arc-shaped grooves 116 by using the positioning assemblies 117, distances between the radio frequency modules 120 and the geometric center A of the Luneberg lens antenna 130 are also equal. When the positioning assembly 117 is fastened to any position of the arc-shaped groove 116, one fixing part 141 may be formed. When the radio frequency modules 120 are disposed on the fixing parts 141, distances between the radio frequency modules 120 and the Luneberg lens antenna 130 are equal, and it is indirectly ensured that distances between waveguide assemblies 121 of the radio frequency modules 120 and the geometric center A of the Luneberg lens antenna 130 are within the first range. In this way, it can be ensured that the microwave apparatus 100 works normally. That is, the positioning assembly 117 may form a plurality of fixing parts 141 on the arc-shaped groove 116.

**[0101]** In the microwave apparatus 100 in this application, there are at least two fixing parts 141 formed on the bracket 110. FIG. 20 is a diagram in which radio frequency modules 120 are respectively disposed on two fixing parts 141. In FIG. 20, the radio frequency module 120 may be located at a fixing part 141a, or may be located at a fixing part 141b. When the radio frequency modules 120 are located at the fixing part 141a and the fixing part 141b, distances between waveguide assemblies 122 of the radio frequency modules 120 and the Luneberg lens antenna 130 both fall within the first range. The first range may be understood as that the waveguide assembly 122 abuts or forms a small gap with the Luneberg lens antenna 130. Therefore, when the radio frequency modules 120 are located at the two fixing parts 141, the waveguide assemblies 122 of the radio frequency modules 120 both can form preset fitting with the Luneberg lens antenna 130. In addition, when the radio frequency modules 120 are located at the two fixing parts 141, an included angle C is formed on the outer surface 1131.

**[0102]** Refer to FIG. 21. When the radio frequency module 120 located at the fixing part 141a works, the radio frequency module 120 sends a radio frequency signal along an extension direction of the pointing end 1224, and the radio frequency signal radiates outwards through the extension direction of the Luneberg lens antenna 130 toward the pointing end 1224. When the radio frequency module 120 located at the fixing part 141b works, the radio frequency module 120 sends a radio frequency signal along an extension direction of the pointing end 1224, and the radio frequency signal also radiates outwards through the extension direction of the Luneberg lens antenna 130 toward the pointing end 1224. Because the included angle C is formed when the radio frequency modules 120 are located at the two fixing parts 141, an included angle C is also formed between radiation directions of the two radio frequency signals.

**[0103]** Therefore, the at least two fixing parts 141 are disposed in the microwave apparatus 100 in this application, so as to implement an angle adjustment function of the radio frequency module 120 in a direction parallel to the first plane 151. When a plurality of fixing parts 141

are disposed on the bracket 110, the radio frequency module 120 may be fastened to each fixing part 141, and form a radio frequency signal receiving and sending function in an angle direction corresponding to the radio frequency module 120, thereby improving an angle adjustment capability of the radio frequency signal in the direction of the first plane 151. It may be understood that, when the first plane 151 is a horizontal plane, a structure of the plurality of fixing parts 141 is used to implement an angle adjustment function of the microwave apparatus 100 in a horizontal direction. With reference to the foregoing embodiment in which the radio frequency module 120 may further adjust an angle in a tilt direction, compared with a structure with a fixed direction such as a parabolic antenna in the conventional technology, the microwave apparatus 100 in this application has a larger angle adjustment range, a simpler structure, and smaller occupied space, thereby reducing bearing load of the microwave communication site 200. Therefore, the microwave communication site 200 provided in this application also has an angle adjustment function of a radio frequency signal because the microwave apparatus 100 in the foregoing embodiments is equipped.

**[0104]** It should be noted that structures such as the fixing plate 113, the arc-shaped groove 116, and the positioning assembly 117 are merely presented as an embodiment of the bracket 110 provided in this application. In some other embodiments, a plurality of fixing parts 141 that are located on the first plane 151 may be formed on the bracket 110 by separately disposing a plurality of support frames for fixing, to implement positioning fitting between the radio frequency module 120 and the Luneberg lens antenna 130. Alternatively, in some embodiments, a plurality of fixing parts 141 may be formed on the outer surface 1131 of the fixing plate 113 by disposing a plurality of support frames on the fixing plate 113, to implement positioning fitting between the radio frequency module 120 and the Luneberg lens antenna 130. In this case, the plurality of support frames on the fixing plate 113 may be arranged in an arc shape. There are many manners similar to the foregoing manner of forming a plurality of fixing parts 141 on a same plane of the bracket 110, and details are not described in this application.

**[0105]** In addition, the fixing part 141 is configured to control a distance between the waveguide assembly 122 and the Luneberg lens antenna 130. The foregoing embodiment in which the radio frequency module 120 is fitting with the fixing part 141 is applicable to a scenario in which the main part 121 and the waveguide assembly 122 of the radio frequency module 120 are of an integrated structure. When the main part 121 and the waveguide assembly 122 are of a separate structure, the fixing part 141 is configured to adjust an angle of the waveguide assembly 122 on the first plane 151, and the fixing plate 113 is configured to be fixedly connected to the waveguide assembly 122, so that similar beneficial effects can also be achieved.

**[0106]** For the structure in which the positioning as-

sembly 117 cooperates with the arc-shaped groove 116 shown in FIG. 19, in some embodiments, the positioning assembly 117 may be further disposed to slide relative to the arc-shaped groove 116. Therefore, the positioning assembly 117 may randomly adjust a signal transmission angle of the radio frequency module 120 within a range of the arc-shaped groove 116. Further, a second motor (not shown in the figure) may be further disposed on the bracket 110. The second motor is fixedly connected to the positioning assembly 117, and is configured to drive sliding of the positioning assembly 117 relative to the arc-shaped groove 116. In this case, the second motor drives the positioning assembly 117 to slide in the arc-shaped groove 116, so that the radio frequency module 120 can be driven to rotate around the geometric center A of the Luneberg lens antenna 130 relative to the Luneberg lens antenna 130, thereby achieving effect that the microwave apparatus 100 automatically adjusts a radio frequency signal angle in a direction range of the first plane 151.

**[0107]** In an embodiment, there may be a plurality of radio frequency modules 120. The plurality of radio frequency modules 120 each are fastened to one fixing part 141, to form a plurality of different signal transmission directions on the first plane 151, and communicate with microwave antennas 6 of different base stations. For details, refer to FIG. 22 and FIG. 23. In embodiments, the radio frequency modules 120 include a first radio frequency module 120a and a second radio frequency module 120b, a first fixing part 141a and a second fixing part 141b are separately formed on the fixing plate 113 by using two positioning assemblies 117, and the first fixing part 141a and the second fixing part 141b form an included angle D on the first plane 151. The first radio frequency module 120a is fastened to the first fixing part 141a, and the second radio frequency module 120b is fastened to the second fixing part 141b. In this case, the first radio frequency module 120a and the second radio frequency module 120b send radio frequency signals to the Luneberg lens antenna 130 at respective fixing parts 141. The first radio frequency module 120a and the second radio frequency module 120b are also arranged in an included angle D in the first direction 151, and a relative angle relationship of the included angle D is also formed between radio frequency signals sent by the first radio frequency module 120a and the second radio frequency module 120b.

**[0108]** Because of the foregoing structure setting, the microwave apparatus 100 in this application may transmit radio frequency signals at the same time in two different directions by using the first radio frequency module 120a and the second radio frequency module 120b. In this case, the first radio frequency module 120a and the second radio frequency module 120b may be configured to transmit radio frequency signals of a same band, and communicate with two different microwave antennas 6 at the same time. In some other embodiments, the first radio frequency module 120a and the second radio frequency module 120b may alternatively be configured to

transmit radio frequency signals of different bands, to avoid interference between signals of two microwave antennas 6.

**[0109]** Further, the included angle D between the first fixing part 141a and the second fixing part 141b is adjusted, so that an included angle between the two radio frequency signals can be further controlled. In an embodiment, based on a feature of the Luneberg lens antenna 130, it is set that a maximum included angle between the first radio frequency module 120a and the second radio frequency module 120b does not exceed  $175^\circ$ , that is, a maximum included angle between two fixing parts is less than or equal to  $175^\circ$ . In this case, the two radio frequency signals can run through the Luneberg lens antenna 130 and radiate outwards, and are not blocked by a radio frequency module 120 corresponding to another radio frequency signal. In an embodiment, it may be further defined that a maximum included angle between the first radio frequency module 120a and the second radio frequency module 120b does not exceed  $90^\circ$ , that is, a maximum included angle between two fixing parts is less than or equal to  $90^\circ$ . In this way, radio frequency signal receiving and sending quality of the first radio frequency module 120a and the second radio frequency module 120b can be ensured, and mutual interference between radio frequency signals can be avoided.

**[0110]** It may be understood that, when the positioning assembly 117 may slide relative to the arc-shaped groove 116, an included angle between two radio frequency modules 120 may be randomly set. When the second motor is disposed on the positioning assembly 117, automatic adjustment of an angle relationship between the two radio frequency modules 120 may be further controlled, to meet requirements in different working scenarios.

**[0111]** For an embodiment, refer to FIG. 24. A plurality of radio frequency modules 120 may be further disposed in the microwave apparatus 100 in this application. Each radio frequency module 120 is fastened to one fixing part 141 (refer to FIG. 25), and the plurality of radio frequency modules 120 transmit radio frequency signals by using a same Luneberg lens antenna 130. It may be understood that a quantity of radio frequency modules 120 in the microwave apparatus 100 in this application needs to be less than or equal to a quantity of fixing parts 141 that can be disposed on the radio frequency modules 120, so that each radio frequency module 120 can be fastened to one fixing part 141, and a distance between each radio frequency module 120 and the Luneberg lens antenna 130 is ensured.

**[0112]** Refer to FIG. 26. When the plurality of radio frequency modules 120 are respectively disposed on different fixing parts 141, the plurality of radio frequency modules 120 may separately radiate radio frequency signals in a plurality of directions by using the Luneberg lens antenna 130. The radio frequency signals may be located in different bands, so that the microwave apparatus 100 in this application can implement coverage of different

bands, and establish communication with microwave antennas 6 in different directions. It may be understood that, in some embodiments, radio frequency signals received and sent by some of the plurality of radio frequency modules 120 are located in a same band, and a specific angle difference is formed between radio frequency modules 120 configured to receive and send radio frequency signals of a same band, so that the microwave apparatus 100 separately communicates with microwave antennas 6 of a same band but in different directions. Because radio frequency signals sent from the Luneberg lens antenna 130 are expanded in a sector shape, an angle between radio frequency modules 120 configured to receive and send radio frequency signals of a same band is properly controlled, so that a radiation area of the band in a preset direction can be better covered.

**[0113]** In embodiments provided in this application, the radio frequency modules 120 are in a plate structure, and the radio frequency modules 120 are disposed in parallel to each other, so that more radio frequency modules 120 can be accommodated within a same radius range, and a plurality of radio frequency modules 120 can share the Luneberg lens antenna 130. Further, each plate-shaped radio frequency module 120 may be disposed in parallel to the second plane 152. Because the plurality of fixing parts 141 are provided, the microwave apparatus 100 in this application may further randomly adjust a combination manner of the radio frequency modules 120 according to a requirement. This helps adjust a quantity of radio frequency modules 120 and an included angle between the radio frequency modules 120 according to a use requirement. Corresponding to the embodiment in which the main part 121 and the waveguide assembly 122 of the radio frequency module 120 are separately disposed, each waveguide assembly 122 may be disposed in a plate structure, and the waveguide assembly 122 may be further disposed in parallel to the second plane 152, so as to achieve a similar beneficial effect.

**[0114]** As shown in FIG. 27, when a radio frequency module 120 needs to be added to the microwave apparatus 100 (or a waveguide assembly 122 connected to the external main part 121 by using a transmission line is independently added), the newly added radio frequency module 120 (or waveguide assembly 122) may be directly fastened to a reserved fixing part 141. As shown in FIG. 27, the reserved fixing part 141 is located on one side of the plurality of assembled radio frequency modules 120. In some other scenarios, the reserved fixing part 141 may be located at any one of the plurality of assembled radio frequency modules 120. In this case, by sliding the plurality of assembled radio frequency modules 120, space of a fixing part 141 may be reserved at a preset position for a to-be-added radio frequency module 120, and the newly disposed radio frequency module 120 is inserted between the plurality of assembled radio frequency modules 120, so that an operation of adding the radio frequency module 120 can be completed.

**[0115]** It may be understood that, because the plurality

of radio frequency modules 120 work independently, and each radio frequency module 120 is further independently fastened to a corresponding fixing part 141, the microwave apparatus 100 in this application is further characterized by easy maintenance. When some radio frequency modules 120 (or waveguide assemblies 122) need to be repaired, maintained, or replaced, only the corresponding radio frequency modules 120 (or waveguide assemblies 122) need to be removed, and fitting between the other radio frequency modules 120 (or waveguide assemblies 122) and the Luneberg lens antenna 130 is not affected. Because the microwave communication site 200 provided in this application is mounted with the microwave apparatus 100 in the foregoing embodiments, a radiation angle adjustment capability of the microwave communication site 200 is improved, and functions of multi-band coverage and synchronous signal receiving and sending can be implemented.

**[0116]** The foregoing descriptions are merely specific embodiments of this application, but are not intended to limit the protection scope of this application. Any variation or replacement, for example, reducing or adding a structural member, and changing a shape of a structural member, 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. When no conflict occurs, embodiments of this application and the features in embodiments may be mutually combined. Therefore, the protection scope of this application shall be subject to the protection scope of the claims.

## Claims

1. A microwave apparatus, comprising a bracket, and a Luneberg lens antenna and a radio frequency module that are fastened to the bracket, wherein

the radio frequency module comprises a waveguide assembly, at least two fixing parts are disposed on the bracket, and the waveguide assembly is installed at any one of the fixing parts and can be switched between different fixing parts; and

when waveguide assemblies are located at different fixing parts, the waveguide assemblies all extend in a direction close to a geometric center of the Luneberg lens antenna, and distances between the waveguide assemblies and the Luneberg lens antenna are all within a preset first range; and the radio frequency module implements receiving and sending functions of a radio frequency signal by using a path formed by the waveguide assembly and the Luneberg lens antenna.

2. The microwave apparatus according to claim 1, wherein each fixing part is located on a first plane.

3. The microwave apparatus according to claim 2, wherein a distance between each fixing part and the geometric center of the Luneberg lens antenna is within a preset second range.
4. The microwave apparatus according to claim 2 or 3, wherein the waveguide assembly comprises a fixed segment and a sliding segment, the sliding segment is located between the fixed segment and the Luneberg lens antenna, the sliding segment is slidably connected to the fixed segment, and has at least two fitting positions with the Luneberg lens antenna, the at least two fitting positions are all located on a second plane, and the second plane intersects with the first plane.
5. The microwave apparatus according to claim 4, wherein the second plane and the first plane are perpendicular to each other.
6. The microwave apparatus according to claim 4 or 5, wherein a track of sliding of the sliding segment relative to the fixed segment is arc-shaped, and a center of the sliding track coincides with the geometric center of the Luneberg lens antenna.
7. The microwave apparatus according to any one of claims 4 to 6, wherein there are two fixed segments, the two fixed segments are disposed at an interval, and the sliding segment is located between the two fixed segments and slides relative to the two fixed segments at the same time.
8. The microwave apparatus according to claim 7, wherein the two fixed segments separately transmit signals to the sliding segment, and transmit a combined signal to the Luneberg lens antenna after the signals are combined on the sliding segment.
9. The microwave apparatus according to claim 8, wherein the signals separately transmitted by the two fixed segments to the sliding segment are located in a same band.
10. The microwave apparatus according to claim 9, wherein the signals separately transmitted by the two fixed segments to the sliding segment have a same polarization direction and different frequencies; or the signals separately transmitted by the two fixed segments to the sliding segment have a same frequency and different polarization directions.
11. The microwave apparatus according to any one of claims 4 to 10, wherein the radio frequency module comprises a first motor and a transmission mechanism, the first motor is fastened to the fixed segment, the transmission mechanism is connected between the first motor and the sliding segment in a transmission manner, and the first motor drives, by using the transmission mechanism, the sliding segment to slide relative to the fixed segment.
12. The microwave apparatus according to any one of claims 4 to 11, wherein the radio frequency module comprises a switch and a transceiver assembly, the transceiver assembly is configured to receive or transmit a radio frequency signal, and the switch is configured to control turn-on and turn-off of the transceiver assembly.
13. The microwave apparatus according to claim 12, wherein both the transceiver assembly and the waveguide assembly are located on the fixing part; and/or the transceiver assembly is fastened to the bracket, and is communicatively connected to the waveguide assembly located on the fixing part by using a transmission line.
14. The microwave apparatus according to any one of claims 2 to 13, wherein there are a plurality of radio frequency modules, a quantity of radio frequency modules is less than or equal to a quantity of fixing parts, and waveguide assemblies of the plurality of radio frequency modules are respectively installed on different fixing parts.
15. The microwave apparatus according to claim 14, wherein the plurality of radio frequency modules comprise a first radio frequency module and a second radio frequency module, and a band covered by the first radio frequency module is different from a band covered by the second radio frequency module.
16. The microwave apparatus according to claim 14 or 15, wherein a maximum included angle between the plurality of fixing parts is less than or equal to 175°.
17. The microwave apparatus according to any one of claims 2 to 16, wherein the bracket comprises a fixing plate, the fixing plate is fixedly connected to the Luneberg lens antenna, and the first plane is constructed as an outer surface of the fixing plate close to the Luneberg lens antenna.
18. The microwave apparatus according to claim 17, wherein the bracket comprises a positioning assembly, the fixing plate is provided with an arc-shaped groove, projection of the geometric center of the Luneberg lens antenna on the first plane coincides with a center of the arc-shaped groove, and the positioning assembly is connected between the arc-shaped groove and the waveguide assembly to form the fixing part.

19. The microwave apparatus according to claim 18, wherein the positioning assembly is slidably installed in the arc-shaped groove.

20. The microwave apparatus according to claim 19, wherein the bracket further comprises a second motor, and the second motor is configured to drive the positioning assembly to slide relative to the arc-shaped groove.

21. A microwave communication site, wherein the microwave communication site comprises a column and the microwave apparatus according to any one of claims 1 to 20, and the microwave apparatus is installed on the column.

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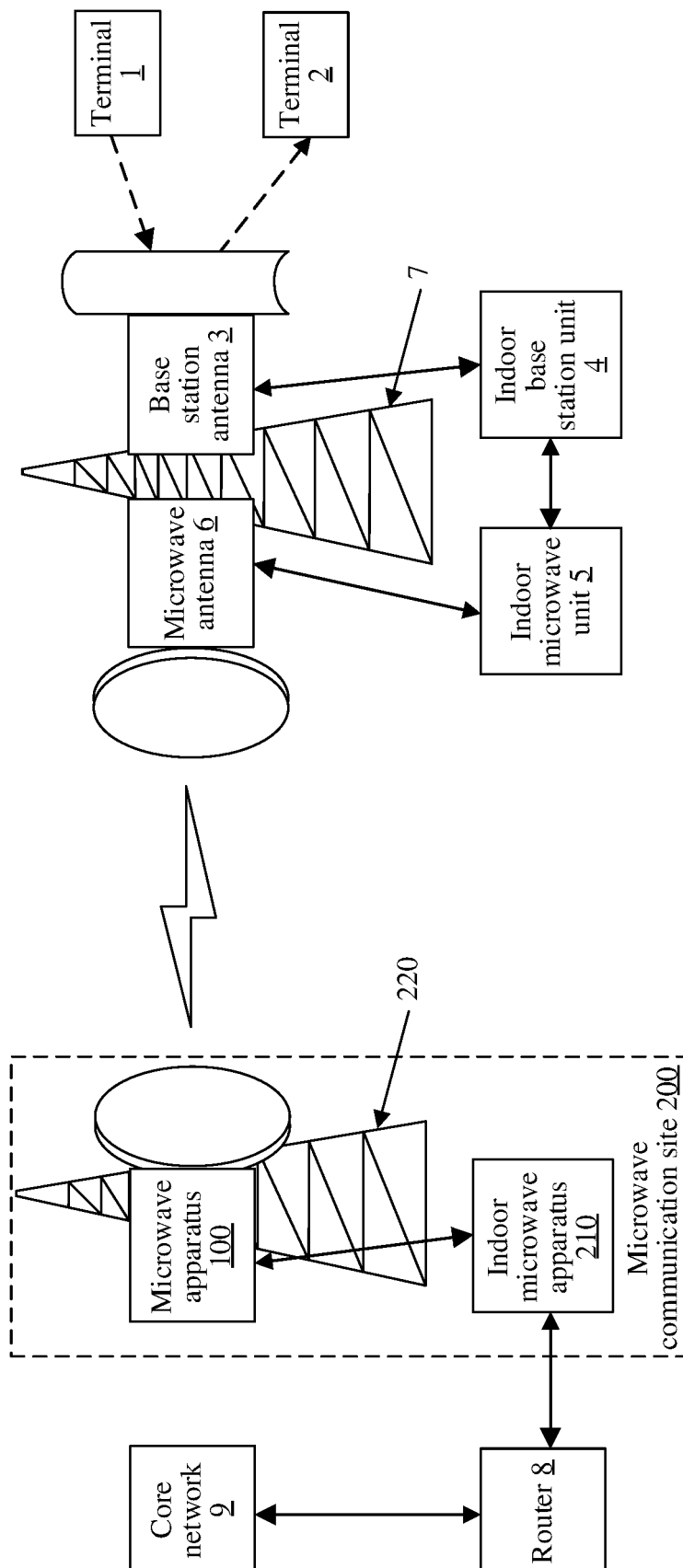


FIG. 1

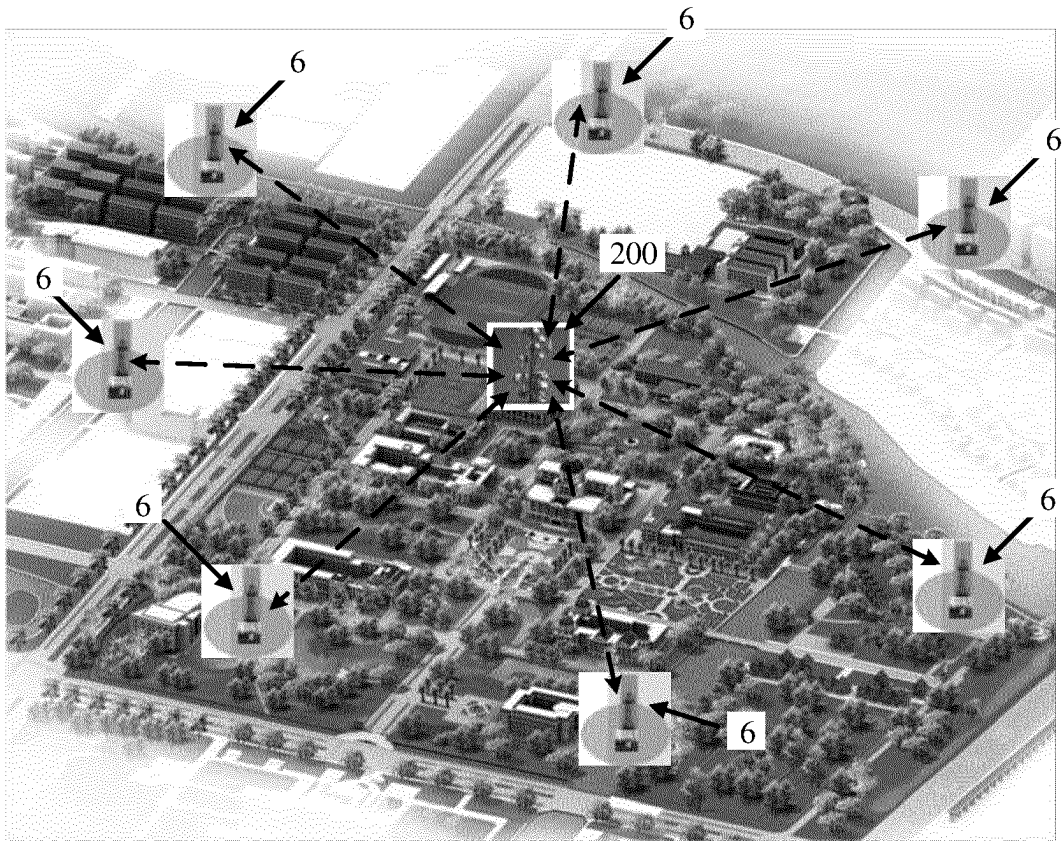


FIG. 2

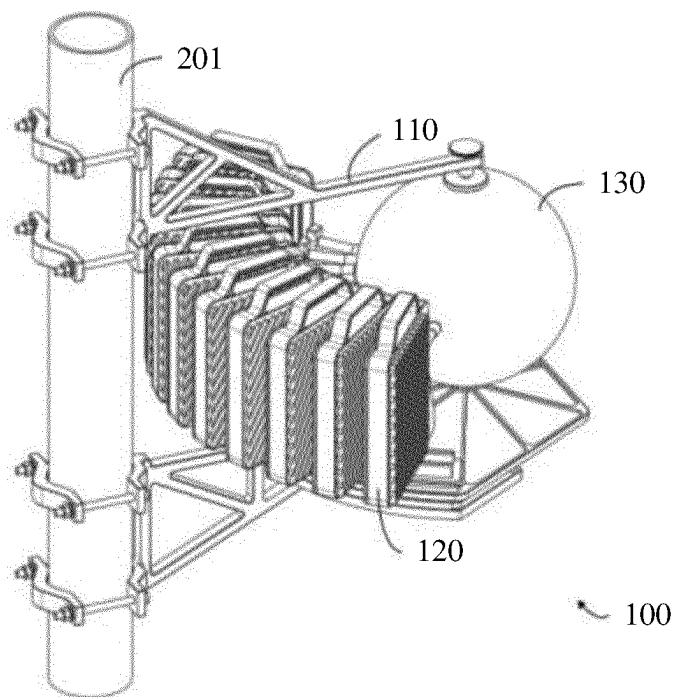


FIG. 3

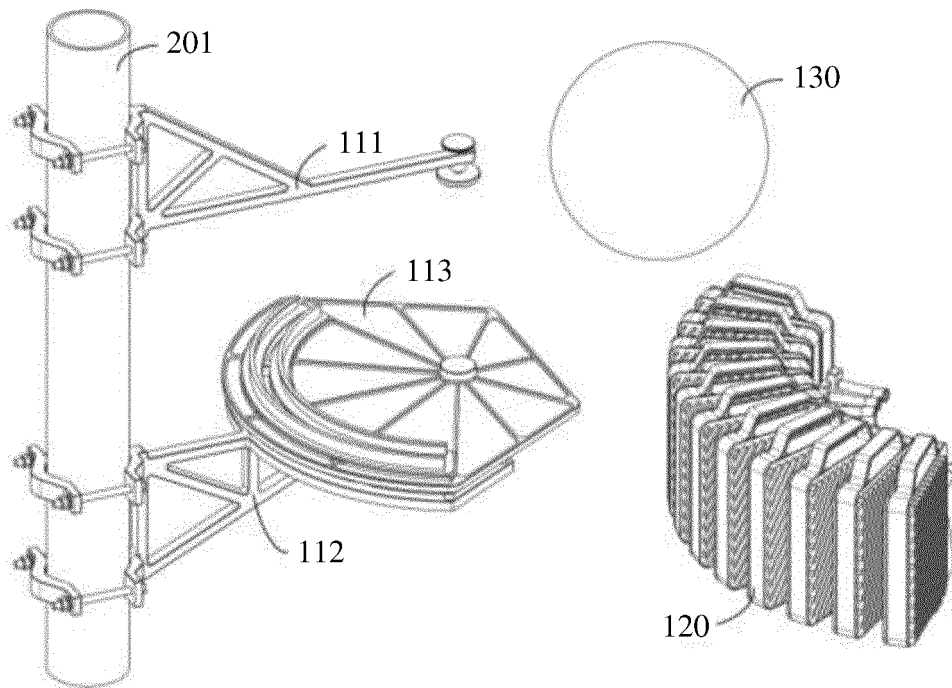


FIG. 4

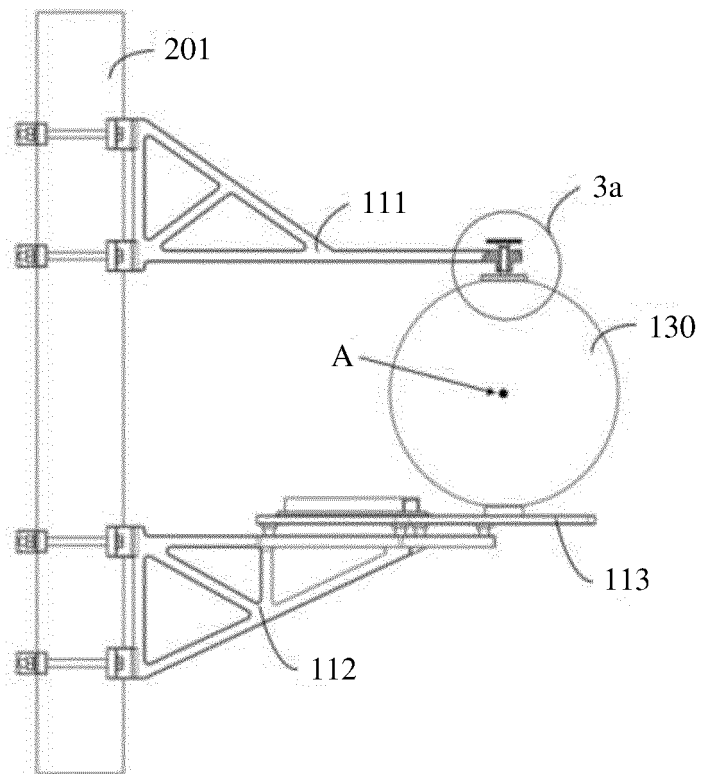


FIG. 5

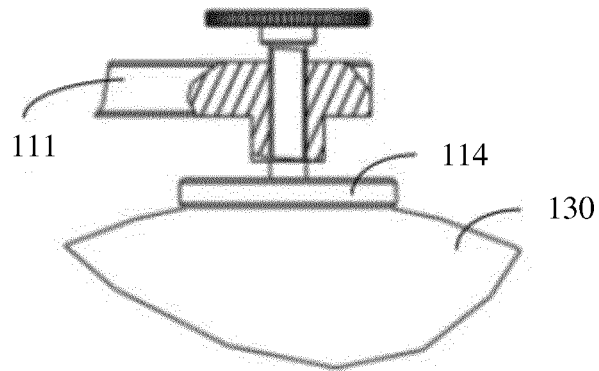


FIG. 5a

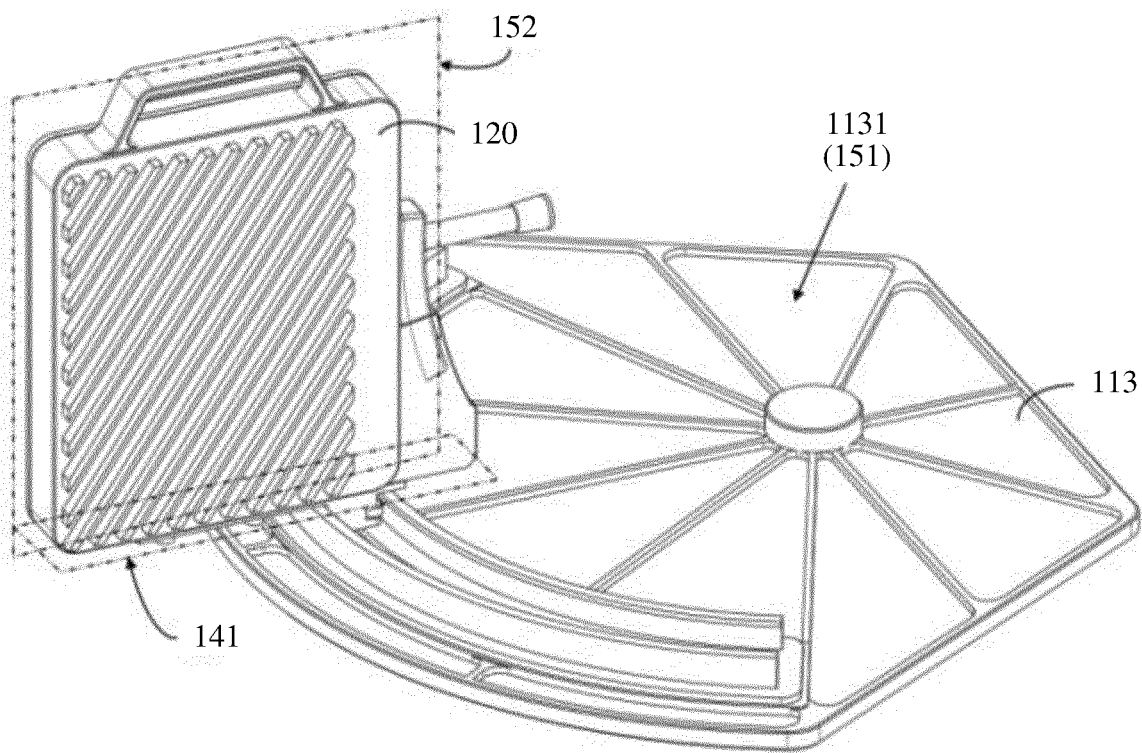


FIG. 6

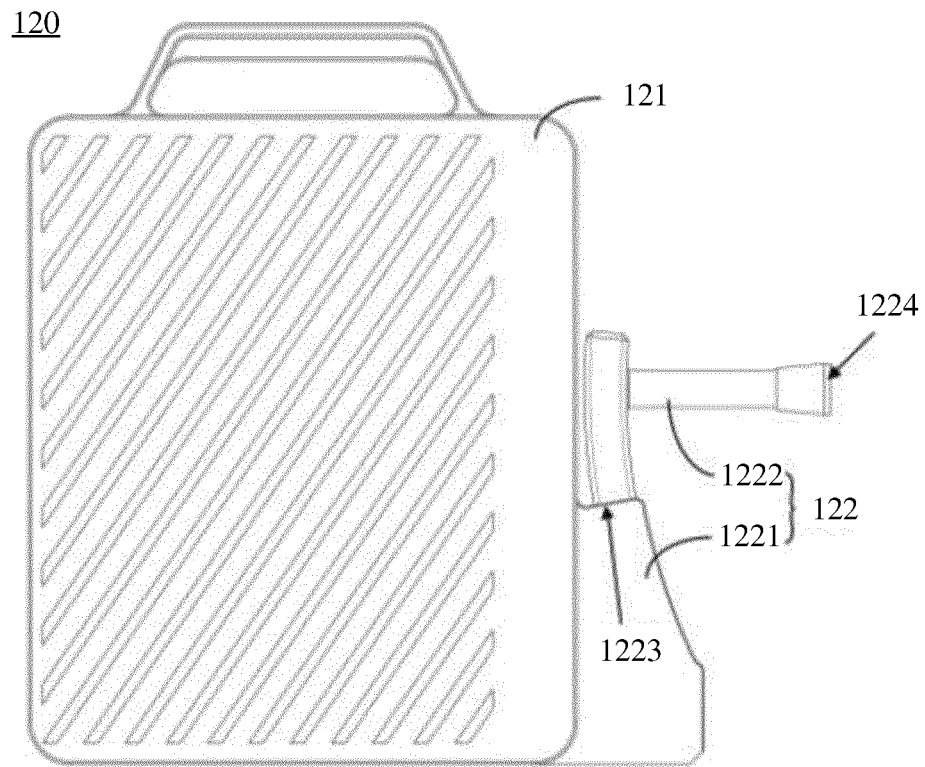


FIG. 7

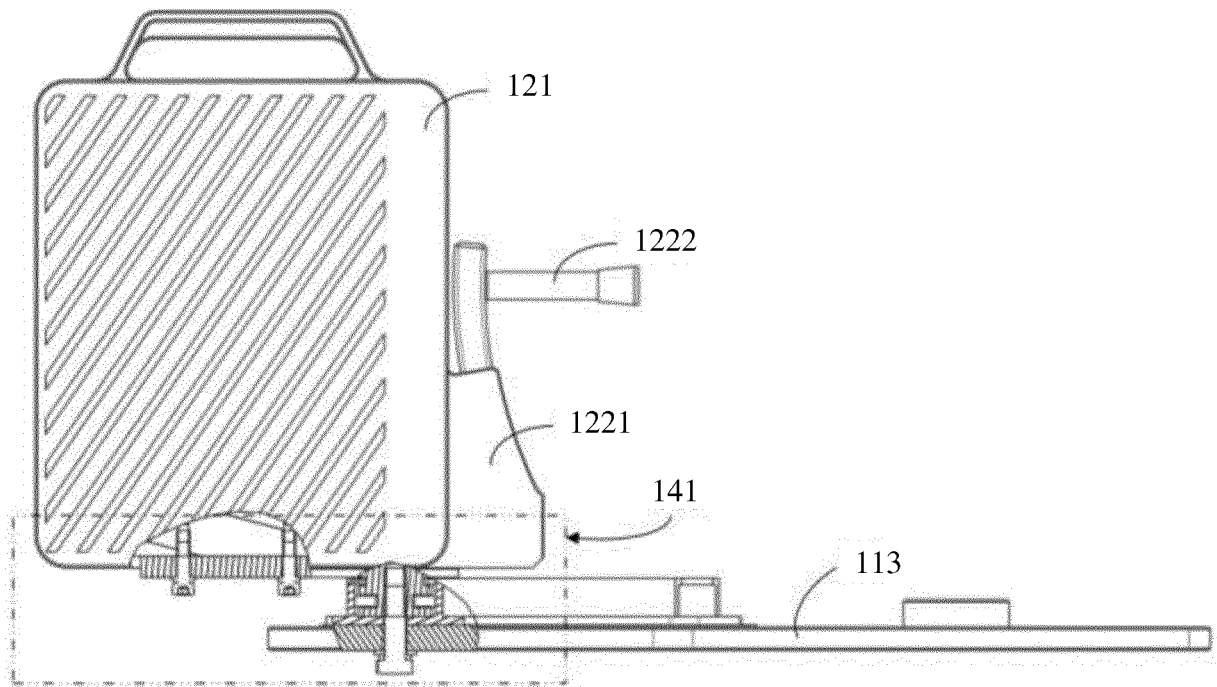


FIG. 8

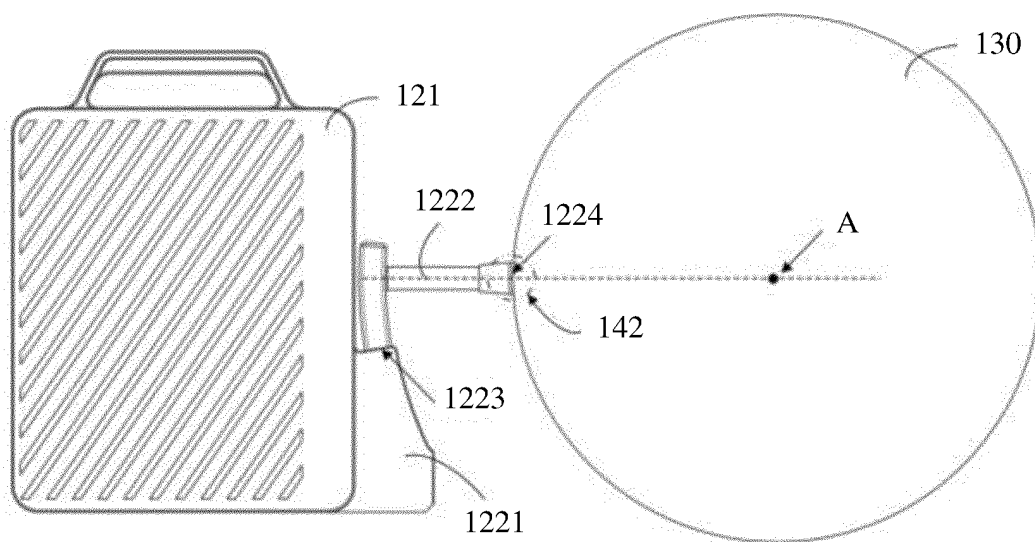


FIG. 9

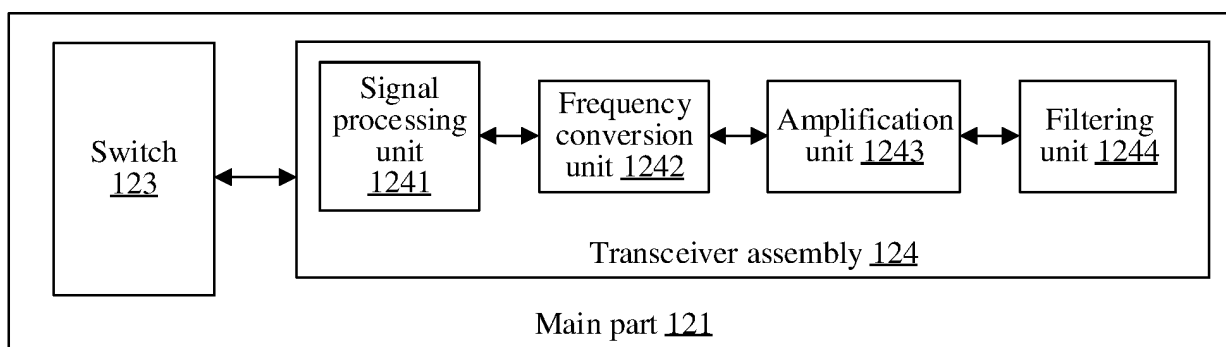


FIG. 10

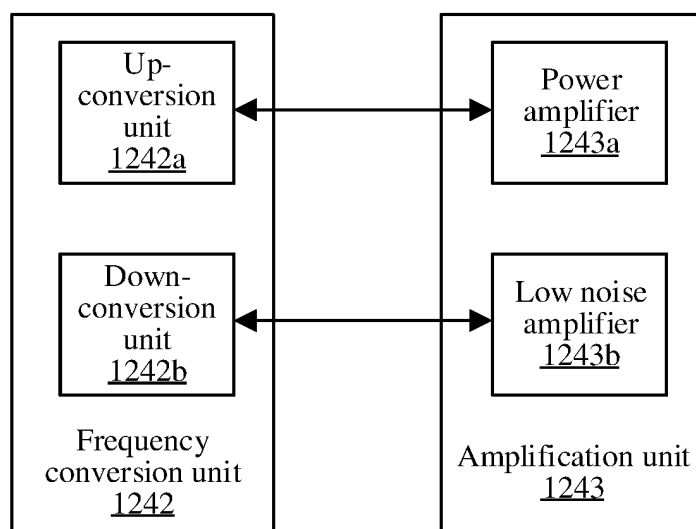


FIG. 11

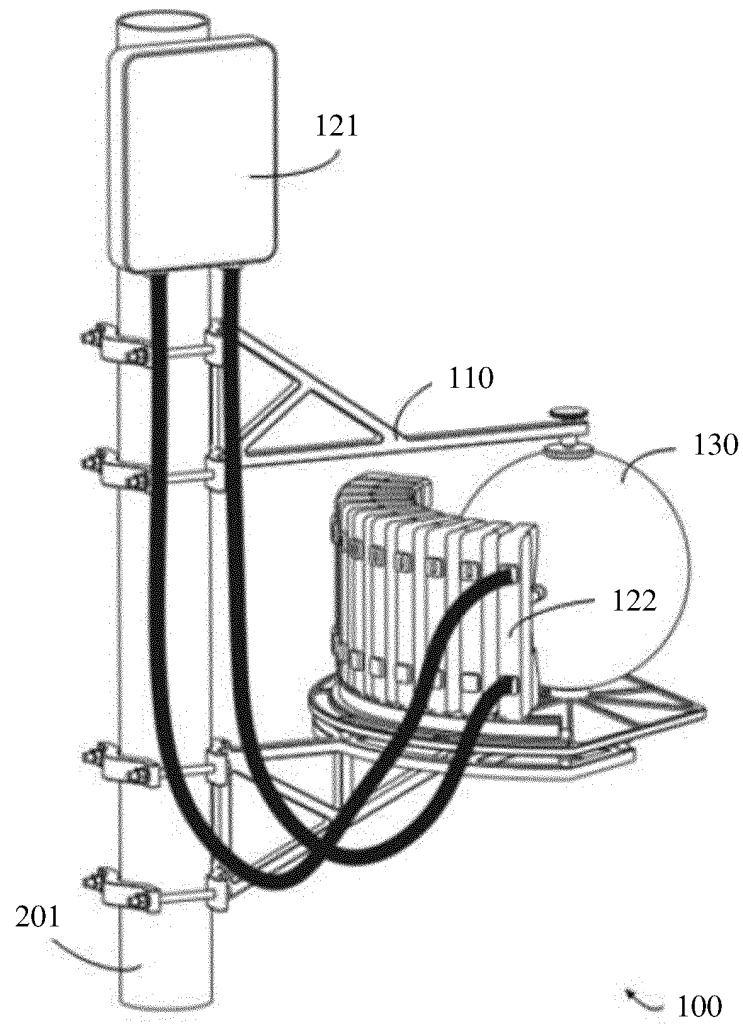


FIG. 12

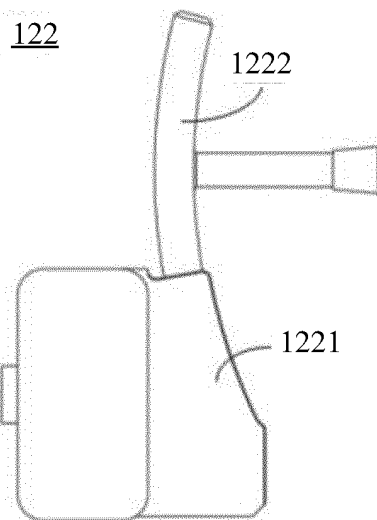


FIG. 13

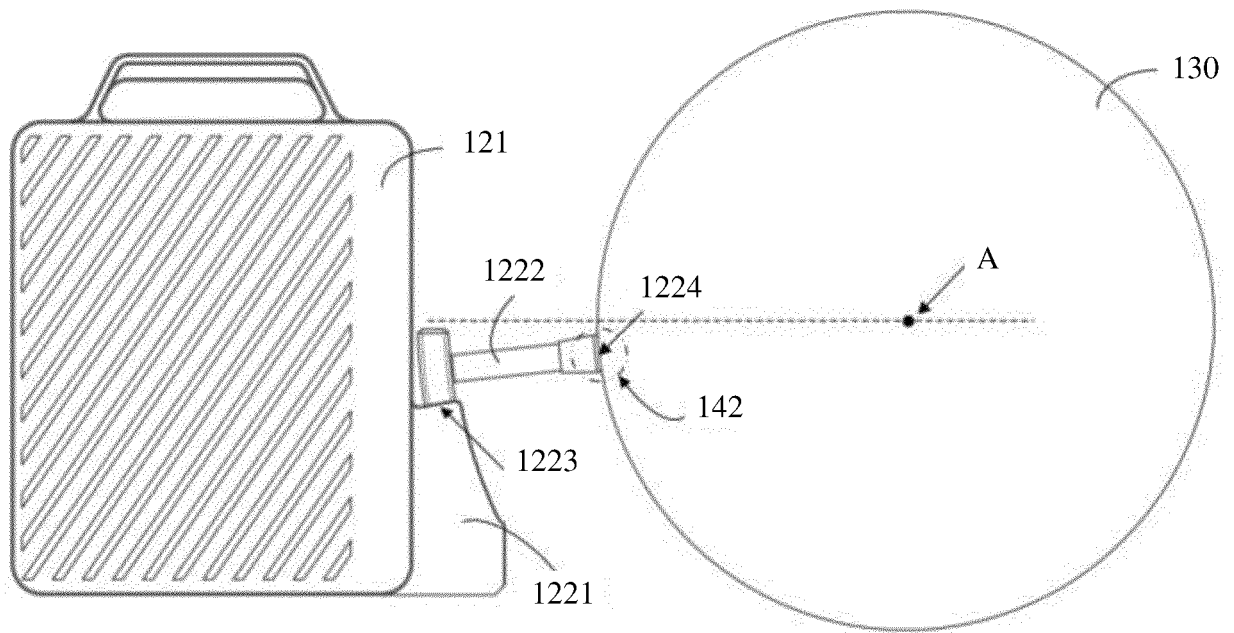


FIG. 14

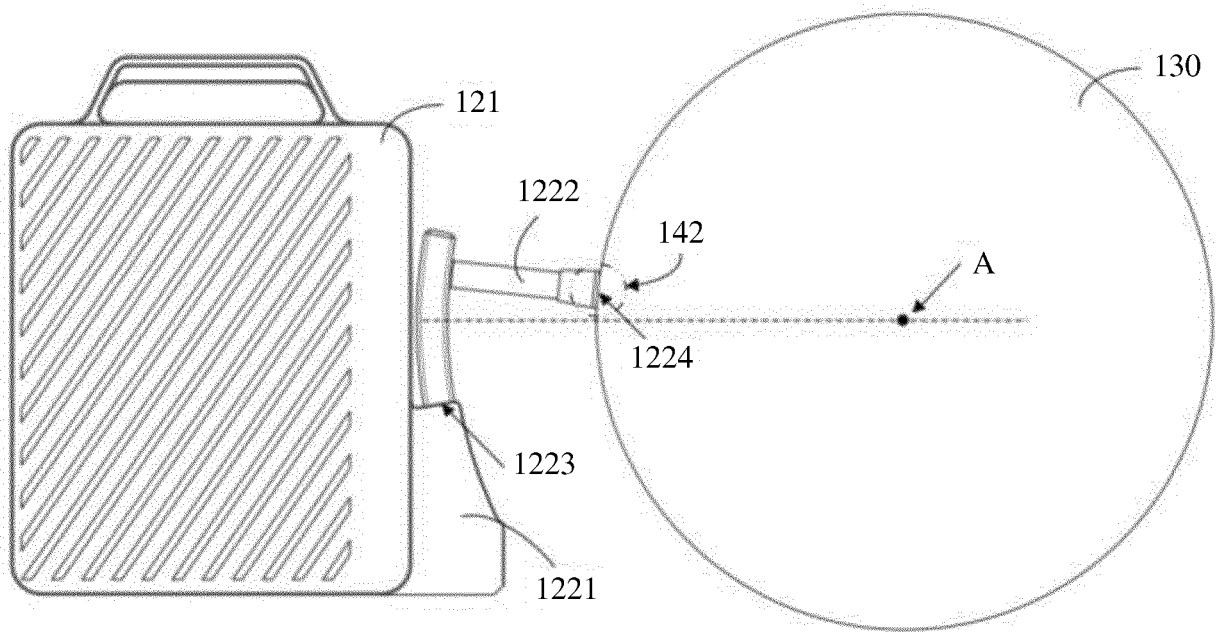


FIG. 15

120

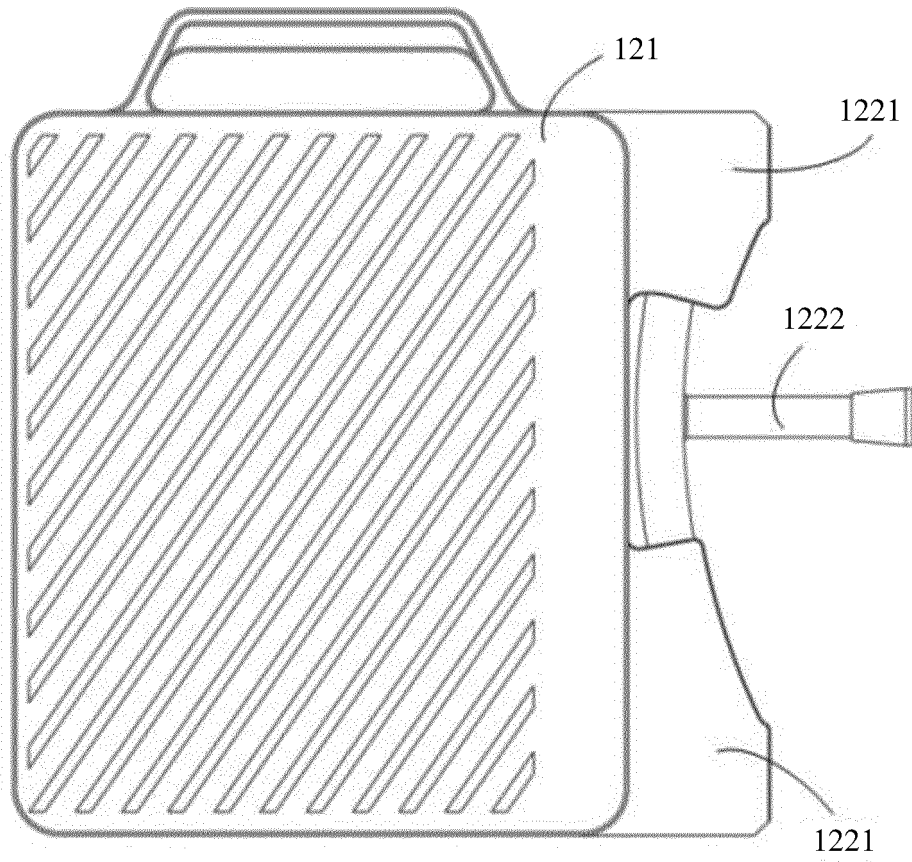


FIG. 16

122

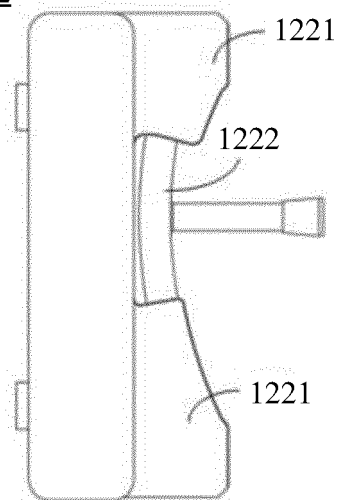


FIG. 17

113

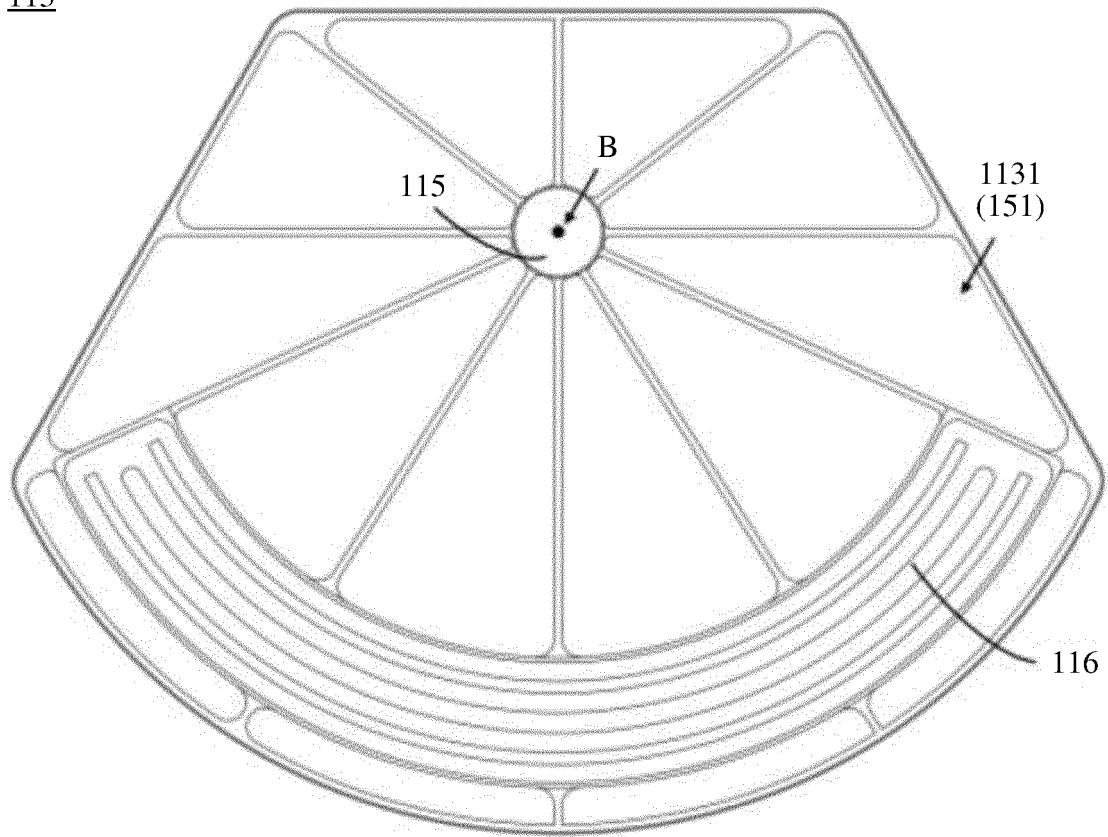


FIG. 18

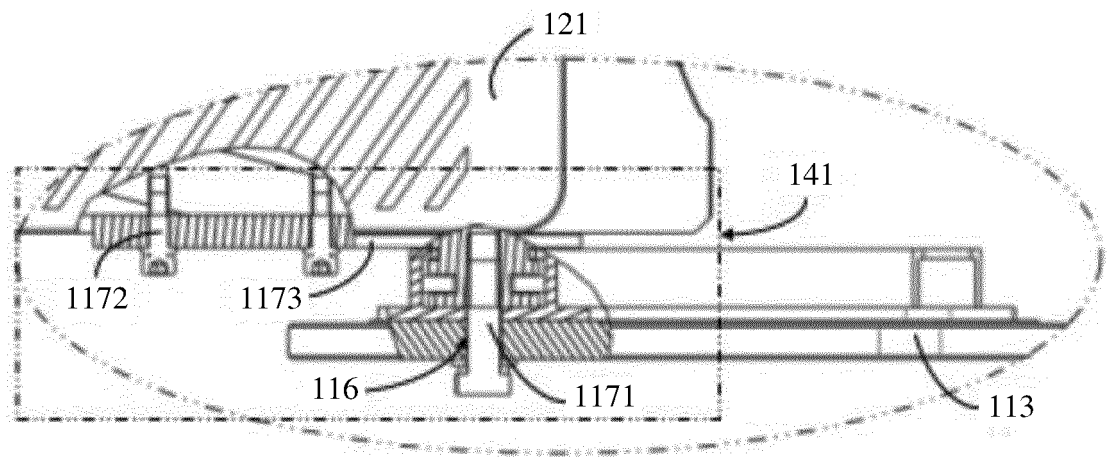


FIG. 19

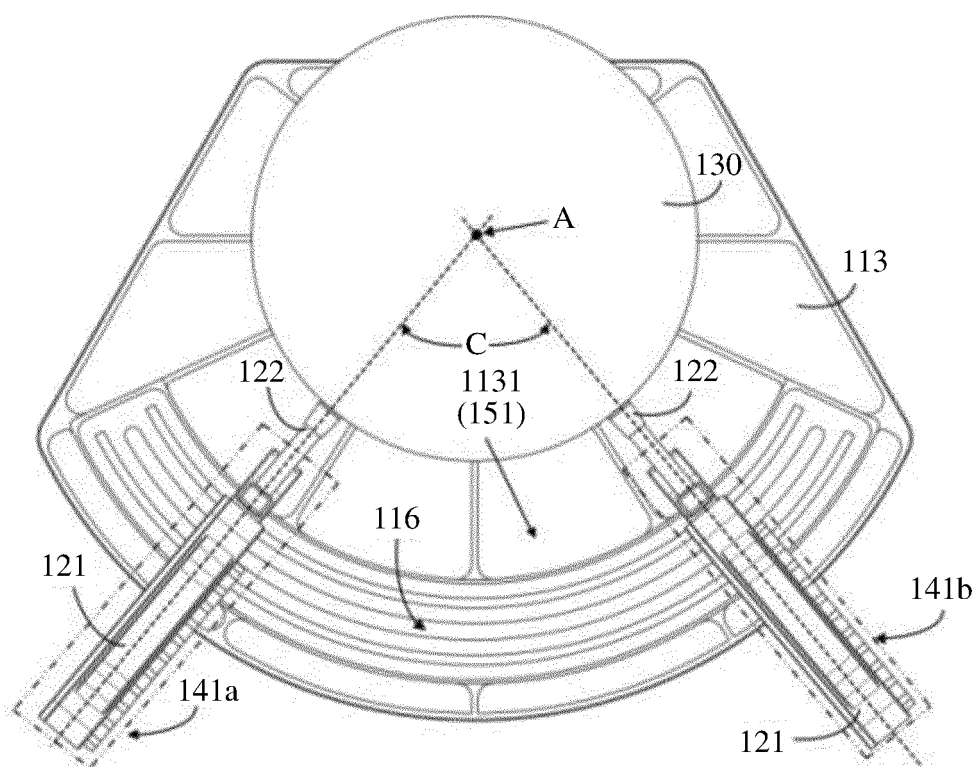


FIG. 20

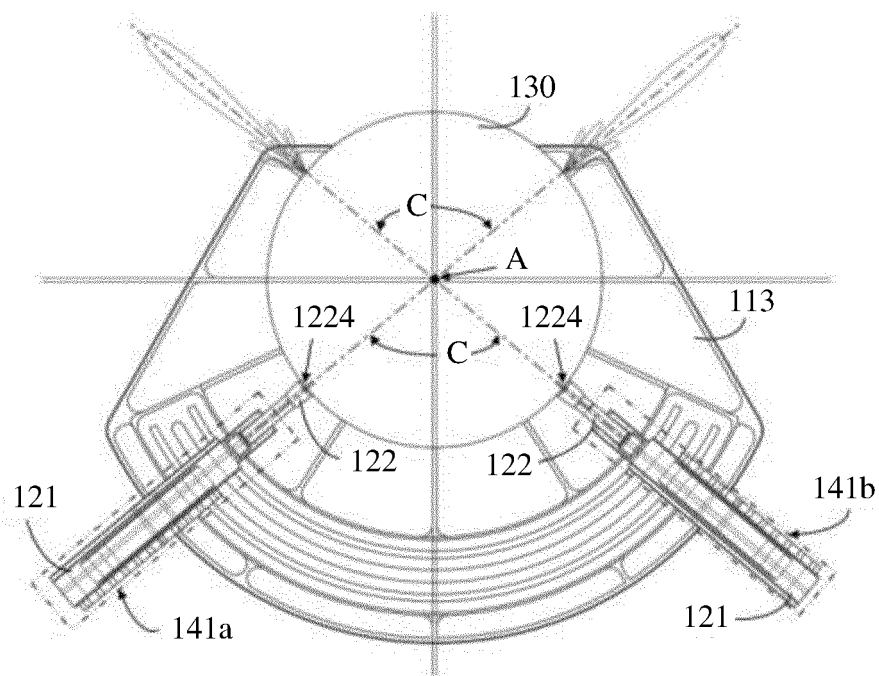


FIG. 21

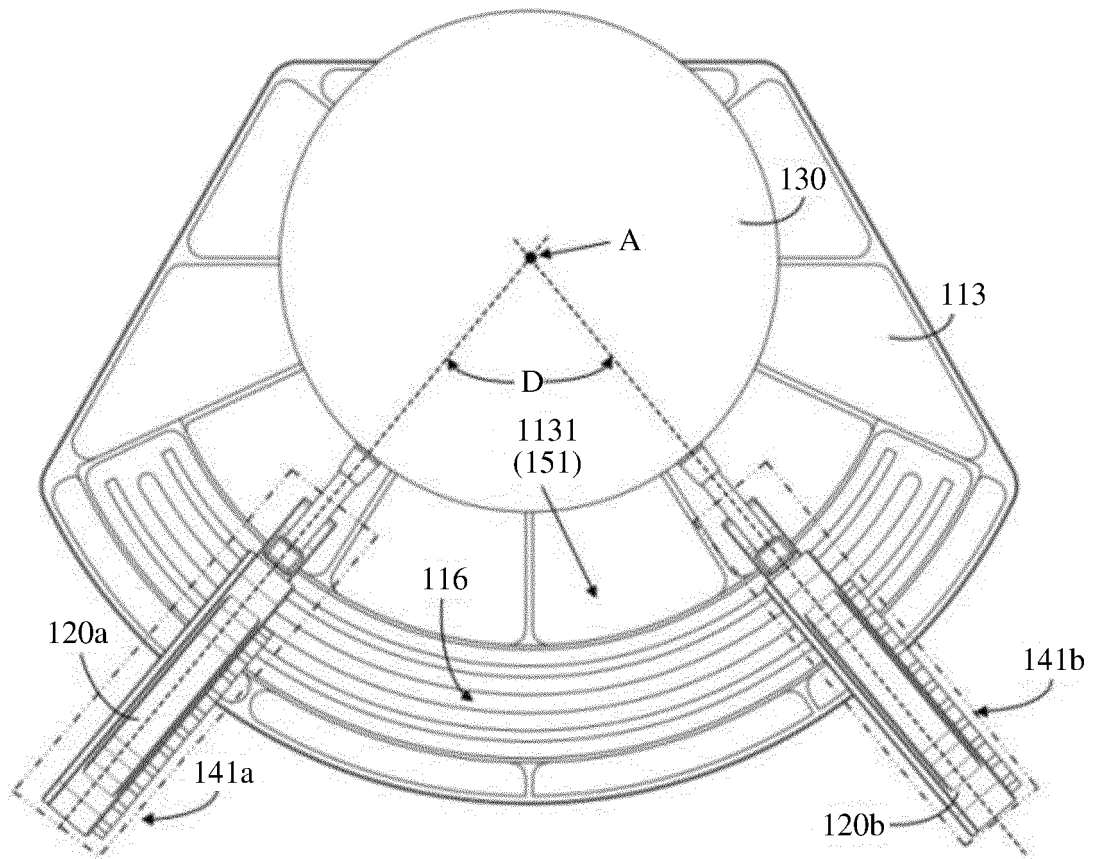


FIG. 22

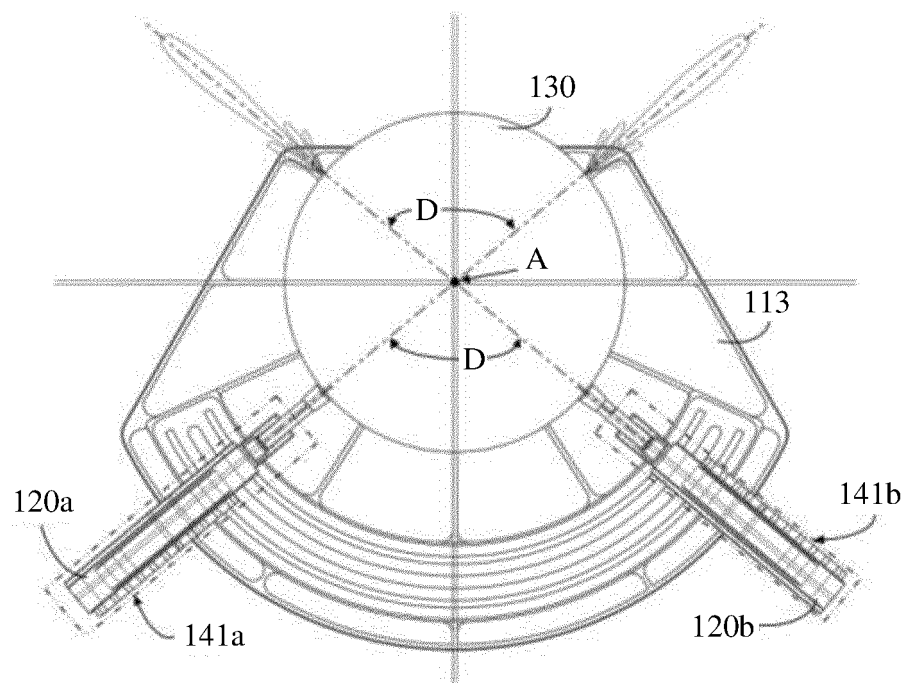


FIG. 23

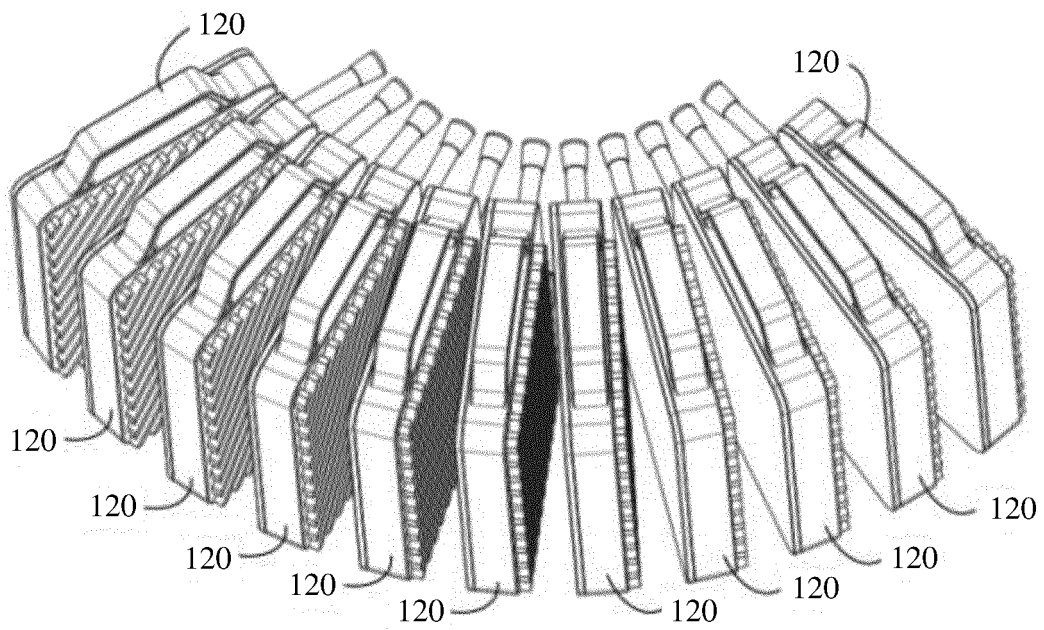


FIG. 24

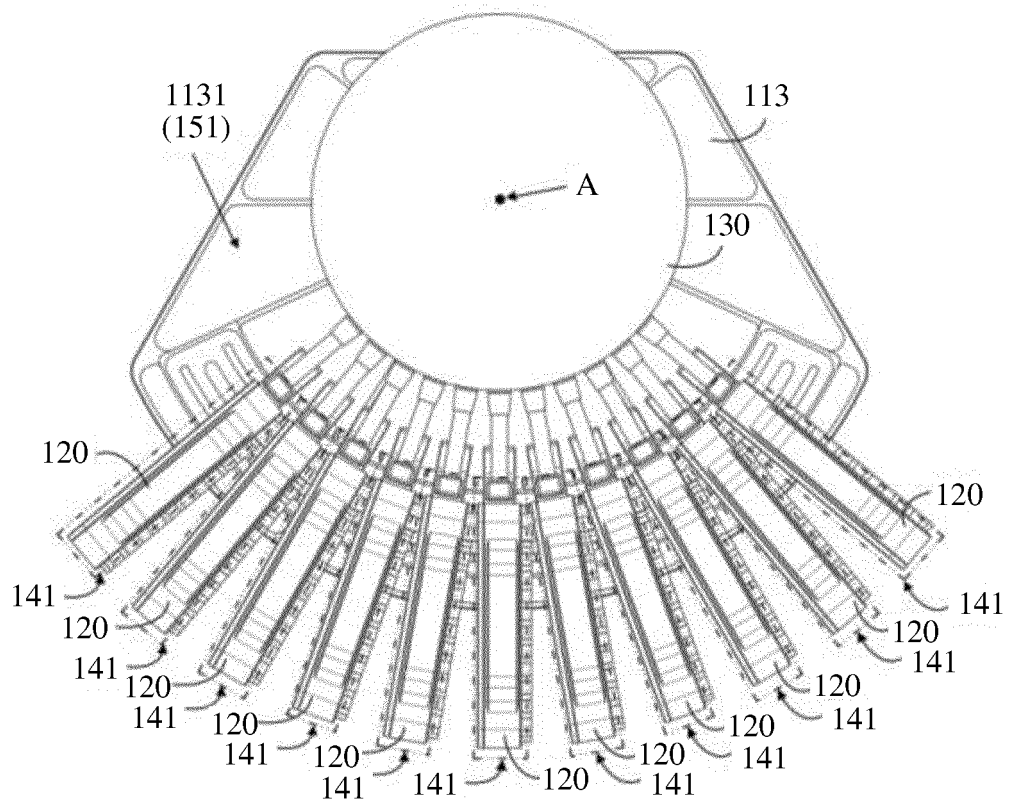


FIG. 25

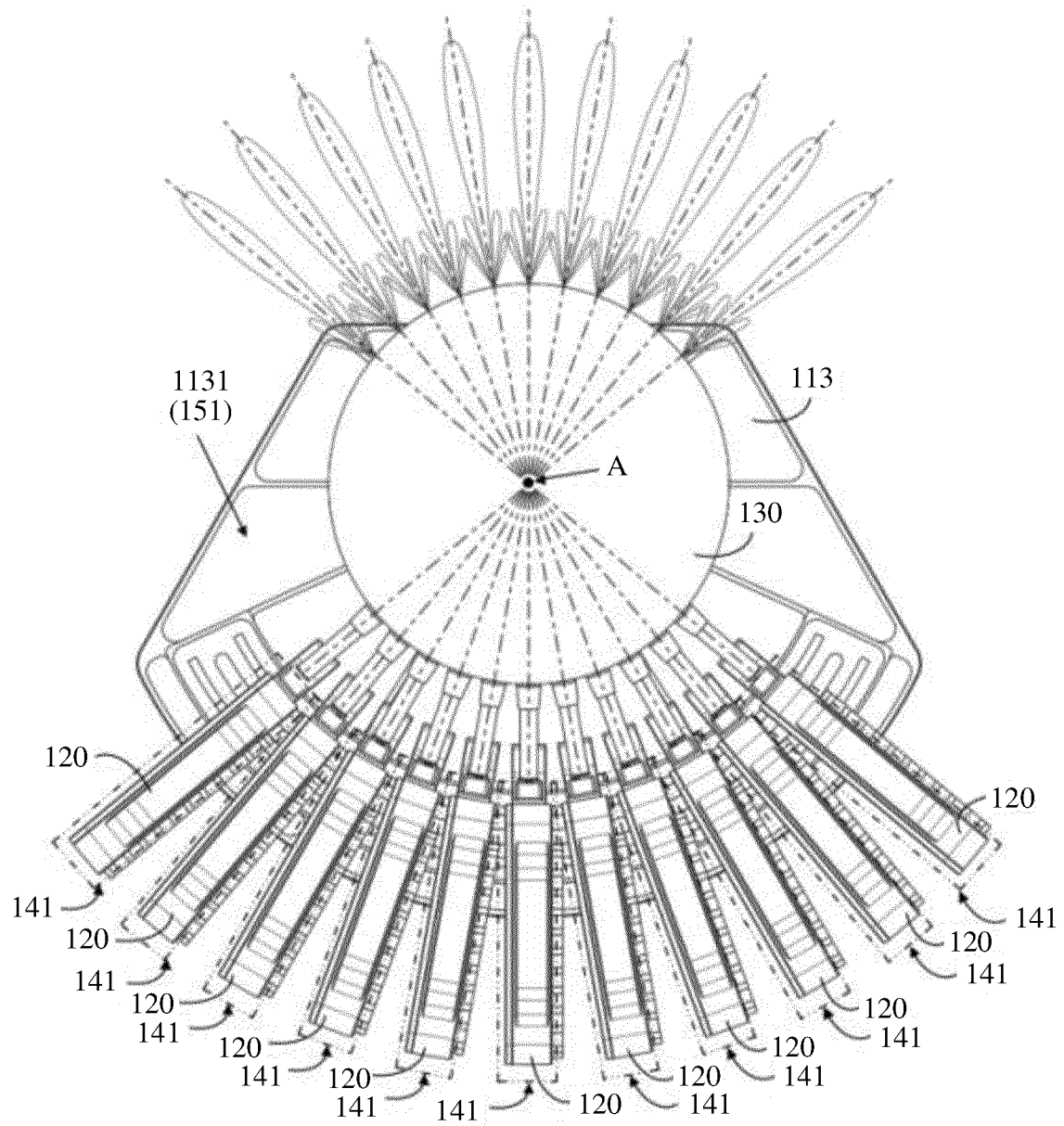


FIG. 26

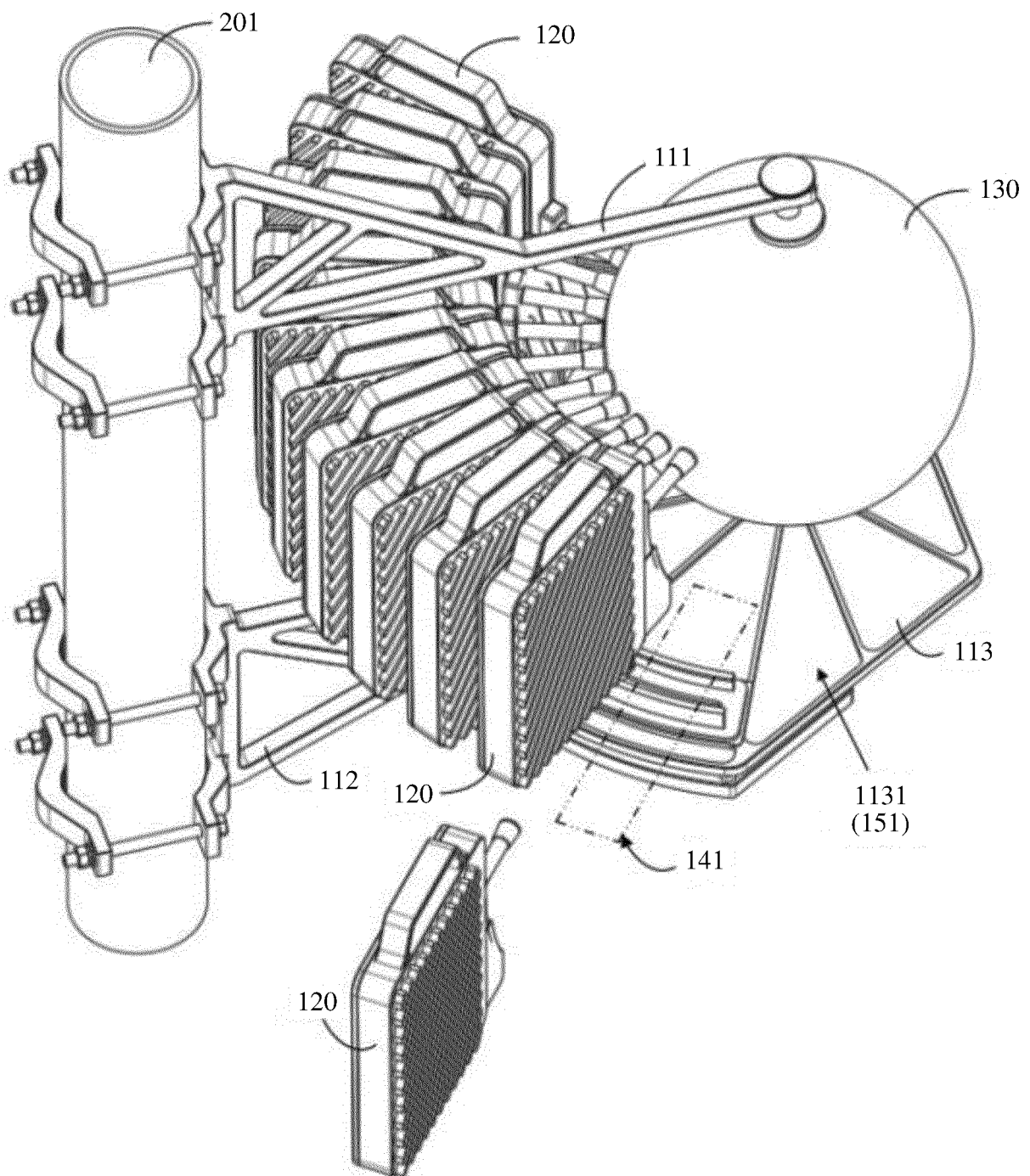


FIG. 27

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2021/131549

| <b>A. CLASSIFICATION OF SUBJECT MATTER</b><br>H01Q 19/06(2006.01)i; H01Q 15/02(2006.01)i; H01Q 3/02(2006.01)i; H04B 7/14(2006.01)i<br><br>According to International Patent Classification (IPC) or to both national classification and IPC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |   |                                                                                                                                   |            |   |                                                                                                     |            |   |                                                                                                                                              |         |   |                                                                                |      |   |                                                                                                       |      |   |                                                                                                |      |
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| <b>B. FIELDS SEARCHED</b><br><br>Minimum documentation searched (classification system followed by classification symbols)<br>H01Q; H04B<br><br>Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |   |                                                                                                                                   |            |   |                                                                                                     |            |   |                                                                                                                                              |         |   |                                                                                |      |   |                                                                                                       |      |   |                                                                                                |      |
| <br>Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)<br><br>CNABS; CNTXT; CNKI; VEN; USTXT; EPTXT; WOTXT; IEEE: 华为, 谢勇锋, 陈泽峰, 赵春雨, 喻斌, 季魁文, 潘明, 龙伯, 龙勃, 透镜, 棱镜, 反射, 天线, 微波, 中继, 基站, 固定, 扫描, 旋转, 波束, 轨道, 滑道, 滑轨, 槽, 电机, 马达, HUAWEI, xie yongfeng, chen zefeng, zhao chunyu, yu bin, ji kuiwen, pan ming, luneberg, lens, prism, reflector, antenna, microwave, relay, base station, NB, fix, scan, beam, pattern, rotate, rail, slot, motor                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |   |                                                                                                                                   |            |   |                                                                                                     |            |   |                                                                                                                                              |         |   |                                                                                |      |   |                                                                                                       |      |   |                                                                                                |      |
| <b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X</td> <td>CN 106785444 A (NO.54 RESEARCH INSTITUTE OF CETC) 31 May 2017 (2017-05-31) description, paragraphs [0026]-[0032], and figures 1-7</td> <td>1-3, 14-21</td> </tr> <tr> <td>X</td> <td>US 6266029 B1 (DATRONTRANSOC INC.) 24 July 2001 (2001-07-24) description, column 2, and figures 1-4</td> <td>1-3, 14-16</td> </tr> <tr> <td>X</td> <td>CN 110380229 A (FOSHAN EAHISON COMMUNICATION CO., LTD.) 25 October 2019 (2019-10-25) description, paragraphs [0036]-[0049], and figures 1-11</td> <td>1-3, 21</td> </tr> <tr> <td>A</td> <td>WO 2016200454 A2 (QUALCOMM INC.) 15 December 2016 (2016-12-15) entire document</td> <td>1-21</td> </tr> <tr> <td>A</td> <td>CN 112216983 A (JIANGSU CHENCHUANG TECHNOLOGY CO., LTD.) 12 January 2021 (2021-01-12) entire document</td> <td>1-21</td> </tr> <tr> <td>A</td> <td>JP 2005061905 A (SUMITOMO ELECTRIC INDUSTRIES LTD.) 10 March 2005 (2005-03-10) entire document</td> <td>1-21</td> </tr> </tbody> </table>                                                                                                                                                                                                                                                                                                                                                                                  | Category*                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Relevant to claim No. | X | CN 106785444 A (NO.54 RESEARCH INSTITUTE OF CETC) 31 May 2017 (2017-05-31) description, paragraphs [0026]-[0032], and figures 1-7 | 1-3, 14-21 | X | US 6266029 B1 (DATRONTRANSOC INC.) 24 July 2001 (2001-07-24) description, column 2, and figures 1-4 | 1-3, 14-16 | X | CN 110380229 A (FOSHAN EAHISON COMMUNICATION CO., LTD.) 25 October 2019 (2019-10-25) description, paragraphs [0036]-[0049], and figures 1-11 | 1-3, 21 | A | WO 2016200454 A2 (QUALCOMM INC.) 15 December 2016 (2016-12-15) entire document | 1-21 | A | CN 112216983 A (JIANGSU CHENCHUANG TECHNOLOGY CO., LTD.) 12 January 2021 (2021-01-12) entire document | 1-21 | A | JP 2005061905 A (SUMITOMO ELECTRIC INDUSTRIES LTD.) 10 March 2005 (2005-03-10) entire document | 1-21 |
| Category*                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Relevant to claim No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                       |   |                                                                                                                                   |            |   |                                                                                                     |            |   |                                                                                                                                              |         |   |                                                                                |      |   |                                                                                                       |      |   |                                                                                                |      |
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| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | CN 112216983 A (JIANGSU CHENCHUANG TECHNOLOGY CO., LTD.) 12 January 2021 (2021-01-12) entire document                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 1-21                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |   |                                                                                                                                   |            |   |                                                                                                     |            |   |                                                                                                                                              |         |   |                                                                                |      |   |                                                                                                       |      |   |                                                                                                |      |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | JP 2005061905 A (SUMITOMO ELECTRIC INDUSTRIES LTD.) 10 March 2005 (2005-03-10) entire document                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1-21                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |   |                                                                                                                                   |            |   |                                                                                                     |            |   |                                                                                                                                              |         |   |                                                                                |      |   |                                                                                                       |      |   |                                                                                                |      |
| <input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.<br><table border="0"> <tr> <td style="vertical-align: top;"> * Special categories of cited documents:<br/> “A” document defining the general state of the art which is not considered to be of particular relevance<br/> “E” earlier application or patent but published on or after the international filing date<br/> “L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)<br/> “O” document referring to an oral disclosure, use, exhibition or other means<br/> “P” document published prior to the international filing date but later than the priority date claimed </td> <td style="vertical-align: top;"> “T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention<br/> “X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone<br/> “Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art<br/> “&amp;” document member of the same patent family </td> </tr> </table> | * Special categories of cited documents:<br>“A” document defining the general state of the art which is not considered to be of particular relevance<br>“E” earlier application or patent but published on or after the international filing date<br>“L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)<br>“O” document referring to an oral disclosure, use, exhibition or other means<br>“P” document published prior to the international filing date but later than the priority date claimed                                                                   | “T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention<br>“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone<br>“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art<br>“&” document member of the same patent family |                       |   |                                                                                                                                   |            |   |                                                                                                     |            |   |                                                                                                                                              |         |   |                                                                                |      |   |                                                                                                       |      |   |                                                                                                |      |
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| Date of the actual completion of the international search<br><br><b>15 December 2021</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Date of mailing of the international search report<br><br><b>05 January 2022</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |   |                                                                                                                                   |            |   |                                                                                                     |            |   |                                                                                                                                              |         |   |                                                                                |      |   |                                                                                                       |      |   |                                                                                                |      |
| Name and mailing address of the ISA/CN<br><br><b>China National Intellectual Property Administration (ISA/CN)</b><br><b>No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China</b><br>Facsimile No. (86-10)62019451                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Authorized officer<br><br><br>Telephone No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |   |                                                                                                                                   |            |   |                                                                                                     |            |   |                                                                                                                                              |         |   |                                                                                |      |   |                                                                                                       |      |   |                                                                                                |      |

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## INTERNATIONAL SEARCH REPORT

International application No.

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