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(54) **DUAL-REFLECTOR ANTENNA AND CONTROL METHOD THEREFOR, AND COMMUNICATION SYSTEM**

DOPPELREFLEKTORANTENNE UND STEUERUNGSVERFAHREN DAFÜR SOWIE
KOMMUNIKATIONSSYSTEM

ANTENNE DOUBLE-RÉFLECTEUR ET PROCÉDÉ DE COMMANDE ASSOCIÉ, ET SYSTÈME DE
COMMUNICATION

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Description

TECHNICAL FIELD

[0001] This application relates to the field of antenna technologies, and in particular, to a dual reflector antenna, a dual reflector antenna control method, and a communication system.

BACKGROUND

[0002] With rapid development of wireless communication technologies, especially a sharp increase in base station data traffic in the era of the 5th generation (5G), a transmission capacity requirement for point-to-point microwave communication (Point-To-Point Microwave Communication) is increasingly high.

[0003] An E-band (E-band) ranges from 71 GHz to 76 GHz and from 81 GHz to 86 GHz. Due to a wide operating frequency band and a large capacity, the E-band gradually becomes a main frequency band for 5G transmission. However, rain fade of electromagnetic waves in the E-band is particularly serious. The "rain fade" herein refers to fade caused when an electric wave enters a rain layer. The "rain fade" limits a transmission distance of the E-band. Therefore, a high-gain E-band antenna is required to increase the transmission distance of the E-band antenna.

[0004] However, the high-gain E-band antenna has a problem that a half-power angle of a radiation pattern is small. For example, in a radiation pattern of an E-band antenna with a diameter of 0.6 m or a diameter of more than 0.6 m shown in FIG. 1, in FIG. 1, a horizontal coordinate indicates an angle, and a vertical coordinate indicates a gain. It can be learned from FIG. 1 that a half-power angle of the antenna is only approximately 0.5°.

[0005] In actual application, an antenna is usually installed on a tower, and the tower and the antenna may shake and deflect under the influence of wind. To prevent a receive frequency of a link on which the antenna is located from greatly decreasing when the antenna shakes, an antenna beam needs to be adjusted in most cases, to ensure stability of signal transmission of the link on which the antenna is located.

[0006] However, when the antenna beam is adjusted, a fault may occur. As a result, the antenna is located at a position within an adjustable range or the antenna is outside the adjustable range. In this way, stability of signal transmission of the link on which the antenna is located deteriorates, and even use of the antenna is limited.

[0007] GB2201293A discloses an aerial sub-reflector mounting structure comprising a tripod, bipod and monopod in which each of the six legs is of variable length. This structure has the advantages that changes in the position or orientation of the sub-reflector may be effected while the sub-reflector remains completely supported by the mounting structure. Preferably the legs of the structure

comprise two threaded bars joined by bottle screws or turn buckles.

[0008] US20160134006A1 discloses terrestrial data communications wireless link including a first link end that has a first directional antenna, a first beacon and a first redirecting assembly coupled to the first directional antenna. The wireless link also includes a second link end having a second directional antenna, a second beacon and a second redirecting assembly coupled to the second directional antenna. In use the first directional antenna and the second directional antenna are maintained in mutual alignment by the first redirecting assembly redirecting the first directional antenna in response to a signal from the second beacon and the second redirecting assembly redirecting the second directional antenna in response to a signal from the first beacon.

[0009] US7446721B2 relates to a satellite tracking antenna system and a satellite tracking method. Step tracking in which the size of a satellite signal sampled in at least one position in which a reflector of the satellite tracking antenna system is tilted is compared to track a satellite is performed, and a measured value of the satellite signal sampled in a specific position in which the reflector is tilted in N-1th tracking and a measured value of the satellite signal sampled in the specific position in which the reflector is tilted in Nth tracking are averaged to compute a value. The reflector is driven according to the value to track the satellite, thereby minimizing a satellite tracking error caused by a sudden movement of a mobile body equipped with the satellite tracking antenna system.

SUMMARY

[0010] Embodiments of this application provide a dual reflector antenna, a dual reflector antenna control method, and a communication system, to provide a dual reflector antenna that can restore the antenna to an initial position and be used as a common antenna when an antenna beam direction cannot be adjusted.

[0011] To achieve the foregoing objective, the following technical solutions are used in embodiments of this application.

[0012] According to a first aspect, this application provides a dual reflector antenna. The dual reflector antenna includes a primary reflector, a secondary reflector, a feed, a first driving structure, and a connecting piece. The secondary reflector is opposite to the primary reflector, and the feed is configured to radiate an electromagnetic wave to the secondary reflector. The first driving structure has a telescopic shaft. The connecting piece is connected to the secondary reflector. When the telescopic shaft is extended, the telescopic shaft abuts against the connecting piece, to drive the secondary reflector to restore to an initial position. The initial position is a position in which a plane on which a diameter of the secondary reflector is located is parallel to a plane on which a diameter of the primary reflector is located.

[0013] The dual reflector antenna provided in this embodiment of this application includes the first driving structure that has the telescopic shaft and the connecting piece that is connected to the secondary reflector, the telescopic shaft can abut against the connecting piece when the telescopic shaft is extended, and the secondary reflector is driven by using the connecting piece to restore to the initial position. In this way, when the dual reflector antenna cannot adjust a beam direction, the telescopic shaft of the first driving structure may be extended and abut against the connecting piece, and the secondary reflector is rotated to the initial position by pushing the connecting piece. Compared with that the secondary reflector deviates from the initial position, the dual reflector antenna can be used as a common antenna to ensure basic performance of the antenna.

[0014] In addition, for example, a size and a weight of the primary reflector are far greater than a size and a weight of the secondary reflector. In this embodiment of this application, the first driving structure drives the secondary reflector with a smaller size and weight to rotate. In this way, compared with driving the primary reflector, power consumption of the first driving structure is reduced.

[0015] In a possible implementation of the first aspect, the dual reflector antenna further includes a second driving structure. The second driving structure has a rotating shaft. The rotating shaft is configured to drive the secondary reflector to rotate along a pitch axis relative to the primary reflector, to adjust the beam direction of the dual reflector antenna. The pitch axis is parallel to the plane on which the diameter of the primary reflector is located.

[0016] In other words, the primary reflector is fastened, and the secondary reflector is rotatable under the drive of the rotating shaft of the second driving structure. In this way, after the dual reflector antenna is installed on a tower, when the tower and the dual reflector antenna shake under the influence of wind, the rotating shaft may drive the secondary reflector to rotate around the pitch axis relative to the primary reflector, to adjust the beam direction of the antenna. In addition, even if the antenna shakes at a large angle under the drive of the tower, a gain of the antenna does not decrease sharply, thereby avoiding interruption of a link on which the antenna is located.

[0017] In a possible implementation of the first aspect, the connecting piece includes a first connecting piece and a second connecting piece. One end of the first connecting piece is connected to the rotating shaft, and the other end of the first connecting piece abuts against the telescopic shaft when the telescopic shaft is extended. One end of the second connecting piece is connected to the rotating shaft, and the other end of the second connecting piece is connected to the secondary reflector.

[0018] Power consumption of the first driving structure and the second driving structure can be further reduced by using the first connecting piece and the second con-

necting piece that are connected to the rotating shaft.

[0019] In a possible implementation of the first aspect, the dual reflector antenna further includes a support. The first driving structure is disposed close to the secondary reflector. One end of the support is fastened relative to the first driving structure, and the other end of the support is fastened relative to the primary reflector.

[0020] In other words, the support is used to support the first driving structure that is close to the secondary reflector and that is suspended in the air.

[0021] In a possible implementation of the first aspect, a part that is of the support, that is located between the primary reflector and the secondary reflector, and that is at least close to the secondary reflector is made of a dielectric material.

[0022] In this way, after the electromagnetic wave radiated by the feed to the secondary reflector is reflected for a first time, the reflected electromagnetic wave radiates to the primary reflector after completely passing through the dielectric material. In this way, performance of the gain and a pattern of the antenna are not deteriorated.

[0023] In a possible implementation of the first aspect, a radial size of a part that is of the support and that is located between the secondary reflector and the primary reflector gradually decreases along a direction from the secondary reflector to the primary reflector, to form a conical structure.

[0024] The conical structure may be used to further reduce influence on the gain and the pattern.

[0025] In a possible implementation of the first aspect, an included angle between a busbar and an axis of the conical structure is 10° to 30°.

[0026] Defining the conical structure may prevent the gain and the pattern from being affected by a wall thickness.

[0027] In a possible implementation of the first aspect, the wall thickness h of the part that is of the support and that is located between the primary reflector and the

secondary reflector is:
$$h = N \times \frac{c}{2f\sqrt{\epsilon_r}}$$
. c is a speed of light, f is an operating frequency of the dual reflector antenna, ϵ_r is a relative dielectric constant of the dielectric material, and N is a positive integer greater than or equal to 1.

[0028] Defining the wall thickness of the support may prevent the gain and the pattern from being affected by the wall thickness.

[0029] In a possible implementation of the first aspect, a sealed cavity is formed in the support, and the first driving structure and the secondary reflector are disposed in the sealed cavity.

[0030] The first driving structure and the secondary reflector are disposed in the sealed cavity to prevent rainwater from entering and damaging the first driving structure and the secondary reflector.

[0031] In a possible implementation of the first aspect,

the support includes a first support, a second support, and a third support. The first support is fastened relative to the primary reflector, and the feed is disposed in the first support. The second support is fastened relative to the first support, and the second support is made of the dielectric material. The third support is fastened relative to the second support, and the first driving structure is fastened in the third support.

[0032] In a possible implementation of the first aspect, the dual reflector antenna further includes an underpan, both the primary reflector and the feed are fastened relative to the underpan, and the feed passes through the primary reflector and faces the secondary reflector.

[0033] According to a second aspect, this application further provides a communication system, including the dual reflector antenna in any implementation of the first aspect and a first controller. The first controller is configured to detect whether a secondary reflector can adjust a beam direction of the dual reflector antenna, and when it is determined that the secondary reflector cannot adjust the beam direction, the first controller controls a telescopic shaft to extend and abut against a connecting piece, to drive the secondary reflector to restore to an initial position.

[0034] In the communication system of this application, when determining that the secondary reflector cannot adjust the beam direction, the first controller controls a first driving structure. The first driving structure starts and extends the telescopic shaft to drive the secondary reflector to rotate to the initial position, to ensure that the dual reflector antenna is a common antenna and has a basic function of the antenna.

[0035] In a possible implementation of the second aspect, the dual reflector antenna further includes a second driving structure that has a rotating shaft, and the communication system further includes an angle detection element and a second controller. The angle detection element is configured to detect a deflection angle of a primary reflector. The second controller controls the rotating shaft to rotate based on the deflection angle, to drive the secondary reflector to rotate relative to the primary reflector, so as to adjust the beam direction of the dual reflector antenna.

[0036] The communication system further includes the angle detection element and the first controller. When the dual reflector antenna is disposed on a tower, and the tower and the dual reflector antenna shake under the influence of wind, the angle detection element may detect a deflection angle at which the dual reflector antenna shakes with the tower. In addition, after receiving a deflection angle signal, the second controller may output instructions that enable the secondary reflector to rotate, and then the second controller controls the second driving structure. In this way, the secondary reflector is driven by the rotating shaft of the second driving structure to adjust the beam direction of the antenna, so that a gain of the antenna basically remains unchanged, and a service of a link on which the antenna is located is maintained to

run normally.

[0037] In a possible implementation of the second aspect, the dual reflector antenna further includes a power supply and an energy storage element. The power supply is configured to supply power to the first driving structure and the second driving structure. When the power supply cannot supply power to the first driving structure, the energy storage element is configured to supply power to the first driving structure.

[0038] The energy storage element is separately disposed to supply power to the first controller and the first driving structure. In this way, when the power supply of the dual reflector antenna fails, the energy storage element can be used to supply power to the first controller and the first driving structure, to ensure that the secondary reflector is restored to the initial position under action of the first controller and the first driving structure.

[0039] According to a third aspect, this application further provides a dual reflector antenna control method. A dual reflector antenna includes a first driving structure that has a telescopic shaft, and a connecting piece connected to a secondary reflector of the dual reflector antenna, and the control method includes:

determining that the secondary reflector of the dual reflector antenna cannot adjust a beam direction of the dual reflector antenna; and
controlling the telescopic shaft to extend and abut against the connecting piece, to drive the secondary reflector to restore to an initial position, where the initial position is a position in which a plane on which a diameter of the secondary reflector is located is parallel to a plane on which a diameter of a primary reflector of the dual reflector antenna is located.

[0040] In a possible implementation of the third aspect, the connecting piece includes a first connecting piece and a second connecting piece, and the dual reflector antenna further includes a second driving structure that has a rotating shaft. One end of the first connecting piece is connected to the rotating shaft. One end of the second connecting piece is connected to the rotating shaft, and the other end of the second connecting piece is connected to the secondary reflector.

[0041] Driving the secondary reflector to restore to an initial position includes:

controlling the telescopic shaft to extend and abut against the first connecting piece, and pushing the first connecting piece and the second connecting piece to rotate around the rotating shaft, to drive the secondary reflector to rotate to the initial position.

[0042] In a possible implementation of the third aspect, the dual reflector antenna further includes a second controller and an angle detection element.

[0043] The control method includes: determining at least one of the following:

determining that the rotating shaft has a rotation

function;
 determining that the second controller has a function of controlling the rotating shaft to rotate; and
 determining that the angle detection element has a function of detecting a deflection angle of the primary reflector.

[0044] In this way, the first controller may detect the rotating shaft, and the second controller may detect the angle detection element, so as to detect any structure that affects rotation of the secondary reflector, thereby improving performance of the dual reflector antenna.

BRIEF DESCRIPTION OF DRAWINGS

[0045]

FIG. 1 is a curve diagram of a gain of a dual reflector antenna;
 FIG. 2 is a schematic diagram of a structure of a dual reflector antenna;
 FIG. 3 is a schematic diagram of a partial structure of a communication system according to an embodiment of this application;
 FIG. 4 is a schematic diagram of a state in which a secondary reflector rotates relative to a primary reflector in a communication system according to an embodiment of this application;
 FIG. 5 is a schematic diagram of a structure of a dual reflector antenna according to an embodiment of this application;
 FIG. 6 is a schematic diagram of a structure of a dual reflector antenna according to an embodiment of this application;
 FIG. 7 is a simulation diagram of beam scanning of a dual reflector antenna according to an embodiment of this application;
 FIG. 8 is a block diagram of a control part of a dual reflector antenna according to an embodiment of this application;
 FIG. 9 is a block diagram of a control part of a dual reflector antenna according to an embodiment of this application;
 FIG. 10 is a schematic diagram of a structure of a dual reflector antenna according to an embodiment of this application;
 FIG. 11 is a schematic diagram of a partial structure of FIG. 10;
 FIG. 12 is a simulation diagram of electrical performance of a dual reflector antenna according to an embodiment of this application;
 FIG. 13 is a flow block diagram of a dual reflector antenna control method according to an embodiment of this application;
 FIG. 14 is a flow block diagram of a dual reflector antenna control method according to an embodiment of this application; and
 FIG. 15 is a flow block diagram of a dual reflector

antenna control method according to an embodiment of this application.

Reference numerals:

[0046] 1: primary reflector; 2: secondary reflector; 3: feed; 4: support base; 5: first motor; 51: telescopic shaft; 6: second motor; 61: rotating shaft; 7: support; 71: first support; 72: second support; 73: third support; 8: underpan; 9: connecting piece; 91: first connecting piece; 92: second connecting piece; and 10: sealing strip.

DESCRIPTION OF EMBODIMENTS

[0047] To facilitate understanding of technical solutions, the following explains technical terms in this application.

[0048] A half-power angle is also referred to as 3 dB beamwidth or half-power beamwidth. In an antenna pattern, for example, each antenna has two or more lobes. A largest lobe is referred to as a main lobe, and the other lobes are referred to as side lobes. Radiation energy of the main lobe is the strongest. In the antenna pattern, in a plane containing a maximum radiation direction of the main lobe, an included angle between two points at which power flux density drops to half (or less than a maximum value 3 dB) of the power flux density relative to the maximum radiation direction is referred to as the half-power angle. A smaller half-power angle indicates better directivity and a stronger anti-interference capability of the antenna.

[0049] Antenna beam (antenna beam): For example, the antenna beam refers to the main lobe (also referred to as a main beam), and is an area in which antenna energy is most concentrated. For example, the antenna has only one main beam, and adjusting the antenna beam refers to adjusting the main beam of the antenna.

[0050] A direction of the antenna beam is a direction of the main beam of the antenna.

[0051] The following describes the technical solutions in embodiments in this application in detail with reference to accompanying drawings.

[0052] In the field of antenna, there is a dual reflector antenna. The dual reflector antenna (for example, a Cassegrain antenna or a Gregory antenna) is commonly used in microwave and millimeter wave bands, and is widely used in satellite communication, microwave communication, a radar, remote sensing, and other wireless communication systems.

[0053] FIG. 2 is a diagram of a structure of a dual reflector antenna. The dual reflector antenna includes a primary reflector 1, a secondary reflector 2, and a feed 3. An electromagnetic signal enters through the feed 3, radiates to the secondary reflector 2 and then is reflected for a first time. The reflected electromagnetic signal propagates to the primary reflector 1 and then is reflected for a second time, and the electromagnetic signal radiates to space after the second reflection. Black dashed

lines with arrows in FIG. 2 indicate propagation paths of the electromagnetic signal. For example, in the dual reflector antenna, the primary reflector 1 uses a rotatable paraboloid, and the secondary reflector 2 uses a rotational hyperboloid.

[0054] Based on characteristics of a hyperboloid and a paraboloid, as shown in FIG. 2, wave paths of beams emitted by F1 of the feed 3 to an aperture S are equal, for example, $F1A1+A1B1+B1C1=F1A2+A2B2+B2C2$. In this case, a spherical wave of the feed whose phase center is at F1 is bound to become a plane wave on a diameter of the primary reflector 1, that is, the S plane is an equal-phase plane, so that the dual reflector antenna has performance of a high gain, a sharp beam, and a small half-power angle.

[0055] When designing the primary reflector 1, a focal-length-to-diameter ratio F/D of the primary reflector 1 is a key parameter. As shown in FIG. 2, in the focal-length-to-diameter ratio F/D of the primary reflector 1, F is a focal length of the primary reflector 1, and D is the diameter of the primary reflector 1. When focal-length-to-diameter ratios F/D are different, gain rollback values obtained when beams are deflected by a same angle are also different. For example, a value range of the focal-length-to-diameter ratio F/D is 0.25 to 0.4. In this embodiment of this application, a primary reflector 1 whose F/D is 0.357 may be selected.

[0056] For example, a diameter of the secondary reflector 2 is approximately one tenth of the diameter of the primary reflector 1, and performance of a secondary reflector whose diameter is 60 mm to 100 mm is better. In this application, a secondary reflector 2 whose diameter is 80 mm may be used.

[0057] The feed 3 may select an open-circular waveguide. To reduce waveguide losses caused by the open-circular waveguide, a diameter of the open-circular waveguide is generally 3 mm to 4 mm. In this application, an open-circular waveguide with a diameter of 3.56 mm may be selected.

[0058] In some implementations, for example, in a communication system, as shown in FIG. 3, the dual reflector antenna is installed on a support base 4 (which may also be referred to as a tower). In this way, the dual reflector antenna shakes with the support base 4 under action of wind force or the like. In FIG. 3, black solid lines indicate structures of the support base 4 and the dual reflector antenna when the support base 4 and the dual reflector antenna do not deflect, and black dashed lines indicate structures of the support base 4 and the dual reflector antenna after deflection. As long as shaking angles of the tower and the dual reflector antenna are greater than a half-power angle of the dual reflector antenna, a gain and a pattern of the antenna are deteriorated, and a received signal level of a link on which the dual reflector antenna is located is greatly reduced, causing interruption of the link including the dual reflector antenna. Therefore, a beam direction of the dual reflector antenna that shakes with the tower needs to be adjusted.

[0059] In some implementations, the primary reflector 1 is fastened relative to the support base 4. In this case, to adjust the beam direction of the antenna, with reference to FIG. 4, the secondary reflector 2 may rotate around a pitch axis L relative to the primary reflector 1. In this way, after an electromagnetic wave radiated by the feed radiates to the secondary reflector 2, a transmission direction of the electromagnetic wave reflected by the secondary reflector 2 changes. Then, the electromagnetic wave is transmitted to the primary reflector 1, and a transmission direction of the electromagnetic wave reflected by the primary reflector 1 also changes. Therefore, beam scanning is implemented, to adjust the beam direction of the antenna and prevent gain deterioration.

[0060] However, when the secondary reflector 2 rotates relative to the primary reflector 1 to adjust the beam direction of the antenna, some abnormal phenomena may occur. As a result, the secondary reflector 2 cannot rotate relative to the primary reflector 1, and the secondary reflector 2 is at a specific position within an adjustable range. Alternatively, a rotation range of the secondary reflector 2 is beyond the adjustable range. For example, the secondary reflector needs to rotate between -15° to 15° , but the secondary reflector cannot continue to rotate when the secondary reflector rotates to 13° , or the secondary reflector rotates to 18° . When the foregoing cases occur, stability of signal transmission of the link on which the antenna is located deteriorates or even is interrupted.

[0061] To find out in time whether the antenna can perform beam direction adjustment, and ensure stability of signal transmission of the link on which the antenna is located, the dual reflector antenna provided in this embodiment of this application further includes a first driving structure and a connecting piece. The connecting piece is connected to the secondary reflector, and the first driving structure has a telescopic shaft. When the secondary reflector cannot adjust the beam direction of the dual reflector antenna, the telescopic shaft of the first driving structure extends and abuts against the connecting piece, and the connecting piece drives the secondary reflector 2 to restore to an initial position. The initial position herein is a position in which a plane on which the diameter of the secondary reflector 2 is located is parallel to a plane on which the diameter of the primary reflector 1 is located, in other words, the diameter of the secondary reflector 2 is aligned with the diameter of the primary reflector 1.

[0062] When the secondary reflector 2 is directly aligned with the primary reflector 1, the dual reflector antenna in this state cannot implement beam scanning or change the beam direction. However, compared with an antenna whose secondary reflector is at another position, the antenna may further be used as a common antenna and has a basic function of the antenna. The common antenna herein is the antenna in which the diameter of the secondary reflector 2 is aligned with the diameter of the primary reflector 1.

[0063] FIG. 5 shows that the first driving structure may

be a first motor 5, and an output shaft of the first motor may move along an axial direction. For example, the output shaft of the first motor 5 is a telescopic shaft 51, and the telescopic shaft 51 of the first motor may move to a connecting piece 9 that is connected to the secondary reflector 2. Force is applied to the connecting piece 9 to push the secondary reflector 2 to rotate around the pitch axis L shown in FIG. 4 relative to the primary reflector 1.

[0064] In addition, the first driving structure may alternatively be a telescopic cylinder, a telescopic oil cylinder, or the like, and telescopic rods in the telescopic cylinder and the telescopic oil cylinder each are the telescopic shaft in this application. The first driving structure is not specifically limited in this application, and may alternatively be another driving structure that has a telescopic shaft.

[0065] To control extension of the telescopic shaft of the first driving structure, optionally, the dual reflector antenna further includes a first controller. The first controller is configured to determine whether the secondary reflector can adjust the beam direction of the dual reflector antenna. When it is determined that the secondary reflector cannot adjust the beam direction, the first controller controls the telescopic shaft of the first driving structure to extend and abut against the connecting piece, to drive the secondary reflector to restore to the initial position.

[0066] This application further provides a structure configured to rotate the secondary reflector relative to the primary reflector, to adjust a beam of the antenna. For example, the dual reflector antenna further includes a second driving structure, and the second driving structure has a rotating shaft. The rotating shaft is parallel to the plane on which the diameter of the primary reflector 1 is located, and the secondary reflector 2 is driven to rotate by using the rotating shaft. In other words, the second driving structure provides rotation power to the secondary reflector 2, to prompt the secondary reflector 2 to rotate.

[0067] Optionally, this application further provides the second driving structure configured to drive the secondary reflector 2 to rotate. Compared with the primary reflector 1, the secondary reflector 2 has a smaller volume and a lighter weight. Therefore, compared with driving the primary reflector 1 to rotate, power consumption of the second driving structure is reduced, and power consumption of the entire dual reflector antenna is reduced. In addition, the second driving structure with the light weight and the small volume may be selected, so that a weight and a volume of the entire antenna are reduced.

[0068] The second driving structure that drives the secondary reflector 2 to rotate may have a plurality of structures. For example, the second driving structure may be a motor whose output shaft can rotate, and the output shaft of the motor is directly connected to the secondary reflector, to drive the secondary reflector to rotate. For another example, the second driving structure

may alternatively be a motor with a telescopic output shaft, and the output shaft of the motor is connected to a transmission structure. The transmission structure herein can convert a linear motion into a rotational motion, for example, a spiral transmission structure. Then, the transmission structure is connected to the secondary reflector. In other words, the output shaft of the motor moves linearly, and the secondary reflector rotates through conversion of the transmission structure. The second driving structure is not specifically limited in this application, and may alternatively be another driving structure that has a rotation function.

[0069] FIG. 6 shows that the second driving structure is a second motor 6, and an output shaft of the second motor 6 is a rotating shaft 61. Herein, the rotating shaft 61 is disposed in parallel to the pitch axis L, and the rotating shaft 61 is connected to the secondary reflector 2. After the second motor 6 is started, the rotating shaft 61 of the second motor rotates, to drive the secondary reflector 2 to rotate around the rotating shaft 61 that is of the second motor and that is parallel to the pitch axis.

[0070] FIG. 7 is a simulation diagram in which the second driving structure is used to drive the secondary reflector to perform beam scanning. The figure shows a corresponding range of an antenna beam scanning angle when the second driving structure drives the secondary reflector to rotate in a range of -15° to 0° . In FIG. 7, a horizontal coordinate is a beam scanning angle, and a vertical coordinate is a gain. It can be learned from this figure that, when the second driving structure drives the secondary reflector to rotate in the range of -15° to 0° , a range of the antenna beam scanning angle is close to -2° to 0° . In addition, it can be learned from FIG. 7 that, when the antenna beam scanning angle is close to 0° , the gain is close to 53.6 dB, and when the antenna beam scanning angle is close to -2° , the gain is close to 50.5 dB. Therefore, when the antenna beam is scanned to a range of -2° to 0° , the gain is only approximately 3 dB lower than that when no scanning is performed, and antenna performance is excellent.

[0071] To adjust the beam direction of the antenna in real time and improve the antenna performance, with reference to FIG. 8, the dual reflector antenna may further include an angle detection element and a second controller. The angle detection element is configured to detect a deflection angle of the primary reflector, for example, an angle at which the primary reflector is deflected when driven by the tower. The second controller controls the rotating shaft of the second driving structure to rotate based on the deflection angle detected by the angle detection element, to drive the secondary reflector 2 to rotate relative to the primary reflector 1.

[0072] In other words, the angle detection element detects that the primary reflector is deflected, and transmits a deflection angle signal to the second controller. After performing corresponding processing, the second controller outputs an angle control signal, and controls the rotating shaft 61 of the second motor to rotate, so that

the secondary reflector 2 rotates to a corresponding angle.

[0073] The angle detection element herein has a plurality of embodiments. For example, a gyroscope may be used for detection, an angle detection sensor may be used, or another structure used for angle detection may be used.

[0074] The angle detection element may be installed on the primary reflector 1 or on the tower.

[0075] The angle detection element and the second controller may be installed in a control box, and the control box is electrically connected to the second motor through a cable.

[0076] The dual reflector antenna provided in this embodiment of this application further includes a power supply, and the power supply may supply power to the first driving structure and the second driving structure. For example, the power supply is disposed in the control box, and is connected to the first driving structure and the second driving structure through the cable.

[0077] It should be noted that the first controller and the second controller may be different microcontroller units (Microcontroller Units, MCUs), or a same MCU.

[0078] When the dual reflector antenna includes the first driving structure, the second driving structure, the angle detection element, and the power supply, a condition for triggering the first controller to control the telescopic shaft of the first driving structure to extend to drive the secondary reflector to restore to the initial position may include at least one of the following. As shown in FIG. 9, for example, the first controller determines that the rotating shaft of the second driving structure can rotate to drive the secondary reflector to rotate. For another example, the first controller determines whether the second controller has a function of controlling the rotating shaft of the second driving structure to rotate. For another example, the first controller determines whether the angle detection element has a function of detecting the deflection angle of the primary reflector, in other words, whether the angle detection element can detect the deflection angle of the primary reflector. For another example, the first controller determines whether the power supply can supply power to the first driving structure and the second driving structure.

[0079] It can be understood that, when detecting that any of the foregoing structures cannot work normally, the first controller triggers extension of the telescopic shaft of the first driving structure, to make the secondary reflector return to zero. Returning to zero herein is to restore the secondary reflector to the initial position.

[0080] When the power supply cannot supply power to the first driving structure and the second driving structure, the first driving structure cannot drive the secondary reflector to restore to the initial position. Therefore, the dual reflector antenna in this embodiment of this application further includes an energy storage element. When the power supply cannot supply power to the first driving structure, the energy storage element supplies power to

the first controller and the first driving structure, to restore the secondary reflector to the initial position.

[0081] The energy storage element may be a large-capacity battery, a rechargeable battery, a large-capacity capacitor, or the like.

[0082] When the dual reflector antenna has both the first driving structure and the second driving structure, this application provides a structure that can make a connection structure compact and reduce power consumption. For example, with reference to FIG. 10, the connecting piece 9 includes a first connecting piece 91 and a second connecting piece 92. One end of the first connecting piece 91 is connected to the rotating shaft 61, and the other end of the first connecting piece 91 abuts against the telescopic shaft 51 when the telescopic shaft 51 is extended. One end of the second connecting piece 92 is connected to the rotating shaft 61, and the other end of the second connecting piece 92 is connected to the secondary reflector 2.

[0083] A working process of the structure shown in FIG. 10 is as follows: When the secondary reflector 2 rotates relative to the primary reflector 1 to adjust the beam direction, the telescopic shaft 51 is in a retracted state, is separated from the first connecting piece 91 without contacting, and the rotating shaft 61 rotates. The second connecting piece 92 drives the secondary reflector to rotate relative to the primary reflector 1, to adjust the beam direction. When it is determined that the secondary reflector 2 cannot rotate relative to the primary reflector 1, the beam direction of the dual reflector antenna cannot be adjusted. In this case, the telescopic shaft 51 is extended and abuts against the first connecting piece 91, and applies pushing force to the first connecting piece 91, so that the first connecting piece 91 and the second connecting piece 92 rotate around the rotating shaft 61. Because the rotating shaft 61 is parallel to the pitch axis, the secondary reflector 2 is driven to restore to the initial position.

[0084] In other words, in FIG. 10, the telescopic shaft 51 and the rotating shaft 61 are matched by using the first connecting piece 91 and the second connecting piece 92. In this way, when the secondary reflector 2 rotates by a same angle, power consumption of the first driving structure and the second driving structure can be correspondingly reduced. In addition, in this application, the pushing force is applied to the first connecting piece 91 to push the rotating shaft 61 to rotate, so as to enable the secondary reflector to be restored to the initial position. In this way, when the dual reflector antenna cannot perform beam direction adjustment, the telescopic shaft keeps pushing the rotating shaft, so that the secondary reflector is in a stable state and does not shake, and stability of the gain and the pattern when the dual reflector antenna is used as a common antenna is ensured.

[0085] In some implementations, with reference to FIG. 10, the primary reflector 1 is fastened relative to an underpan 8, and the secondary reflector 2, the first motor 5, and the second motor 6 are located on a side that

is of the primary reflector 1 and that is away from the underpan 8. In this case, the dual reflector antenna further includes a support 7. The first motor 5 and the second motor 6 are fastened relative to the support 7, and the other end of the support 7 is fastened relative to the primary reflector 1, or is fastened relative to the underpan 8 through the primary reflector 1, that is, the first motor 5 and second motor 6 suspended in the air are fastened by using the support 7. The support 7 may be in a regular shape such as a cone, a cylinder, or a rectangle, or may be in an irregular shape.

[0086] A part of the support 7 is on a propagation path of the electromagnetic signal. Therefore, in order to prevent the support 7 from blocking propagation of the electromagnetic signal, a part that is of the support 7 and that is between the primary reflector 1 and the secondary reflector 2 is made of a dielectric material. The dielectric material has a relative dielectric constant less than 4.5. For example, the dielectric material includes a material such as polyphenylene oxide (Polyphenylene Oxide, PPO) or polycarbonate (Polycarbonate, PC). In this way, an electromagnetic wave signal reflected from the secondary reflector 2 radiates to the primary reflector 1 after completely passing through the support 7, and the antenna performance is not affected compared with a support made of metal.

[0087] The closer a part of the support 7 is to the primary reflector 1, the fewer electromagnetic signals passing through the part. Therefore, the part that is of the support 7, that is located between the primary reflector 1 and the secondary reflector 2, and that is close to the secondary reflector 2 can be made of the dielectric material. The rest may be made of a dielectric electrical material or another material (for example, a metal material) with higher strength. In this way, the antenna performance is not affected on the premise that high strength and good stability of an entire structure is ensured.

[0088] Selection of a shape and a wall thickness of the part that is of the support 7 and that is between the primary reflector 1 and the secondary reflector 2 also affects the antenna performance.

[0089] With reference to FIG. 11, a radial size (size of D in the figure) of the support 7 gradually decreases along a direction from the secondary reflector 2 to the primary reflector 1, and it can be understood that the support 7 is of a conical structure. In addition, an included angle θ between a busbar and an axis of the conical structure is between 10° and 30° , or between 12° and 30° . In the dual reflector antenna in this application, θ may be selected as 20° .

[0090] With reference to FIG. 11, the wall thickness h of the part that is of the support 7 and that is between the primary reflector 1 and the secondary reflector 2 is:

$$h = N \times \frac{c}{2f\sqrt{\epsilon_r}}$$
 C is a speed of light, f is a center frequency of the dual reflector antenna, ϵ_r is the relative dielectric constant of the dielectric material, and N is a positive integer greater than or equal to 1. For example,

when an operating frequency range of the dual reflector antenna is 71 GHz to 86 GHz, the center frequency f is 78.5 GHz. When the relative dielectric constant ϵ_r of the dielectric material is selected as 2.55, h may be selected as 1.2 mm, 2.4 mm, 3.6 mm, 4.8 mm, or the like. h may alternatively be selected to be close to 1.2 mm, 2.4 mm, 3.6 mm, or 4.8 mm, for example, a tolerance is approximately 5% or 10%.

[0091] In some implementations, with reference to FIG. 10, the feed 3 is installed in a first support 71, the first motor 5 and the second motor 6 are installed in a third support 73, and the support 7 further includes a second support 72. The first support 71, the second support 72, and the third support 73 may be assembled into the support 7 described above.

[0092] When the dual reflector antenna is installed on site, after the primary reflector 1 and the first support 71 mounted with the feed 3 are fastened relative to the underpan 8, the second support 72 and the third support 73 mounted with the first motor 5 and the second motor 6 are assembled, and relative positions of the primary reflector 1 and the secondary reflector 2 are adjusted.

[0093] Optionally, in order to make the first motor 5, the second motor 6, and the secondary reflector 2 locate in an environment with good air tightness, a sealed cavity is formed in the support 7. The first motor 5, the second motor 6, and the secondary reflector 2 are located in the sealed cavity to prevent rainwater from entering the cavity formed by the supports and influencing performance of the first motor and the second motor. Therefore, when the second support 72 is installed with the first support 71 and the third support 73, sealing strips 10 are disposed at a joint between the second support 72 and the first support 71 and a joint between the second support 72 and the third support 73, so that the first motor, the second motor, and the secondary reflector are in a closed environment.

[0094] Because the second support 72 is located between the primary reflector 1 and the secondary reflector 2, the second support 72 is made of the dielectric material, and the first support 71 is close to the primary reflector 1, and has little impact on transmission of the electromagnetic signal. Therefore, the first support 71 may be made of the metal material, to ensure strength of the entire structure. The third support 73 may also be made of the metal material.

[0095] FIG. 12 is a simulation diagram of electrical performance of the dual reflector antenna in this application when h of the second support 72 is selected as 3.6 mm and θ is 20° , and a simulation diagram of electrical performance of a dual reflector antenna that is not provided with a second support. In FIG. 12, a horizontal coordinate is an angle, a vertical coordinate is a gain, a curve 1 is a gain curve of the dual reflector antenna that is not provided with the second support 72, and a curve 2 is a gain curve of the dual reflector antenna provided with the second support 72. It can be learned from results that the two curves basically coincide, and this proves that the

second support made of the dielectric material in the present invention had little deterioration effect on the performance of the gain and the pattern of the antenna.

[0096] For the dual reflector antenna, this application further provides a dual reflector antenna control method. The control method includes a control method for returning the secondary reflector to zero, and a control method for adjusting the beam direction.

[0097] With reference to FIG. 13, a control method for returning a secondary reflector to zero includes the following steps.

[0098] S11: Determine that the secondary reflector cannot adjust a beam direction of a dual reflector antenna.

[0099] S12: Control a telescopic shaft to extend and abut against a connecting piece, to drive the secondary reflector to restore to an initial position, where the initial position is a position in which a plane on which a diameter of the secondary reflector is located is parallel to a plane on which a diameter of a primary reflector of the dual reflector antenna is located. That is, the secondary reflector is returned to zero.

[0100] When a structure of the dual reflector antenna is shown in FIG. 10, to be specific, when the dual reflector antenna includes a first connecting piece 91 and a second connecting piece 92, driving the secondary reflector to restore to an initial position specifically includes: controlling a telescopic shaft 51 to extend and abut against the first connecting piece 91, and pushing the first connecting piece 91 and the second connecting piece 92 to rotate around a rotating shaft 61, to drive the secondary reflector 2 to rotate to the initial position.

[0101] In step S11, a condition for determining that the secondary reflector cannot adjust the beam direction of the dual reflector antenna is described above, and details are not described herein again.

[0102] With reference to FIG. 14, a control method for adjusting a beam direction includes the following steps.

[0103] S21: Detect a deflection angle of a primary reflector.

[0104] When a dual reflector antenna including the primary reflector and a secondary reflector shakes with a tower, a deflection angle of the primary reflector or a deflection angle of the tower may be detected.

[0105] S22: Control a rotating shaft based on the deflection angle, where the rotating shaft drives the secondary reflector to rotate along a pitch axis relative to the primary reflector, to adjust the beam direction of the dual reflector antenna.

[0106] For example, when it is detected that the deflection angle of the primary reflector is -15° , the rotating shaft drives the secondary reflector to rotate -1.5° relative to the primary reflector. This is only an example description, and does not mean that in practice, when the deflection angle of the primary reflector is -15° , a rotation angle of the secondary reflector needs to be -1.5° .

[0107] It should be noted that: when a plane on which a diameter of the secondary reflector is located is parallel to

a plane on which a diameter of the primary reflector is located, an angle at which the secondary reflector rotates relative to the primary reflector is 0° ; when the secondary reflector rotates relative to the primary reflector in a first direction, the rotation angle is greater than 0° ; and when the secondary reflector rotates relative to the primary reflector in a second direction opposite to the first direction, the rotation angle is less than 0° .

[0108] In a beam direction adjustment process, whether the secondary reflector can adjust the beam direction may be detected in real time, or may be detected periodically.

[0109] During specific implementation, if it is detected that the secondary reflector cannot adjust the beam direction, the secondary reflector is returned to zero, and a fault alarm may be activated to prompt replacement or maintenance of a device.

[0110] Before the beam direction adjustment is performed, self-check may further be performed on the dual reflector antenna, to ensure that the beam direction adjustment can be performed. In this case, before the secondary reflector rotates relative to the primary reflector, the control method further includes: detecting whether the secondary reflector can adjust the beam direction of the dual reflector antenna. When it is detected that the secondary reflector can adjust the beam direction, the rotating shaft drives the secondary reflector to rotate; and when it is detected that the secondary reflector cannot adjust the beam direction, the fault alarm is activated to prompt replacement or maintenance of the device.

[0111] In addition to detection before and in a rotation process of the secondary reflector, in some scenarios, a first controller may also control a telescopic shaft of a first driving structure to extend, to drive the secondary reflector to restore to the initial position. For example, the dual reflector antenna needs to be maintained, an angle detection element indicates long-term shaking beyond an allowable range, the first controller and the first driving structure need to be checked periodically, and the like.

[0112] FIG. 15 is a flow block diagram of specific use of a dual reflector antenna. After a dual reflector antenna system is initialized, when it is determined that a secondary reflector can adjust a beam direction of the dual reflector antenna, the beam direction of the dual reflector antenna is adjusted. A method for adjusting the beam direction of the dual reflector antenna is described above. The beam direction of the dual reflector antenna is adjusted, and fault detection is performed. When it is determined that the beam direction of the dual reflector antenna cannot be adjusted, a telescopic shaft is controlled to extend and abut against a connecting piece, to drive the secondary reflector to restore to an initial position.

[0113] In the descriptions of this specification, specific features, structures, materials, or characteristics may be combined in a proper manner in any one or more of embodiments or examples.

[0114] The foregoing descriptions are merely specific implementations of this application, but are not intended to limit the protection scope of this application. Any variation or replacement readily figured out by a person skilled in the art within the technical scope disclosed in this application shall fall within the protection scope of this application. Therefore, the protection scope of this application shall be subject to the protection scope of the claims.

Claims

1. A dual reflector antenna, comprising:

a primary reflector (1), a secondary reflector (2), and a feed (3), wherein the primary reflector (1) is opposite to the secondary reflector (2), and the feed (3) is configured to radiate an electromagnetic wave to the secondary reflector (2);
a first driving structure, having a telescopic shaft (51); and
a connecting piece (9), connected to the secondary reflector (2), wherein the dual reflector antenna is configured such that
when the telescopic shaft (51) is extended, the telescopic shaft (51) abuts against the connecting piece (9), to drive the secondary reflector (2) to restore to an initial position, wherein the initial position is a position in which a plane on which a diameter of the secondary reflector (2) is located is parallel to a plane on which a diameter of the primary reflector (1) is located.

2. The dual reflector antenna according to claim 1, wherein the dual reflector antenna further comprises:

a second driving structure, having a rotating shaft, wherein
the rotating shaft is configured to drive the secondary reflector to rotate relative to the primary reflector along a pitch axis, to adjust a beam direction of the dual reflector antenna, wherein the pitch axis is parallel to the plane on which the diameter of the primary reflector is located.

3. The dual reflector antenna according to claim 2, wherein the connecting piece comprises a first connecting piece and a second connecting piece;

one end of the first connecting piece is connected to the rotating shaft, and when the telescopic shaft is extended, the other end of the first connecting piece abuts against the telescopic shaft; and
one end of the second connecting piece is connected to the rotating shaft, and the other end of

the second connecting piece is connected to the secondary reflector.

4. The dual reflector antenna according to any one of claims 1 to 3, wherein the dual reflector antenna further comprises:

a support, wherein the first driving structure is disposed close to the secondary reflector, one end of the support is fastened relative to the first driving structure, and the other end of the support is fastened relative to the primary reflector.

5. The dual reflector antenna according to claim 4, wherein a part that is of the support, that is located between the primary reflector and the secondary reflector, and that is at least close to the secondary reflector is made of a dielectric material.

6. The dual reflector antenna according to claim 4 or 5, wherein a radial size of a part that is of the support and that is located between the secondary reflector and the primary reflector gradually decreases along a direction from the secondary reflector to the primary reflector, to form a conical structure.

7. The dual reflector antenna according to claim 6, wherein an included angle between a busbar and an axis of the conical structure is 10° to 30°.

8. The dual reflector antenna according to any one of claims 4 to 7, wherein a wall thickness h of the part that is of the support and that is located between the secondary reflector and the primary reflector is:

$$h = N \times \frac{c}{2f\sqrt{\epsilon_r}}, \text{ wherein}$$

c is a speed of light, f is a center frequency of the dual reflector antenna, ϵ_r is a relative dielectric constant of the dielectric material, and N is a positive integer greater than or equal to 1.

9. The dual reflector antenna according to any one of claims 4 to 8, wherein a sealed cavity is formed in the support, and the first driving structure and the secondary reflector are disposed in the sealed cavity.

10. The dual reflector antenna according to any one of claims 4 to 9, wherein the support comprises:

a first support, wherein the first support is fastened relative to the primary reflector, and the feed is disposed in the first support;
a second support, wherein the second support is fastened relative to the first support, and the second support is made of a dielectric material; and
a third support, wherein the third support is fastened relative to the second support, and the first driving structure is fastened in the third

support.

11. A communication system, comprising:

the dual reflector antenna according to any one of claims 1 to 10; and
a first controller, wherein the first controller is configured to detect whether a secondary reflector (2) can adjust a beam direction of the dual reflector antenna, and when it is determined that the secondary reflector (2) cannot adjust the beam direction, the first controller controls a telescopic shaft (51) to extend and abut against a connecting piece (9), to drive the secondary reflector (2) to restore to an initial position.

12. The communication system according to claim 11, wherein the dual reflector antenna further comprises a second driving structure that has a rotating shaft, and the communication system further comprises:

an angle detection element, configured to detect a deflection angle of a primary reflector; and
a second controller, configured to control, based on the deflection angle, the rotating shaft to rotate, to drive the secondary reflector to rotate relative to the primary reflector, so as to adjust the beam direction of the dual reflector antenna.

13. A dual reflector antenna control method, wherein a dual reflector antenna comprises a first driving structure that has a telescopic shaft (51) and a connecting piece (9) that is connected to a secondary reflector (2) of the dual reflector antenna, and the control method comprises:

determining that the secondary reflector (2) of the dual reflector antenna cannot adjust a beam direction of the dual reflector antenna; and
controlling the telescopic shaft (51) to extend and abut against the connecting piece (9), to drive the secondary reflector (2) to restore to an initial position, wherein the initial position is a position in which a plane on which a diameter of the secondary reflector (2) is located is parallel to a plane on which a diameter of a primary reflector (1) of the dual reflector antenna is located.

14. The dual reflector antenna control method according to claim 13, wherein the connecting piece comprises a first connecting piece and a second connecting piece, the dual reflector antenna further comprises a second driving structure that has a rotating shaft, one end of the first connecting piece is connected to the rotating shaft, one end of the second connecting piece is connected to the rotating shaft, and the other end of the second connecting piece is connected to

the secondary reflector; and
driving the secondary reflector to restore to an initial position comprises:

controlling the telescopic shaft to extend and abut against the first connecting piece, and pushing the first connecting piece and the second connecting piece to rotate around the rotating shaft, to drive the secondary reflector to rotate to the initial position.

15. The dual reflector antenna control method according to claim 14, wherein the dual reflector antenna further comprises a second controller and an angle detection element; and
the control method comprises: determining at least one of the following:

determining that the rotating shaft has a rotation function;
determining that the second controller has a function of controlling the rotating shaft to rotate; and
determining that the angle detection element has a function of detecting a deflection angle of the primary reflector.

Patentansprüche

1. Doppelreflektorantenne, die umfasst:

einen Primärreflektor (1), einen Sekundärreflektor (2) und eine Zuleitung (3), wobei der Primärreflektor (1) dem Sekundärreflektor (2) gegenüberliegt und die Zuleitung (3) konfiguriert ist, um eine elektromagnetische Welle an den Sekundärreflektor (2) auszustrahlen;
eine erste Antriebsstruktur, die eine Teleskopwelle (51) aufweist; und
ein Verbindungsstück (9), das mit dem Sekundärreflektor (2) verbunden ist, wobei die Doppelreflektorantenne derart konfiguriert ist, dass, wenn die Teleskopwelle (51) ausgefahren ist, die Teleskopwelle (51) gegen das Verbindungsstück (9) stößt, um den Sekundärreflektor (2) anzutreiben, um eine Ausgangsposition wiederherzustellen,
wobei die Ausgangsposition eine Position ist, in der eine Ebene, auf der sich ein Durchmesser des Sekundärreflektors (2) befindet, parallel zu einer Ebene, auf der sich ein Durchmesser des Primärreflektors (1) befindet, ist.

2. Doppelreflektorantenne nach Anspruch 1, wobei die Doppelreflektorantenne ferner umfasst:
eine zweite Antriebsstruktur, die eine Drehwelle aufweist, wobei die Drehwelle konfiguriert ist, um den Sekundärreflektor anzutreiben, um sich relativ zu dem Primärreflektor entlang einer Nickachse zu dre-

hen, um eine Strahlrichtung der Doppelreflektorantenne anzupassen, wobei die Nickachse parallel zu der Ebene, auf der sich der Durchmesser des Primärreflektors befindet, ist.

3. Doppelreflektorantenne nach Anspruch 2, wobei das Verbindungsstück ein erstes Verbindungsstück und ein zweites Verbindungsstück umfasst;

ein Ende des ersten Verbindungsstücks mit der Drehwelle verbunden ist, und wenn die Teleskopwelle ausgefahren ist, das andere Ende des ersten Verbindungsstücks gegen die Teleskopwelle stößt; und

ein Ende des zweiten Verbindungsstücks mit der Drehwelle verbunden ist, und das andere Ende des zweiten Verbindungsstücks mit dem Sekundärreflektor verbunden ist.

4. Doppelreflektorantenne nach einem der Ansprüche 1 bis 3, wobei die Doppelreflektorantenne ferner umfasst:

eine Halterung, wobei die erste Antriebsstruktur nahe dem Sekundärreflektor angeordnet ist, ein Ende der Halterung relativ zu der ersten Antriebsstruktur befestigt ist und das andere Ende der Halterung relativ zu dem Primärreflektor befestigt ist.

5. Doppelreflektorantenne nach Anspruch 4, wobei ein Teil, der zu der Halterung gehört, der sich zwischen dem Primärreflektor und dem Sekundärreflektor befindet, und der mindestens nahe dem Sekundärreflektor ist, aus einem dielektrischen Material hergestellt ist.

6. Doppelreflektorantenne nach Anspruch 4 oder 5, wobei eine radiale Größe eines Teils, der zu der Halterung gehört und der sich zwischen dem Sekundärreflektor und dem Primärreflektor befindet, entlang einer Richtung von dem Sekundärreflektor zu dem Primärreflektor allmählich abnimmt, um eine konische Struktur auszubilden.

7. Doppelreflektorantenne nach Anspruch 6, wobei ein eingeschlossener Winkel zwischen einer Sammelschiene und einer Achse der konischen Struktur 10° bis 30° beträgt.

8. Doppelreflektorantenne nach einem der Ansprüche 4 bis 7, wobei eine Wandstärke h des Teils, der zu der Halterung gehört und der sich zwischen dem Sekundärreflektor und dem Primärreflektor befindet,

beträgt:
$$h = N \times \frac{c}{2f\sqrt{\epsilon_r}}$$
, wobei

c eine Lichtgeschwindigkeit ist, f eine Mittenfrequenz der Doppelreflektorantenne ist, ϵ_r eine relative Dielektrizitätskonstante des dielektrischen Ma-

terials ist, und N eine positive ganze Zahl größer als oder gleich 1 ist.

9. Doppelreflektorantenne nach einem der Ansprüche 4 bis 8, wobei ein abgedichteter Hohlraum in der Halterung ausgebildet ist und die erste Antriebsstruktur und der Sekundärreflektor in dem abgedichteten Hohlraum angeordnet sind.

10. Doppelreflektorantenne nach einem der Ansprüche 4 bis 9, wobei die Halterung umfasst:

eine erste Halterung, wobei die erste Halterung relativ zu dem Primärreflektor befestigt ist und die Zuleitung in der ersten Halterung angeordnet ist;

eine zweite Halterung, wobei die zweite Halterung relativ zu der ersten Halterung befestigt ist und die zweite Halterung aus einem dielektrischen Material hergestellt ist; und

eine dritte Halterung, wobei die dritte Halterung relativ zu der zweiten Halterung befestigt ist und die erste Antriebsstruktur in der dritten Halterung befestigt ist.

11. Kommunikationssystem, das umfasst:

die Doppelreflektorantenne nach einem der Ansprüche 1 bis 10; und

eine erste Steuervorrichtung, wobei die erste Steuervorrichtung konfiguriert ist, um zu erkennen, ob ein Sekundärreflektor (2) eine Strahlrichtung der Doppelreflektorantenne anpassen kann, und wenn bestimmt wird, dass der Sekundärreflektor (2) die Strahlrichtung nicht anpassen kann, die erste Steuervorrichtung eine Teleskopwelle (51) steuert, um auszufahren und gegen ein Verbindungsstück (9) zu stoßen, um den Sekundärreflektor (2) anzutreiben, um eine Ausgangsposition wiederherzustellen.

12. Kommunikationssystem nach Anspruch 11, wobei die Doppelreflektorantenne ferner eine zweite Antriebsstruktur umfasst, die eine Drehwelle aufweist, und das Kommunikationssystem ferner umfasst:

ein Winkelerkennungselement, das konfiguriert ist, um einen Ablenkwinkel eines Primärreflektors zu erkennen; und

eine zweite Steuervorrichtung, die konfiguriert ist, um basierend auf dem Ablenkwinkel die Drehwelle zu steuern, um sich zu drehen, um den Sekundärreflektor anzutreiben, um sich relativ zu dem Primärreflektor zu drehen, um die Strahlrichtung der Doppelreflektorantenne anzupassen.

13. Doppelreflektorantennensteuerverfahren, wobei ei-

ne Doppelreflektorantenne eine erste Antriebsstruktur umfasst, die eine Teleskopwelle (51) und ein Verbindungsstück (9) aufweist, das mit einem Sekundärreflektor (2) der Doppelreflektorantenne verbunden ist, und das Steuerverfahren umfasst:

Bestimmen, dass der Sekundärreflektor (2) der Doppelreflektorantenne eine Strahlrichtung der Doppelreflektorantenne nicht anpassen kann; und
Steuern der Teleskopwelle (51), um auszufahren und gegen das Verbindungsstück (9) zu stoßen, um den Sekundärreflektor (2) anzutreiben, um eine Ausgangsposition wiederherzustellen, wobei die Ausgangsposition eine Position ist, in der eine Ebene, auf der sich ein Durchmesser des Sekundärreflektors (2) befindet, parallel zu einer Ebene, auf der sich ein Durchmesser eines Primärreflektors (1) der Doppelreflektorantenne befindet, ist.

14. Doppelreflektorantennensteyerverfahren nach Anspruch 13, wobei das Verbindungsstück ein erstes Verbindungsstück und ein zweites Verbindungsstück umfasst, die Doppelreflektorantenne ferner eine zweite Antriebsstruktur, die eine Drehwelle aufweist, umfasst, ein Ende des ersten Verbindungsstücks mit der Drehwelle verbunden ist, ein Ende des zweiten Verbindungsstücks mit der Drehwelle verbunden ist und das andere Ende des zweiten Verbindungsstücks mit dem Sekundärreflektor verbunden ist; und
das Antreiben des Sekundärreflektors, um eine Ausgangsposition wiederherzustellen, umfasst:
Steuern der Teleskopwelle, um auszufahren und gegen das erste Verbindungsstück zu stoßen, und Schieben des ersten Verbindungsstücks und des zweiten Verbindungsstücks, um sich um die Drehwelle zu drehen, um den Sekundärreflektor in die Ausgangsposition zu drehen.

15. Doppelreflektorantennensteyerverfahren nach Anspruch 14, wobei die Doppelreflektorantenne ferner eine zweite Steuervorrichtung und ein Winkelerkennungselement umfasst; und
das Steuerverfahren umfasst: Bestimmen mindestens eines der Folgenden:

Bestimmen, dass die Drehwelle eine Drehfunktion aufweist;
Bestimmen, dass der zweite Steuervorrichtung eine Funktion zum Steuern der Drehwelle aufweist, um sich zu drehen; und
Bestimmen, dass das Winkelerkennungselement eine Funktion zum Erkennen eines Ablenkwinkels des Primärreflektors aufweist.

Revendications

1. Antenne à double réflecteur, comprenant :

un réflecteur primaire (1), un réflecteur secondaire (2) et une source (3), dans laquelle le réflecteur primaire (1) est opposé au réflecteur secondaire (2) et la source (3) est configurée pour rayonner une onde électromagnétique vers le réflecteur secondaire (2) ;
une première structure d'entraînement, ayant un arbre télescopique (51) ; et
une pièce de connexion (9), connectée au réflecteur secondaire (2), dans laquelle l'antenne à double réflecteur est configurée de telle sorte que lorsque l'arbre télescopique (51) est déployé, l'arbre télescopique (51) vient en butée contre la pièce de connexion (9), pour entraîner le réflecteur secondaire (2) à revenir à une position initiale, dans laquelle la position initiale est une position dans laquelle un plan sur lequel un diamètre du réflecteur secondaire (2) est situé est parallèle à un plan sur lequel un diamètre du réflecteur primaire (1) est situé.

2. Antenne à double réflecteur selon la revendication 1, dans laquelle l'antenne à double réflecteur comprend en outre :

une seconde structure d'entraînement, ayant un arbre rotatif, dans laquelle l'arbre rotatif est conçu pour entraîner la rotation du réflecteur secondaire par rapport au réflecteur primaire le long d'un axe de tangage, afin d'ajuster une direction de faisceau de l'antenne à double réflecteur, dans laquelle l'axe de tangage est parallèle au plan sur lequel le diamètre du réflecteur primaire est situé.

3. Antenne à double réflecteur selon la revendication 2, dans laquelle la pièce de connexion comprend une première pièce de connexion et une seconde pièce de connexion ;

une extrémité de la première pièce de connexion est connectée à l'arbre rotatif et, lorsque l'arbre télescopique est déployé, l'autre extrémité de la première pièce de connexion vient en butée contre l'arbre télescopique ; et
une extrémité de la seconde pièce de connexion est connectée à l'arbre rotatif, et l'autre extrémité de la seconde pièce de connexion est connectée au réflecteur secondaire.

4. Antenne à double réflecteur selon l'une quelconque des revendications 1 à 3, dans laquelle l'antenne à double réflecteur comprend en outre :

un support, dans laquelle la première structure d'entraînement est disposée à proximité du réflecteur secondaire, une extrémité du support est fixée par

rapport à la première structure d'entraînement, et l'autre extrémité du support est fixée par rapport au réflecteur primaire.

5. Antenne à double réflecteur selon la revendication 4, dans laquelle une partie qui est celle du support, qui est située entre le réflecteur primaire et le réflecteur secondaire, et qui est au moins à proximité du réflecteur secondaire, est constituée d'un matériau diélectrique. 5
6. Antenne à double réflecteur selon la revendication 4 ou 5, dans laquelle une taille radiale d'une partie qui est celle du support et qui est située entre le réflecteur secondaire et le réflecteur primaire diminue progressivement le long d'une direction allant du réflecteur secondaire au réflecteur primaire, pour former une structure conique. 10
7. Antenne à double réflecteur selon la revendication 6, dans laquelle un angle inclus entre une barre omnibus et un axe de la structure conique est compris entre 10° et 30°. 15
8. Antenne à double réflecteur selon l'une quelconque des revendications 4 à 7, dans laquelle une épaisseur de paroi h de la partie qui est celle du support et qui est située entre le réflecteur secondaire et le réflecteur primaire est : 20

$$h = N \times \frac{c}{2f\sqrt{\epsilon_r}}$$
 , dans laquelle C représente une vitesse de la lumière, f représente une fréquence centrale de l'antenne à double réflecteur, ϵ_r représente une constante diélectrique relative du matériau diélectrique, et N représente un nombre entier positif supérieur ou égal à 1. 25
9. Antenne à double réflecteur selon l'une quelconque des revendications 4 à 8, dans laquelle une cavité scellée est formée dans le support, et la première structure d'entraînement et le réflecteur secondaire sont disposés dans la cavité scellée. 30
10. Antenne à double réflecteur selon l'une quelconque des revendications 4 à 9, dans laquelle le support comprend : 35
 - un premier support, dans laquelle le premier support est fixé par rapport au réflecteur primaire, et la source est disposée dans le premier support ; 40
 - un deuxième support, dans laquelle le deuxième support est fixé par rapport au premier support, et le deuxième support est constitué d'un matériau diélectrique ; et 45
 - un troisième support, dans laquelle le troisième support est fixé par rapport au deuxième sup-

port, et la première structure d'entraînement est fixée dans le troisième support.

11. Système de communication, comprenant :

l'antenne à double réflecteur selon l'une quelconque des revendications 1 à 10 ; et un premier dispositif de commande, dans lequel le premier dispositif de commande est configuré pour détecter si un réflecteur secondaire (2) peut ajuster une direction de faisceau de l'antenne à double réflecteur, et lorsqu'il est déterminé que le réflecteur secondaire (2) ne peut pas ajuster la direction de faisceau, le premier dispositif de commande commande un arbre télescopique (51) pour qu'il se déploie et vienne en butée contre une pièce de connexion (9), afin d'entraîner le réflecteur secondaire (2) pour qu'il revienne à une position initiale.

12. Système de communication selon la revendication 11, dans lequel l'antenne à double réflecteur comprend en outre une seconde structure d'entraînement qui a un arbre rotatif, et le système de communication comprend en outre :

un élément de détection d'angle, configuré pour détecter un angle de déviation d'un réflecteur primaire ; et un second dispositif de commande, configuré pour commander, en fonction de l'angle de déviation, la rotation de l'arbre rotatif, pour entraîner la rotation du réflecteur secondaire par rapport au réflecteur primaire, de manière à ajuster la direction de faisceau de l'antenne à double réflecteur.

13. Procédé de commande d'antenne à double réflecteur, dans lequel une antenne à double réflecteur comprend une première structure d'entraînement qui a un arbre télescopique (51) et une pièce de connexion (9) qui est connectée à un réflecteur secondaire (2) de l'antenne à double réflecteur, et le procédé de commande comprend :

le fait de déterminer que le réflecteur secondaire (2) de l'antenne à double réflecteur ne peut pas ajuster une direction de faisceau de l'antenne à double réflecteur ; et la commande de l'arbre télescopique (51) pour qu'il se déploie et vienne en butée contre la pièce de connexion (9), afin d'entraîner le réflecteur secondaire (2) à revenir à une position initiale, dans lequel la position initiale est une position dans laquelle un plan sur lequel un diamètre du réflecteur secondaire (2) est situé est parallèle à un plan sur lequel un diamètre d'un réflecteur primaire (1) de l'antenne à double

réflecteur est situé.

14. Procédé de commande d'antenne à double réflecteur selon la revendication 13, dans lequel la pièce de connexion comprend une première pièce de connexion et une seconde pièce de connexion, l'antenne à double réflecteur comprend en outre une seconde structure d'entraînement qui a un arbre rotatif, une extrémité de la première pièce de connexion est connectée à l'arbre rotatif, une extrémité de la seconde pièce de connexion est connectée à l'arbre rotatif, et l'autre extrémité de la seconde pièce de connexion est connectée au réflecteur secondaire ; et l'entraînement du réflecteur secondaire pour qu'il revienne à une position initiale comprend : la commande de l'arbre télescopique pour qu'il se déploie et vienne en butée contre la première pièce de connexion, et la poussée de la première pièce de connexion et de la seconde pièce de connexion pour qu'elles soient en rotation autour de l'arbre rotatif, afin d'entraîner la rotation du réflecteur secondaire jusqu'à la position initiale.
15. Procédé de commande d'antenne à double réflecteur selon la revendication 14, dans lequel l'antenne à double réflecteur comprend en outre un second dispositif de commande et un élément de détection d'angle ; et le procédé de commande comprend : la détermination d'au moins l'un parmi ce qui suit :
- le fait de déterminer que l'arbre rotatif a une fonction de rotation ;
 - le fait de déterminer que le second dispositif de commande a pour fonction de commander la rotation de l'arbre rotatif ; et
 - le fait de déterminer que l'élément de détection d'angle a pour fonction de détecter un angle de déviation du réflecteur primaire.

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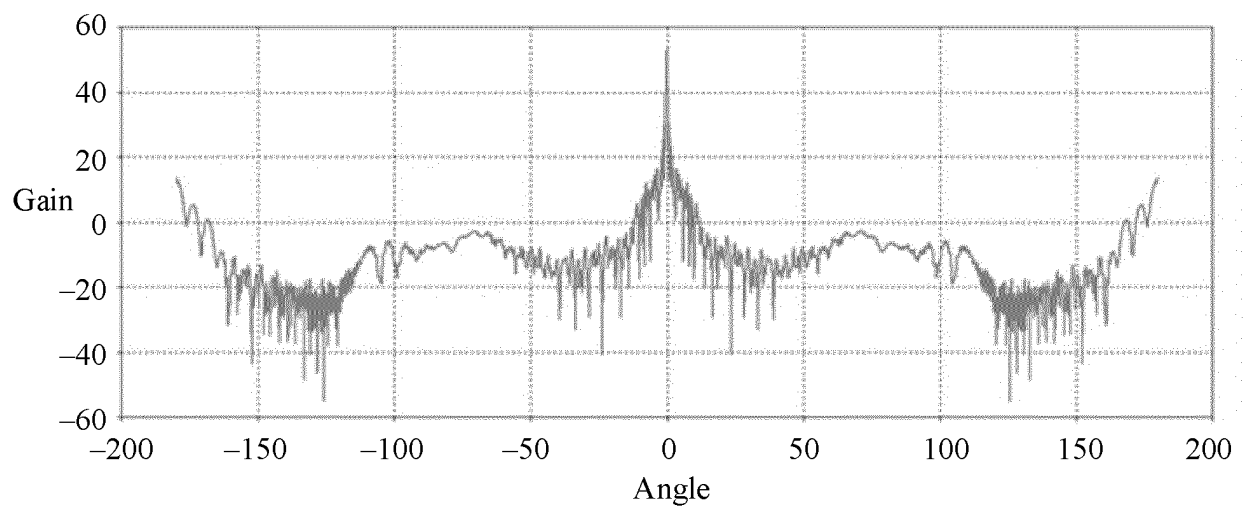


FIG. 1

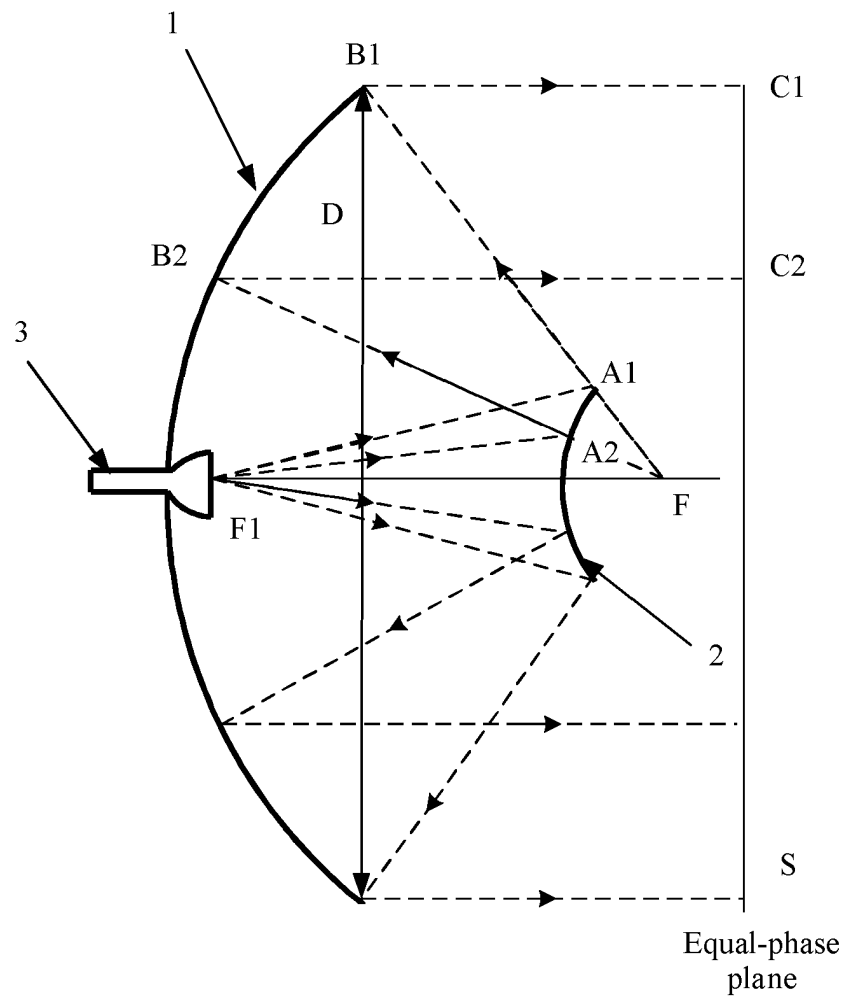


FIG. 2

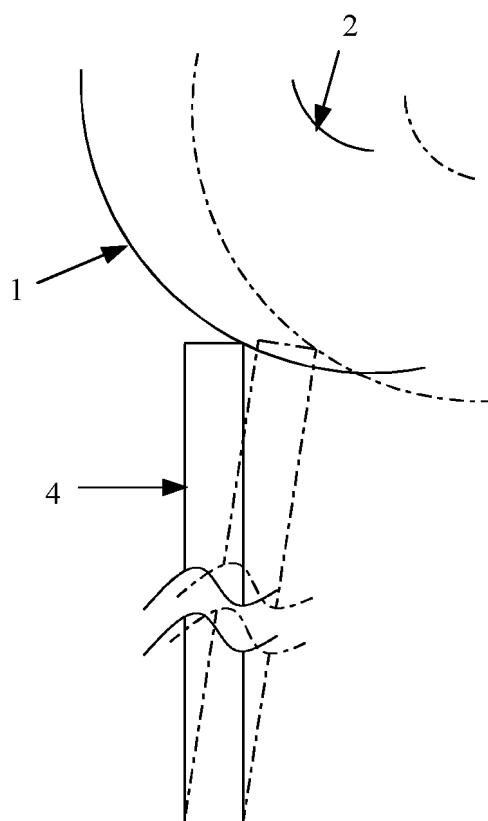


FIG. 3

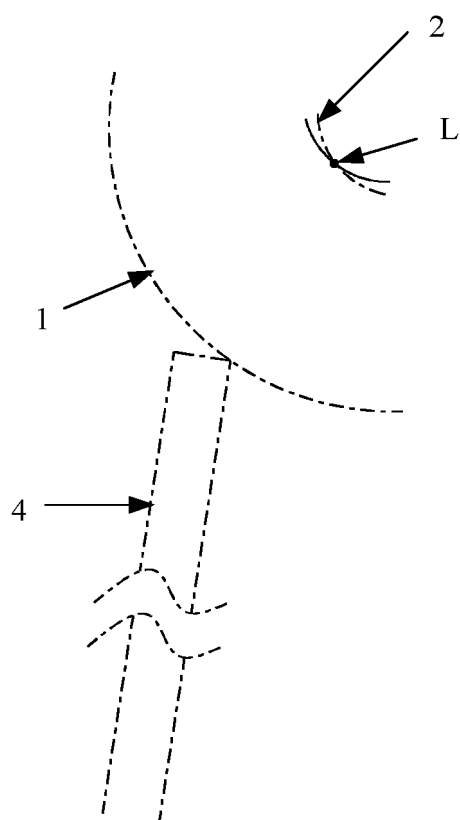


FIG. 4

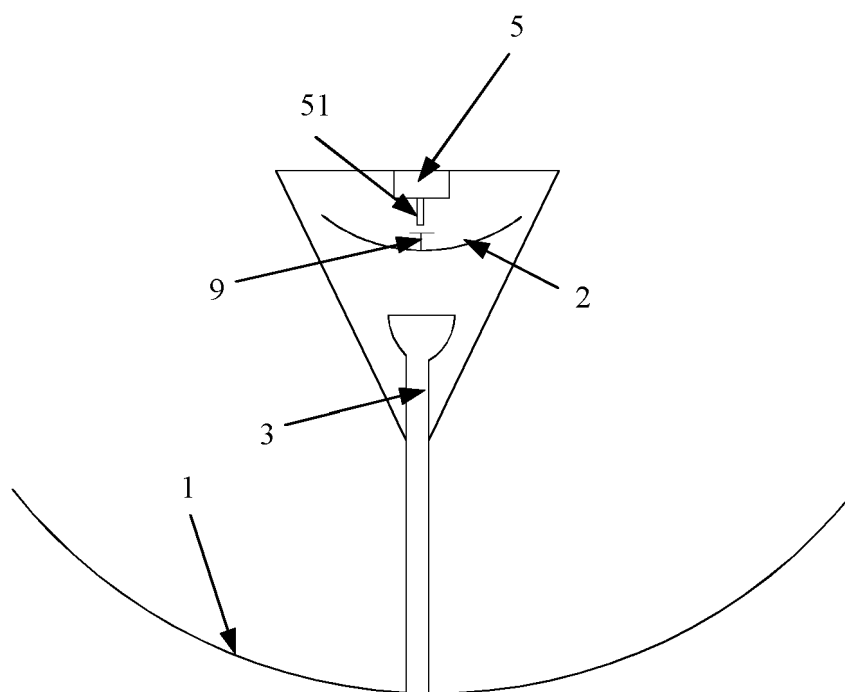


FIG. 5

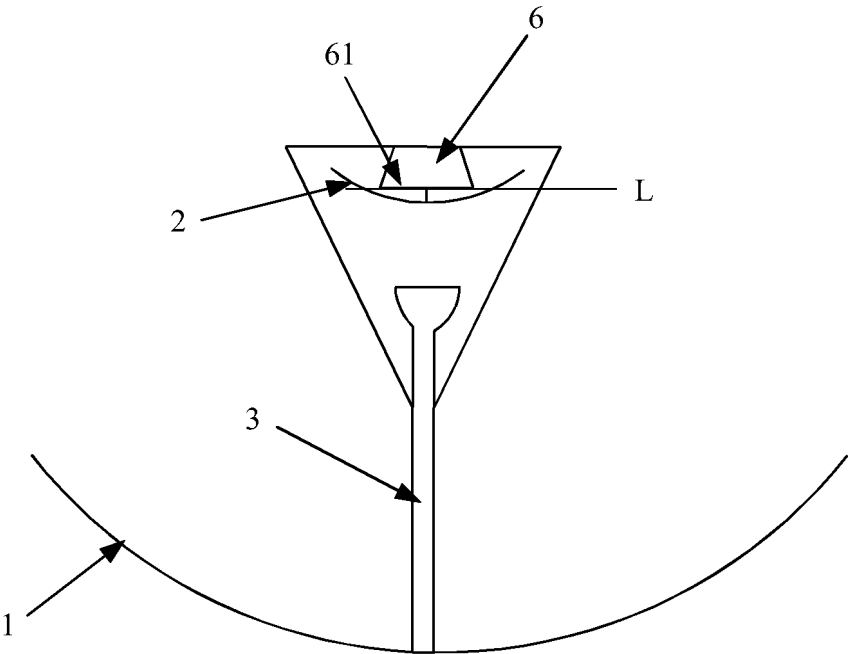


FIG. 6

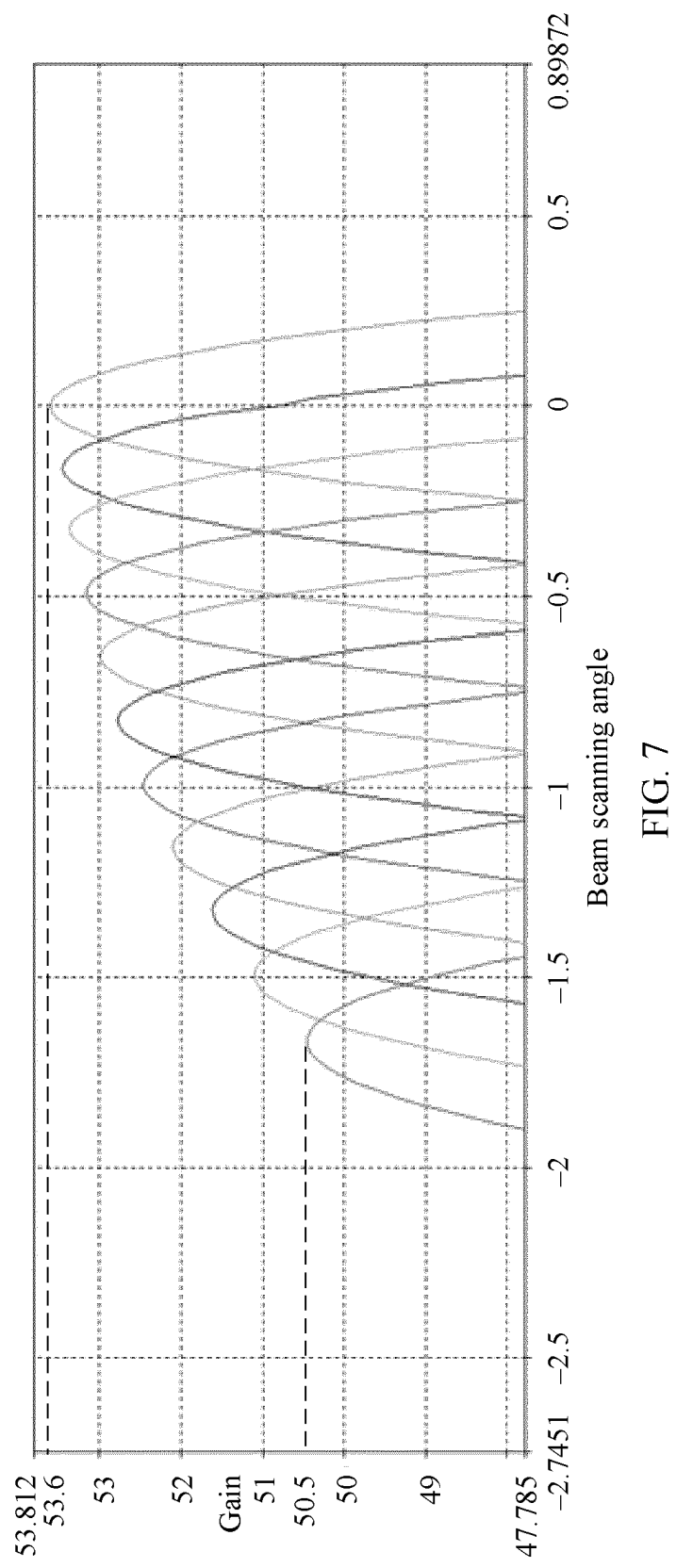


FIG. 7

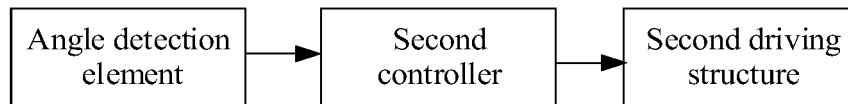


FIG. 8

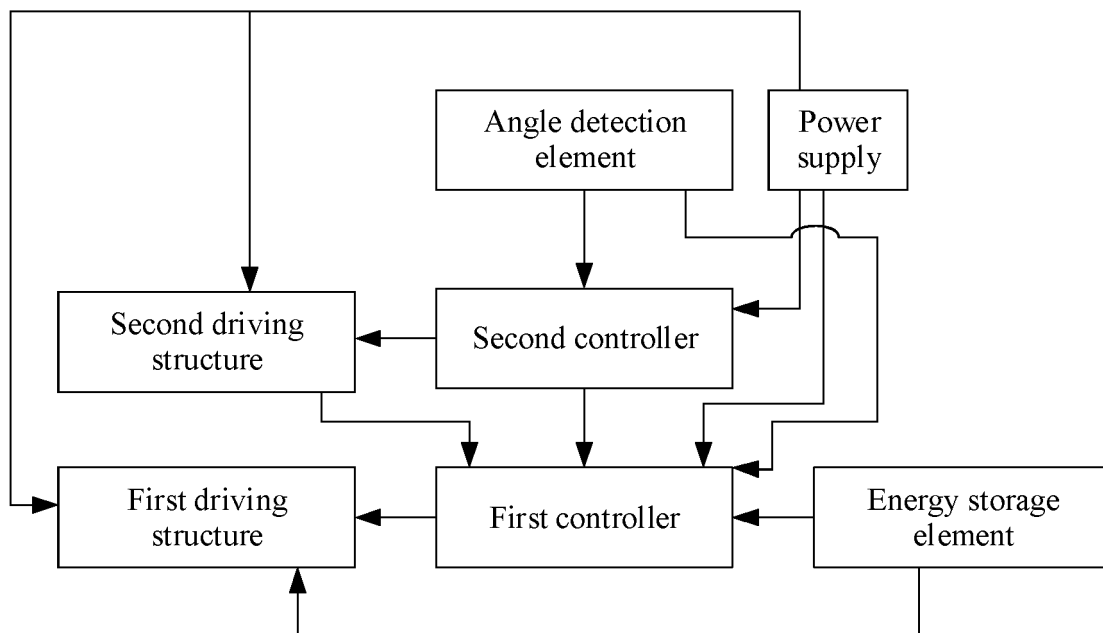


FIG. 9

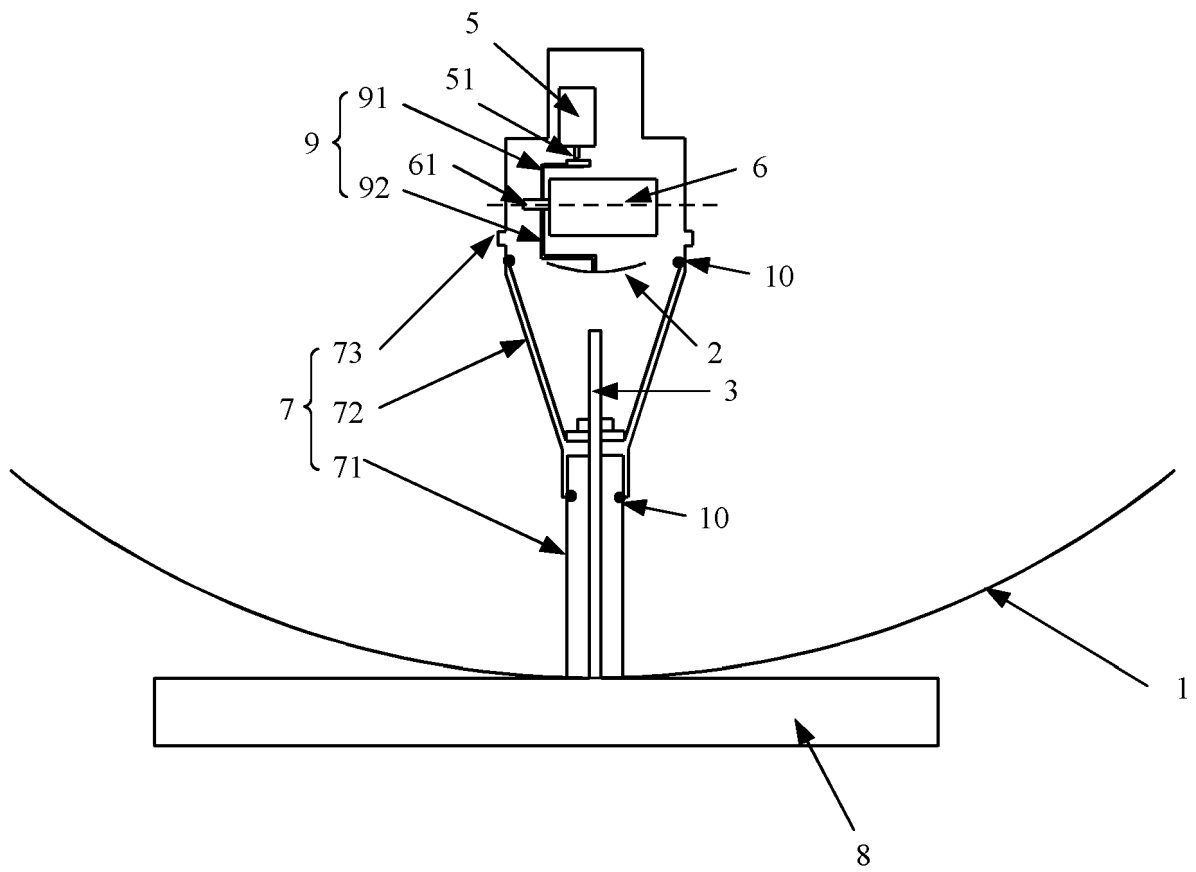


FIG. 10

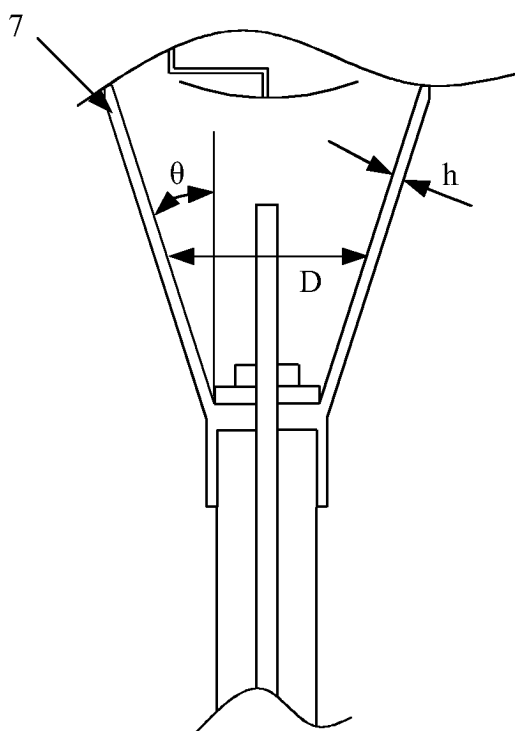


FIG. 11

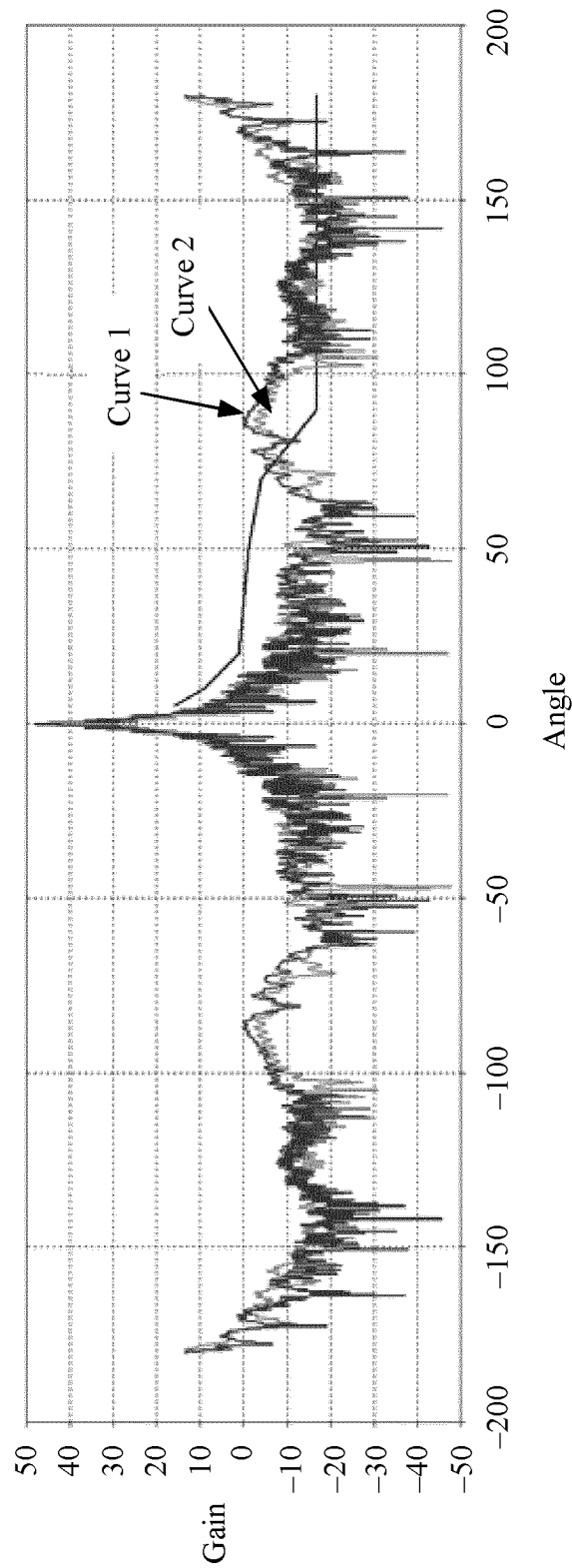


FIG. 12

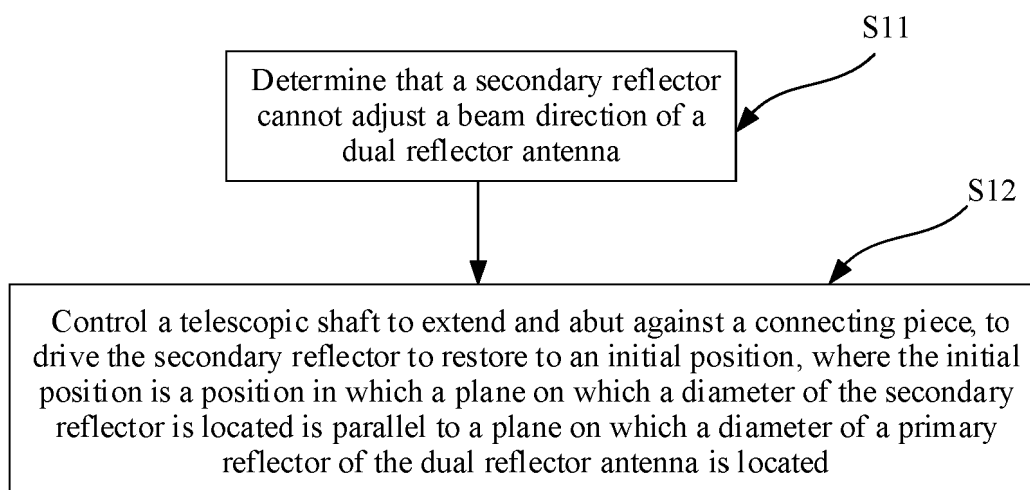


FIG. 13

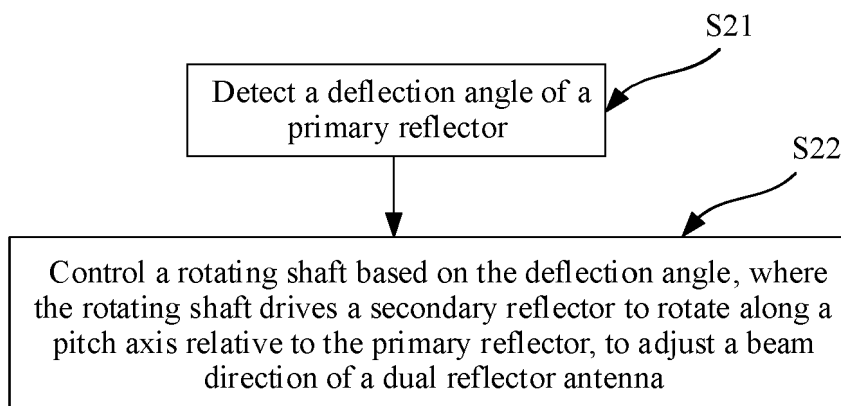


FIG. 14

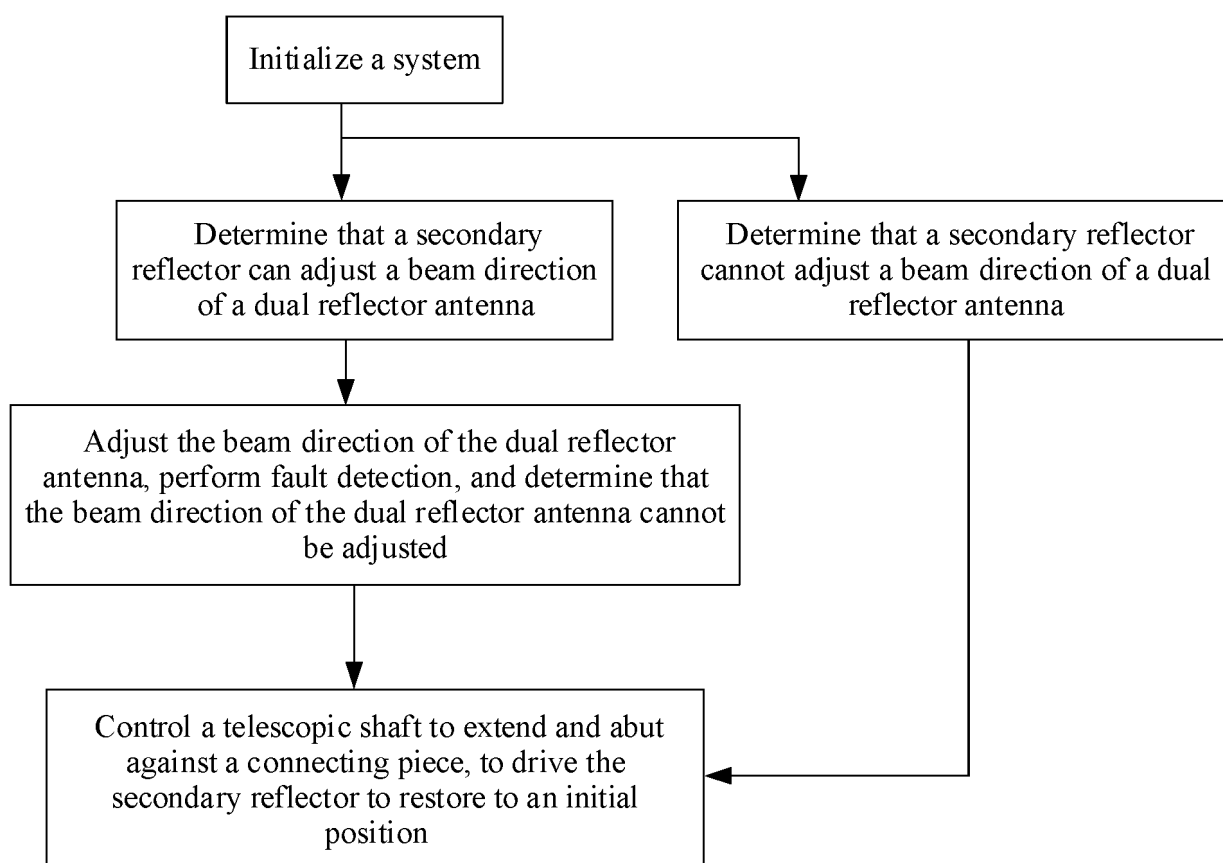


FIG. 15

REFERENCES CITED IN THE DESCRIPTION

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