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(54) **PHASE SHIFTER AND ANTENNA**

PHASENVERSCHIEBER UND ANTENNE

DÉPHASEUR ET ANTENNE

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EP 2 629 358 B1

Description

FIELD OF THE INVENTION

[0001] Embodiments of the present invention relate to the field of wireless communications technologies, and in particular, to a phase shifter and an antenna.

BACKGROUND OF THE INVENTION

[0002] A phase shifter may control a change of a signal phase, and is a key component in an antenna of a wireless communication base station. By using a phase shifter, a phase of an input signal may be shifted, a relative phase of a signal between antenna units may be changed, and a downtilt angle of an antenna beam may be adjusted, so as to facilitate the optimization of a communication network.

[0003] FIG. 1 is a schematic structural diagram of a phase shifter in the prior art. As shown in FIG. 1, the phase shifter provided in the prior art includes a first arc conductor 101 and a second arc conductor 102, where the first arc conductor 101 and the second arc conductor 102 are concentrically disposed; and a coupling arm 103, which is a physically integrated structure, and laps over the first arc conductor 101 and the second arc conductor 102, where a capacitive coupling electrical connection is formed at a lapping position between the coupling arm 103 and each arc conductor. When an input end 104 of the coupling arm 103 inputs signals, the signals are coupled to the first arc conductor 101 and the second arc conductor 102 along the coupling arm 103, the signal coupled to the first arc conductor 101 is output from a first output end 1011 and a second output end 1012 of the first arc conductor 101, and the signal coupled to the second arc conductor 102 is output from a third output end 1021 and a fourth output end 1022 of the second arc conductor 102. By rotating the coupling arm 103 to swing around the first arc conductor 101 and the second arc conductor 102, a lapping position between the first arc conductor 101 and the coupling arm 103 and a lapping position between the second arc conductor 102 and the coupling arm 103 may be changed, so that a transmission path of a signal on an arc conductor is changed, and signals with opposite phases are output from two ends of the arc conductor, thereby implementing phase shift of the signal.

[0004] However, in a structure of an existing phase shifter, because a coupling arm is an integrated structure, the coupling arm needs to be coupled to two arc conductors at the same time, so that coupling between the two arc conductors is strong and signal interference between the arc conductors is intense. To ensure the performance of the phase shifter, it is required to increase a distance between the arc conductors, which causes that the size of the phase shifter is large. In addition, because the coupling arm is an integrated structure, to ensure that capacitive coupling is formed at a lapping position between the coupling arm and each of the two arc conductors, high manufacturing precision is required for the coupling arm, which leads to a high manufacture cost of the phase shifter.

[0005] FR2930078 discloses a rotary phase shifting device for panel type antenna in mobile telephone network. The device has upper and lower conductive pieces displaced in rotation around a longitudinal axis with respect to an electrically conductive strip (81). Lower and upper layers made of dielectric material, are arranged on both sides of the strip. Each conductive piece has a rotary arm (83) rotated around the axis. The arm has a distal end provided with a coupling zone (84) that partially covers the strip. The zone has a covering surface extended from a side of the arm. The covering surface is larger than a covering surface extended from an opposite side of the arm.

SUMMARY OF THE INVENTION

[0006] Embodiments of the present invention provide a phase shifter and an antenna, which may effectively solve problems that coupling between arc conductors in an existing phase shifter in which a coupling arm is an integrated structure is strong and a manufacture cost is high.

[0007] An embodiment of the present invention provides a phase shifter, including an arc conductor component and a coupling arm component swingably disposed along the arc conductor component, where the arc conductor component includes:

a first arc conductor and a second arc conductor that are concentrically disposed, where a radius of the first arc conductor is smaller than that of the second arc conductor;
the coupling arm component includes a first coupling arm and a second coupling arm that are disposed in a spatially isolated manner;
a first end of the first coupling arm laps over the first arc conductor, and a second end of the first coupling arm is an input end for inputting a signal;
a first end of the second coupling arm laps over the first arc conductor, and a second end of the second coupling arm laps over the second arc conductor; and
the first coupling arm and the second coupling arm lap over the first arc conductor at different positions, and a capacitive coupling electrical connection is formed at a lapping position between each coupling arm and each arc conductor
wherein an input signal is coupled to the first arc conductor (11) through the first coupling arm (21), then coupled from the first arc conductor (11) to the second coupling arm (22), and finally coupled from the second coupling arm (22) to the second arc conductor (12);
wherein the arc conductor component is disposed

on a first substrate (10), and the coupling arm component is disposed on a second substrate (20); and wherein the first substrate (10) and the second substrate (20) are connected through a pivot (30) that is located at the center position of the first arc conductor (11), and the coupling arm component is adapted to swing along the arc conductor through the pivot(30).

[0008] An embodiment of the present invention provides an antenna, including a phase shifter, where each output end of the phase shifter is connected to an antenna unit; and
the phase shifter adopts a phase shifter provided in the foregoing embodiment of the present invention.

[0009] With the phase shifter and the antenna provided in the embodiments of the present invention, a first coupling arm and a second coupling arm of a coupling arm component are disposed in a spatially isolated manner and the first coupling arm and the second coupling arm lap over a first arc conductor at different positions, so that coupling between the first arc conductor and a second arc conductor may be effectively reduced, signal interference between the arc conductors is avoided, the precision of an output signal of the phase shifter is improved, and at the same time, the size of the phase shifter is effectively decreased, and manufacture costs of the phase shifter and the antenna are reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] To describe the technical solutions in the embodiments of the present invention or in the prior art more clearly, the accompanying drawings required for describing the embodiments or the prior art are introduced briefly in the following. Apparently, the accompanying drawings in the following description show merely some embodiments of the present invention, and persons of ordinary skill in the art may still derive other drawings from these accompanying drawings without creative efforts.

FIG. 1 is a schematic structural diagram of a phase shifter in the prior art;
FIG. 2A is a front view of a phase shifter according to a first embodiment of the present invention;
FIG. 2B is a schematic diagram of an assembly structure of the phase shifter according to the first embodiment of the present invention;
FIG. 3 is a schematic structural diagram of a phase shifter according to a second embodiment of the present invention;
FIG. 4 is a schematic structural diagram of a phase shifter according to a third embodiment of the present invention;
FIG. 5 is a schematic structural diagram of a phase shifter according to a fourth embodiment of the present invention;
FIG. 6 is a schematic structural diagram of a phase shifter according to a fifth embodiment of the present invention; and
FIG. 7 is a schematic structural diagram of an antenna according to a sixth embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0011] To make the objectives, technical solutions, and advantages of the embodiments of the present invention more comprehensible, the technical solutions in the embodiments of the present invention are described clearly and completely in the following with reference to the accompanying drawings in the embodiments of the present invention. Apparently, the embodiments to be described are merely a part rather than all of the embodiments of the present invention. All other embodiments obtained by persons of ordinary skill in the art based on the embodiments of the present invention without creative efforts shall fall within the protection scope of the present invention.

[0012] To solve problems that coupling between arc conductors in an existing phase shifter in which a coupling arm is an integrated structure is strong and a manufacture cost is high, the embodiments of the present invention provide a phase shifter, so as to implement signal transmission between arc conductors by using separately disposed coupling arms. The phase shifter specifically includes an arc conductor component and a coupling arm component that is swingably disposed along the arc conductor component. The arc conductor component includes a first arc conductor and a second arc conductor that are concentrically disposed, where a radius of the first arc conductor is smaller than that of the second arc conductor. The coupling arm component includes a first coupling arm and a second coupling arm that are disposed in a spatially isolated manner. A first end of the first coupling arm laps over the first arc conductor, and a second end of the first coupling arm is used to connect an input signal. A first end of the second coupling arm laps over the first arc conductor, and a second end of the second coupling arm laps over the second arc conductor. The first coupling arm and the second coupling arm lap over the first arc conductor at different positions, and a capacitive coupling electrical connection is formed at a lapping position between each coupling arm and each arc conductor. In the technical solution of this embodiment, the first coupling arm and the second coupling arm are separate structures disposed in a spatially isolated manner and lap over the first arc conductor at different positions. In this way, the input signal at the second end of the first coupling arm is first coupled to the first arc conductor through the first coupling arm, then coupled from the first arc conductor to the second coupling arm, and finally coupled from the second coupling arm to the second arc conductor, so that coupling between the first arc conductor and the second arc conductor may be smaller, so as to decrease signal interference between the arc conductors and improve the performance of the phase shifter. Meanwhile, a shorter distance between the first arc conductor and the second arc conductor may be set to reduce the size of the phase shifter. In addition, the first coupling arm and the second coupling arm are disposed as separate structures disposed in a spatially isolated manner, so that manufacture complexity of a coupling arm is simplified, coupling precision between the coupling arm and the arc conductor is more easily controlled, and a manufacture cost of the phase shifter is reduced.

[0013] In this embodiment, when each coupling arm laps over an arc conductor, one or more lapping portions may lap over a corresponding arc conductor. Preferably, the first end of the first coupling arm may include at least two lapping portions, and the first coupling arm may lap over the first arc conductor at different positions through the at least two lapping portions. In addition, the first end of the second coupling arm may also include at least two lapping portions, and the second coupling arm may lap over the first arc conductor at different positions through the at least two lapping portions. In addition, the second end of the second coupling arm may also include at least two lapping portions, and the second coupling arm may lap over the second arc conductor at different positions through the at least two lapping portions.

[0014] In this embodiment, swingable disposition of the coupling arm component along the arc conductor component indicates that, the coupling arm component may be disposed in a manner of being rotatable around the center of the arc conductors in the arc conductor component, so that the coupling arm component may rotate and swing along the arc conductor component when rotating around the center.

[0015] The technical solutions in the embodiments of the present invention are described in the following by taking a specific structure of a phase shifter as an example.

[0016] FIG. 2A is a front view of a phase shifter according to a first embodiment of the present invention, and FIG. 2B is a schematic diagram of an assembly structure of the phase shifter according to the first embodiment of the present invention. The phase shifter according to this embodiment of the present invention is a four-port phase shifter. Specifically, as shown in FIG. 2A and FIG. 2B, an arc conductor component 1 in the phase shifter includes a first arc conductor 11 and a second arc conductor 12, where the first arc conductor 11 and the second arc conductor 12 are concentrically disposed, and a radius of the first arc conductor 11 is smaller than that of the second arc conductor 12. A coupling arm component 2 includes a first coupling arm 21 and a second coupling arm 22. A first end 201 of the first coupling arm 21 laps over the first arc conductor 11, and a second end 202 of the first coupling arm 21 serves as an input end for inputting a signal and is used to connect an input signal. A first end of the second coupling arm 22 laps over the first arc conductor 11, and a second end of the second coupling arm 22 laps over the second arc conductor 12. A capacitive coupling electrical connection may be formed through the lapping between each coupling arm and each arc conductor, so that the input signal connected by the second end 202 of the first coupling arm 21 may be transmitted to end portions of each arc conductor through the capacitive coupling electrical connection formed at a lapping position between the coupling arm and the arc conductor.

[0017] In this embodiment, as shown in FIG. 2A and FIG. 2B, output ends A1 and A2 are disposed at two ends of the first arc conductor 11 respectively, and output ends B1 and B2 are disposed at two ends of the second arc conductor 12 respectively, where A1 and B1 are located at the same side, and A2 and B2 are located at the same side. The input signal input through the second end 202 of the first coupling arm 21 may be output as a signal with a certain phase from the four output ends.

[0018] In this embodiment, the first end 201 of the first coupling arm 21 may lap over the first arc conductor 11 through two or more lapping portions. Specifically, as shown in FIG. 2A and FIG. 2B, the first end 201 of the first coupling arm 21 has two first lapping portions 211, where the two first lapping portions 211 may be disposed symmetrically and each lap over the first arc conductor 11, and the two first lapping portions 211 are located on the first arc conductor 11 at different positions. In this way, the input signal input from the second end 202 of the first coupling arm 21 may be coupled to the first arc conductor 11 through the two first lapping portions 211 and be output from the two ends A1 and A2 of the first arc conductor 11.

[0019] In this embodiment, as shown in FIG. 2A, one lapping portion 221 is disposed at each of the two ends of the second coupling arm 22, and the two lapping portions 221 lap over the first arc conductor 11 and the second arc conductor 12 respectively. The lapping portion 221 that laps over the first arc conductor 11 and the two first lapping portions 211 on the first coupling arm 21 are located on the first arc conductor 11 at different positions, so that the first coupling arm 21 and the second coupling arm 22 are disposed in a spatially isolated manner. Preferably, the two first lapping portions 211 on the first end 201 of the first coupling arm 21 may be symmetrically disposed relative to the lapping portion 221. In this way, a signal coupled to the first arc conductor 11 through the first coupling arm 21 is coupled to the second coupling arm 22 at the lapping portion 221 of the first arc conductor 11, finally coupled, through the second coupling arm 22, to the second arc conductor 12 at the lapping portion 221 that is located on the second arc conductor 12, and output from the two ends B1 and B2 of the second arc conductor 12.

[0020] In this embodiment, as shown in FIG. 2A and FIG. 2B, the arc conductor component 1 may be disposed on a first substrate 10, the coupling arm component 2 is disposed on a second substrate 20, and the first substrate 10 and the second substrate 20 are connected through a pivot 30 that is located at the center position of the first arc conductor 11, so that the second substrate 20 may swing around the pivot 30 along the first substrate 10 and drive the coupling arm component 2 to swing along the arc conductor component 1. In this way, as the coupling arm component 2 swings along the arc conductor component 1, a lapping position between each coupling arm and each arc conductor may be changed, thereby implementing phase shift of a signal. In this embodiment, by controlling a swinging position of the second substrate 20, phases of signals output from the two ends of each arc conductor can be controlled and adjusted, thereby implementing adjustment of output phases.

[0021] In this embodiment, after the arc conductor component 1 is disposed on the first substrate 10 and the coupling arm component 2 is disposed on the second substrate 20, the first substrate 10 and the second substrate 20 are folded and are connected through the pivot 30, so as to form a phase shifter.

[0022] Persons skilled in the art may understand that, to implement swinging of the coupling arm component 2 along the arc conductor component 1, the first substrate 10 and the second substrate 20 may be connected in other manners. For example, a blind hole may be disposed at the center position of the first arc conductor 11 on the first substrate 10, and a positioning column may be disposed at a corresponding position on the second substrate 20; therefore, the second substrate 20 can swing along the first substrate 10 through coordination between the positioning column and the blind hole.

[0023] Persons skilled in the art may understand that, concentric disposition of the first arc conductor and the second arc conductor indicates that the center positions of the two arc conductors overlap completely or are close to each other, for example, with a distance being less than 1 mm. Likewise, connection of the first substrate and the second substrate through the pivot that is disposed at the center position of the first arc conductor indicates that the pivot is disposed at or near the center position of the first arc conductor.

[0024] Persons skilled in the art may understand that, disposition of the first coupling arm and the second coupling arm in a spatially isolated manner indicates that the first coupling arm and the second coupling arm are physically separate structures.

[0025] In this embodiment, the first substrate 10 and the second substrate 20 are printed circuit boards (Printed Circuit Board, PCB), where the arc conductor component 1 and the coupling arm component 2 are metal wires printed on the PCBs. Specifically, as shown in FIG. 2B, the first arc conductor 11 and the second arc conductor 12 are metal arc strips formed on the PCB that serves as the first substrate 10, and the first coupling arm 21 and the second coupling arm 22 are metal strips formed on the PCB that serves as the second substrate 20. Each metal arc strip and each metal strip may form a circuit with a microstrip structure, so as to implement signal transmission in the circuit. By forming a required arc conductor and coupling arm on a PCB, a cost of the phase shifter may be effectively reduced, on the basis that the same function of an conventional phase shifter is implemented; moreover, the phase shifter may have a smaller size, so that an integration level is higher when the phase shifter is connected to another component.

[0026] Persons skilled in the art may understand that, the metal arc strip and the metal strip may be fabricated by using an etching process, so as to obtain a metal wire structure with a required shape. Meanwhile, the formed arc conductors or coupling arms may also be a strip line structure, which is not limited in this embodiment.

[0027] In this embodiment, as shown in FIG. 2A and FIG. 2B, a signal input conductor portion 3 may further be disposed on the first substrate 10 and is used to connect an input signal. The second end 202 of the first coupling arm 21 laps over the signal input conductor portion 3. The signal input conductor portion 3 is a circular metal wire printed on the PCB that serves as the first substrate 10. The circular metal wire laps over a corresponding position of the metal strip that is printed on the second substrate 20 and serves as the first coupling arm 21, and a capacitive coupling electrical connection is formed at a lapping position. In this way, the input signal input from the signal input conductor portion 3 may be coupled to the first coupling arm 21 through the capacitive coupling electrical connection at a lapping position between the signal input conductor portion 3 and the first coupling arm 21, then coupled from the first coupling arm 21 to the first arc conductor 11 and coupled from the first arc conductor 11 to the second coupling arm 22, and finally coupled from the second coupling arm 22 to the second arc conductor 12.

[0028] In this embodiment, to avoid a direct electrical contact between a coupling arm and an arc conductor, green oil may be coated or an isolation film made of a nonmetallic material may be added on the coupling arm and the arc conductor, so as to ensure that a capacitive coupling electrical connection between the coupling arm and the arc conductor is formed at a lapping position.

[0029] In this embodiment, when the second substrate 20 swings around the pivot 30 relative to the first substrate 10, the lapping position between the first coupling arm 21 and the first arc conductor 11, the lapping position between the second coupling arm 22 and the first arc conductor 11, and the lapping position between the second coupling arm 22 and the second arc conductor 12 move along the arc conductors with the swinging. During this process, through capacitive coupling at each lapping position, the input signal input from the signal input conductor portion 3 may form an output signal with a certain phase at each of the two ends of the first arc conductor and the second arc conductor, where phase change trends of output signals from the two ends of the same arc conductor are opposite, and phase change trends of output signals from the output ends of the two arc conductors at the same side are the same. Specifically, as shown in FIG. 2A, the output ends A1 and A2 of the first arc conductor 11 output the output signals with opposite phase change trends, the output ends B1 and B2 of the second arc conductor also output the output signals with opposite phase change trends, but A1 and B1 output the output signals with the same phase change trend. Persons skilled in the art may understand that, phase variation amounts of signals output by output ends of different arc conductors may be determined by radiuses of the arc conductors, and therefore, arc conductors with proper radiuses may be disposed according to an actual requirement.

[0030] In this embodiment, preferably, each lapping portion that is on each coupling arm and is used to lap over each arc conductor is an arc structure having the same shape as that of the arc conductor, that is, at a lapping position between a coupling arm and an arc conductor, a lapping portion of the coupling arm has the same shape as that of the arc conductor, and in this way, performance of a capacitive coupling electrical connection formed at the lapping position between the coupling arm and the arc conductor may be better.

[0031] To sum up, with the phase shifter provided in this embodiment of the present invention, coupling arms are disposed as separate structures in an isolated manner, so that an input signal is coupled to a first arc conductor through a first coupling arm, then coupled from the first arc conductor to a second coupling arm, and finally coupled from the second coupling arm to a second arc conductor, so that coupling between the first arc conductor and the second arc conductor may be smaller, signal interference between the arc conductors is avoided, and the precision of an output signal of the phase shifter is improved. Meanwhile, because the coupling between the arc conductors is weak, a distance between the arc conductors may be smaller, so that the size of the phase shifter may be decreased. In addition, because the coupling arms are separate structures disposed in an isolated manner, it is required to ensure only the precision of a lapping position between each coupling arm and a corresponding arc conductor, and therefore, manufacture of the coupling arm is simpler, the precision is easy to be controlled, and a manufacture cost of the phase shifter is lower.

[0032] FIG. 3 is a schematic structural diagram of a phase shifter according to a second embodiment of the present invention. A difference from the technical solution in the embodiment shown in FIG. 2A and FIG. 2B lies in that, in this embodiment, there is only one lapping portion at which a first coupling arm laps over a first arc conductor, while a second coupling arm laps over the first arc conductor through two second lapping portions. Specifically, as shown in FIG. 3, in the phase shifter according to this embodiment, a first end of a first coupling arm 21 has one lapping portion 212 and laps over a first arc conductor 11, and a capacitive coupling electrical connection is formed at a lapping position. A first end of a second coupling arm 22 has two second lapping portions 222, so that the second coupling arm 22 may lap over the first arc conductor 11 through the two second lapping portions 222. Positions of the two second lapping portions 222 on the first arc conductor 11 are different, and the two second lapping portions 222 are located at two sides of a lapping position between the first coupling arm 21 and the first arc conductor 11 and may be disposed symmetrically. A second end of the second coupling arm 22 has one lapping portion 221 and laps over a second arc conductor 12.

[0033] In this embodiment, when input signals are input from a second end 202 of the first coupling arm 21, the input signals are coupled to the first arc conductor 11 through the lapping portion 212 on the first coupling arm 21. One part of the signals coupled to the first arc conductor 11 are output from two ends along the first arc conductor 11; and the other part of the signals are coupled to the second coupling arm 22 through a capacitive coupling electrical connection at a lapping position between the first arc conductor 11 and the second coupling arm 22, finally coupled to the second arc conductor 12 through the lapping portion 221 on the second coupling arm 22, and output from the two ends of the second arc conductor 12 along the second arc conductor 12. By controlling the swinging of the coupling arm component along the arc conductor component, lapping positions of the first coupling arm 21 and the second coupling arm 22 on the first arc conductor 11 and the second arc conductor 12 may be changed, and therefore, phases of the output signals at the two ends of each arc conductor may be changed.

[0034] Persons skilled in the art may understand that, in FIG. 2A or FIG. 3, the first coupling arm and the second coupling arm each may also have one lapping portion when they lap over each arc conductor, as long as the lapping positions on the same arc conductor are different. In addition, in FIG. 2A or FIG. 3, the second end of the second coupling arm, which laps over the second arc conductor, may have two or more lapping portions, so that the second coupling arm may lap over the second arc conductor through at least two lapping portions, and the at least two lapping portions correspond to different positions of the second arc conductor.

[0035] FIG. 4 is a schematic structural diagram of a phase shifter according to a third embodiment of the present invention. Based on the technical solution in the embodiment shown in FIG. 2A, a third arc conductor and a third coupling arm may be disposed in this embodiment, so as to form a phase shifter with six ports. Specifically, as shown in FIG. 4, based on the structure shown in FIG. 2A, an arc conductor component 1 may further include a third arc conductor 13. The third arc conductor 13 and a first arc conductor 11 are concentrically disposed, and a radius of the third arc conductor 13 is greater than that of a second arc conductor 12. Accordingly, a coupling arm component 2 may further include a third coupling arm 23. A first end of the third coupling arm 23 laps over the second arc conductor 12, a second end of the third coupling arm 23 laps over the third arc conductor 13 to form a capacitive coupling electrical connection at each lapping position, so that a signal is coupled from an arc conductor to a coupling arm or coupled from a coupling arm to an arc conductor through a capacitive coupling electrical connection.

[0036] In this embodiment, a second coupling arm 22 and the third coupling arm 23 may be a spatially and physically integrated structure. Because the signal strength of an input signal is gradually reduced after the input signal passes through a first coupling arm 21, the first arc conductor 11, and the second coupling arm 22, when the signal is coupled to the second arc conductor 12 and the third arc conductor 13 respectively through the second coupling arm 22 and the third coupling arm 23 that are an integrated structure, coupling between the second arc conductor 12 and the third arc conductor 13 is smaller and signal interference between the two arc conductors is weaker, which does not affect the precision of the phase shifter.

[0037] In this embodiment, input signals input from a second end 202 of the first coupling arm 21 may be coupled to the first arc conductor 11 through the first coupling arm 21. Part of the signals are output from two ends of the first arc conductor 11 and phase change trends of the signals output from the two ends are opposite, and part of the signals are coupled to the second coupling arm 22. One part of the signals coupled to the second coupling arm 22 are coupled to the second arc conductor 12, and one part of the signals are coupled to the third arc conductor 13. The signals coupled to the second arc conductor 12 are output from two ends of the second arc conductor 12, the signals coupled to the third arc conductor 13 are output from two ends of the third arc conductor 13, and phase change trends of the signals output from the two ends of each arc conductor are opposite.

[0038] FIG. 5 is a schematic structural diagram of a phase shifter according to a fourth embodiment of the present invention. A difference from the technical solution in the embodiment shown in FIG. 4 lies in that, in this embodiment, there is only one lapping portion at which a first coupling arm laps over a first arc conductor, while a second coupling arm laps over the first arc conductor through two second lapping portions. Specifically, as shown in FIG. 5, a first end of a first coupling arm 21 has one lapping portion 212 and laps over a first arc conductor 11, and a capacitive coupling electrical connection is formed at a lapping position. A first end of a second coupling arm 22 has two second lapping portions 222, so that the second coupling arm 22 may lap over the first arc conductor 11 through the two second lapping portions 222. Positions of the two second lapping portions 222 on the first arc conductor 11 are different, and the two second lapping portions 222 are located at two sides of a lapping position between the first coupling arm 21 and the first arc conductor 11 and may be disposed symmetrically. A second end of the second coupling arm 22 has one lapping portion 221 and laps over a second arc conductor 12.

[0039] In this embodiment, an input signal input from a second end 202 of the first coupling arm 21 may also be first coupled to the first arc conductor 11 through the first coupling arm 21, then coupled from the first arc conductor 11 to the second coupling arm 22, and finally coupled to the second arc conductor 12 and a third arc conductor 13 from the second coupling arm 22 and a third coupling arm 23 that are an integrated structure.

[0040] FIG. 6 is a schematic structural diagram of a phase shifter according to a fifth embodiment of the present invention. A difference from the technical solution in the embodiment shown in FIG. 4, in this embodiment, a second coupling arm laps over each of a first arc conductor and a second arc conductor through two lapping portions. A third coupling arm and the second coupling arm are disposed in a spatially isolated manner, that is, the third coupling arm and the second coupling arm are physically separate structures. Specifically, as shown in FIG. 6, two ends of a second coupling arm 22 each have two second lapping portions 222; and a lapping position between a third coupling arm 23 and a second arc conductor 12 may be located between the two second lapping portions 222 through which a second coupling arm 22 laps over the second arc conductor 12, and the two second lapping portions 222 may be disposed symmetrically.

[0041] In this embodiment, a signal coupled from a first arc conductor 11 to the second coupling arm 22 is first coupled to the second arc conductor 12, then coupled from the second arc conductor 12 to the third coupling arm 23, and finally coupled from the third coupling arm 23 to a third arc conductor 13. In this way, coupling between the arc conductors is smaller, which may be adapted to phase shift control with greater signal strength.

[0042] Persons skilled in the art may understand that, when each foregoing coupling arm laps over an arc conductor, each foregoing coupling arm laps over each arc conductor through one or two lapping portions; and in addition, each foregoing coupling arm may also lap over an arc conductor through more lapping portions, for example, three or more lapping portions. In an actual application, the proper number of lapping portions may be set according to an actual requirement to lap over a corresponding arc conductor.

[0043] Persons skilled in the art may understand that, in addition to the four-port phase shifter and the six-port phase shifter, other phase shifters with the required number of ports, such as an eight-port phase shifter and a thirteen-port phase shifter, may also be implemented by increasing the number of arc conductors, and have a structure similar to that of the four-port phase shifter or the six-port phase shifter, which is not described in detail herein again.

[0044] FIG. 7 is a schematic structural diagram of an antenna according to a sixth embodiment of the present invention. As shown in FIG. 7, the antenna according to this embodiment includes a phase shifter 100, and each output end of the phase shifter 100 is connected to an antenna unit 200. The phase shifter 100 may adopt the phase shifter in the technical solution in the embodiment shown in FIG. 2A and FIG. 2B, which is not described in detail herein again.

[0045] In the antenna according to this embodiment, the foregoing antenna unit may be an antenna radiation unit. A specific structure and function of the antenna radiation unit are the same as those of an antenna radiation unit in a conventional antenna, which is not described in detail herein again.

[0046] In the antenna according to this embodiment, a phase of a signal output from an output end of each arc conductor of the phase shifter 100 may be changed by controlling a swinging position of a coupling arm in the phase shifter 100. In this way, by changing a relative phase of a signal between antenna units, a downtilt angle of an antenna beam is adjusted, where its specific implementation is the same as or similar to that of the conventional antenna, which is not described in detail herein again.

[0047] Persons skilled in the art may understand that, the antenna according to this embodiment may also adopt the phase shifter shown in FIG. 3. In addition, in an actual application, a phase shifter with the proper number of ports may be selected according to the number of antenna units. For example, when the antenna has six antenna units, the six-port phase shifter shown in FIG. 4, FIG. 5, or FIG. 6 may be selected, or the four-port phase shifter shown in FIG. 2A or FIG. 3 may be selected, and output ends of the phase shifter may be shared, which is not limited in this embodiment.

[0048] Finally, it should be noted that the foregoing embodiments are merely intended for describing the technical solutions of the present invention, rather than limiting the present invention. Although the present invention is described in detail with reference to the foregoing embodiments, persons of ordinary skill in the art should understand that they may still make modifications to the technical solutions described in the foregoing embodiments, or make equivalent substitutions to some or all the technical features of the technical solutions, as long as these modifications or substitutions do not cause the essence of corresponding technical solutions to depart from the scope of the technical solutions in the embodiments of the present invention.

Claims

1. A phase shifter, comprising an arc conductor component and a coupling arm component that is swingably disposed along the arc conductor component, wherein the arc conductor component comprises:

   a first arc conductor (11) and a second arc conductor (12) that are concentrically disposed, wherein a radius of the first arc conductor is smaller than that of the second arc conductor;

   the coupling arm component comprises a first coupling arm (21) and a second coupling arm (22) that are disposed in a spatially isolated manner;

   a first end (201) of the first coupling arm laps over the first arc conductor, and a second end (202) of the first coupling arm is an input end for inputting a signal;

   a first end of the second coupling arm laps over the first arc conductor, and a second end of the second coupling arm laps over the second arc conductor; and

   the first coupling arm and the second coupling arm lap over the first arc conductor at different positions, and a capacitive coupling electrical connection is formed at a lapping position between each coupling arm and each arc conductor;

   wherein an input signal is coupled to the first arc conductor (11) through the first coupling arm (21), then coupled from the first arc conductor (11) to the second coupling arm (22), and finally coupled from the second coupling arm (22) to the second arc conductor (12);

   wherein the arc conductor component is disposed on a first substrate (10), and the coupling arm component is disposed on a second substrate (20); and

   wherein the first substrate (10) and the second substrate (20) are connected through a pivot (30) that is located at the center position of the first arc conductor (11), and the coupling arm component is adapted to swing along the arc conductor through the pivot(30).

2. The phase shifter according to claim 1, wherein the first end of the first coupling arm comprises at least two lapping portions (211), and the first coupling arm laps over the first arc conductor at different positions through the at least two lapping portions;wherein the first end (221) of the second coupling arm is between the at least two lapping portions (211) of the first coupling arm.

3. The phase shifter according to claim 1, wherein the first end of the second coupling arm comprises at least two lapping portions (222), and the second coupling arm laps over the first arc conductor at different positions through the at least two lapping portions;wherein the first end (212) of the first coupling arm is between the at least two lapping portions of the second coupling arm (222).

4. The phase shifter according to any one of claims 1 to 3 wherein the arc conductor
   component further comprises at least one third arc conductor (13);
   the third arc conductor and the first arc conductor

are concentrically disposed, and a radius of the third arc conductor is greater than that of the second arc conductor;

the coupling arm component further comprises a third coupling arm (23); and

a first end of the third coupling arm laps over the second arc conductor, and a second end of the third coupling arm laps over the third arc conductor;

the input signal is coupled to the third coupling arm (23), and finally coupled from the third coupling arm (23) to the third arc conductor (13).

5. The phase shifter according to claim 4 , wherein the second coupling arm and the third coupling arm are disposed in a spatially isolated manner.

6. The phase shifter according to claim 1, wherein a signal input conductor portion is further disposed on the first substrate; and

the second end of the first coupling arm laps over the signal input conductor portion, and the signal input conductor portion connects an input signal.

7. The phase shifter according to claim 6 wherein a lapping position between the first coupling arm and the signal input conductor portion is located at the center position of the first arc conductor; and

a capacitive coupling electrical connection is formed at the lapping position between the first coupling arm and the signal input conductor portion.

8. The phase shifter according to claim 1, wherein both the first substrate and the second substrate are printed circuit boards; and

the arc conductor component and the coupling arm component are metal wires printed on the printed circuit boards.

9. An antenna, comprising a phase shifter, wherein each output end of the phase shifter is connected to an antenna unit; and

the phase shifter adopts a phase shifter according to any one of claims 1 to 8.

Patentansprüche

1. Phasenschieber, der eine bogenförmige Leiterkomponente und eine Kopplungsarmkomponente umfasst, die schwenkbar entlang der bogenförmigen Leiterkomponente angeordnet ist, wobei die bogenförmige Leiterkomponente das Folgende umfasst:

einen ersten bogenförmigen Leiter (11) und einen zweiten bogenförmigen Leiter (12), die konzentrisch angeordnet sind, wobei ein Radius des ersten bogenförmigen Leiters kleiner ist als der des zweiten bogenförmigen Leiters;

die Kopplungsarmkomponente umfasst einen ersten Kopplungsarm (21) und einen zweiten Kopplungsarm (22), die auf räumlich isolierte Weise angeordnet sind;

ein erstes Ende (201) des ersten Kopplungsarms überlappt den ersten bogenförmigen Leiter und ein zweites Ende (202) des ersten Kopplungsarms ist ein Eingangsende zum Eingeben eines Signals;

ein erstes Ende des zweiten Kopplungsarms überlappt den ersten bogenförmigen Leiter und ein zweites Ende des zweiten Kopplungsarms überlappt den zweiten bogenförmigen Leiter; und

der erste Kopplungsarm und der zweite Kopplungsarm überlappen den ersten bogenförmigen Leiter an unterschiedlichen Positionen und eine kapazitiv gekoppelte elektrische Verbindung wird an einer Überlappposition zwischen jedem Kopplungsarm und jedem bogenförmigen Leiter gebildet;

wobei ein Eingangssignal über den ersten Kopplungsarm (21) zu dem ersten bogenförmigen Leiter (11) gekoppelt wird, dann von dem ersten bogenförmigen Leiter (11) zu dem zweiten Kopplungsarm (22) gekoppelt wird und schließlich von dem zweiten Kopplungsarm (22) zu dem zweiten bogenförmigen Leiter (12) gekoppelt wird;

wobei die bogenförmige Leiterkomponente auf einem ersten Substrat (10) angeordnet ist und die Kopplungsarmkomponente auf einem zweiten Substrat (20) angeordnet ist; und

wobei das erste Substrat (10) und das zweite Substrat (20) durch eine Schwenkachse (30) verbunden sind, die an der Mittenposition des ersten bogenförmigen Leiters (11) lokalisiert ist, und wobei die Kopplungsarmkomponente dafür ausgelegt ist, entlang dem bogenförmigen Leiter durch die Schwenkachse (30) zu schwenken.

2. Phasenschieber nach Anspruch 1, wobei das erste Ende des ersten Kopplungsarms mindestens zwei Überlappteile (211) umfasst und der erste Kopplungsarm den ersten bogenförmigen Leiter an unterschiedlichen Positionen mit den mindestens zwei Überlappteilen überlappt; wobei das erste Ende (221) des zweiten Kopplungsarms zwischen den mindestens zwei Überlappteilen (211) des ersten Kopplungsarms liegt.

3. Phasenschieber nach Anspruch 1, wobei das erste Ende des zweiten Kopplungsarms mindestens zwei Überlappteile (222) umfasst und der zweite Kopplungsarm den ersten bogenförmigen Leiter an unterschiedlichen Positionen mit den mindestens zwei Überlappteilen überlappt; wobei das erste Ende

(212) des ersten Kopplungsarms zwischen den mindestens zwei Überlappteilen des zweiten Kopplungsarms liegt (222).

4. Phasenschieber nach einem der Ansprüche 1 bis 3, wobei die bogenförmige Leiterkomponente ferner mindestens einen dritten bogenförmigen Leiter (13) umfasst;
der dritte bogenförmige Leiter und der erste bogenförmige Leiter sind konzentrisch angeordnet und ein Radius des dritten bogenförmigen Leiters ist größer als der des zweiten bogenförmigen Leiters;
die Kopplungsarmkomponente umfasst ferner einen dritten Kopplungsarm (23); und ein erstes Ende des dritten Kopplungsarms überlappt den zweiten bogenförmigen Leiter und ein zweites Ende des dritten Kopplungsarms überlappt den dritten bogenförmigen Leiter;
das Eingangssignal wird zu dem dritten Kopplungsarm (23) und schließlich von dem dritten Kopplungsarm (23) zu dem dritten bogenförmigen Leiter (13) gekoppelt.

5. Phasenschieber nach Anspruch 4, wobei der zweite Kopplungsarm und der dritte Kopplungsarm auf räumlich isolierte Weise angeordnet sind.

6. Phasenschieber nach Anspruch 1, wobei ein Signaleingangsleiterteil ferner auf dem ersten Substrat angeordnet ist; und
das zweite Ende des ersten Kopplungsarms das Signaleingangsleiterteil überlappt und das Signaleingangsleiterteil ein Eingangssignal anschließt.

7. Phasenschieber nach Anspruch 6, wobei eine Überlappposition zwischen dem ersten Kopplungsarm und dem Signaleingangsleiterteil an der Mittenposition des ersten bogenförmigen Leiters lokalisiert ist; und
eine kapazitiv gekoppelte elektrische Verbindung zwischen dem ersten Kopplungsarm und dem Signaleingangsleiterteil an der Überlappposition gebildet wird.

8. Phasenschieber nach Anspruch 1, wobei sowohl das erste Substrat als auch das zweite Substrat gedruckte Schaltungsplatinen sind; und
die bogenförmige Leiterkomponente und die Kopplungsarmkomponente auf den gedruckten Schaltungsplatinen aufgedruckte Metalldrähte sind.

9. Antenne, die einen Phasenschieber umfasst, wobei jedes Ausgangsende des Phasenschiebers mit einer Antenneneinheit verbunden ist; und
der Phasenschieber einen Phasenschieber nach einem der Ansprüche 1 bis 8 annimmt.

Revendications

1. Déphaseur, comprenant un composant conducteur en arc et un composant bras de couplage qui est disposé avec une faculté de balancement le long du composant conducteur en arc, dans lequel le composant conducteur en arc comprend :

un premier conducteur en arc (11) et un deuxième conducteur en arc (12) qui sont disposés de façon concentrique, un rayon du premier conducteur en arc étant inférieur à celui du deuxième conducteur en arc ;
le composant bras de couplage comprend un premier bras de couplage (21) et un deuxième bras de couplage (22) qui sont disposés d'une manière isolée spatialement ;
une première extrémité (201) du premier bras de couplage recouvre le premier conducteur en arc, et une deuxième extrémité (202) du premier bras de couplage est une extrémité d'entrée pour l'entrée d'un signal ;
une première extrémité du deuxième bras de couplage recouvre le premier conducteur en arc, et une deuxième extrémité du deuxième bras de couplage recouvre le deuxième conducteur en arc ; et
le premier bras de couplage et le deuxième bras de couplage recouvrent le premier conducteur en arc à différentes positions, et une connexion électrique à couplage capacitif est formée à une position de recouvrement entre chaque bras de couplage et chaque conducteur en arc ;
dans lequel un signal d'entrée est couplé au premier conducteur en arc (11) par le biais du premier bras de couplage (21), puis couplé du premier conducteur en arc (11) au deuxième bras de couplage (22), et finalement couplé du deuxième bras de couplage (22) au deuxième conducteur en arc (12) ;
dans lequel le composant conducteur en arc est disposé sur un premier substrat (10), et le composant bras de couplage est disposé sur un deuxième substrat (20) ; et
dans lequel le premier substrat (10) et le deuxième substrat (20) sont reliés par un pivot (30) qui se situe à la position centrale du premier conducteur en arc (11), et le composant bras de couplage est adapté pour se balancer le long du conducteur en arc par le biais du pivot (30).

2. Déphaseur selon la revendication 1, dans lequel la première extrémité du premier bras de couplage comprend au moins deux portions de recouvrement (211), et le premier bras de couplage recouvre le premier conducteur en arc à différentes positions par le biais des au moins deux portions de recouvrement ; dans lequel la première extrémité

(221) du deuxième bras de couplage se situe entre les au moins deux portions de recouvrement (211) du premier bras de couplage.

3. Déphaseur selon la revendication 1, dans lequel la première extrémité du deuxième bras de couplage comprend au moins deux portions de recouvrement (222), et le deuxième bras de couplage recouvre le premier conducteur en arc à différentes positions par le biais des au moins deux portions de recouvrement ; dans lequel la première extrémité (212) du premier bras de couplage se situe entre les au moins deux portions de recouvrement du deuxième bras de couplage (222).

4. Déphaseur selon l'une quelconque des revendications 1 à 3, dans lequel le composant conducteur en arc comprend en outre au moins un troisième conducteur en arc (13) ; le troisième conducteur en arc et le premier conducteur en arc sont disposés de façon concentrique, et un rayon du troisième conducteur en arc est supérieur à celui du deuxième conducteur en arc ;
le composant bras de couplage comprend en outre un troisième bras de couplage (23) ; et
une première extrémité du troisième bras de couplage recouvre le deuxième conducteur en arc, et une deuxième extrémité du troisième bras de couplage recouvre le troisième conducteur en arc ;
le signal d'entrée est couplé au troisième bras de couplage (23), et finalement couplé du troisième bras de couplage (23) au troisième conducteur en arc (13).

5. Déphaseur selon la revendication 4, dans lequel le deuxième bras de couplage et le troisième bras de couplage sont disposés d'une manière isolée spatialement.

6. Déphaseur selon la revendication 1, dans lequel une portion de conducteur d'entrée de signal est de plus disposée sur le premier substrat ; et
la deuxième extrémité du premier bras de couplage recouvre la portion de conducteur d'entrée de signal, et la portion de conducteur d'entrée de signal connecte un signal d'entrée.

7. Déphaseur selon la revendication 6, dans lequel une position de recouvrement entre le premier bras de couplage et la portion de conducteur d'entrée de signal se situe à la position centrale du premier conducteur en arc; et
une connexion électrique à couplage capacitif est formée à la position de recouvrement entre le premier bras de couplage et la portion de conducteur d'entrée de signal.

8. Déphaseur selon la revendication 1, dans lequel le premier substrat et le deuxième substrat sont tous deux des cartes de circuits imprimés ; et
le composant conducteur en arc et le composant bras de couplage sont des fils métalliques imprimés sur les cartes de circuits imprimés.

9. Antenne, comprenant un déphaseur, chaque extrémité de sortie du déphaseur étant reliée à une unité d'antenne ; et
le déphaseur adoptant un déphaseur selon l'une quelconque des revendications 1 à 8.

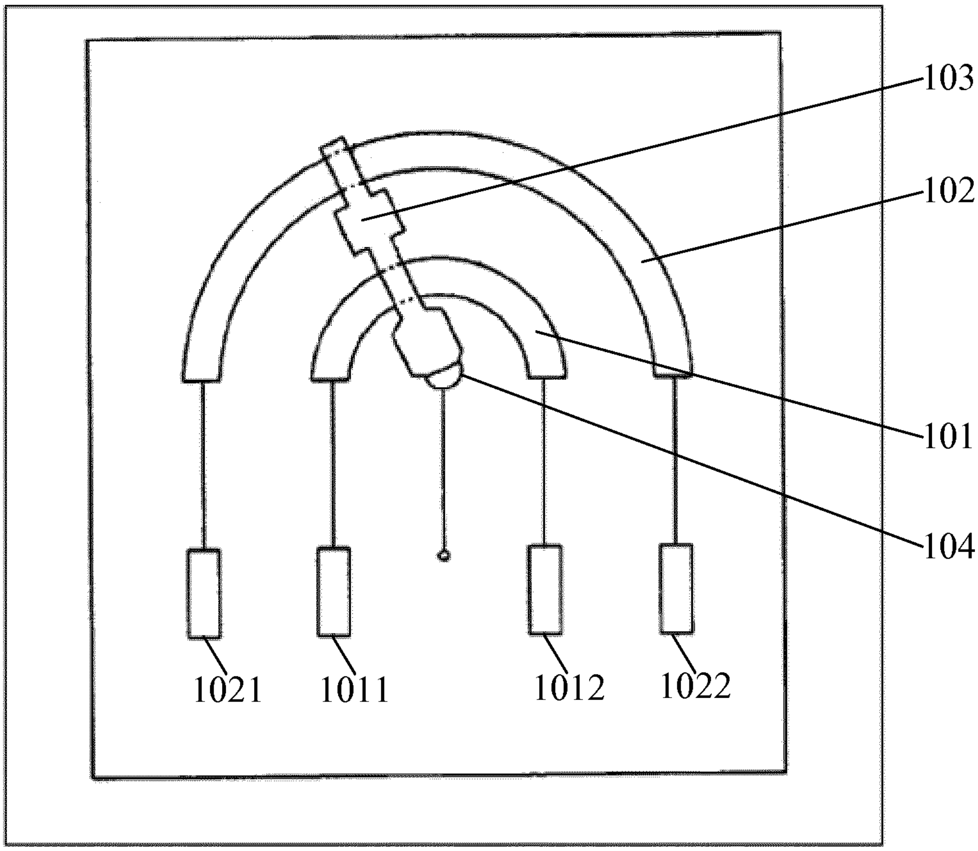

FIG. 1

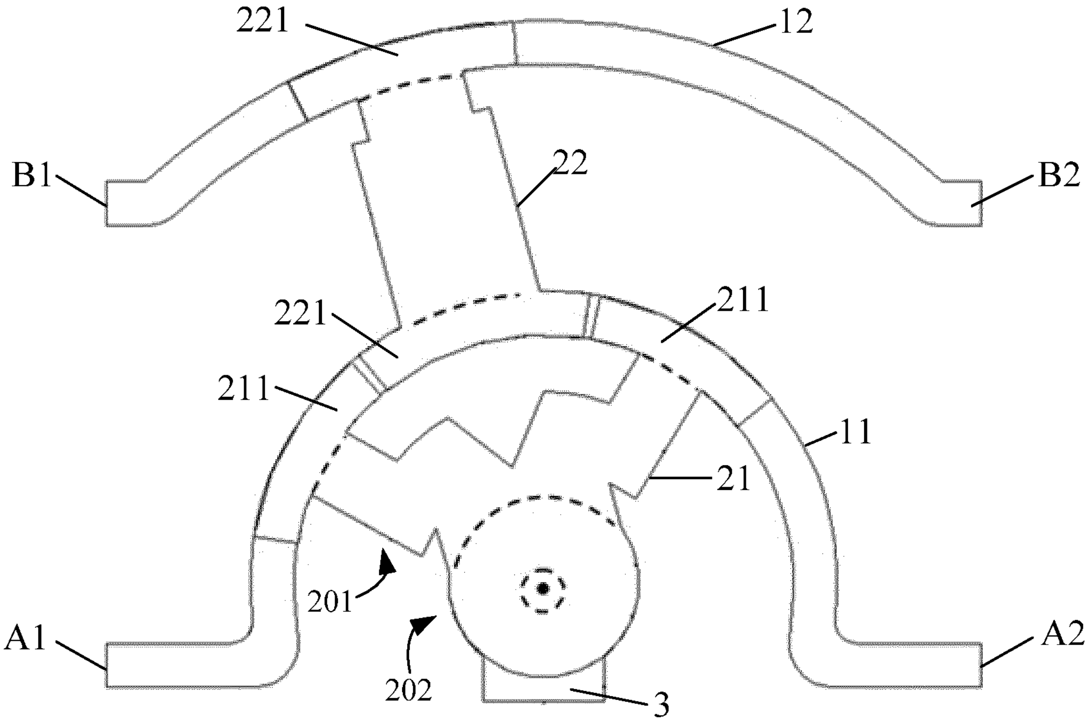

FIG. 2A

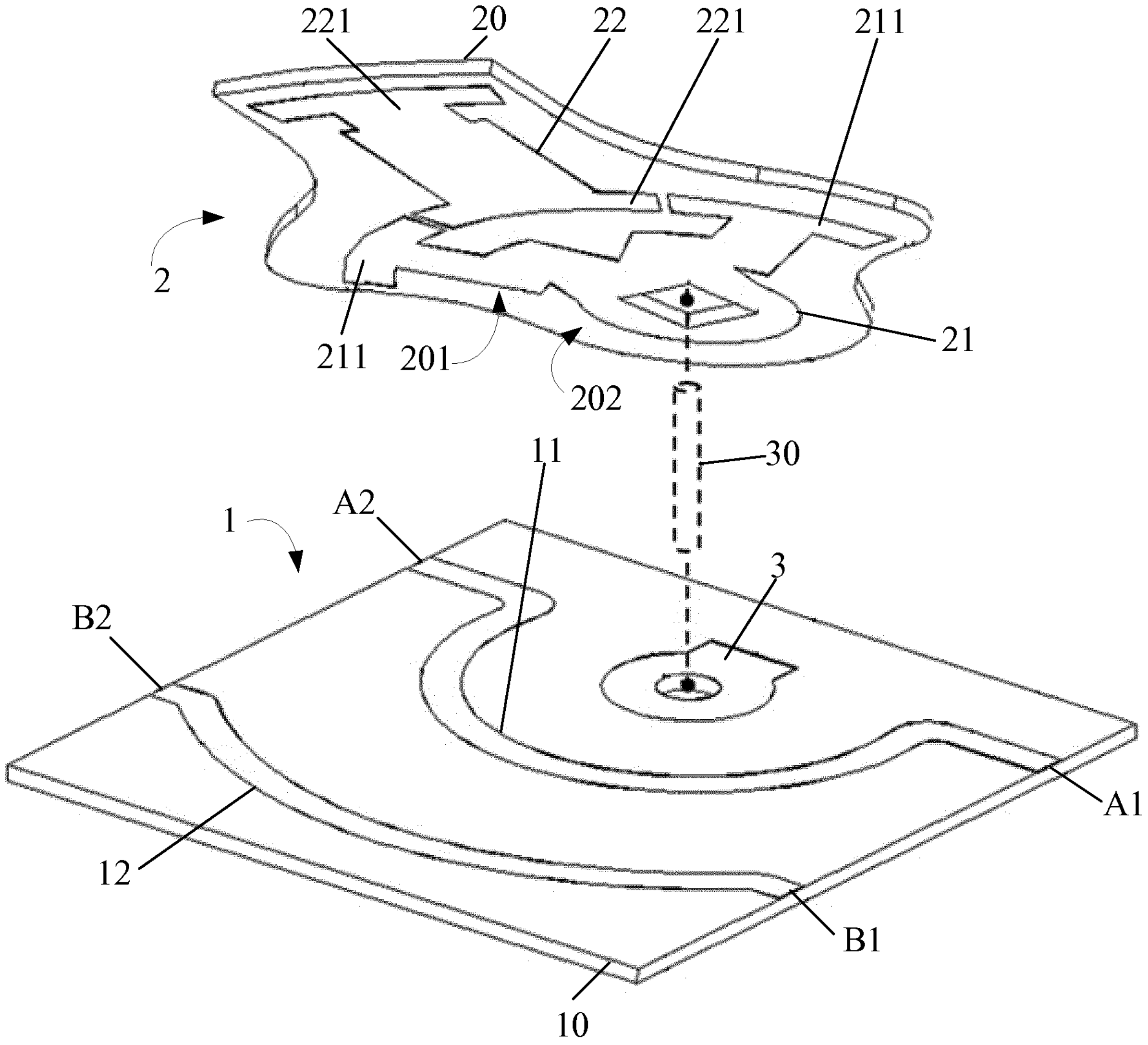

FIG. 2B

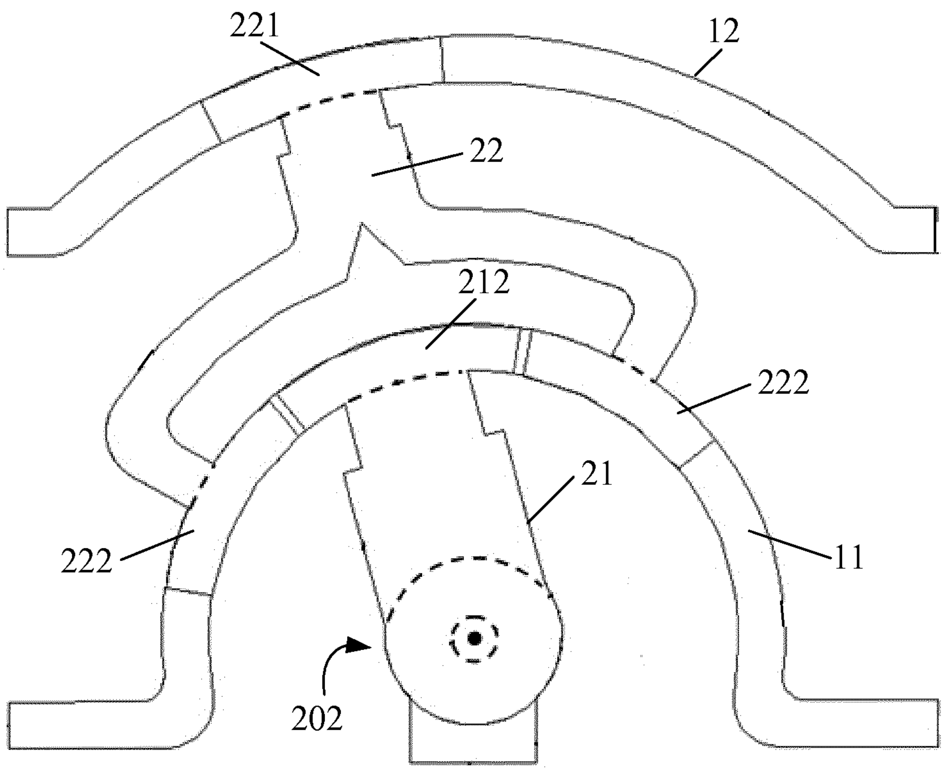

FIG. 3

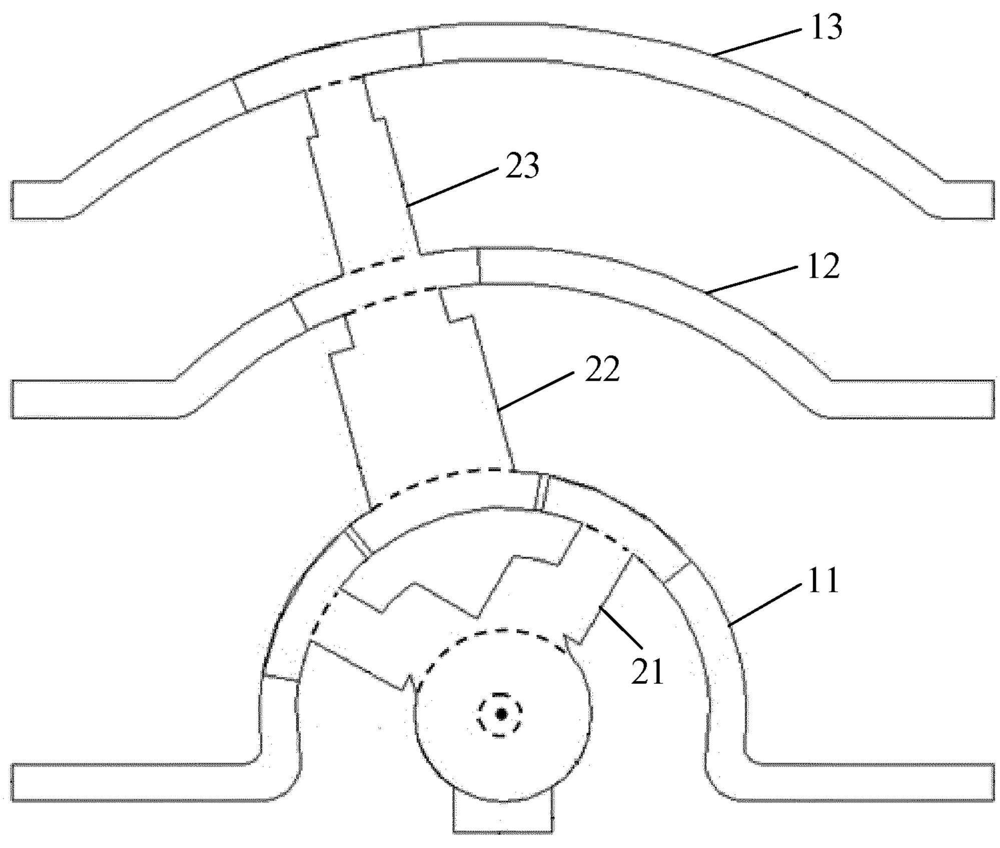

FIG. 4

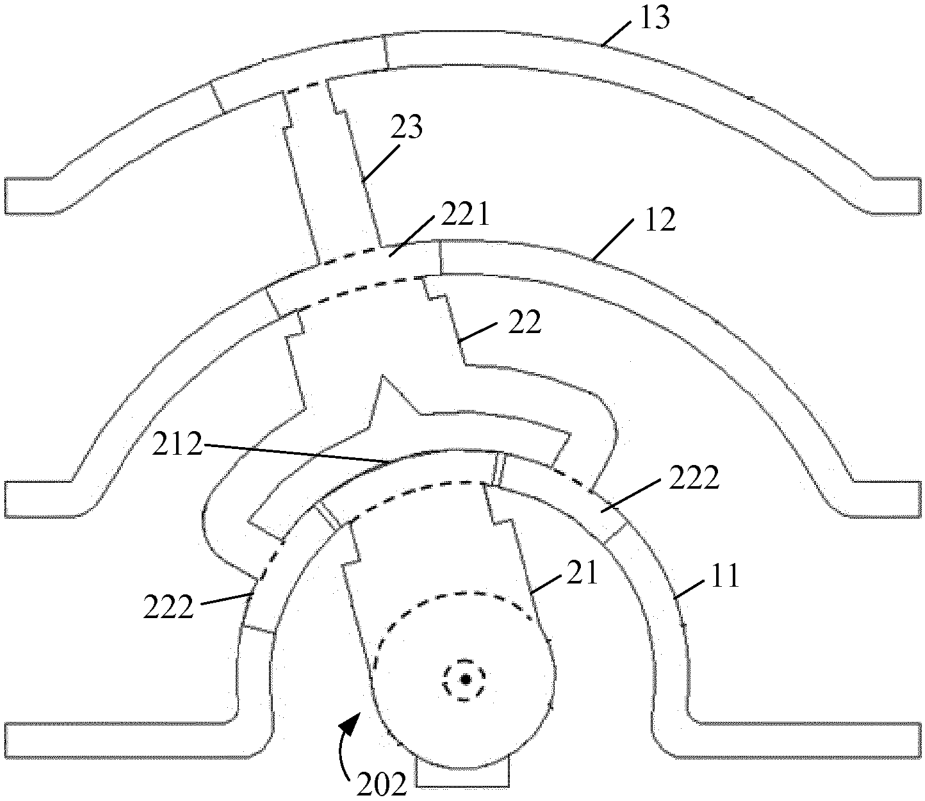

FIG. 5

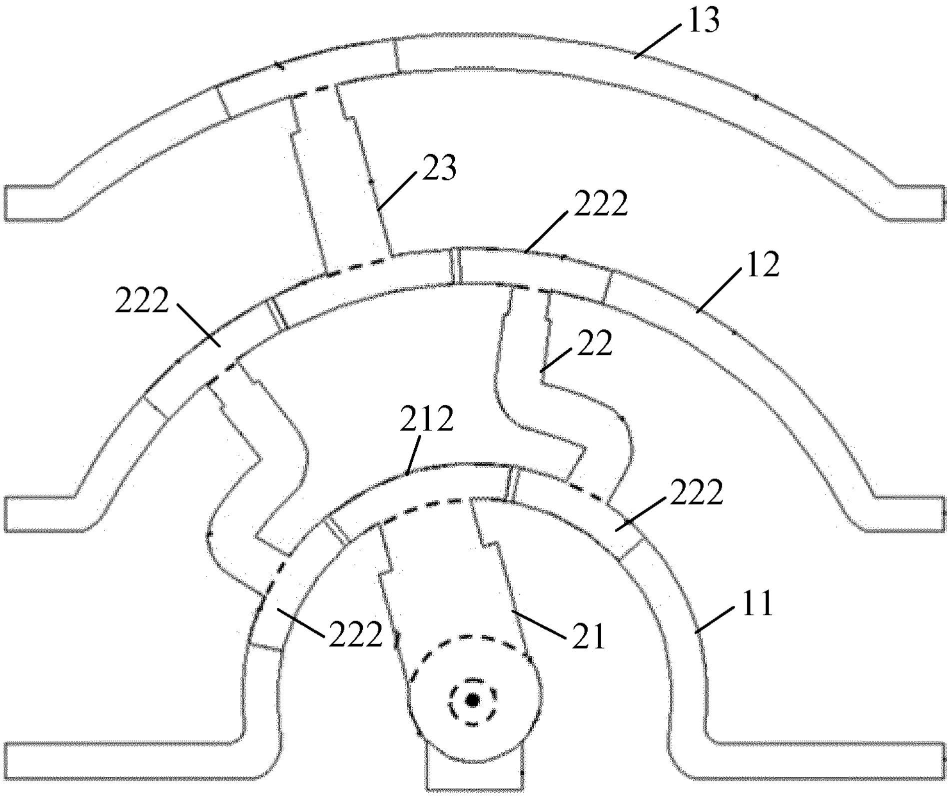

FIG. 6

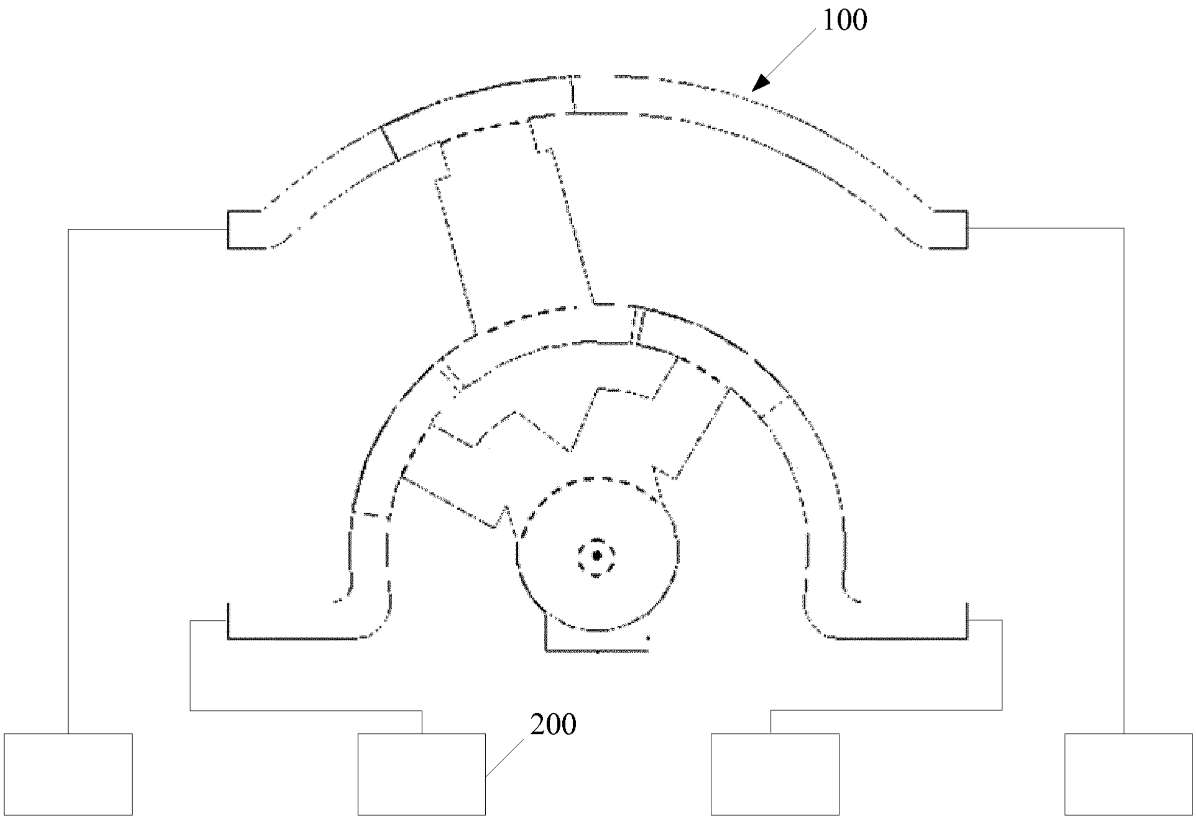

FIG. 7

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- FR 2930078 **[0005]**