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(54) **ANTENNA UNIT AND ANTENNA ARRAY**

(57) The present application discloses an antenna unit and an antenna array. The antenna unit includes a plurality of radiation oscillators, at least one feeding part, and a switch apparatus. The radiation oscillators are provided along a first longitudinal direction. The feeding part is electrically connected to the radiation oscillator via a feeding channel. The switch apparatus is provided at the feeding channels and configured to control connection and disconnection between at least one of the radiation oscillators and the feeding part.

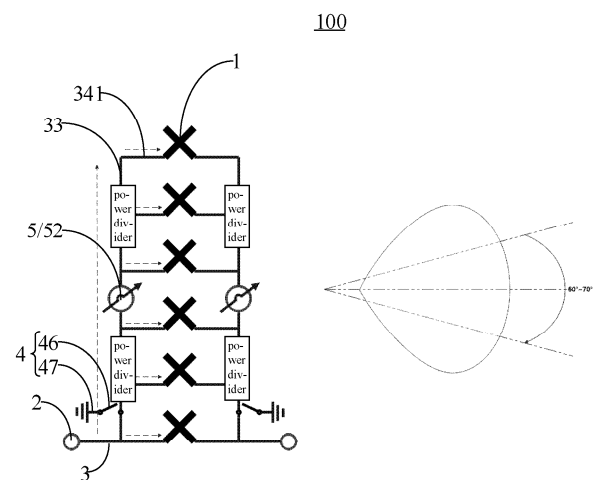


FIG. 1

Description

CROSS-REFERENCE TO RELATED APPLICATIONS

- 5 [0001] This application claims priority to Chinese Patent Application No. 202311268363.9, filed on September 26, 2023. The disclosures of the above-mentioned applications are incorporated herein by reference in their entireties.

TECHNICAL FIELD

- 10 [0002] The present application relates to the technical field of communication, specifically to an antenna unit and an antenna array.

BACKGROUND

- 15 [0003] With the evolution of technology and the expansion of business and information processing needs, the integration of communication and sensing has become one of the dominant trends in future technology and business. Future networks are expected to be a fusion of mobile communication networks, sensing networks, and computing networks. In conventional networks, communication and sensing exist independently, while the integrated design of communication and sensing can reduce the waste of wireless spectrum and hardware resources, and reduce latency
20 during information processing.

SUMMARY

- [0004] The main purpose of the present application is to provide an antenna unit and an antenna array.
25 [0005] To achieve the above purposes, the present application proposes an antenna unit including: a plurality of radiation oscillators provided along a first longitudinal direction; at least one feeding part, and the feeding part is electrically connected to the radiation oscillator via a feeding channel; and a switch apparatus provided at the feeding channels and configured to control connection and disconnection between at least one of the radiation oscillators and the feeding part.
[0006] The present application also proposes an antenna array including a plurality of the antenna units. The antenna
30 unit includes a plurality of radiation oscillators, at least one feeding part, and a switch apparatus. The radiation oscillators are provided along a first longitudinal direction. The feeding part is electrically connected to the radiation oscillator via a feeding channel. The switch apparatus is provided at the feeding channels and configured to control connection and disconnection between at least one of the radiation oscillators and the feeding part. The plurality of antenna units are provided in an array.
35

BRIEF DESCRIPTION OF THE DRAWINGS

- [0007] In order to explain the embodiments of the present application or the technical solutions in the existing technology more clearly, the accompanying drawings needed to be used in the description of the embodiments or the existing
40 technology will be briefly introduced below. Obviously, the accompanying drawings in the following description are only some embodiments of the present application, other accompanying drawings can be obtained based on the provided accompanying drawings without exerting creative efforts for those skilled in the art.

- 45 FIG. 1 is a simplified plan view and beam diagram of a first embodiment of an antenna unit provided in the present application.
FIG. 2 is a simplified plan view and beam diagram of a second embodiment of an antenna unit provided in the present application.
FIG. 3 is a simplified plan view and beam diagram of a third embodiment of an antenna unit provided in the present application.
50 FIG. 4 is a simplified plan view and beam diagram of a fourth embodiment of an antenna unit provided in the present application.
FIG. 5 is a simplified plan view of a first embodiment of a switch apparatus in the first embodiment of the antenna unit provided in the present application.
FIG. 6 is a simplified plan view of a second embodiment of a switch apparatus in the first embodiment of the antenna
55 unit provided in the present application.
FIG. 7 is a simplified plan view of a third embodiment of a switch apparatus in the first embodiment of the antenna unit provided in the present application.
FIG. 8 is a simplified plan view of a first embodiment of a branch channel in the second embodiment of the antenna unit

provided in the present application.

FIG. 9 is a simplified plan view of a second embodiment of a branch channel in the second embodiment of the antenna unit provided in the present application.

FIG. 10 is a simplified plan view of a third embodiment of a branch channel in the second embodiment of the antenna unit provided in the present application.

FIG. 11 is a simplified plan view of a fourth embodiment of a branch channel in the second embodiment of the antenna unit provided in the present application.

FIG. 12 is a simplified plan view of a fifth embodiment of a branch channel in the second embodiment of the antenna unit provided in the present application.

FIG. 13 is a simplified plan view of a sixth embodiment of a branch channel in the second embodiment of the antenna unit provided in the present application.

FIG. 14 is a simplified plan view of an antenna array provided in the present application.

FIG. 15 is a simplified diagram of a connectivity state of a radiation oscillator in FIG. 14 in communication mode and sensing signal mode.

Explanation of reference numbers:

[0008]

number	name	number	name
1000	antenna array	342	diversion channel
100	antenna unit	3421	first connection channel
1	radiation oscillator	3422	first hybrid connection channel
11	first radiation oscillator	3423	second connection channel
12	second radiation oscillator	3424	second hybrid connection channel
2	feeding part	4	switch apparatus
3	feeding channel	41	switching switch
31	first feeding channel	42	first switch
32	second feeding channel	43	second switch
33	main channel	44	third switch
331	first connection point	45	fourth switch
332	second connection point	46	switch unit
333	first flow channel section	47	grounding channel
334	second flow channel section	5	phase shifter
34	branch channel	51	first phase shifter
341	branch road	52	second phase shifter
3411	first branch road	200	antenna group
3412	second branch road	300	antenna unit group

[0009] The realization of the purpose, functional features and advantages of the present application will be further described in conjunction with the embodiments and with reference to the accompanying drawings.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0010] The technical solutions in the embodiments according to the present application will be clearly and completely described below in conjunction with the accompanying drawings in the embodiments according to the present application, and it is clear that the described embodiments are only a part of the embodiments according to the present application, and not all of the embodiments. Based on the embodiments in the present application, all other embodiments obtained by those skilled in the art without making creative labor fall within the scope of the present application.

[0011] It should be noted that if there are directional instructions (such as up, down, left, right, front, back or the like)

involved in the embodiments of the present application, the directional indications are only used to explain the relative positional relationship, movement and so on between various components in a specific posture (as shown in the accompanying drawings). If the specific posture changes, the directional indication will also change accordingly.

[0012] Furthermore, if the embodiments of the present application involve descriptions such as "first," "second," etc., these descriptions are only for descriptive purposes and should not be construed as indicating or implying their relative importance or implicitly specifying the number of technical features indicated. Therefore, features defined with "first" or "second" may explicitly or implicitly include at least one of those features. Furthermore, the use of "and/or" or "and/or" throughout the text implies three parallel solutions. For example, "A and/or B" includes solution A, solution B, or a solution satisfying both A and B simultaneously. In addition, the technical solutions of various embodiments can be combined with each other, but it is based on that those skilled in the art can realize. When the combination of technical solutions is contradictory or cannot be realized, it should be considered that such combination of technical solutions does not exist and is not within the scope claimed by the present application.

[0013] With the evolution of technology and the expansion of business and information processing needs, the integration of communication and sensing has become one of the dominant trends in future technology and business. Future networks are expected to be a fusion of mobile communication networks, sensing networks, and computing networks. In conventional networks, communication and sensing exist independently, while the integrated design of communication and sensing can reduce the waste of wireless spectrum and hardware resources, and reduce latency during information processing.

[0014] Therefore, the present application provides an antenna unit. FIG. 1 to FIG. 13 is embodiments of the antenna unit provided in the present application. The antenna unit will be described below with reference to specific accompanying drawings.

[0015] Referring to FIG. 1 to FIG. 13, the antenna unit 100 includes a plurality of radiation oscillators 1, at least one feeding part 2, and a switch apparatus 4. The radiation oscillators 1 are provided along a first longitudinal direction. The feeding part 2 is electrically connected to the radiation oscillator 1 via a feeding channel 3. The switch apparatus 4 is provided at the feeding channels 3 and configured to control connection and disconnection between at least one of the radiation oscillators 1 and the feeding part 2.

[0016] In the technical solution of the present application, when the antenna unit 100 is configured for communication, generally, connecting the plurality of radiation oscillators 1 to the feeding part 2 to obtain the farthest radiation distance and ensure communication quality. At this time, the beam angle after loading the plurality of radiation oscillators 1 is small, this can meet the communication requirements. However, when the antenna unit 100 is configured to sense signals, the small beam angle results in low spatial coverage in the first direction. Although the coverage range in the first direction can be improved by performing multi-channel digital scanning in the first direction of the antenna unit 100 or by adding phase shifters 5 for simulated beam scanning, multi-channel digital scanning requires increasing the number of channels and expanding the antenna array, which has high implementation cost. In the scheme of adding phase shifters 5 for simulated beam scanning, it is not necessary to expand the antenna array, but the plurality of phase shifters 5 need to be added, which is complex to control and also has a high cost. Therefore, in the present application, a switch apparatus 4 is provided at the feeding channel 3. The switch apparatus 4 controls the number of operating radiation oscillators 1 within the antenna unit 100. When the antenna unit 100 is configured for signal sensing, the number of operating radiation oscillators 1 can be reduced to shorten the sensing distance while achieving a larger beam angle, thus improving sensing coverage in the first direction and meeting the spatial coverage requirements of the sensing signal. This solution is simple to implement, low in cost, and effective. Simultaneously, when the antenna unit 100 is configured for communication, the switch apparatus 4 can be controlled to connect the plurality of radiation oscillators 1 to the feeding part 2, restoring the communication usage state of the antenna unit 100 without affecting its communication function. Thus, the switch apparatus 4 can control the antenna unit 100 to switch between communication mode and sensing signal mode, so as to realize the integration of communication function and signal sensing function and realize the integrated setting of communication and sensing.

[0017] The antenna unit 100 can also be configured without the switch apparatus 4. It can be loaded by the plurality of radiation oscillators 1 and used for both communication and sensing signals, thus achieving integrated communication and sensing capabilities for the antenna unit 100. However, as mentioned above, after loading the plurality of radiation oscillators 1, the beam angle is smaller and the spatial coverage is lower. When sensing signals, the covered spatial range is small, and it can only sense signals within a relatively small area, resulting in poor practicality. Therefore, when the switch apparatus 4 is configured to select the sensing signal mode, the number of radiation oscillators 1 connected to the feeding part 2 is primarily based on actual usage requirements and is not limited. The more connected radiation oscillators 1, the farther the sensing distance, but the lower the spatial coverage; the more radiation oscillators 1, the more complex the beam loading and tuning becomes. Conversely, fewer connected radiation oscillators 1 result in a shorter sensing distance, but higher spatial coverage, and simpler beam loading and tuning.

[0018] Referring to FIG. 5 to FIG. 7, in the first embodiment of the antenna unit 100, at least two feeding channels 3 are provided, one feeding channel 3 is connected to the feeding part 2 and at least one of the radiation oscillators 1, and the other feeding channel 3 is connected to the feeding part 2 and a portion of the radiation oscillators 1; and the switch

apparatus 4 is provided between the two feeding channels a3 and the feeding part 2. The two feeding channels 3 include a first feeding channel 31 and a second feeding channel 32. By setting at least two feeding channels 3 to correspond to the communication mode and sensing signal mode of the antenna unit 100 respectively, in this embodiment, the two modes are directly distinguished. The first feeding channel 31 or the second feeding channel 32 is selected by the switch apparatus 4, thereby directly completing the mode switching of the antenna unit 100. The feeding channel 3 has a large number of channels and occupies a large area, but the logic is simple, easy to operate, and convenient to implement. The number of feeding channels 3 is set according to the number of sensing signal modes of the antenna unit 100. That is, different numbers of radiation oscillators 1 are configured to sense signals according to different requirements, necessitating different numbers of feeding channels 3. The switch apparatus 4 is configured to select the desired feeding channel 3 from among the plurality of feeding channels 3 for connection, satisfying the usage requirements. However, obviously, the more feeding channels 3 there are, the larger the area occupied and the more complex it becomes. Considering practical usage requirements, as in the first embodiment of the antenna unit 100 described above, two feeding channels 3 are set, corresponding to the communication mode and sensing signal mode of the antenna unit 100 respectively, which is simple and practical. The number of radiation oscillators 1 connected in the second feeding channel 32 is mainly based on actual needs, as described in detail above, and will not be repeated here.

[0019] In a first embodiment of the antenna unit 100, the switch apparatus 4 has multiple embodiments correspondingly, as shown in FIG. 5. In the first embodiment of the switch apparatus 4, the switch apparatus 4 includes a switching switch 41 provided between the two feeding channels 3 and the feeding part 2, the switching switch 41 is configured to switch one of the two feeding channels 3 to electrically connect to the feeding part 2. In this embodiment, the switch apparatus 4 is configured as the switching switch 41, which can select between the first feeding channel 31 and the second feeding channel 32. It has a simple structure, is easy to operate, and avoids the abnormal situation where the switch apparatus 4 simultaneously connects the first feeding channel 31 and the second feeding channel 32. In a second embodiment of the switch apparatus 4, referring to FIG. 6, the switch apparatus 4 includes two first switches 42 respectively provided at the two feeding channels 3. In this embodiment, one first switch 42 is respectively provided at the first feeding channel 31 and the second feeding channel 32, which can independently control the connection between the first feeding channel 31 and the second feeding channel 32. When one first switch 42 is damaged and fails, the other first switch 42 can still perform its function, satisfying the normal use of the antenna unit 100 in one mode, so as to minimize the impact of the damage to the antenna unit 100 caused by the first switch 42.

[0020] Based on the second embodiment of the switch apparatus 4, a third embodiment of the switch apparatus 4 is given, specifically referring to FIG. 7. A plurality of the feeding part 2 can be provided. Regarding the configuration of the first feeding channel 31 and the second feeding channel 32, it can be that the first feeding channel 31 and the second feeding channel 32 are respectively connected to one feeding part 2. In this case, the plurality of feeding parts 2 can feed the same digital signal. The first switch 42 is also respectively configured on one feeding channel 3 to control two feeding channels 3 to connect to their corresponding feeding parts 2.

[0021] Furthermore, regarding the aforementioned problem of having multiple feeding channels 3 to correspond to different usage modes of the antenna unit 100, resulting in a large number of feeding channels 3, a large area occupied, and complex installation, the present application also proposes a second embodiment of the antenna unit 100, specifically referring to FIG. 8 to FIG. 13. The feeding channel 3 includes a main channel 33 and branch channels 34. The main channel 33 is connected to the feeding part 2; the branch channel 34 are connected to the main channel 33, the branch channel 34 includes a plurality of branch roads 341, and the branch road 341 is connected to the radiation oscillator 1; at least one of the main channel 33 and the branch channel 34 is provided with the switch apparatus 4. The branch channel 34 includes a branch road 341 connected to the plurality of radiation oscillators 1. At this time, setting the switch apparatus 4 in the branch channel 34 allows selective connection of the radiation oscillator 1 within the branch channel 34. Conversely, at this time, setting the switch apparatus 4 in the main channel 33 allows selective connection of at least a portion of the radiation oscillator 1 within the branch channel 34 with the feeding part 2. This configuration allows for the selection of multiple radiation oscillators 1 within the antenna unit 100 by coordinating the feeding channel 3 and the switch apparatus 4 on the feeding channel 3, thus satisfying different usage modes of the antenna unit 100. Compared to the first embodiment of the antenna unit 100 which uses multiple radiation channels to correspond to different usage modes of the antenna unit 100, this embodiment features radiation channels that occupy less space, have higher utilization, lower cost, and are more practical.

[0022] Referring to FIG. 8 to FIG. 9, are the first second embodiment and the second embodiment of the branch channel 34, where one end of the plurality of branch roads 341 is connected to the main channel 33. In this embodiment, the plurality of radiation oscillators 1 are directly connected in parallel to the main channel 33. The feeding channel 3 is simple to lay and easy to implement. Correspondingly, the switch apparatus 4 has multiple embodiments, that is, the switch apparatus 4 is provided at the branch road 341 or the switch apparatus 4 is provided at the main channel 33. In the first embodiment of the branch channel 34, referring to FIG. 8, the branch road 341 is equipped with the switch apparatus 4, so that one radiation oscillator 1 corresponds to one switch apparatus 4, allowing each radiation oscillator 1 to be independently controlled. This provides flexible operation. However, the setup of the switch apparatus 4 is cumbersome. Furthermore, during the

switching between the communication mode and the sensing signal mode of the antenna unit 100, the number of radiation oscillators 1 used is relatively fixed, requiring no flexible control. Therefore, independent control of each radiation oscillator 1 is impractical.

[0023] Based on this, a second embodiment of the branch channel 34 is proposed, specifically referring to FIG. 9. The plurality of radiation oscillators 1 include a first radiation oscillator 11 and a second radiation oscillator 12; the plurality of branch roads 341 include a first branch road 3411 connected to the first radiation oscillator 11 and a second branch road 3412 connected to the second radiation oscillator 12; one end of the main channel 33 is connected to the feeding part 2, the main channel 33 is provided with a first connection point 331 connected to the first branch road 3411 and a second connection point 332 connected to the second branch road 3412, and the first connection point 331 is provided between the second connection point 332 and the feeding part 2; and the switch apparatus 4 includes a second switch 43 provided between the first connection point 331 and the second connection point 332. That is, when the plurality of branch roads 341 are connected in parallel to the main channel 33, the switch apparatus 4 is provided at the main channel 33, and the switch apparatus 4 is adjusted to be the second switch 43 provided between the above-mentioned first connection point 331 and the second connection point 332. The second switch 43 then connects and disconnects the main channel 33, controls the connection and disconnection between the main channel 33 and the second branch road 3412, thus serving as a selection function for the radiation oscillator 1.

[0024] plurality of second radiation oscillators 12 are provided. During the setting of the position of the second switch 43, at least one second branch roads 3412 are provided, and in this embodiment, a plurality of second branch roads 3412 are provided, meaning the plurality of second radiation oscillators 12 are provided. This allows the second switch 43 to simultaneously control the connection and disconnection of the plurality of second radiation oscillators 12. Compared to the above method where the switch apparatus 4 independently controls each radiation oscillator 1, this method is clearly less costly.

[0025] Furthermore, referring to FIG. 10 to FIG. 13, for the third embodiment to the sixth embodiment of the branch channel 34, the radiation oscillator 1 includes a first radiation oscillator 11 and a plurality of second radiation oscillators 12; the plurality of branch roads 341 include a first branch road 3411 connected to the first radiation oscillator 11 and a plurality of second branch roads 3412 correspondingly connected to the plurality of second radiation oscillators 12; the branch channel 34 includes a plurality of diversion channels 342 connecting the main channel 33 and the plurality of branch roads 341, at least one of the diversion channels 342 includes a first connection channel 3421, one end of the first connection channel 3421 is connected to at least two of the branch roads 341, and a branch road 341 connected to the first connection channel 3421 is the second branch road 3412; and the switch apparatus 4 is configured to control connection and disconnection with the first connection channel 3421. That is, the branch channel 34 includes the plurality of parallel diversion channels 342, and each diversion channel 342 can be connected to at least one branch road 341. When the antenna unit 100 switches between communication mode and sensing signal mode, if it is necessary to switch the connection and disconnection of the plurality of radiation oscillators 1 (that is, to switch the connection and disconnection of the plurality of second radiation oscillators 12), the plurality of second branch roads 3412 corresponding to the plurality of second radiation oscillators 12 can be centrally connected to the diversion channel 342, that is, connected to the first connection channel 3421. The switch apparatus 4 controls the connection and disconnection of the first connection channel 3421 to achieve synchronous control of the connection and disconnection of the plurality of second radiation oscillators 12.

[0026] Referring to FIG. 10, which is a third embodiment of the branch channel 34, the switch apparatus 4 includes a third switch 44 provided at the first connection channel. That is, the third switch 44 is directly provided at the first connection channel, and when there are the plurality of first connection channels, each first connection channel is controlled by a corresponding third switch 44, thus enabling independent control and avoiding impact on other branch roads 341.

[0027] Furthermore, referring to FIG. 11, in a fourth embodiment of the branch channel 34, the feeding part 2 is connected to a middle section of the main channel 33, the feeding part 2 is configured to divide the main channel 33 into a first flow channel section 333 and a second flow channel section 334; the other end of the first connection channel 3421 is connected to the first flow channel section 333, and the other diversion channels 342 are connected to the second flow channel section 334; and the switch apparatus 4 includes a fourth switch 45 provided at the first flow channel section 333. Corresponding to the third embodiment of the branch channel 34, by connecting the feeding part 2 to the middle section of the main channel 33, the main channel 33 is divided into a first flow channel section 333 and a second flow channel section 334. In this case, the first flow channel section 333 is only connected to the first connection channel 3421, while the other diversion channels 342 are connected to the second flow channel section 334. This allows the switch apparatus 4 to be configured as the fourth switch 45 provided at the first flow channel section 333, and the fourth switch 45 is also configured to connect and disconnect the first connection channel 3421.

[0028] Furthermore, referring to FIG. 12, which is a fifth embodiment of the branch channel 34, at least one of the diversion channels 342 includes a first hybrid connection channel 3422 and a first connection channel 3421; one end of the first hybrid connection channel 3422 is connected to the main channel 33; one end of the first connection channel 3421 is connected to at least two of the branch roads 341, and a branch road 341 connected to the first connection channel 3421 is

the second branch road 3412; the other end of the first hybrid connection channel 3422 is connected to the other end of the first connection channel 3421 and to at least one of the first branch roads 3411. In this embodiment, the diversion channel 342 includes a first hybrid connection channel 3422, and the first hybrid connection channel 3422 connects to the main channel 33 and diverts traffic to the first connection channel 3421 and at least one first branch road 3411; that is, the traffic is diverted to the plurality of second radiation oscillators 12 and at least one first radiation oscillator 11 integrated by the first connection channel 3421. In this case, the switch apparatus 4 can be provided at the first connection channel 3421 or at one end of the hybrid connection channel 3422 connecting to the first connection channel 3421, as long as it enables connection and disconnection of the first connection channel 3421. No limitation is imposed here; the choice depends on actual usage requirements.

[0029] Referring to FIG. 13, which is the sixth embodiment of the branch channel 34, at least one of the diversion channels 342 includes a second hybrid connection channel 3424 and a second connection channel 3423. One end of the second hybrid connection channel 3424 is connected to the main channel 33; and one end of the second connection channel 3423 is connected to at least two of the branch roads 341, and the branch road 341 connected to the second connection channel 3423 is the first branch road 3411; the other end of the second hybrid connection channel 3424 is connected to the other end of the second connection channel 3423 and at least one of the second branch roads 3412. Corresponding to the fifth embodiment of the branch channel 34, the diversion channel 342 may further include a second hybrid connection channel 3424. This second hybrid connection channel 3424 connects to the main channel 33 and diverts traffic to the second connection channel 3423 and at least one second branch road 3412; that is, the traffic is diverted to the plurality of first radiation oscillators 11 and at least one second radiation oscillator 12 integrated by the second connection channel 3423. In this case, the switch apparatus 4 can be provided at the second branch road 3412, or at one end of the hybrid connection channel 3424 connecting to the second branch road 3412, as long as it enables connection and disconnection of two branch roads 3412. No limitation is imposed here; the choice depends on actual usage requirements.

[0030] Furthermore, the radiation oscillator 1 includes a first radiation oscillator 11 and a second radiation oscillator 12, and the switch apparatus 4 is configured to control connection and disconnection between the second radiation oscillator 12 and the feeding part 2; and the radiation oscillator 1 includes at least two first radiation oscillators 11. When the antenna unit 100 is in the signal sensing mode, the specific setting of the number of radiation oscillators 1 connected to the feeding part 2 has been described in detail above and will not be repeated here. In this embodiment, at least two first radiation oscillators 11 are connected to the feeding part 2.

[0031] The two first radiation oscillators 11 are provided adjacent to each other in a first direction. Generally, the plurality of radiation oscillators 1 on the antenna unit 100 are provided along a first direction. When the antenna unit 100 is in communication mode, all the radiation oscillators 1 are connected to the feeding part 2 to form a radiating whole by loading. Generally, the distance between adjacent radiation oscillators 1 is a certain value to facilitate beam adjustment after the plurality of radiation oscillators 1 are loaded. When the antenna unit 100 is in the sensing signal mode, the feeding part 2 is connected to at least two first radiation oscillators 11. When the two first radiation oscillators 11 are spaced apart by the second radiation oscillator 12, the beam loading of the two first radiation oscillators 11 needs to be further adjusted. Compared with directly setting the two first radiation oscillators 11 adjacently, the required operation and design steps are more numerous, more complex, and less practical. Therefore, in this embodiment, the two first radiation oscillators 11 are directly provided adjacently in the first direction.

[0032] In addition, a phase shifter 5 is provided at the feeding channel, and the phase shifter 5 includes a first phase shifter 51 capable of controlling a phase of one of the two first radiation oscillators 11. When the two first radiation oscillators 11 are connected to the feeding part 2, their beam extension direction is the second transverse direction. Compared to using only one first radiation oscillator 11, using two first radiation oscillators 11 reduces the beam angle by nearly half, which does not meet the spatial coverage for the upper half of the horizontal plane or the spatial coverage for the lower half of the horizontal plane in practical use. Therefore, in this embodiment, a first phase shifter 51 is provided on the feeding path. By changing the phase of one of the two first radiation oscillators 11 by the first phase shifter 51, the beams extended along the second transverse direction loaded by both are deflected in the first longitudinal direction. Corresponding to actual use, the beam can be tilted upward relative to the horizontal plane to meet the spatial coverage of the upper half of the horizontal plane, or the beam can be tilted downward relative to the horizontal plane to meet the spatial coverage of the lower half of the horizontal plane. The phase shifting of the first phase shifter 51 is selected according to actual needs and is not limited here.

[0033] Furthermore, a phase shifter 5 is provided at the feeding channel 3, and the phase shifter 5 includes a second phase shifter 52 capable of controlling phases of a portion of the plurality of radiation oscillators 1. When the antenna unit 100 is in communication mode, it is generally necessary to ensure beam coverage of the lower half of its horizontal plane to guarantee communication quality. Without setting the second phase shifter 52, the beams of the multiple radiation oscillators 1 after loading extend horizontally, and their beam angles are small, failing to meet the requirement of beam coverage of the lower half of the horizontal plane. Therefore, in this embodiment, the second phase shifter 52 is added to tilt the beams of the plurality of radiation oscillators 1 downwards relative to the horizontal plane, thereby achieving beam

coverage of the lower half of the horizontal plane and ensuring communication quality.

[0034] Furthermore, the switch apparatus 4 includes a switch unit 46 connected in series at the feeding channel 3; and the switch apparatus 4 includes a grounding channel 47 connected in parallel to the feeding channel 3 and a switch unit 46 provided at the grounding channel 47. The switch apparatus 4 can be configured in several ways. The present application proposes two configuration methods. The first configuration method involves a switch unit 46 directly connected in series at the feeding channel 3, controlling the connection and disconnection of the feeding channel 3 by directly switching. The second configuration method involves a grounding channel 47 connected in parallel to the feeding channel 3, a switch unit 46 is connected in series with the grounding channel 47, so as to control the connection and disconnection of the switch unit 46, to cause that the portion of the feeding channel 3 downstream of the grounding channel 47 is grounded and shielded by the grounding channel 47, which also allows for control of the connection and disconnection of the feeding channel 3. The present application does not limit the specific configuration of either configuration; any configuration that meets the usage requirements is acceptable.

[0035] Furthermore, the radiation oscillator 1 includes a dual-polarized radiation oscillator 1, and the feeding part 2, the feeding channel 3, and the switch apparatus 4 are correspondingly configured in two sets. The radiation oscillator 1 can be a single-polarized radiation oscillator 1, a circularly polarized radiation oscillator 1, or a dual-polarized radiation oscillator 1, depending on the actual usage requirements, and is not limited here. In this embodiment, the dual-polarized radiation oscillator 1 is used. Based on this, the feeding part 2, the feeding channel 3, and the switch apparatus 4 needs to be configured as two sets to control and connect one polarized radiation unit in the dual-polarized radiation oscillator 1 respectively.

[0036] A phase shifter 5 is provided at the feeding channel 3, and is correspondingly provided at two sets of feeding channels 3. The specific installation and function of the phase shifter 5 have been described in detail above and will not be repeated here. Based on the configuration of the dual-polarized radiation oscillator 1, when the feeding part 2, the feeding channel 3, and the switch apparatus 4 are configured in two sets, the phase shifter 5 also needs to be configured in two corresponding sets to meet the usage requirements.

[0037] Specifically, referring to FIG. 1, in the first specific embodiment of the antenna unit 100 of the present application, the feeding part 2 is sequentially connected to the branch road 341 where the six dual-polarized radiation oscillators 1 are provided via the main channel 33. A second phase shifter 52 is loaded at the position between the third radiation oscillator 1 and the fourth radiation oscillator 1 in the first longitudinal direction of the main channel 33, thereby realizing electrically adjustable downtilt control of the channel beam of the antenna unit 100 in communication mode. Simultaneously, a switch apparatus 4 is loaded between the fifth radiation oscillator 1 and the sixth radiation oscillator 1 in the first longitudinal direction of the main channel 33, and the switch apparatus 4 and the second phase shifter 52 are correspondingly arranged on the two sets of feeding channels 3. When the switch apparatus 4 is in the first state, the radio frequency signal emitted by the feeding part 2 is transmitted to the six radiation oscillators 1 via the feeding channel 3, forming a narrow communication beam to achieve ground communication coverage. Simultaneously, the second phase shifter 52 is used to electrically adjust and control the downtilt of the ground communication beam. When the switch apparatus 4 is in the second state, the top five radiation oscillators 1 in the feeding channel 3 are blocked by the switch apparatus 4, and the radio frequency signal cannot be transmitted to these five radiation oscillators 1; the radio frequency signal is only transmitted to the sixth radiation oscillator 1. In a conventional base station antenna layout, the channel beam is a 60° to 70° wide beam, and the air-sensing beam coverage can reach more than 30°. As shown in the beam diagram, the beam width is 60° to 70°, which is the angle represented by the dashed line in the beam. Since the maximum beam direction is horizontal, the upward beamwidth in the horizontal direction is half the total beamwidth, which is more than 30°. Therefore, full vertical beam coverage is achieved.

[0038] Referring to FIG. 2, in the second specific embodiment of the antenna unit 100 of the present application, the feeding part 2 is connected to six dual-polarized radiation oscillators 1 via a parallel-feed power divider. The parallel-feed power divider has a two-stage design: first, every three radiation oscillators 1 are connected using a 1-to-3 power divider; then, a 1-to-2 power divider combines the two paths. Simultaneously, the second phase shifter 52 is loaded on the branch road 341 of the 1-to-2 power divider to achieve electrically adjustable downtilt control of the channel beam. Simultaneously, the switch apparatus 4 is loaded in the branch road 341 of the 1-to-2 and 1-to-3 power dividers, and the switch apparatus 4 and the second phase shifter 52 are correspondingly installed on the two sets of feeding channels 3. When the switch apparatus 4 is in the first state, the radio frequency signal is transmitted to the six radiation oscillators 1 via the feeding channel 3, forming a narrow communication beam to achieve ground communication coverage. At the same time, the second phase shifter 52 is used to realize the electrical downtilt control and adjustment of the ground communication beam. When the switch apparatus 4 is in the second state, the top five radiation oscillators 1 in the feeding channel 3 are isolated by the switch, and the radio frequency signal cannot be transmitted to these five radiation oscillators 1. All signals are only transmitted to the sixth radiation oscillator 1. In a conventional base station antenna layout, the channel beam is a 60° to 70° wide beam, and the air-sensing beam coverage can reach over 30°. As shown in the beam diagram, the beamwidth is 60° to 70°, which is the angle represented by the dashed line in the beam. Since the maximum beam direction is horizontal, the upward beamwidth in the horizontal direction is half the total beamwidth, which is over 30°. Therefore, full vertical beam coverage is achieved.

[0039] Referring to FIG. 3, in the third specific embodiment of the antenna unit 100 of the present application, the feeding part 2 is connected to the six dual-polarized radiation oscillators 1 via a parallel-feed power divider. The parallel-feed power divider is designed in two stages: first, every three radiation oscillators 1 are connected using a 1-to-3 power divider, and then the two paths are combined using a 1-to-2 power divider. Simultaneously, the second phase shifter 52 is loaded on the upper branch road 341 of the 1-to-2 power divider to achieve electrically adjustable downtilt control of the channel beam. To select the radiation oscillators 1, the switch apparatus 4 is introduced into the network branch road 341 in the figure, and the first phase shifter 51 is loaded into the network of the bottom two radiation oscillators 1. When the switch apparatus 4 is in the first state, the radio frequency signal is transmitted to the six radiation oscillators 1 via the feeding channel 3, forming a narrow communication beam to achieve ground communication coverage. Simultaneously, the two second phase shifters 52 are used to electrically adjust and control the downtilt of the ground communication beam. When the switch apparatus 4 is in the second state, the upper four units of the feeding channel 3 are isolated by the switch apparatus 4, and the radio frequency signal cannot be transmitted to these four radiation oscillators 1. All signals are transmitted only to the fifth radiation oscillator 1 and the sixth radiation oscillator 1. In a conventional base station antenna layout, the channel beam is a 30° to 35° beam at this time. By using the lower first phase shifter 51 to adjust the beam pointing upwards by 15° to 18°, the air-sensing beam coverage can reach over 30°. As shown in the diagram, the beamwidth is 30° to 35°, which is the angle represented by the dashed line in the beam. To achieve coverage of the upper half of space, the first phase shifter 51 between the two radiation oscillators 1 after switching using the switch apparatus 4 is used to make the maximum beam angle upward by 15° to 18°. At this time, the horizontal upward beamwidth is greater than 30° (that is, the beamwidth). Therefore, beam coverage of the entire vertical space is achieved.

[0040] Referring to FIG. 4, in the fourth specific embodiment of the antenna unit 100 of the present application, the feeding part 2 is connected to the six dual-polarized radiation oscillators 1 via a parallel-feed power divider. The power divider is designed in two stages. First, every three radiation oscillators 1 is connected using a 1-to-3 power divider, and then the two paths are combined using a 1-to-2 power divider. Simultaneously, the second phase shifter 52 is applied to the upper branch road 341 of the 1-to-2 power divider to achieve electrically adjustable downtilt control of the channel beam. To select the radiation oscillators 1, a switch apparatus 4 is introduced into the network branch road 341 in the figure. When the switch apparatus 4 is in its first state, the radio frequency signal is transmitted to the six radiation oscillators 1 via the feeding channel 3, combining a narrow communication beam to achieve ground communication coverage. At the same time, the second phase shifter 52 is used to achieve electrically adjustable downtilt control and adjustment of the ground communication beam. When the switch apparatus 4 is in the second state, the top two and bottom two radiation oscillators 1 in the feeding channel 3 are isolated by the switch apparatus 4, and the radio frequency signal cannot be transmitted to these four radiation oscillators 1. All signals are only transmitted to the third radiation oscillator 1 and the fourth radiation oscillator 1. In a conventional base station antenna layout, the channel beam is a 30° to 35° beam at this time. By using the second phase shifter 52 (in this embodiment, the first phase shifter 51 and the second phase shifter 52 are the same phase shifter 5) to adjust the beam pointing upwards by 15° to 18°, the air sensing beam coverage can reach more than 30°. As shown in the beam diagram, the beamwidth is 30° to 35°, which is the angle of the dashed line in the beam. To achieve coverage of the upper half of the space, the second phase shifter 52 between the two radiation oscillators 1 after switching using the switch apparatus 4 causes the beam to point upwards at a maximum angle of 15° to 18°. At this angle, the horizontal upward beamwidth is greater than 30° (that is, the beamwidth). Thus, beam coverage of the entire vertical space is achieved.

[0041] The present application also proposes an antenna array 1000, which includes antenna units 100. The specific structure of the antenna unit 100 is described in the above embodiments. Since the antenna array 1000 adopts all the technical solutions of all the above embodiments, it possesses at least all the beneficial effects brought about by the technical solutions of the above embodiments, which will not be elaborated further here. The plurality of antenna units 100 are provided in an array.

[0042] The plurality of antenna units 100 provided along a first direction form an antenna group 200, and the antenna array 1000 includes a plurality of the antenna groups 200 provided along a second transverse direction; two antenna units 100 at both ends of at least one antenna group 200, in response to that the switch apparatus 4 controls disconnection between at least one radiation oscillator 1 and the feeding part 2, have a channel spacing greater than their center distance. The distance between the longitudinal center point of the plurality of radiation oscillators 1 connected to the feed section on one antenna unit 100 and the longitudinal center point of the plurality of radiation oscillators 1 connected to the feed section on another antenna unit 100 is defined as the channel spacing. From the perspective of the target angle measurement mechanism, the larger the aperture of the antenna array 1000, that is, the larger the channel spacing between the two antenna units 100, the higher the angular resolution and the higher the sensing accuracy. Therefore, in rooftop design, it is necessary to maximize the maximum distance between channels within the limited rooftop space to obtain a larger aperture. Based on this, in this embodiment, the channel spacing between the two antenna units 100 in signal sensing mode is set to be at least greater than the center distance between them, in order to increase the maximum distance between channels and improve sensing accuracy.

[0043] In response to that the switch apparatus 4 within the antenna unit 100 controls the disconnection between at least

one radiation oscillator 1 and the feeding part 2, the antenna array 1000 includes at least two antenna unit groups 300 forming different channel spacing, and the antenna unit group 300 includes two antenna units 100 provided at intervals in the first direction. Given a fixed number of digital channels, increasing the aperture inevitably leads to an increase in the channel spacing, potentially introducing target mirroring issues and affecting sensing accuracy. Therefore, in this embodiment, in addition to the antenna group 200 with the maximum distance between the channels as described above, an antenna unit group 300 with a different maximum distance is also provided. When the antenna array 1000 has only two rows in the second horizontal direction, one antenna group 200 is equivalent to one antenna unit group 300. At this time, the channel spacing of the plurality of antenna groups 200 arranged in the second horizontal direction is set to be different, so that the antenna array 1000 has different apertures, which satisfies the requirement of improving sensing accuracy while suppressing the mirror problem. When the antenna array 1000 is arranged in at least three rows in the second horizontal direction, an antenna group 200 may include the plurality of antenna unit groups 300, allowing antenna unit groups 300 with different channel spacing to be arranged within the antenna group 200. This enables the antenna group 200 to have different apertures, satisfying the requirement of improving sensing accuracy while suppressing image problems.

[0044] Larger channel spacing between two antenna units 100 can improve angular resolution, but it will cause a mirroring problem. Conversely, smaller channel spacing between two antenna units 100 can reduce the mirroring problem, but it will reduce angular resolution. Both settings will affect the final sensing accuracy. Therefore, there is no perfect solution when setting the channel spacing between two antenna units 100. Thus, when designing the antenna array 1000, it is necessary to consider both aperture and mirror suppression effects. The design should be based on a larger spacing between some antenna unit groups 300 and a smaller spacing between some antenna unit groups 300 to comprehensively meet the sensing accuracy requirements of the antenna array.

[0045] Referring to FIG. 14 and FIG. 15, in a specific embodiment of the antenna array 1000 described in the present application, the antenna array 1000 is composed of two antenna units 100 as described in the fourth embodiment above and four antenna units 100 as described in the third embodiment above, arranged in an array to form a two-row, three-column antenna array. When all the switch apparatus 4 are in the second state, only the radiation oscillator 1 in the dark position shown in FIG. 15 is connected to the feeding part 2. At this time, the maximum aperture in the vertical direction of the entire array is determined by the centers of the two most distant equivalent channels in the third column of the array, and its aperture size is equal to 10 times the spacing of the radiation oscillators 1. In contrast, the antenna array composed of conventional fixed six-element antenna units 300 arranged in the same pattern has a vertical aperture only six times the spacing between the radiation oscillators 1. Therefore, the array design presented in the present application can achieve a larger aperture without increasing the number of radiation oscillators 1, thus enabling higher-precision target sensing. However, if each column of the antenna array 1000 uses the same antenna group combination as the third column, the large spacing between the two channels, while resulting in a large vertical aperture, may lead to multiple target mirror images during target sensing, affecting accuracy. Therefore, the present application selects different radiation oscillator 1 combinations in the first and second columns compared to the third column. Combining the three columns of antenna groups 200 for target sensing effectively suppresses the mirror image problem. In summary, by employing various antenna architectures and combining them appropriately, an antenna array 1000 with a larger antenna aperture can be obtained without increasing the number of radiation oscillators 1, thereby suppressing the image of the sensed target and achieving higher precision sensing.

[0046] The above descriptions are merely some embodiments of the present application and do not limit the scope of the present application. All equivalent structural transformations made based on the inventive concept of the present application and the content of this specification and drawings, or direct/indirect applications in other related technical fields, are included within the scope of the present application.

Claims

1. An antenna unit, **characterized by** comprising:

a plurality of radiation oscillators provided along a first longitudinal direction;
at least one feeding part, wherein the feeding part is electrically connected to the radiation oscillator via a feeding channel; and
a switch apparatus provided at the feeding channel and configured to control connection and disconnection between at least one of the radiation oscillators and the feeding part.

2. The antenna unit according to claim 1, wherein at least two feeding channels are provided, one feeding channel is connected to the feeding part and at least one of the radiation oscillators, and the other feeding channel is connected to the feeding part and a portion of the radiation oscillators; and

the switch apparatus is provided between the two feeding channels and the feeding part.

3. The antenna unit according to claim 2, wherein the switch apparatus comprises a switching switch provided between the two feeding channels and the feeding part, the switching switch is configured to switch one of the two feeding channels to electrically connect to the feeding part; or
the switch apparatus comprises two first switches respectively provided at the two feeding channels.

4. The antenna unit according to claim 1, wherein the feeding channel comprises:

a main channel connected to the feeding part; and
a branch channel connected to the main channel, wherein the branch channel comprises a plurality of branch roads, and the branch road is connected to the radiation oscillator;
at least one of the main channel and the branch channel is provided with the switch apparatus.

5. The antenna unit according to claim 4, wherein one end of the plurality of branch roads is connected to the main channel.

6. The antenna unit according to claim 5, wherein the plurality of radiation oscillators comprise a first radiation oscillator and a second radiation oscillator;

the plurality of branch roads comprise a first branch road connected to the first radiation oscillator and a second branch road connected to the second radiation oscillator;
one end of the main channel is connected to the feeding part, the main channel is provided with a first connection point connected to the first branch road and a second connection point connected to the second branch road, and
the first connection point is provided between the second connection point and the feeding part; and
the switch apparatus comprises a second switch provided between the first connection point and the second connection point.

7. The antenna unit according to claim 4, wherein the radiation oscillator comprises a first radiation oscillator and a plurality of second radiation oscillators;

the plurality of branch roads comprise a first branch road connected to the first radiation oscillator and a plurality of second branch roads correspondingly connected to the plurality of second radiation oscillators;
the branch channel comprises a plurality of diversion channels connecting the main channel and the plurality of branch roads, at least one of the diversion channels comprises a first connection channel, one end of the first connection channel is connected to at least two of the branch roads, and a branch road connected to the first connection channel is the second branch road; and
the switch apparatus is configured to control connection and disconnection with the first connection channel.

8. The antenna unit according to claim 7, wherein the switch apparatus comprises a third switch provided at the first connection channel.

9. The antenna unit according to claim 7, wherein the feeding part is connected to a middle section of the main channel, the feeding part is configured to divide the main channel into a first flow channel section and a second flow channel section;

the other end of the first connection channel is connected to the first flow channel section, and the other diversion channels are connected to the second flow channel section; and
the switch apparatus comprises a fourth switch provided at the first flow channel section.

10. The antenna unit according to claim 7, wherein at least one of the diversion channels comprises:

a first hybrid connection channel, wherein one end of the first hybrid connection channel is connected to the main channel; and
a first connection channel, wherein one end of the first connection channel is connected to at least two of the branch roads, and the branch road connected to the first connection channel is the second branch road;
wherein the other end of the first hybrid connection channel is connected to the other end of the first connection channel and to at least one of the first branch roads.

11. The antenna unit according to claim 7, wherein at least one of the diversion channels comprises:

a second hybrid connection channel, wherein one end of the second hybrid connection channel is connected to the main channel; and

a second connection channel, wherein one end of the second connection channel is connected to at least two of the branch roads, and the branch road connected to the second connection channel is the first branch road; wherein the other end of the second hybrid connection channel is connected to the other end of the second connection channel and at least one of the second branch roads.

12. The antenna unit according to claim 1, wherein the radiation oscillator comprises a first radiation oscillator and a second radiation oscillator, and the switch apparatus is configured to control connection and disconnection between the second radiation oscillator and the feeding part; and the radiation oscillator comprises at least two first radiation oscillators.

13. The antenna unit according to claim 12, wherein the two first radiation oscillators are provided adjacent to each other in a first direction.

14. The antenna unit according to claim 12 or 13, wherein a phase shifter is provided at the feeding channel, and the phase shifter comprises a first phase shifter capable of controlling a phase of one of the two first radiation oscillators.

15. The antenna unit according to claim 1, wherein a phase shifter is provided at the feeding channel, and the phase shifter comprises a second phase shifter capable of controlling phases of a portion of the plurality of radiation oscillators.

16. The antenna unit according to claim 1, wherein the switch apparatus comprises a switch unit connected in series at the feeding channel; and the switch apparatus comprises a grounding channel connected in parallel to the feeding channel and a switch unit provided at the grounding channel.

17. The antenna unit according to claim 1, wherein the switch apparatus comprises a switch unit connected in series at the feeding channel.

18. The antenna unit according to claim 1, wherein the switch apparatus comprises a grounding channel connected in parallel to the feeding channel and a switch unit provided at the grounding channel.

19. The antenna unit according to claim 1, wherein the radiation oscillator comprises a dual-polarized radiation oscillator, and the feeding part, the feeding channel, and the switch apparatus are correspondingly configured in two sets.

20. An antenna array comprising a plurality of the antenna units according to any one according to claims 1 to 18, and the plurality of antenna units are provided in an array.

21. The antenna array according to claim 20, wherein the plurality of antenna units provided along a first direction form an antenna group, and the antenna array comprises a plurality of the antenna groups provided along a second transverse direction; wherein two antenna units at both ends of at least one antenna group, in response to that the switch apparatus controls disconnection between at least one radiation oscillator and the feeding part, have a channel spacing greater than their center distance.

22. The antenna array according to claim 20, wherein in response to that the switch apparatus within the antenna unit controls the disconnection between at least one radiation oscillator and the feeding part, the antenna array comprises at least two antenna unit groups forming different channel spacing, and the antenna unit group comprises two antenna units provided at intervals in the first direction.

100

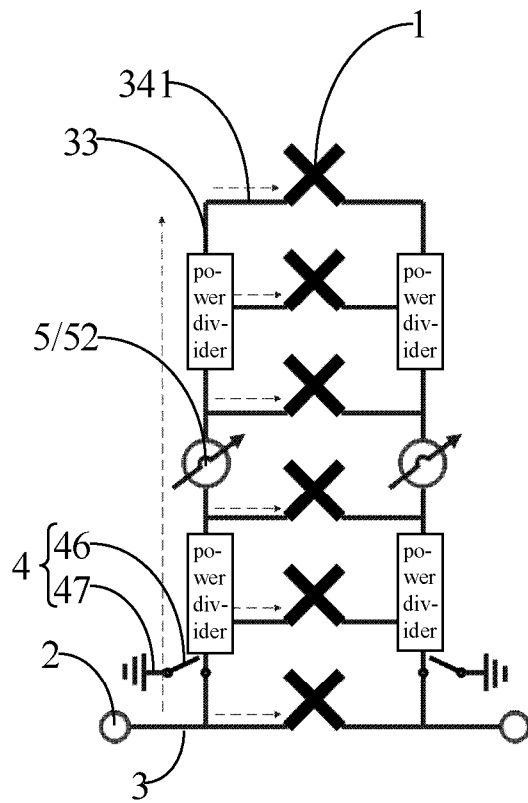


FIG. 1

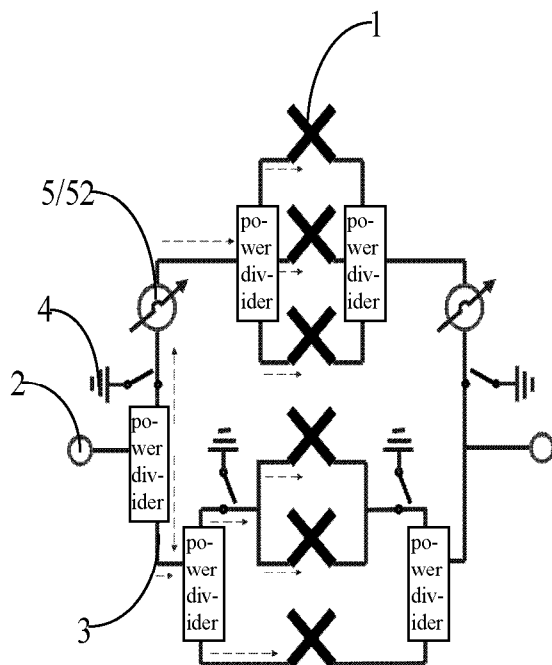


FIG. 2

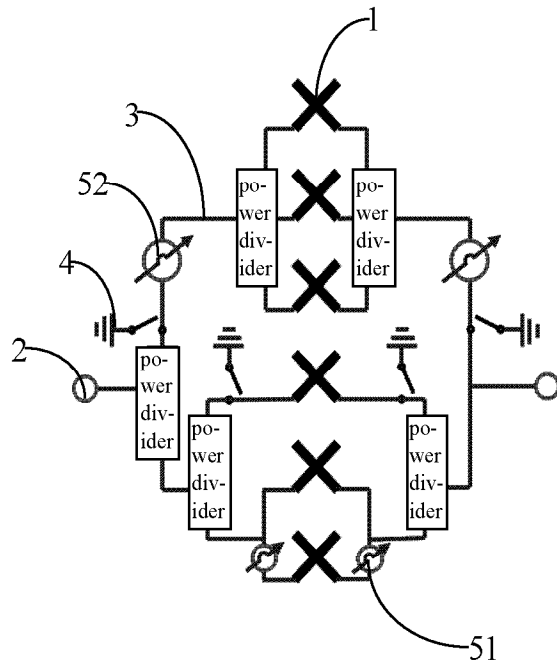


FIG. 3

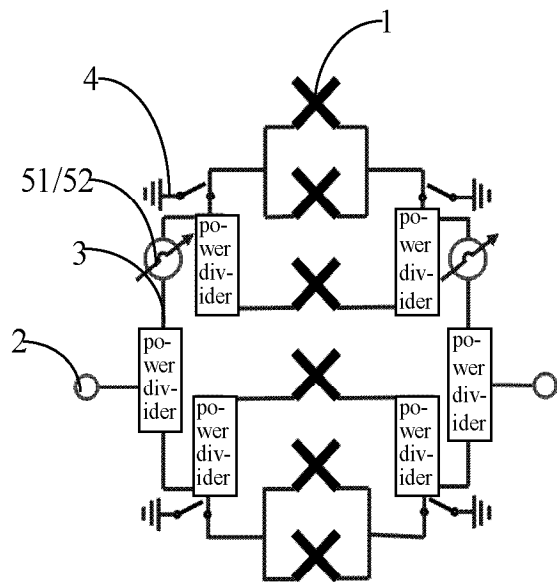


FIG. 4

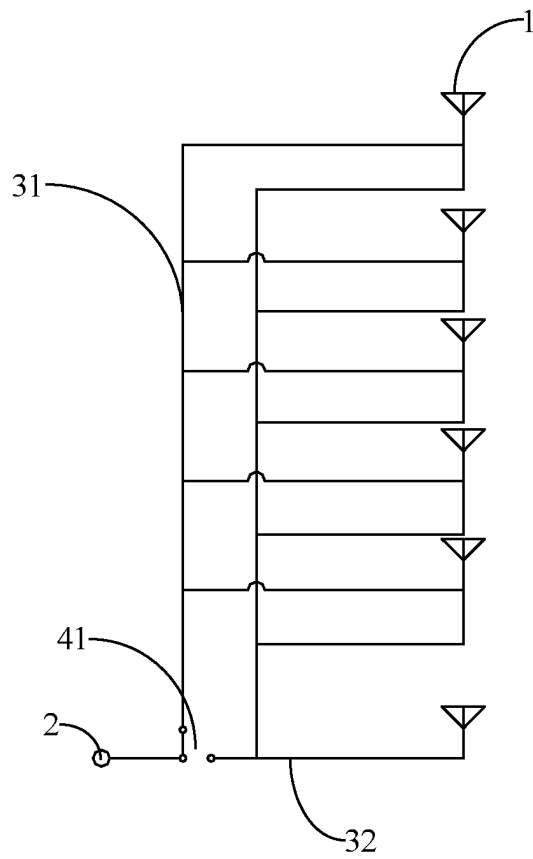


FIG. 5

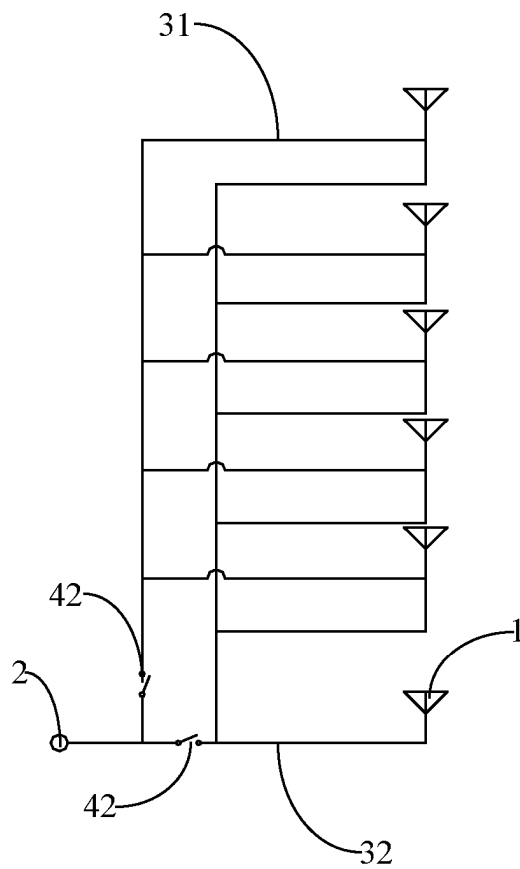


FIG. 6

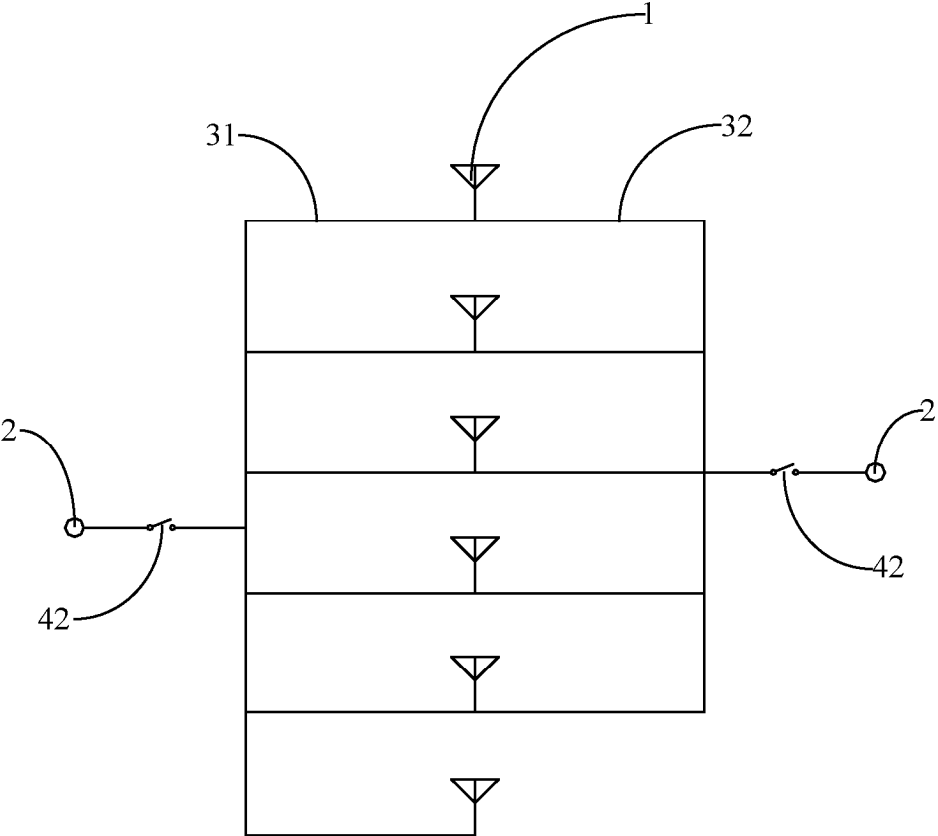


FIG. 7

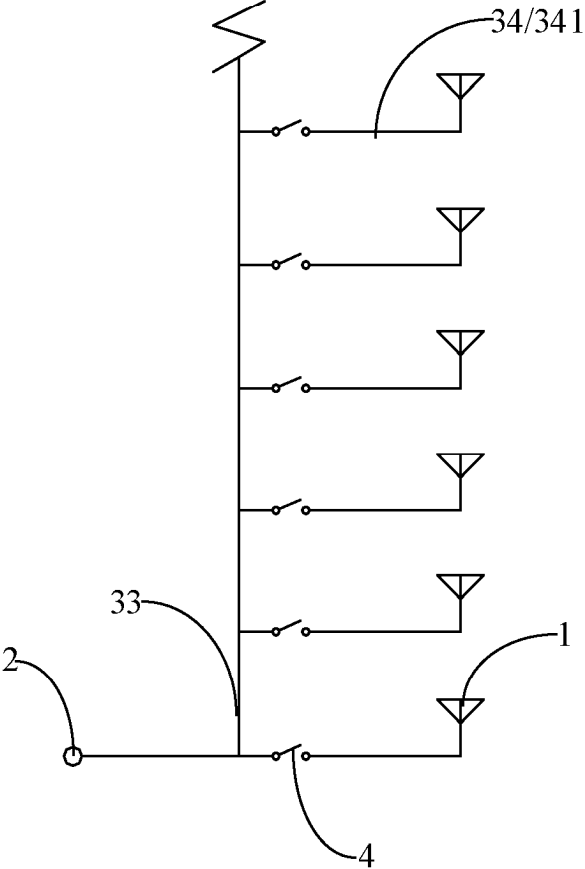


FIG. 8

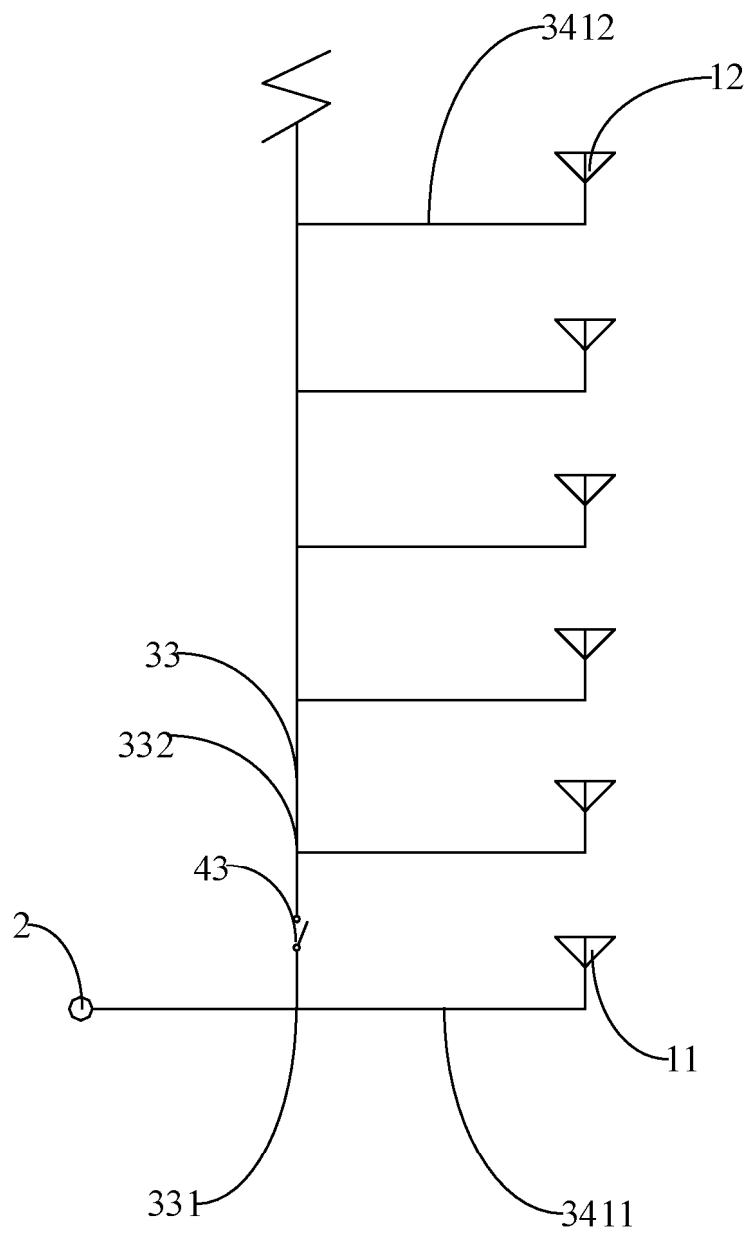


FIG. 9

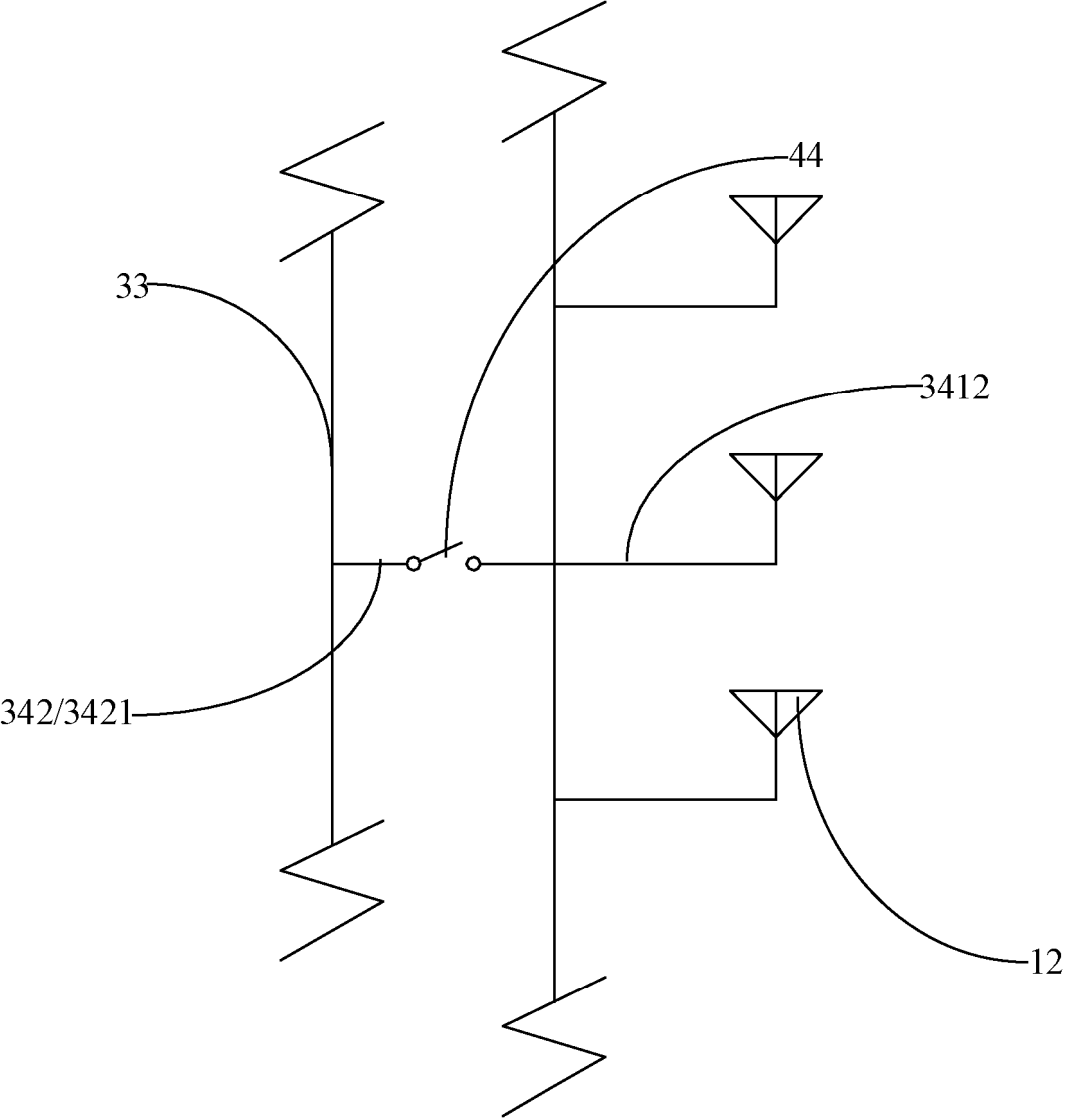


FIG. 10

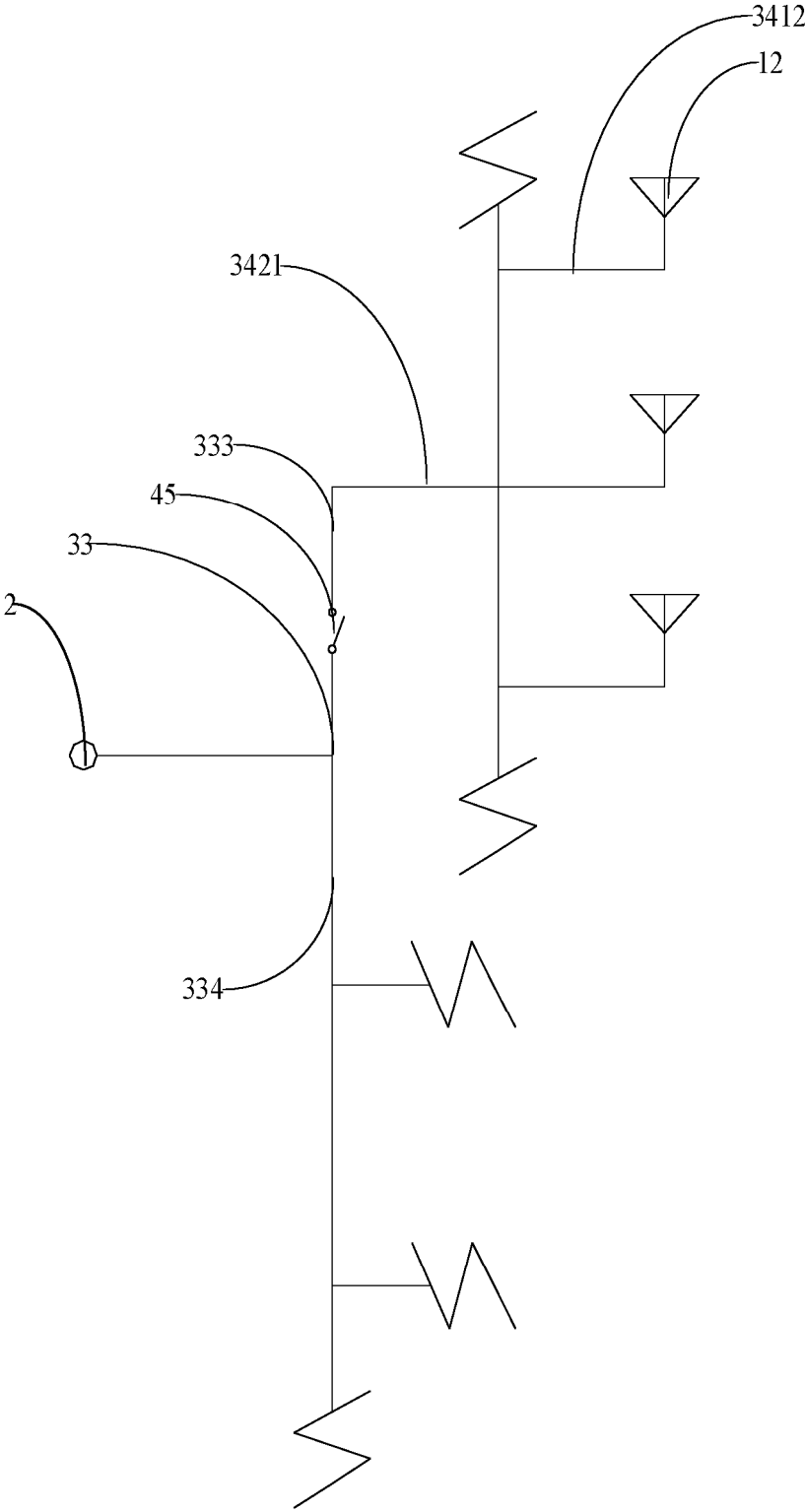


FIG. 11

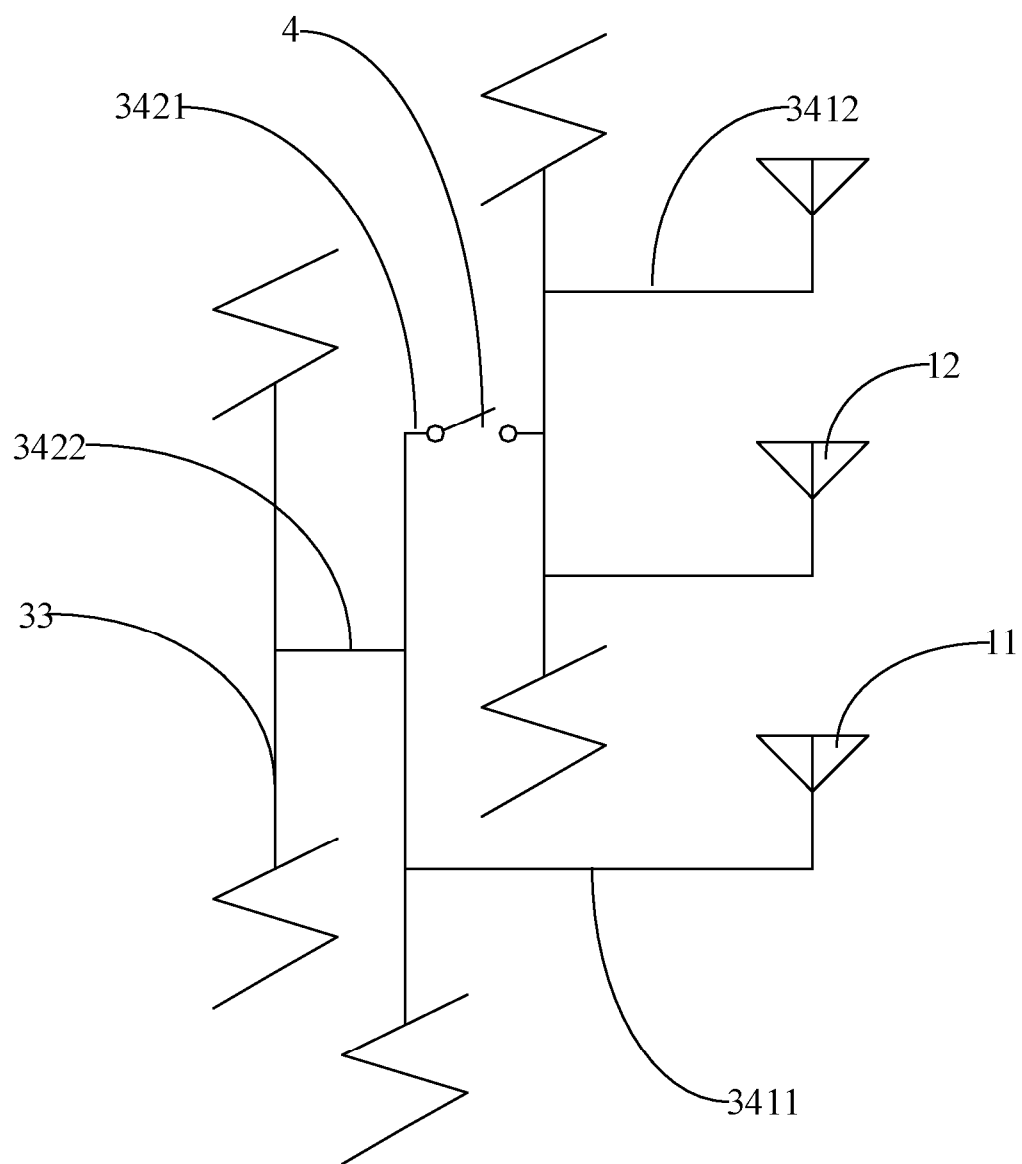


FIG. 12

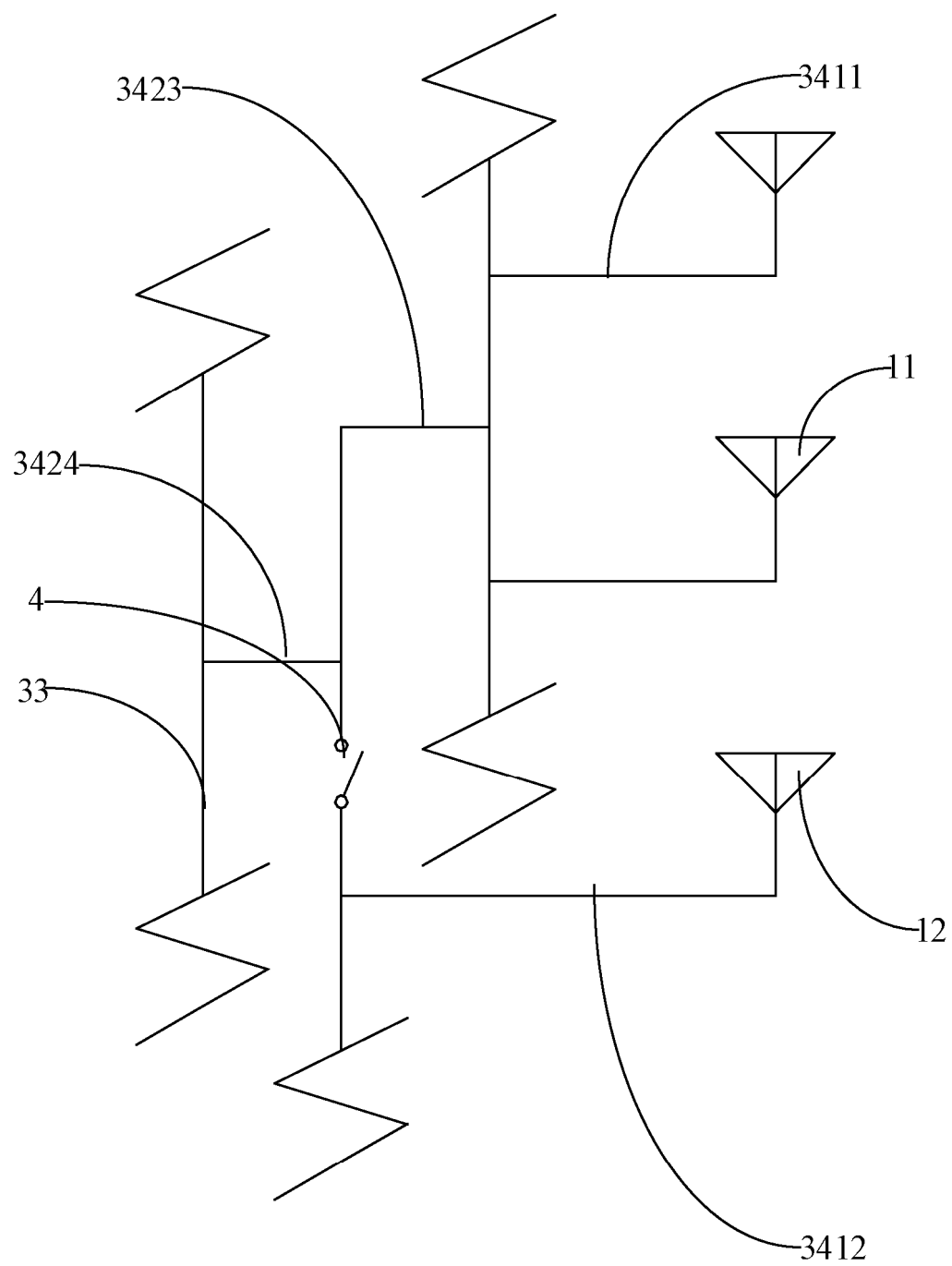


FIG. 13

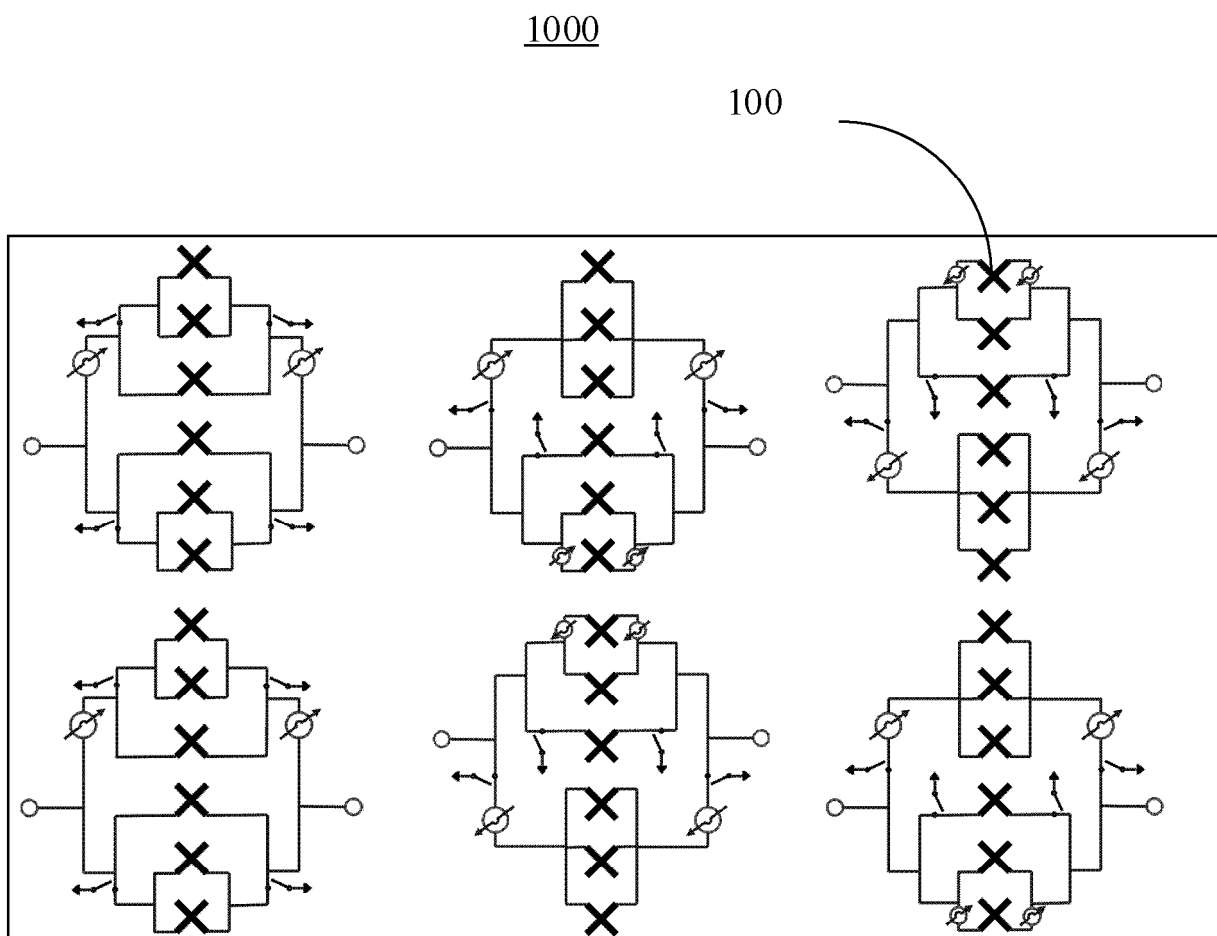


FIG. 14

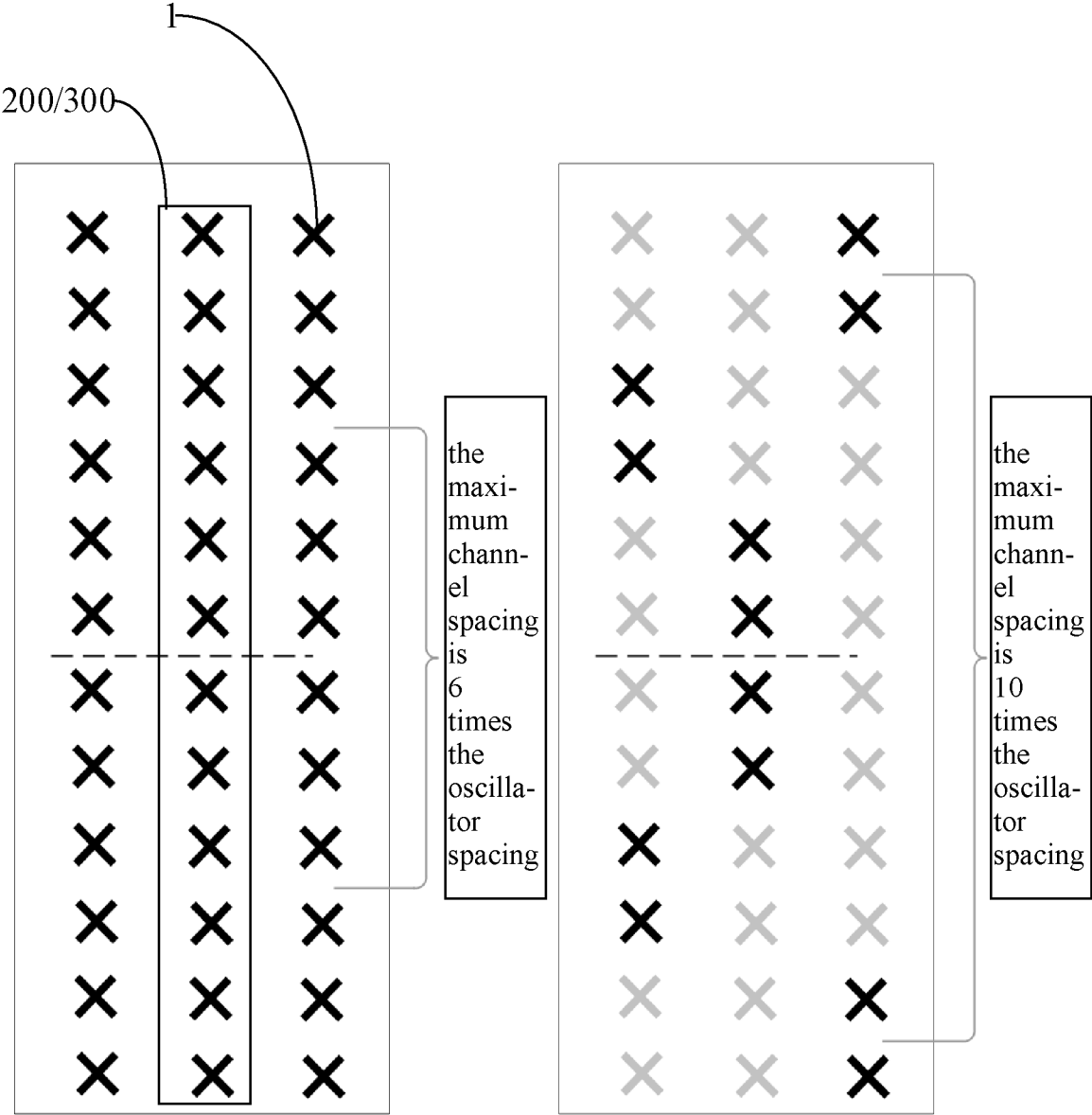


FIG. 15

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2024/116651

A. CLASSIFICATION OF SUBJECT MATTER

H01Q21/08(2006.01)i; H01Q1/50(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNTXT, ENTXTC, ENTXT, VEN, CNKI: 阵列, 子阵, 天线, 辐射, 振子, 开关, 切换, 选择, 全部, 部分, 数量, 数目, 个数, 辐射距离, 距离, 波束角, 高增益, array, antenna?, radiat+, switch+, part, all, number, distance, beam angle, high gain

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2023178888 A1 (ARRIS ENTERPRISES LLC) 08 June 2023 (2023-06-08) description, paragraphs 41-56, and figure 5	1-3, 15-22
Y	US 2023178888 A1 (ARRIS ENTERPRISES LLC) 08 June 2023 (2023-06-08) description, paragraphs 41-56, and figure 5	4-14
Y	CN 111710961 A (GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP., LTD.) 25 September 2020 (2020-09-25) description, paragraphs 32-40, 60-61, and 69-70, and figures 1-2 and 6	4-14
A	CN 106207461 A (SUZHOU WUTONG ANTENNA CO., LTD.) 07 December 2016 (2016-12-07) entire document	1-22

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

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"D" document cited by the applicant in the international application	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"E" earlier application or patent but published on or after the international filing date	"&" document member of the same patent family
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 27 November 2024	Date of mailing of the international search report 10 December 2024
Name and mailing address of the ISA/CN China National Intellectual Property Administration (ISA/CN) China No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2022)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2024/116651

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Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
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CN	111710961	A	25 September 2020	None	
CN	106207461	A	07 December 2016	None	

REFERENCES CITED IN THE DESCRIPTION

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- CN 202311268363 [0001]