(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 4 254 651 A1

(12) # EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
04.10.2023 Bulletin 2023/40

(21) Application number: **20965411.0**

(22) Date of filing: **15.12.2020**

(51) International Patent Classification (IPC):
H01P 1/203 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
H01P 1/203

(86) International application number:
PCT/CN2020/136616

(87) International publication number:
WO 2022/126393 (23.06.2022 Gazette 2022/25)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

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(54) **DIELECTRIC FILTER, TRANSCEIVER, AND BASE STATION**

(57) This application provides a dielectric filter, a transceiver, and a base station, to resolve problems of a limited layout of a dielectric filter topology and a poor out-of-band rejection capability, and further to achieve a flexible layout of a filter topology and improve the out-of-band rejection capability of the dielectric filter. The dielectric filter includes a dielectric body, and an input port, an output port, internal dielectric resonators, and external dielectric resonators that are disposed on the dielectric body, a plurality of internal dielectric resonators are disposed between the input port and the output port, and form a main-coupling-channel cascaded resonator; and two external dielectric resonators are disposed on one side of the input port, where an amount of coupling between the external dielectric resonator and the input port is greater than an amount of coupling between the external dielectric resonator and any of the internal dielectric resonators; and/or two external dielectric resonators are disposed on one side of the output port, where an amount of coupling between the external dielectric resonator and the output port is greater than an amount of coupling between the external dielectric resonator and any of the internal dielectric resonators.

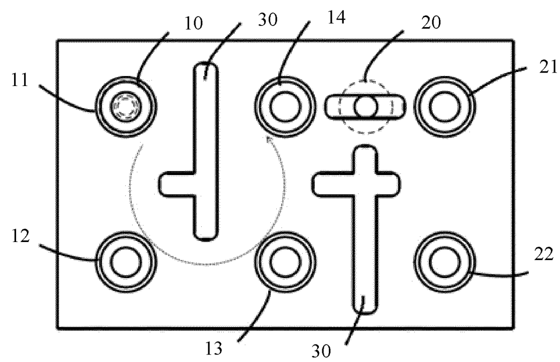

FIG. 1

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Description

TECHNICAL FIELD

[0001] This application relates to the field of communication device components, and in particular, to a dielectric filter, a transceiver, and a base station.

BACKGROUND

[0002] With the rapid development of wireless communication base station devices, especially wide application of base stations using a 5G massive multiple-input multiple-output (Massive Multiple-Input Multiple-Output, Massive MIMO) technology, a dielectric waveguide filter, as a good implementation of miniaturization and integration, attracts more attention and is increasingly studied in the industry.

[0003] A dielectric filter is usually composed of a plurality of resonators and coupling between the resonators. Coupling between the resonators are classified into inductive coupling (which may also be referred to as positive coupling) and capacitive coupling (which may also be referred to as negative coupling) based on a polarity. Based on the polarity of coupling between the resonators, a transmission zero may be formed. The transmission zero, also referred to as an attenuation pole or a notch point, is a frequency outside a passband of a filter at which rejection applied by the filter at the frequency to a signal of the frequency is theoretically infinite.

[0004] For a dielectric filter in conventional technologies, a transmission zero feature of the dielectric filter is usually implemented by adding cross coupling on a main transmission channel of the dielectric filter. However, this may make structure complicated and out-of-band rejection.

SUMMARY

[0005] Embodiments of this application provide a dielectric filter, a transceiver, and a base station, to resolve a problem that a dielectric filter has a poor out-of-band rejection capability, and improve the out-of-band rejection capability of the dielectric filter.

[0006] To achieve the foregoing objectives, the following technical solutions are used in this application.

[0007] According to a first aspect, a dielectric filter is provided. The dielectric filter includes a dielectric body, and an input port, an output port, internal dielectric resonators, and external dielectric resonators that are disposed on the dielectric body. A plurality of internal dielectric resonators are disposed between the input port and the output port, and form a main-coupling-channel cascaded resonator. Two external dielectric resonators are disposed on one side of the input port, where an amount of coupling between the external dielectric resonator and the input port is greater than an amount of coupling between the external dielectric resonator and any of the internal dielectric resonators; and/or two external dielectric resonators are disposed on one side of the output port, where an amount of coupling between the external dielectric resonator and the output port is greater than an amount of coupling between the external dielectric resonator and any of the internal dielectric resonators.

[0008] The internal dielectric resonator is configured to transmit a radio frequency signal. A plurality of internal dielectric resonators may be disposed. A specific quantity of internal dielectric resonators to be disposed depends on factors such as a transmission requirement of a radio frequency signal and a size of a dielectric filter. The plurality of internal dielectric resonators disposed between the input port and the output port are coupled to form a main coupling channel, and a radio frequency signal is transmitted along the main coupling channel. Two external dielectric resonators are disposed on one side of the input port, and an amount of coupling between the external dielectric resonator and the input port is greater than an amount of coupling between the external dielectric resonator and any of the internal dielectric resonators. Alternatively, two external dielectric resonators are disposed on one side of the output port, and an amount of coupling between the external dielectric resonator and the output port is greater than an amount of coupling between the external dielectric resonator and any of the internal dielectric resonators. In this way, one pair of transmission zeros can be obtained, where two transmission zeros are respectively disposed on two sides of a passband of the dielectric filter. If the foregoing condition is met, and two external dielectric resonators are disposed on one side of the input port and one side of the output port, two pairs of transmission zeros may be obtained. The one side of the input port or the output port in embodiments is either side of the input port or the output port. Because the amount of coupling between the external dielectric resonator and the input port or the output port needs to be greater than the amount of coupling between the external dielectric resonator and any of the internal dielectric resonators, preferably, the internal dielectric resonators and the external dielectric resonators are respectively located on two sides of the input port or the output port. Two transmission zeros can be implemented by adding two external dielectric resonators outside the input port or the output port, thereby improving the out-of-band rejection capability of the dielectric filter. In addition, an internal layout of the dielectric filter is flexible because both a cascaded resonator of a staggered topology structure and a cascaded resonator of a linear topology structure can be used. Therefore, dielectric filters have a simple structure, good reliability, cost-effectiveness, and can be molded, favorable to mass production.

[0009] In a possible implementation of the first aspect, an included angle between a first line and a second line is greater than or equal to 90°, and/or an included angle between a third line and a fourth line is greater than or equal to 90°.

[0010] The first line is a line between a center of the external dielectric resonator and a center of the input port. The second line is a line between a center of an internal dielectric resonator closest to the input port and the center of the input port. The third line is a line between a center of the external dielectric resonator and a center of the output port. The fourth line is a line between a center of an internal dielectric resonator closest to the output port and a center of the output port.

[0011] In this case, positions of the external dielectric resonators are set by setting the included angle between the first line and the second line and the included angle between the third line and the fourth line, allowing the amount of coupling between the external dielectric resonator and the input port or the output port to be greater than the amount of coupling between the external dielectric resonator and any internal dielectric resonator. In this way, one pair of transmission zeros or two pairs of transmission zeros can be obtained.

[0012] In a possible implementation of the first aspect, the two external dielectric resonators are coupled, one of the external dielectric resonators that is close to the input port or the output port is a first external dielectric resonator; the other external dielectric resonator is a second external dielectric resonator; and the first external dielectric resonator is coupled to the input port or the output port. In this case, the first external dielectric resonator is coupled to the input port or the output port in a manner of cascading, and the second external dielectric resonator is coupled to the first external dielectric resonator. This helps implement a flexible layout of the external dielectric resonators, and such a design facilitates obtaining of the transmission zeros.

[0013] In a possible implementation of the first aspect, the main-coupling-channel cascaded resonator includes a cascaded resonator of a linear topology structure and a cascaded resonator of a staggered topology structure. In this case, a structure design of a dielectric filter can be simplified by using the cascaded resonator of the linear topology structure, where a plurality of dielectric resonators can be disposed in one straight line. The structure is simple, and arrangement of the dielectric filter is convenient. Cross coupling can be formed among a plurality of adjacent internal dielectric resonators in the cascaded resonator of the staggered topology structure. Cross coupling is beneficial to implementation of a transmission zero feature of the dielectric filter, and the out-of-band rejection capability of the dielectric filter is improved due to transmission zeros formed by disposing the external dielectric resonators.

[0014] When the main-coupling-channel cascaded resonator is a non-linear cascaded resonator, a first coupling groove is disposed between two adjacent internal dielectric resonators. In this case, an amount of dielectric between the two adjacent internal dielectric resonators may be controlled by disposing the first coupling groove. The amount of dielectric is controlled by controlling a size of the first coupling groove, and then the amount of coupling between the two internal dielectric resonators can be controlled. By controlling the amount of coupling between the internal dielectric resonators, formation of a main coupling channel is controlled. The main-coupling-channel cascaded resonator may be in different forms. In actual application, a layout of the main-coupling-channel cascaded resonator may be flexibly adjusted, facilitating entire arrangement of the dielectric filter.

[0015] In a possible implementation of the first aspect, the external dielectric resonator includes a resonator body defined by a part of a dielectric body and a debug hole located on the resonator body. The debug hole is a blind hole or a through hole. In this case, the debug hole is set as a blind hole or a through hole, so that design flexibility of the external dielectric resonator can be maintained.

[0016] In embodiments of this application, a shape of the first coupling groove is related to an amount of coupling between the internal dielectric resonators in the cascaded resonator of the staggered topology structure. Because the first coupling groove may be used to control the amount of coupling between the two internal dielectric resonators by controlling the amount of dielectric between the two internal dielectric resonators, the amount of dielectric between different internal dielectric resonators may be determined by setting the amount of coupling between the two internal dielectric resonators, to determine a corresponding shape of the first coupling groove.

[0017] In a possible implementation of the first aspect, the second external dielectric resonator is coupled to a near-port internal dielectric resonator, and the near-port internal dielectric resonator is an internal dielectric resonator adjacent to a port that is on a side on which the second external dielectric resonator is located. In this case, the first external dielectric resonator is coupled to the input port or the output port, the input port is coupled to the adjacent internal dielectric resonator, and the output port is coupled to the adjacent internal dielectric resonator. The second external dielectric resonator is additionally coupled to the near-port internal dielectric resonator. Therefore, a layout of a filter topology may be a staggered layout when the external dielectric resonator is additionally coupled to the near-port internal dielectric resonator. To be specific, the two external dielectric resonators and the near-port internal dielectric resonators are arranged in a form of a triangle. With this arrangement, cross coupling is more likely to occur between the two external dielectric resonators and the near-port internal dielectric resonator, thereby achieving a better out-of-band rejection effect.

[0018] In a possible implementation of the first aspect, a coupling hole and/or a coupling groove are/is disposed between the external dielectric resonator and the near-port internal dielectric resonator; and the near-port internal dielectric resonator is an internal dielectric resonator adjacent to a port that is on a side on which the external dielectric resonator is located.

[0019] In this case, by disposing a coupling hole or a second coupling groove, the disposed coupling hole or the second coupling groove may be used to adjust the amount of coupling of the input port with the internal dielectric resonator and the external dielectric resonator that are located on the two sides of the input port, or the amount of coupling of the output port with the internal dielectric resonator and the external dielectric resonator that are located on the two sides of the output port. The coupling hole and the second coupling groove are devices in different forms for adjusting the amount of coupling of the input port with the internal dielectric resonator and the external dielectric resonator, and adjusting the amount of coupling of the output port with the internal dielectric resonator and the external dielectric resonator. In actual application, a corresponding coupling hole or second coupling groove may be designed according to a requirement of an amount of coupling of the input port or the output port with the internal dielectric resonator and the external dielectric resonator. The coupling hole and the second coupling groove may be used together, to implement diversified designs and flexible adjustment to an amount of coupling between the internal dielectric resonator and the external dielectric resonator.

[0020] In a possible implementation of the first aspect, the coupling hole is a blind hole or a through hole, and the second coupling groove is a blind groove. In this case, the coupling hole is set as a through hole or a blind hole, where an effect of adjusting the amount of coupling of the input port or the output port with the dielectric resonators of the corresponding port by using a through hole is different from that produced by using a blind hole. Whether to use a through hole or a blind hole depends on a requirement of adjusting the amount of coupling. In this way, the amount of coupling between the input port or the output port and different dielectric resonators is adjusted in a simpler manner. This simple adjustment manner facilitates production and processing of the dielectric filter.

[0021] In a possible implementation of the first aspect, the second coupling groove is disposed between the internal dielectric resonator and the external dielectric resonator that are adjacent to the input port or the output port, and the second coupling groove communicates with neither the internal dielectric resonator located at one end of the second coupling groove nor the external dielectric resonator located at the other end of the second coupling groove.

[0022] In this case, the internal dielectric resonator and the external dielectric resonator are both adjacent to the input port or both adjacent to the output port. Because the second coupling groove is designed to communicate with neither the internal dielectric resonator nor the external dielectric resonator, the amount of coupling between the input port and the internal dielectric resonator and the amount of coupling between the input port and the external dielectric resonator can be reduced; and/or the amount of coupling between the output port and the internal dielectric resonator and the amount of coupling between the output port and the external dielectric resonator can be reduced.

[0023] In a possible implementation of the first aspect, the second coupling groove is disposed between the internal dielectric resonator and the external dielectric resonator that are adjacent to the input port or the output port, and one end of the second coupling groove communicates with the internal dielectric resonator located at one end of the second coupling groove or the external dielectric resonator located at the other end of the second coupling groove.

[0024] In this case, both the internal dielectric resonator and the external dielectric resonator are adjacent to the input port or the output port. By configuring one end of the second coupling groove to communicate with the internal dielectric resonator located at one end of the second coupling groove or the external dielectric resonator located at one end of the second coupling groove, the amount of coupling between the input port or the output port and the internal dielectric resonator or the external dielectric resonator that communicates with one end of the second coupling groove may be increased, but an amount of coupling between the input port or the output port and an internal dielectric resonator or an external dielectric resonator that does not communicate with the second coupling groove is reduced. In this way, the amount of coupling between the input port or the output port and the internal dielectric resonator or the external dielectric resonator is adjusted by using the dielectric resonator.

[0025] In a possible implementation of the first aspect, the second coupling groove is disposed between the internal dielectric resonator and the external dielectric resonator that are adjacent to the input port or the output port, and two ends of the second coupling groove respectively communicate with the internal dielectric resonator located at one end of the second coupling groove and the external dielectric resonator located at the other end of the second coupling groove.

[0026] In this case, the internal dielectric resonator and the external dielectric resonator are both adjacent to the input port or both adjacent to the output port. Because the two ends of the second coupling groove respectively communicate with the internal dielectric resonator located at one end of second coupling groove and the external dielectric resonator located at the other end of the second coupling groove, the amount of coupling between the input port and the internal dielectric resonator and the amount of coupling between the input port and the external dielectric resonator can be increased; and/or the amount of coupling between the output port and the internal dielectric resonator and the amount of coupling between the output port and the external dielectric resonator can be increased.

[0027] In a possible implementation of the first aspect, the coupling hole is disposed between the internal dielectric resonator and the external dielectric resonator that are adjacent to the input port or the output port, and an axis of the coupling hole, an axis of the internal dielectric resonator, and an axis of the external dielectric resonator are parallel to each other.

[0028] In this case, the axis of the coupling hole is set to be parallel to the axis of the internal dielectric resonator and the axis of the external dielectric resonator, so that production and processing can be facilitated. Further, a distance between the axis of the coupling hole and the axis of the internal dielectric resonator may be adjusted, to adjust an amount of coupling between the input port or the output port and the internal dielectric resonator, or a distance between the axis of the coupling hole and the axis of the external dielectric resonator may be adjusted, to adjust an amount of coupling between the input port or the output port and the external dielectric resonator.

[0029] In a possible implementation of the first aspect, both an outer surface and an inner surface of the dielectric body are metalized. An inner surface of the dielectric body includes all inner surfaces of through holes, inner surfaces and bottom surfaces of blind holes, and inner surfaces and bottom surfaces of blind grooves disposed on the dielectric body. The outer surface and the inner surface of the dielectric body are metalized, so that a metal wall can be formed on the outer surface and the inner surface of the dielectric body. In this way, a resonance system can be formed in the dielectric body.

[0030] According to a second aspect, a transceiver is provided, including a receiver, a transmitter, an amplification unit, and the dielectric filter provided in any one of the first aspect or the possible implementations of the first aspect. The transceiver and the dielectric filter provided in the foregoing embodiments have same technical effects, and details are not described herein again.

[0031] According to a third aspect, a base station is provided, including an antenna feeder component, a control component, and the transceiver provided in the second aspect. The base station and the transceiver provided in the foregoing embodiments have same technical effects, and details are not described herein again.

BRIEF DESCRIPTION OF DRAWINGS

[0032]

FIG. 1 is a first schematic diagram of a dielectric filter according to an embodiment of this application;
FIG. 2 is a second schematic diagram of a dielectric filter according to an embodiment of this application;
FIG. 3 is a schematic diagram of a topology structure of the dielectric filters shown in FIG. 1 and FIG. 2;
FIG. 4 is a response curve of the dielectric filter shown in FIG. 1;
FIG. 5 is a schematic diagram of a topology structure according to an embodiment of this application;
FIG. 6 is a diagram of an equivalent circuit with an input impedance for the topology structure shown in FIG. 5;
FIG. 7 is a third schematic diagram of a dielectric filter according to an embodiment of this application;
FIG. 8 is a schematic diagram of a topology structure of the dielectric filter shown in FIG. 7;
FIG. 9 is a response curve of the dielectric filter shown in FIG. 7;
FIG. 10 is a first schematic diagram of coupling of an input port with an internal dielectric resonator and an external dielectric resonator in a dielectric filter according to an embodiment of this application;
FIG. 11 is a sectional view for the first schematic diagram of coupling of the port with the internal dielectric resonator and the external dielectric resonator in FIG. 10;
FIG. 12 is a second schematic diagram of coupling of an input port with an internal dielectric resonator and an external dielectric resonator in a dielectric filter according to an embodiment of this application;
FIG. 13 is a sectional view for the second schematic diagram of coupling of the port with the internal dielectric resonator and the external dielectric resonator in FIG. 12;
FIG. 14 is a third schematic diagram of coupling of an input port with an internal dielectric resonator and an external dielectric resonator in a dielectric filter according to an embodiment of this application;
FIG. 15 is a sectional view for the third schematic diagram of coupling of the port with the internal dielectric resonator and the external dielectric resonator in FIG. 14;
FIG. 16 is a fourth schematic diagram of coupling of an input port with an internal dielectric resonator and an external dielectric resonator in a dielectric filter according to an embodiment of this application;
FIG. 17 is a fifth schematic diagram of coupling of an input port with an internal dielectric resonator and an external dielectric resonator in a dielectric filter according to an embodiment of this application;
FIG. 18 is a sixth schematic diagram of coupling of an input port with an internal dielectric resonator and an external dielectric resonator in a dielectric filter according to an embodiment of this application;
FIG. 19 is a sectional view for the sixth schematic diagram of coupling of the port with the internal dielectric resonator and the external dielectric resonator in FIG. 18;
FIG. 20 is a fourth schematic diagram of a dielectric filter according to an embodiment of this application;
FIG. 21 is a schematic diagram of a topology structure of the dielectric filter shown in FIG. 20;
FIG. 22 is a fifth schematic diagram of a dielectric filter according to an embodiment of this application; and
FIG. 23 is a schematic diagram of a topology structure of the dielectric filter shown in FIG. 22.

[0033] Reference numerals: 10-input port; 11, 12, 13, 14, 15-internal dielectric resonator; 20-output port; 21, 22-external dielectric resonator B; 31, 32-external dielectric resonator A; 30, 40-coupling groove; 50-coupling hole; 100-through port hole; 101-connector.

DESCRIPTION OF EMBODIMENTS

[0034] The following describes technical solutions in this application with reference to accompanying drawings.

[0035] In embodiments of this application, words such as "example" or "for example" are used to give an example, an illustration, or a description. Any embodiment or design solution described by using "example" or "for example" in embodiments of this application should not be interpreted as being more preferred or advantageous than another embodiment or design solution. Specifically, the use of words such as "example" and "for example" are intended to present a related concept in a specific manner.

[0036] In embodiments of this application, a subscript such as Wi may be incorrectly presented in a non-subscript form such as W1. When a difference is not emphasized, W_1 and W1 have a same meaning.

[0037] In embodiments of this application, terms "first", "second", "third", and "fourth" are merely used for description, and cannot be understood as indicating or implying relative importance or a quantity of indicated technical features. Therefore, a feature defined by "first", "second", "third", or "fourth" may explicitly or implicitly include one or more of the features.

[0038] It should be understood that terms used for describing various examples in this application are merely intended for describing specific examples and are not intended for limitation. As used in the description of the various examples and in the appended claims, a singular form "a", "an", and "the" are intended to include plural forms, unless the context explicitly indicates otherwise.

[0039] In this application, "at least one" refers to one or more, and "a plurality of" refers to two or more. "At least one of the following items (pieces)" or a similar expression thereof refers to any combination of these items (pieces), including any combination of a single item (piece) or a plurality of the items (pieces). For example, at least one of a, b, or c may represent a, b, or c, a and b, a and c, b and c, or a, b, and c, where a, b, and c may be singular or plural.

[0040] It should also be understood that the term "and/or" used herein refers to and covers any and all of possible combinations of one or more of associated listed items. The term "and/or" indicates an association relationship that describes associated objects, and indicates that three relationships may exist. For example, A and/or B may indicate that only A exists, both A and B exist, and only B exists. In addition, the character "/" in this application usually indicates that associated objects are in an "or" relationship.

[0041] It should be understood that determining B based on A does not mean that B is determined only based on A, and B may also be determined based on A and/or another piece of information.

[0042] It should also be understood that the term "include" (also referred to as "includes", "including", "comprise", and/or "comprising") used in this specification specifies that a stated feature, integer, step, operation, element, and/or component exist/exists, but existence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof is not excluded.

[0043] It should be understood that "an embodiment", "one embodiment", and "a possible implementation" used throughout the specification mean that a specific feature, structure, or characteristic related to the embodiment or the implementation is included in at least one embodiment of this application. Therefore, "an embodiment", "an embodiment of this application", or "a possible implementation" used throughout this specification may not necessarily refer to a same embodiment. Furthermore, specific features, structures, or characteristics may be combined in one or more embodiments in any appropriate manner.

[0044] Refer to FIG. 1. FIG. 1 is one of schematic diagrams of a dielectric filter according to an embodiment of this application. As shown in FIG. 1, the dielectric filter includes a dielectric body and includes an input port 10, an output port 20, internal dielectric resonators, and external dielectric resonators that are disposed on the dielectric body. A plurality of internal dielectric resonators are disposed between the input port 10 and the output port 20, and form a main-coupling-channel cascaded resonator. Two external dielectric resonators are disposed on an outer side of the input port 10, and/or disposed on an outer side of the output port 20.

[0045] In embodiments of this application, the outer side of the input port 10 is a side opposite to a side of the input port 10 facing the output port 20, and the outer side of the output port 20 is a side opposite to a side facing the input port 10. The main-coupling-channel cascaded resonator includes the plurality of internal dielectric resonators that are cascaded. A channel formed by successively connecting channels having a strong coupling effect between two adjacent internal dielectric resonators among the plurality of internal dielectric resonators is a main coupling channel. As shown in FIG. 7, a main coupling channel between an internal dielectric resonator 11, an internal dielectric resonator 12, an internal dielectric resonator 13, and an internal dielectric resonator 14 is shown by using a dashed line in FIG. 7.

[0046] Based on this, the internal dielectric resonators are disposed between the input port 10 and the output port 20. The internal dielectric resonator is configured to transmit a radio frequency signal. A plurality of internal dielectric resonators may be disposed. A specific quantity of the internal dielectric resonators to be disposed depends on factors such as a transmission requirement of a radio frequency signal and a size of a dielectric filter. The plurality of internal dielectric resonators disposed between the input port 10 and the output port 20 are coupled to form the main coupling channel, and a radio frequency signal is transmitted along the main coupling channel. By disposing two external dielectric resonators on the outer side of the input port 10 or the output port 20, a pair of transmission zeros can be obtained, and the two transmission zeros are respectively located on two sides of a passband of the filter. If two external dielectric resonators are disposed on outer sides of both the input port 10 and the output port 20, two pairs of transmission zeros can be obtained.

[0047] By adding two external dielectric resonators outside the input port 10 or the output port 20, two transmission zeros can be implemented without being affected by a layout of a filter topology of the internal dielectric resonators, thereby improving the out-of-band rejection capability of the dielectric filter. In addition, the internal dielectric resonators inside the dielectric filter may be flexibly arranged because both a cascaded resonator of a staggered topology structure and a cascaded resonator of a linear topology structure can be used. Therefore, dielectric filters have a simple structure, good reliability, cost-effectiveness, and can be molded, favorable to mass production.

[0048] A specific quantity of internal dielectric resonators to be disposed depends on an actual function requirement of the dielectric filter. For example, refer to FIG. 1 and FIG. 3. FIG. 1 is a first schematic diagram of a dielectric filter according to an embodiment of this application. FIG. 3 is a schematic diagram of a topology structure of the dielectric filter shown in FIG. 1. As shown in FIG. 1 and FIG. 3, four internal dielectric resonators are disposed: an internal dielectric resonator 11, an internal dielectric resonator 12, an internal dielectric resonator 13, and an internal dielectric resonator 14. The internal dielectric resonator 11 is coupled to the input port 10. The internal dielectric resonator 12 is coupled to the internal dielectric resonator 11. The internal dielectric resonator 13 is coupled to the internal dielectric resonator 12. The internal dielectric resonator 14 is coupled to the internal dielectric resonator 13. The output port 20 is coupled to the internal dielectric resonator 14. In this case, a radio frequency signal is transmitted via the internal dielectric resonator 11, the internal dielectric resonator 12, the internal dielectric resonator 13, and the internal dielectric resonator 14, that is, in a direction indicated by an arrow in FIG. 1. This path is the main coupling channel.

[0049] A principle of generating a transmission zero by disposing two external dielectric resonators on the outer side of the input port 10 and/or the outer side of the output port 20 is explained in the following descriptions. In this embodiment, an example in which two external dielectric resonators are disposed on the outer side of the input port 10 is used for description.

[0050] Refer to FIG. 5 and FIG. 6. FIG. 5 is a schematic diagram of a topology structure according to an embodiment of this application. FIG. 6 is a diagram of an equivalent circuit with an input impedance for the topology structure shown in FIG. 5. In the circuit topology shown in FIG. 5, an external dielectric resonator 1 and an external dielectric resonator 2 in the figure form a series-connected rejection resonator, providing transmission zeros for the entire link. For a conventional outband zero cavity, non-resonant node, and rejection resonator, a resonant frequency of a conventional NRN redundancy resonator is at a transmission zero. However, a resonant frequency of the external dielectric resonator 1 and the external dielectric resonator 2 that are series-connected in the circuit topology shown in FIG. 5 is at a center of a passband of filter. To analyze a mechanism for generating a transmission zero, an input admittance Y_{in} is calculated first.

$$Y_{in} = \frac{J_1^2}{\frac{J_2^2}{s+jb_2}+s+jb_1} = \frac{J_1^2(s+jb_2)}{s^2+j(b_1+b_2)s+J_2^2-b_1b_2}$$

[0051] Let input impedance Z_{in} be:

$$Z_{in} = \frac{J_2^2}{s+jb_2} + s + jb_1$$

[0052] When Y_{in} approaches infinity, that is, when Z_{in} approaches 0 (Z_{in}=0), a transmission zero is generated. When Y_{in} equals 0, a reflection zero is generated. In this case, an obtained transmission zero S_z is:

$$S_z = \frac{-j(b_1+b_2) \pm j\sqrt{(b_2-b_2)^2+4J_2^2}}{2};$$

and

a reflection zero S_p is:

$$S_p = -\mathrm{j}b_2$$

[0053] In the foregoing formulas, b_1 is a frequency factor of the external dielectric resonator 1, b_2 is a frequency factor of the external dielectric resonator 2,j is an imaginary unit in a complex number, J_1 is a factor for coupling between the external dielectric resonator 1 and the input port 10, and J_2 is a factor for coupling between the external dielectric resonator 1 and the external dielectric resonator 2.

[0054] Therefore, when transmission zeros are symmetrically distributed, both the external dielectric resonator 1 and the external dielectric resonator 2 resonate at a center frequency, that is, b_1=b_2=0. In this case, S_z=$\pm jJ_2$, and S_p=0.

[0055] Based on the foregoing analysis, the following conclusions can be drawn.

(1) A pair of out-of-band transmission zeros can be implemented for the topology structure, where the

pair of out-of-band transmission zeros may be symmetrical transmission zeros symmetrically distributed on both sides of a passband, or asymmetric transmission zeros located on both sides of a passband.
(2) J_2 may affect a position of a transmission zero.
(3) J_1 provides only coupling and does not affect a position of a transmission zero.

[0056] When the transmission zeros are symmetrically distributed on both sides of the passband, the external dielectric resonator 1 and the external dielectric resonator 2 provide two reflection zeros at the center frequency.

[0057] In this embodiment of this application, an included angle between a first line and a second line is greater than or equal to 90°, and/or an included angle between a third line and a fourth line is greater than or equal to 90°.

[0058] The first line is a line connecting a center of an external dielectric resonator and a center of an input port. The second line is a line connecting the center of the input port and a center of an internal dielectric resonator closest to the input port. The third line is a line connecting a center of an output port and a center of the external dielectric resonator. The fourth line is a line connecting the center of the output port and a center of an internal dielectric resonator closest to the output port.

[0059] The included angle between the first line and the second line is set to be greater than or equal to 90°, allowing the internal dielectric resonator and the external dielectric resonator are respectively located on two sides of the input port. In this embodiment of this application, a side on which the internal dielectric resonator is located is defined as an inner side of the input port, and the other side is defined as an outer side of the input port. A boundary line between the inner side and the outer side of the input port is a straight line that passes through the center of the input port and is perpendicular to the second line. The center of the external dielectric resonator may be located on the boundary line or located on the outer side of the input port. By setting a position of the external dielectric resonator, the external dielectric resonator is not directly coupled to the internal dielectric resonator without passing through the input port, and becomes a part of the main-coupling-channel cascaded resonator. In this way, a transmission path of a wave passes through the input port and reaches the external dielectric resonator, and then the transmission zero is generated.

[0060] The included angle between the third line and the fourth line is set to be greater than or equal to 90°, allowing the internal dielectric resonator and the external dielectric resonator are respectively located on two sides of the output port. In this embodiment of this application, a side on which the internal dielectric resonator is located is defined as an inner side of the output port, and the other side is defined as an outer side of the output port. A boundary line between the inner side and the outer side of the output port is a straight line that passes through the center of the output port and is perpendicular to the fourth line. The center of the external dielectric resonator may be located on the boundary line or located on the outer side of the output port. By setting a position of the external dielectric resonator, the external dielectric resonator is not directly coupled to the internal dielectric resonator without passing through the output port, and becomes a part of the main-coupling-channel cascaded resonator. In this way, a transmission path of a wave passes through the output port and reaches the external dielectric resonator, and then the transmission zero is generated.

[0061] In this embodiment of this application, two external dielectric resonators are coupled, and an external dielectric resonator close to the input port 10 or the output port 20 is coupled to the input port 10 or the output port 20. It may be understood that one of the external dielectric resonators is coupled to the input port 10 or the output port 20 through cascading. Such a design is in accordance with a theoretical basis for obtaining the transmission zero described above, facilitating obtaining of the transmission zero.

[0062] In this embodiment, an external dielectric resonator and an external dielectric resonator are disposed on the outer side of the input port 10, and an external dielectric resonator and an external dielectric resonator are also disposed outside the output port 20. Therefore, for ease of description and distinguishing, the external dielectric resonator that is close to the input port 10 and that is on the outer side of the input port 10 is referred to as an external dielectric resonator A31; the other external dielectric resonator on the outer side of the input port 10 is referred to as an external dielectric resonator A32; the external dielectric resonator that is on the outer side of the output port 20 and that is close to the output port 20 is referred to as an external dielectric resonator B21; and the other external dielectric resonator that is on outer side of the output port 20 and close to the output port 20 is referred to as an external dielectric resonator B22.

[0063] In this embodiment of this application, the main-coupling-channel cascaded resonator includes a cascaded resonator of a linear topology structure and a cascaded resonator of a staggered topology structure. Using the cascaded resonator of the linear topology structure can simplify a structure design of a dielectric filter by disposing a plurality of internal dielectric resonators in a straight line, making a structure simple and facilitating arrangement of the dielectric filter. Using the cascaded resonator of the staggered topology structure provides cross coupling formed by a plurality of adj acent internal dielectric resonators, where cross coupling facilitates implementation of a transmission zero feature of a dielectric filter. In addition, a transmission zero obtained by disposing an external dielectric resonator helps enhance an out-of-band rejection feature of the dielectric filter.

[0064] The following separately describes specific arrangement forms of a cascaded resonator of a linear topology structure and a cascaded resonator of a staggered topology structure.

Example 1

[0065] In this example, reference is made to FIG. 2 and FIG. 3. FIG. 2 is a second schematic diagram of a dielectric filter according to an embodiment of this application. FIG. 3 is a schematic diagram of a topology structure of the dielectric filter shown in FIG. 2. As shown in FIG. 2 and FIG. 3, a plurality of internal dielectric resonators are disposed between the input port 10 and the output port 20. The plurality of internal dielectric resonators are arranged in a straight line, and the input port 10 and the output port 20 are also disposed in the straight line. In this example, four internal dielectric resonators are disposed in total. An internal dielectric resonator 11 is coupled to the input port 10. An internal dielectric resonator 12 is coupled to the internal dielectric resonator 11. An internal dielectric resonator 13 is coupled to the internal dielectric resonator 12. An internal dielectric resonator 14 is coupled to the internal dielectric resonator 13. The output port 20 is coupled to the internal dielectric resonator 14. In this case, a linear main coupling channel is formed. A radio frequency signal is transmitted from the input port 10 to the output port 20 along the main coupling channel. As shown in FIG. 2, two external dielectric resonators are disposed on an outer side of the output port 20: an external dielectric resonator B21 and an external dielectric resonator B22. The external dielectric resonator B21 is coupled to the output port 20. The external dielectric resonator B22 is coupled to the external dielectric resonator B21. The external dielectric resonator B21 and the external dielectric resonator B22 may be disposed in the straight line in which the four internal dielectric resonators are located. In this arrangement, cross coupling between the internal dielectric resonators is not considered, making the structure of the dielectric filter simple, facilitating manufacturing and favorable to mass production.

Example 2

[0066] In this example, reference is made to FIG. 1 and FIG. 3. FIG. 1 is a first schematic diagram of a dielectric filter according to an embodiment of this application. FIG. 3 is a schematic diagram of a topology structure of the dielectric filter shown in FIG. 1. As shown in FIG. 1 and FIG. 3, a plurality of internal dielectric resonators may be disposed between the input port 10 and the output port 20, and the plurality of internal dielectric resonators may be arranged in a plurality of rows. Applying this arrangement facilitates arrangement of the dielectric filter and makes full use of longitudinal space of the dielectric filter. However, the plurality of internal dielectric resonators form only one main coupling channel. In this example, a total of four internal dielectric resonators are disposed in two rows, where each row includes two internal dielectric resonators. As shown in FIG. 1, the four internal dielectric resonators are respectively located at four corners of a rectangle. Certainly, arrangement of the plurality of internal dielectric resonators is not limited thereto. An internal dielectric resonator 11 is coupled to the input port 10. An internal dielectric resonator 12 is coupled to the internal dielectric resonator 11. An internal dielectric resonator 13 is coupled to the internal dielectric resonator 12. An internal dielectric resonator 14 is coupled to the internal dielectric resonator 13. The output port 20 is coupled to the internal dielectric resonator 14. In this case, a main coupling channel in a "U" shape is formed. A radio frequency signal is transmitted from the input port 10 to the output port 20 along the main coupling channel. As shown in FIG. 1, two external dielectric resonators are disposed on an outer side of the output port 20: an external dielectric resonator B21 and an external dielectric resonator B22. The external dielectric resonator B21 is coupled to the output port 20. The external dielectric resonator B22 is coupled to the external dielectric resonator B21. Arrangement of the external dielectric resonator B21 and the external dielectric resonator B22 may be based on the structure of the dielectric filter. In this example, arrangement of the two external dielectric resonators is similar to the portrait layout of the internal dielectric resonators. The layout in this example makes full use of the space of the dielectric filter.

[0067] Two external dielectric resonators are disposed outside the output port 20, allowing to generate two transmission zeros, thereby achieving a good out-of-band rejection effect. Refer to FIG. 4. FIG. 4 is a response curve of the dielectric filter shown in FIG. 1. As shown in FIG. 4, there are two curves in total in the figure. A curve S11 is a signal reflection curve for signal transmission in the dielectric filter in this example, and a curve S21 is a signal transmission curve for signal transmission in the dielectric filter in this example. A portion with relatively small fluctuation in the middle of the curve S11 represents a passband of a main-coupling-channel cascaded resonator in the dielectric filter in this example. Two breakpoints on S21 represent two transmission zeros, and the two transmission zeros are distributed on two sides of the passband.

Example 3

[0068] In this example, reference is made to FIG. 7 and FIG. 8. FIG. 7 is a third schematic diagram of a dielectric filter according to an embodiment of this application. FIG. 8 is a schematic diagram of a topology structure of the dielectric filter shown in FIG. 7. As shown in FIG. 7 and FIG. 8, a plurality of internal dielectric resonators may be disposed between the input port 10 and the output port 20. A layout of the plurality of internal dielectric resonators in this example is similar to the layout of the internal dielectric resonators in Example 2, and details are not described herein again. For details, refer to the description about the layout of the internal dielectric resonators in Example 2. Four internal dielectric resonators form a main coupling channel in a "U" shape, and a radio frequency signal is transmitted from the input port 10 to the output port 20 along the main coupling channel in the "U" shape. As shown in FIG. 7 and FIG. 8, two external dielectric resonators are disposed on an outer side of the input port 10: an external dielectric resonator A31 and an external dielectric resonator A32. The external dielectric resonator A31 is coupled to the input port 10, and the external dielectric resonator A32 is coupled to the external dielectric resonator A31. Two external dielectric resonators are disposed on an outer side of the output port 20: an external dielectric resonator B21 and an external dielectric resonator B22. The external dielectric resonator B21 is coupled to the output port 20, and the external dielectric resonator B22 is coupled to the external dielectric resonator B21. The layout of the two external dielectric resonators at the input port 10 may be the same as a layout of the two external dielectric resonators at the output port 20. For details, refer to the layout of the two external dielectric resonators outside the output port 20 in Example 2.

[0069] Two external dielectric resonators are disposed outside the input port 10 and two external dielectric resonators are disposed outside the output port 20, allowing to form four transmission zeros, and achieving a better out-of-band rejection effect. Refer to FIG. 9. FIG. 9 is a response curve of the dielectric filter shown in FIG. 7. As shown in FIG. 9, there are two curves in total in the figure. A curve S11 is a reflection curve for signal transmission in the dielectric filter in this example, and a curve S21 is a transmission curve for signal transmission in the dielectric filter in this example. A portion with relatively small fluctuation in the middle of the curve S11 represents a passband of a main-coupling-channel cascaded resonator in the dielectric filter in this example. S21 has four breakpoints in total, where each breakpoint thereof represents a transmission zero. The four breakpoints are basically symmetrically distributed on two sides of the passband.

Example 4

[0070] In this example, reference is made to FIG. 20 and FIG. 21. FIG. 20 is a fourth schematic diagram of a dielectric filter according to an embodiment of this application. FIG. 21 is a schematic diagram of a topology structure of the dielectric filter shown in FIG. 20. As shown in FIG. 20 and FIG. 21, a plurality of internal dielectric resonators are disposed between the input port 10 and the output port 20, and the plurality of internal dielectric resonators are staggered. It should be noted that solid lines between the internal dielectric resonators in FIG. 21 represent a main coupling channel, and a dashed line indicates that internal dielectric resonators at two ends of the dashed line are coupled, or indicates that an internal dielectric resonator at one end of the dashed line is also coupled with an external dielectric resonator at the other end. An internal dielectric resonator 11, an internal dielectric resonator 12, and an internal dielectric resonator 13 are used as examples for description.

[0071] A coupling path between the internal dielectric resonator 11 and the internal dielectric resonator 12 and a coupling path between the internal dielectric resonator 12 and the internal dielectric resonator 13 are a part of the main coupling channel. In FIG. 21, the foregoing coupling paths are represented by solid lines. The internal dielectric resonator 11 and the internal dielectric resonator 13 are also coupled. A coupling path between the internal dielectric resonator 11 and the internal dielectric resonator 13 is not a part of the main coupling channel and is represented by a dashed line. In this way, the internal dielectric resonator 11, the internal dielectric resonator 12, and the internal dielectric resonator 13 are cross-coupled.

[0072] In this example, five internal dielectric resonators are disposed in total. The internal dielectric resonator 11 is coupled to the input port 10. The internal dielectric resonator 12 is coupled to the internal dielectric resonator 11. The internal dielectric resonator 13 is coupled to the internal dielectric resonator 12. An internal dielectric resonator 14 is coupled to the internal dielectric resonator 13. An internal dielectric resonator 15 is coupled to the internal dielectric resonator 14. The output port 20 is coupled to the internal dielectric resonator 15. The five internal dielectric resonators are staggered, and then a polyline-shaped main coupling channel is formed. A path of the main coupling channel may be the curve in FIG. 20. An arrow at an end of the curve indicates a transmission path of a radio frequency signal. A radio frequency signal is transmitted from the input port 10 to the output port 20 along the main coupling channel.

[0073] As shown in FIG. 20, two external dielectric resonators are disposed on an outer side of the output port 20: an external dielectric resonator B21 and an external dielectric resonator B22. The external dielectric resonator B21 is coupled to the output port 20. The external dielectric resonator B22 is coupled to the external dielectric resonator B21. The external dielectric resonator B22 may be further coupled to the internal dielectric resonator 15. A layout design of the two external dielectric resonators depends on a design requirement of the dielectric filter. In this example, the two external dielectric resonators are arranged with reference to the layout of the internal dielectric resonators, and the layout of the two external dielectric resonators is the same as the layout of the internal dielectric resonator 14 and the internal dielectric resonator 15. In a cascaded resonator of a staggered topology structure is used, cross coupling may be formed when internal dielectric resonators form a main coupling channel. Cross coupling is beneficial to implementation of a transmission zero feature of a dielectric filter, and an out-of-band rejection capability of the entire dielectric filter is improved due to transmission zeros formed by two external dielectric resonators.

Example 5

[0074] In this example, reference is made to FIG. 22

and FIG. 23. FIG. 22 is a fifth schematic diagram of a dielectric filter according to an embodiment of this application. FIG. 23 is a schematic diagram of a topology structure of the dielectric filter shown in FIG. 22. As shown in FIG. 22 and FIG. 23, a plurality of internal dielectric resonators are disposed between the input port 10 and the output port 20, and the plurality of internal dielectric resonators are staggered.

[0075] In this example, three internal dielectric resonators are disposed in total. An internal dielectric resonator 11 is coupled to the input port 10. An internal dielectric resonator 12 is coupled to the internal dielectric resonator 11. An internal dielectric resonator 13 is coupled to the internal dielectric resonator 12. The output port 20 is coupled to the internal dielectric resonator 13. In this case, the three internal dielectric resonators are staggered, and a polyline-shaped main coupling channel is formed. A radio frequency signal is transmitted from the input port 10 to the output port 20 along the main coupling channel.

[0076] As shown in FIG. 22, two external dielectric resonators are disposed on an outer side of the input port 10: an external dielectric resonator A31 and an external dielectric resonator A32. The external dielectric resonator A31 is coupled to the output port 20. The external dielectric resonator A32 is coupled to the external dielectric resonator A31. The external dielectric resonator A32 may be further coupled to the internal dielectric resonator 11. Two external dielectric resonators are disposed on an outer side of the output port 20: an external dielectric resonator B21 and an external dielectric resonator B22. The external dielectric resonator B21 is coupled to the output port 20. The external dielectric resonator B22 is coupled to the external dielectric resonator B21. The external dielectric resonator B22 may be further coupled to the internal dielectric resonator 13.

[0077] A layout design of the two external dielectric resonators outside each port depends on a design requirement of the dielectric filter. In this example, the external dielectric resonator A31 and the external dielectric resonator A32 are arranged with reference to the layout of the internal dielectric resonator 11 and the internal dielectric resonator 12. The external dielectric resonator B21 and the external dielectric resonator B22 are arranged with reference to the layout of the internal dielectric resonator 13 and the internal dielectric resonator 12. In this example, two external dielectric resonators are disposed at both an outer end of the input port 10 and an outer end of the output port 20, so that four transmission zeros can be formed, and a better out-of-band rejection capability is provided.

[0078] When the main-coupling-channel cascaded resonator is arranged in a non-linear manner, a coupling groove 30 is disposed between two adjacent internal dielectric resonators. As shown in FIG. 1, FIG. 7, FIG. 20, and FIG. 22, an amount of dielectric between two adjacent internal dielectric resonators may be controlled by disposing the coupling groove 30. An amount of dielectric is controlled by controlling a size of the coupling groove 30, and then an amount of coupling between two internal dielectric resonators can be controlled. By controlling the amount of coupling between the internal dielectric resonators, formation of the main coupling channel is controlled. The main-coupling-channel cascaded resonator may be in different forms. In actual application, a layout of the main-coupling-channel cascaded resonator may be flexibly adjusted, facilitating entire arrangement of the dielectric filter.

[0079] A shape of the coupling groove 30 is related to an amount of coupling between the internal dielectric resonators in the cascaded resonator of the staggered topology structure. Because the coupling groove 30 may be used to control the amount of coupling between the two internal dielectric resonators by controlling the amount of dielectric between the two internal dielectric resonators, the amount of dielectric between different internal dielectric resonators may be determined by setting the amount of coupling between the two internal dielectric resonators, to determine a corresponding shape of the coupling groove 30.

[0080] In this embodiment of this application, the external dielectric resonator includes a resonator body formed by a part of a dielectric body and a debug hole located on the resonator body. The debug hole is a blind hole or a through hole. The resonator body in this embodiment is a part of the dielectric body, and the debug hole is set as a blind hole or a through hole. A frequency of an external dielectric resonator may be adjusted by setting a depth of the debug hole. To be specific, whether an external dielectric resonator is a blind hole or a through hole is flexibly depends on a design requirement of the dielectric filter. In this way, design flexibility can be maintained.

[0081] In this embodiment of this application, the external dielectric resonator A32 or the external dielectric resonator B22 is coupled to a near-port internal dielectric resonator. The near-port internal dielectric resonator is an internal dielectric resonator adjacent to a port that is on a side on which the external dielectric resonator A32 or the external dielectric resonator B22 is located. The port on the side on which the external dielectric resonator A32 or the external dielectric resonator B22 is located may be the input port 10 or the output port 20, which is specifically depends on a location of the external dielectric resonator. For example, if the external dielectric resonator A32 is disposed only on a side of the input port 10, the port is the input port 10. If the external dielectric resonator B22 is disposed only on a side of the output port 20, the port is the output port 20. If the external dielectric resonator A32 and the external dielectric resonator B22 is disposed for both the input port 10 and the output port 20, the port includes the input port 10 and the output port 20.

[0082] The external dielectric resonator A32 or the external dielectric resonator B22 is coupled to the input port 10 or the output port 20. The input port 10 is coupled to the internal dielectric resonator adjacent to the input port 10 (the first internal dielectric resonator in the main-coupling-channel cascaded resonator). The output port 20 is coupled to an internal dielectric resonator adjacent to the output port 20 (the last internal dielectric resonator in the main-coupling-channel cascaded resonator). Therefore, a layout of a filter topology may be a staggered layout. To be specific, the two external dielectric resonators and the near-port internal dielectric resonator are arranged in a form of a triangle. With this arrangement, cross coupling is more likely to occur between the two external dielectric resonators and the near-port internal dielectric resonator, thereby achieving a better out-of-band rejection effect.

Example 1

[0083] As shown in FIG. 20, two external dielectric resonators are disposed on the outer side of the output port 20. The external dielectric resonator B21 is coupled to the output port 20. The external dielectric resonator B22 is coupled to the external dielectric resonator B21. The output port 20 is coupled to the internal dielectric resonator 15. In this case, the internal dielectric resonator 15 is a near-port internal dielectric resonator. The external dielectric resonator B22 is coupled to the internal dielectric resonator 15. Cross coupling may be formed between the external dielectric resonator B21, the external dielectric resonator B22, and the internal dielectric resonator 15, achieving a better out-of-band rejection effect.

Example 2

[0084] As shown in FIG. 22, two external dielectric resonators are disposed on both of the outer sides of the input port 10 and the output port 20. The external dielectric resonator A31 on the outer side of the input port 10 is coupled to the input port 10. The external dielectric resonator A32 is coupled to the external dielectric resonator A31. The input port 10 is coupled to the internal dielectric resonator 11. The internal dielectric resonator 11 is a near-port internal dielectric resonator of the input port 10. The external dielectric resonator B21 on the outer side of the output port 20 is coupled to the output port 20. The external dielectric resonator B22 is coupled to the external dielectric resonator B21. The output port 20 is coupled to the internal dielectric resonator 13. In this case, the internal dielectric resonator 13 is a near-port internal dielectric resonator of the output port 20. Cross coupling is formed between the external dielectric resonator A31, the external dielectric resonator A32, and the internal dielectric resonator 11. Cross coupling is formed between the external dielectric resonator B21, the external dielectric resonator B22, and the internal dielectric resonator 13. Cross coupling is generated at both ports, achieving a better out-of-band rejection effect.

[0085] In this embodiment of this application, a coupling hole 50 and/or a coupling groove 40 are/is disposed between an internal dielectric resonator adjacent to the input port 10 and the external dielectric resonator A31 adjacent to the input port 10; and/or a coupling hole 50 and/or a coupling groove 40 is disposed between an internal dielectric resonator adjacent to the output port 20 and the external dielectric resonator B21 adjacent to the output port 20.

[0086] When the coupling hole 50 or the coupling groove 40 is disposed, by using the disposed coupling hole 50 or coupling groove 40, an amount of coupling of the input port 10 with the internal dielectric resonator and the external dielectric resonator A31 that are located on two sides of the input port 10 may be adjusted, or an amount of coupling of the output port 20 with the internal dielectric resonator and the external dielectric resonator B21 that are located on two sides of the output port 20 may be adjusted. The coupling hole 50 and the coupling groove 40 are devices in different forms for adjusting the amount of coupling between the input port 10 or the output port 20 with the internal dielectric resonator and the external dielectric resonator. In actual application, a corresponding coupling hole 50 or coupling groove 40 may be designed according to a requirement of an amount of coupling of the input port 10 or the output port 20 with the internal dielectric resonator and the external dielectric resonator. The coupling hole 50 and the coupling groove 40 may be used together, to implement diversified designs and flexible adjustment to an amount of coupling between the internal dielectric resonator and the external dielectric resonator.

[0087] In this embodiment of this application, the coupling hole 50 is a blind hole or a through hole, and the coupling groove 40 is a blind groove. The coupling hole 50 is set as a through hole or a blind hole. An effect of adjusting the amount of coupling of the input port 10 or the output port 20 with the dielectric resonators of the corresponding port by using a through hole is different from that produced by using a blind hole. Whether the coupling hole 50 is a through hole or a blind hole depends on a requirement of adjusting the amount of coupling. In this way, the amount of coupling between the input port 10 or the output port 20 and different dielectric resonators is adjusted in a simpler manner. This simple adjustment manner facilitates production and processing of the dielectric filter.

[0088] The following describes arrangement and combination of the coupling hole 50 and the coupling groove 40 with reference to FIG. 10 to FIG. 18.

Example 1

[0089] The coupling groove 40 is disposed between an internal dielectric resonator and an external dielectric resonator that are adjacent to the input port 10, or the coupling groove 40 is disposed between an internal dielectric resonator and an external dielectric resonator that are adjacent to the output port 20. The coupling groove 40 communicates with neither an internal dielectric resonator located at one end of the coupling groove 40 nor an external dielectric resonator located at the other end of the coupling groove 40.

[0090] The internal dielectric resonator and the external dielectric resonator are both adjacent to the input port 10 or both adjacent to the output port 20. Because the coupling groove 40 is designed to communicate with neither the internal dielectric resonator nor the external dielectric resonator, an amount of coupling between the input port 10 and the internal dielectric resonator and an amount of coupling between the input port 10 and the external dielectric resonator can be reduced; and/or an amount of coupling between the output port 20 and the internal dielectric resonator and an amount of coupling between the output port 20 and the external dielectric resonator can be reduced.

[0091] An example in which the coupling groove 40 is disposed between the internal dielectric resonator and the external dielectric resonator that are adjacent to the input port 10 is used for description. Refer to FIG. 10 and FIG. 11. FIG. 10 is a first schematic diagram of coupling of an input port with an internal dielectric resonator and an external dielectric resonator in a dielectric filter according to an embodiment of this application. FIG. 11 is a sectional view for the first schematic diagram of coupling of the port with the internal dielectric resonator and the external dielectric resonator in FIG. 10. As shown in FIG. 10 and FIG. 11, an internal dielectric resonator adjacent to the input port 10 is an internal dielectric resonator 11, an external dielectric resonator adjacent to the input port 10 is an external dielectric resonator A31, and the coupling groove 40 is disposed between the internal dielectric resonator 11 and the external dielectric resonator A31, where the coupling groove 40, the internal dielectric resonator 11, and the external dielectric resonator A31 do not communicate. An amount of coupling between the input port 10 and the internal dielectric resonator 11 and an amount of coupling between the input port 10 and the external dielectric resonator may be adjusted by adjusting a size of the coupling groove 40, for example, adjusting a depth, a length, or a width of the coupling groove 40.

Example 2

[0092] The coupling groove 40 is disposed between an internal dielectric resonator and an external dielectric resonator that are adjacent to the input port 10, or the coupling groove 40 is disposed between an internal dielectric resonator and an external dielectric resonator that are adjacent to the output port 20, where one end of the coupling groove 40 communicates with the internal dielectric resonator located at one end of the coupling groove 40, or communicates with the external dielectric resonator located at the other end of the coupling groove 40.

[0093] An example in which the coupling groove 40 is disposed between the internal dielectric resonator and the external dielectric resonator that are adjacent to the input port 10 is used for description. Refer to FIG. 12 and FIG. 13. FIG. 12 is a second schematic diagram of coupling of an input port with an internal dielectric resonator and an external dielectric resonator in a dielectric filter according to an embodiment of this application. FIG. 13 is a sectional view for the second schematic diagram of coupling of the port with the internal dielectric resonator and the external dielectric resonator in FIG. 12. As shown in FIG. 12 and FIG. 13, an internal dielectric resonator adjacent to the input port 10 is an internal dielectric resonator 11, an external dielectric resonator adjacent to the input port 10 is an external dielectric resonator A31, and the coupling groove 40 is disposed between the internal dielectric resonator 11 and the external dielectric resonator A31. The coupling groove 40 does not communicate with the internal dielectric resonator 11, but the coupling groove 40 communicates with the external dielectric resonator A31. Alternatively, the coupling groove 40 communicates with the internal dielectric resonator 11, but the coupling groove 40 does not communicate with the external dielectric resonator A31 (this case is not shown in the figure). In actual application, a communication relationship between the coupling groove 40 and the internal dielectric resonator 11 and the external dielectric resonator A31 may be adjusted according to a specific requirement, so as to adjust amounts of coupling of the input port 10 with the internal dielectric resonator 11 and the external dielectric resonator A31. The example shown in FIG. 12 in which the coupling groove 40 does not communicate with the internal dielectric resonator 11, but the coupling groove 40 communicates with the external dielectric resonator A31 is used. When a distance between the input port 10 and the internal dielectric resonator 11 equals to a distance between the input port 10 and the external dielectric resonator A31, an amount of coupling between the input port 10 and the external dielectric resonator A31 is greater than an amount of coupling between the input port 10 and the internal dielectric resonator 11. In addition, the amount of coupling between the input port 10 and the internal dielectric resonator 11 may be adjusted by adjusting a distance between the coupling groove 40 and the internal dielectric resonator 11. Alternatively, the amount of coupling between the input port 10 and the internal dielectric resonator 11 and the amount of coupling between the input port 10 and the external dielectric resonator A31 may be adjusted by adjusting a depth and a width of the coupling groove 40. Adjusting the amounts of coupling between the port and the corresponding dielectric resonators by adjusting a size of the coupling groove 40 belongs to conventional technologies, and details are not described herein.

[0094] Both the internal dielectric resonator 11 and the external dielectric resonator A31 are adjacent to the input port 10, and one end of the coupling groove 40 is set to communicate with the dielectric resonator 11, so that the amount of coupling between the input port 10 and the internal dielectric resonator 11 can be increased. Alternatively, one end of the coupling groove 40 is set to communicate with the external dielectric resonator A31, so that the amount of coupling between the input port 10 and the external dielectric resonator A31 can be increased. In this way, the amount of coupling of the input port 10 on the dielectric resonator with the internal dielectric resonator 11 or the external dielectric resonator can be adjusted. In this embodiment, the input port 10 is merely used as an example for description. The input port 10 may be replaced with the corresponding output port 20. In this case, the internal dielectric resonator 11 corresponds to an internal dielectric resonator adjacent to the output port 20. The external dielectric resonator A31 corresponds to an external dielectric resonator adjacent to the output port 20.

Example 3

[0095] The coupling groove 40 is disposed between an internal dielectric resonator and an external dielectric resonator that are adjacent to the input port 10, or the coupling groove 40 is disposed between an internal dielectric resonator and an external dielectric resonator that are adj acent to the output port 20, where two ends of the coupling groove 40 respectively communicate with an internal dielectric resonator located at one end of the coupling groove 40 and an external dielectric resonator located at the other end of the coupling groove 40.

[0096] An example in which the coupling groove 40 is disposed between the internal dielectric resonator and the external dielectric resonator that are adjacent to the input port 10 is used for description. Refer to FIG. 14 and FIG. 15. FIG. 14 is a third schematic diagram of coupling of an input port with an internal dielectric resonator and an external dielectric resonator in a dielectric filter according to an embodiment of this application. FIG. 15 is a sectional view for the third schematic diagram of coupling of the port with the internal dielectric resonator and the external dielectric resonator in FIG. 14. As shown in FIG. 14 and FIG. 15, an internal dielectric resonator adjacent to the input port 10 is an internal dielectric resonator 11, an external dielectric resonator adjacent to the input port 10 is an external dielectric resonator A31, and the coupling groove 40 is disposed between the internal dielectric resonator 11 and the external dielectric resonator A31. The coupling groove 40 communicates with both the internal dielectric resonator 11 and the external dielectric resonator A31. When the same arrangement of the input port 10, the internal dielectric resonator 11, and the external dielectric resonator A31 is applied, and the coupling groove 40 communicates with both the internal dielectric resonator 11 and the external dielectric resonator A31, amounts of coupling of the input port 10 with the internal dielectric resonator 11 and the external dielectric resonator A31 are larger than amounts of coupling performed when the coupling groove 40 communicates with neither the internal dielectric resonator 11 nor the external dielectric resonator A31. That is, the amounts of coupling of the input port 10 with the internal dielectric resonator 11 and the external dielectric resonator A31 in the case shown in FIG. 14 are greater than the amounts of coupling of the input port 10 with the internal dielectric resonator 11 and the external dielectric resonator A31 in the case shown in FIG. 12. In this embodiment, the amount of coupling between the input port 10 and the internal dielectric resonator 11 and the amount of coupling between the input port 10 and the external dielectric resonator A31 may be adjusted by adjusting a depth and a width of the coupling groove 40.

[0097] The two ends of the coupling groove 40 is set to communicate with the internal dielectric resonator 11 and the external dielectric resonator A31. In this case, the amount of coupling between the input port 10 and the internal dielectric resonator 11 and the amount of coupling between the input port 10 and the external dielectric resonator A31 can be increased.

[0098] In addition, a coupling hole 50 may be further disposed between the internal dielectric resonator and the external dielectric resonator that are adjacent to the input port 10 or the output port 20, and an axis of the coupling hole 50, an axis of the internal dielectric resonator, and an axis of the external dielectric resonator are parallel to each other.

Example 4

[0099] Refer to FIG. 16. FIG. 16 is a fourth schematic diagram of coupling of an input port with an internal dielectric resonator and an external dielectric resonator in a dielectric filter according to an embodiment of this application. As shown in FIG. 16, an internal dielectric resonator adjacent to the input port 10 is an internal dielectric resonator 11, an external dielectric resonator adjacent to the input port 10 is an external dielectric resonator A31, and a coupling hole 50 is disposed between the internal dielectric resonator 11 and the external dielectric resonator A31. In this example, two coupling holes 50 are disposed. Axes of the two coupling holes 50 are parallel to an axis of the internal dielectric resonator 11 and an axis of the external dielectric resonator A31. Alternatively, the axes of the two coupling holes 50, the axis of the internal dielectric resonator 11, and an axis of the external dielectric resonator A31 may be disposed in a same plane. The two coupling holes 50 are respectively disposed on two sides of the input port 10. The coupling holes 50 may be through holes or blind holes, or may be a combination of a through hole and a blind hole. An amount of coupling between the input port 10 and the internal dielectric resonator 11 may be adjusted by adjusting a location of a coupling hole 50 between the input port 10 and the internal dielectric resonator 11. Also, an amount of coupling between the input port 10 and the external dielectric resonator A31 may be adjusted by adjusting a location of a coupling hole 50 between the input port 10 and the external dielectric resonator A31.

[0100] Refer to FIG. 17. For example, FIG. 17 is a fifth schematic diagram of coupling of an input port with an internal dielectric resonator and an external dielectric resonator in a dielectric filter according to an embodiment of this application. As shown in FIG. 17, the axes of the two coupling holes 50 are parallel to the axis of the internal dielectric resonator 11 and the axis of the external dielectric resonator A31. However, a plane in which the axis of the internal dielectric resonator 11 and the axis of the external dielectric resonator A31 are located is perpendicular to a plane in which the axes of the two coupling holes 50 are located, and the two coupling holes 50 are located on two sides of the plane in which the axis of the internal dielectric resonator 11 and the axis of the external dielectric resonator A31 are located. In actual application, specific locations of the coupling holes 50 depends on the amount of coupling between the input port 10 and the internal dielectric resonator 11 and the amount of coupling between the input port 10 and the external dielectric resonator A31.

[0101] In addition, the positions of the two coupling holes 50 are set to a state shown in FIG. 17, that is, the two coupling holes 50 are located on the two sides of the plane in which the axis of the internal dielectric resonator 11 and the axis of the external dielectric resonator A31 are located. Different from that generated in a state in FIG. 16 in which the axes of the two coupling holes 50 are located in the plane in which the axis of the internal dielectric resonator 11 and the axis of the external dielectric resonator A31 are located, parasitic coupling generated between the internal dielectric resonator 11 and the external dielectric resonator A31 can be suppressed by the coupling holes 50 located on the two sides of the plane. In this way, interference caused by parasitic coupling to implementation of a transmission zero can be reduced.

[0102] When the axes of the coupling holes 50 are set to be parallel to the axis of the internal dielectric resonator and the axis of the external dielectric resonator, production and processing can be facilitated. In this embodiment, the coupling holes 50 may be through holes or blind holes, and may be configured to adjust the amount of coupling between the input port 10 and the internal dielectric resonator 11 and the amount of coupling between the input port 10 and the external dielectric resonator A31.

Example 5

[0103] In addition to the cases shown in the foregoing examples, both a coupling groove 40 and a coupling hole 50 may be disposed between an internal dielectric resonator and an external dielectric resonator that are adjacent to the input port 10 or the output port 20.

[0104] An example in which both the coupling groove 40 and the coupling hole 50 are disposed between the internal dielectric resonator and the external dielectric resonator that are adjacent to the input port 10 is used for description. Refer to FIG. 18 and FIG. 19. FIG. 18 is a sixth schematic diagram of coupling of an input port with an internal dielectric resonator and an external dielectric resonator in a dielectric filter according to an embodiment of this application. FIG. 19 is a sectional view for the sixth schematic diagram of coupling of the port with the internal dielectric resonator and the external dielectric resonator in FIG. 18. As shown in FIG. 18 and FIG. 19, the internal dielectric resonator adjacent to the input port 10 is an internal dielectric resonator 11, the external dielectric resonator adjacent to the input port 10 is an external dielectric resonator A31, and both the coupling groove 40 and the coupling hole 50 are disposed between the internal dielectric resonator 11 and the external dielectric resonator A31. In this example, the coupling groove 40 is disposed on a side close to the external dielectric resonator A31, and the coupling hole 50 is disposed on a side close to the internal dielectric resonator 11. Locations of the coupling groove 40 and the coupling hole 50 are not limited thereto. Adjustment may be made based on an amount of coupling between the input port 10 and the external dielectric resonator A31 and an amount of coupling between the input port 10 and the internal dielectric resonator 11. In this example, a form in which the coupling groove 40 communicates with the external dielectric resonator A31 is used. Alternatively, the coupling groove 40 may be set to not communicate with the external dielectric resonator A31 based on the amount of coupling between the input port 10 and the external dielectric resonator A31. To facilitate production and processing, an axis of the coupling hole 50 may be set in a vertical direction, and one or more coupling holes 50 may be configured based on the amount of coupling between the input port 10 and the internal dielectric resonator 11.

[0105] In this embodiment, the input port 10 is composed of a connector 101 and a through port hole 100. The connector 101 is connected to the dielectric body, and the through port hole 100 is a through hole that penetrates the connector 101 and the dielectric body. If the connector 101 is an evenly-shaped connector 101, an axis of the through port hole 100 may pass through a center of the connector 101 when the through port hole 100 is disposed. In a situation of disposing the coupling groove 40 between the internal dielectric resonator and the external dielectric resonator that are adjacent to the input port 10, the through port hole 100 may communicate with the coupling groove 40 when the through port hole 100 is disposed.

[0106] In the foregoing examples, only cases in which the coupling groove 40 and/or the coupling hole 50 are/is disposed between the internal dielectric resonator 11 and the external dielectric resonator A31 at the input port 10 are described. In actual application, a corresponding internal dielectric resonator and a corresponding external dielectric resonator may be disposed at either the input port 10 or the output port 20, and a coupling groove 40 and/or a coupling hole 50 are/is disposed between the internal dielectric resonator and the external dielectric resonator. The coupling groove 40 and/or the coupling hole 50 may be disposed in the forms shown in the foregoing examples. If the coupling groove 40 and/or the coupling hole 50 are/is disposed at the input port 10, and the coupling groove 40 and/or the coupling hole 50 are/is disposed at the output port 20, the arrangement forms in the foregoing examples may be combined. For example, only the coupling groove 40 is disposed at the input port 10, where a location of the coupling groove 40 is the location shown in Example 1; and only the coupling groove 40 is disposed at the output port 20, where a location of the coupling groove 40 is the location shown in Example 2. For another example, only the coupling hole 50 is disposed at the input port 10, where a location of the coupling hole 50 is the location shown in Example 4; and both the coupling groove 40 and the coupling hole 50 are disposed at the output port 20, where locations of the coupling groove 40 and the coupling hole 50 are the locations shown in Example 5. Not all combinations are described herein by using examples.

[0107] In this embodiment of this application, both an outer surface and an inner surface of the dielectric body are metalized. An inner surface of the dielectric body includes all inner surfaces of through holes, inner surfaces and bottom surfaces of blind holes, and inner surfaces and bottom surfaces of blind grooves disposed on the dielectric body. Both the outer surface and the inner surface of the dielectric body are metalized to form a metal wall on the outer surface and the inner surface of the dielectric body. The metal wall is used to completely wrap the dielectric body to form a resonance system in the dielectric body.

[0108] Based on a same invention concept, an embodiment of this application provides a transceiver. The transceiver includes a receiver, a transmitter, an amplification unit, and the dielectric filter provided in any one of the foregoing embodiments. Technical effects of the transceiver are the same as those of the dielectric filter provided in the foregoing embodiments, and details are not described herein again.

[0109] Based on a same invention concept, an embodiment of this application provides a base station. The base station includes an antenna feeder component, a control component, and the transceiver provided in the foregoing embodiment. Technical effects of the base station are the same as those of the transceiver provided in the foregoing embodiment, and details are not described herein again.

[0110] The foregoing descriptions are merely specific implementations of this application, but are not intended to limit the protection scope of this application. Any variation or replacement readily figured out by a person skilled in the art within the technical scope disclosed in this application shall fall within the protection scope of this application. Therefore, the protection scope of this application shall be subject to the protection scope of the claims.

[0111] Embodiments in this specification are all described in a progressive manner. Each embodiment focuses on differencec from other embodiments. For same or similar parts in the embodiments, mutual reference may be made.

[0112] Although preferred embodiments in embodiments of this application are described, a person skilled in the art may make variations and modifications to these embodiments once the basic inventive concept is learned. Therefore, the appended claims are intended to be construed as including preferred embodiments and all changes and modifications that fall within the scope of embodiments of this application.

[0113] The dielectric filter, the transceiver, and the base station provided in this application are described in detail above. Specific examples are used in this specification to describe principles and implementations of this application. Descriptions in the foregoing embodiments are merely used to help understand the method and a core idea of this application. In addition, a person of ordinary skill in the art may make modifications to the specific implementations and the application scope according to the idea of this application. In conclusion, the content of this specification shall not be construed as a limitation on this application.

Claims

1. A dielectric filter, comprising a dielectric body, and an input port, an output port, internal dielectric resonators, and external dielectric resonators that are disposed on the dielectric body, wherein a plurality of internal dielectric resonators are disposed between the input port and the output port, and form a main-coupling-channel cascaded resonator, and two external dielectric resonators are disposed on one side of the input port, wherein an amount of coupling between the external dielectric resonator and the input port is greater than an amount of coupling between the external dielectric resonator and any of the internal dielectric resonators; and/or two external dielectric resonators are disposed on one side of the output port, wherein an amount of coupling between the external dielectric resonator and the output port is greater than an amount of coupling between the external dielectric resonator and any of the internal dielectric resonators.

2. The dielectric filter according to claim 1, wherein an included angle between a first line and a second line is greater than or equal to 90°; and/or an included angle between a third line and a fourth line is greater than or equal to 90°, wherein

the first line is a line between a center of the external dielectric resonator and a center of the input port, and the second line is a line between a center of an internal dielectric resonator closest to the input port and the center of the input port; and

the third line is a line between a center of the external dielectric resonator and a center of the output port, and the fourth line is a line between a center of an internal dielectric resonator closest to the output port and a center of the output port.

3. The dielectric filter according to claim 1 or 2, wherein the two external dielectric resonators are coupled, one of the external dielectric resonators that is close to the input port or the output port is a first external dielectric resonator; the other external dielectric resonator is a second external dielectric resonator; and the first external dielectric resonator is coupled to the input port or the output port.

4. The dielectric filter according to any one of claims 1 to 3, wherein the main-coupling-channel cascaded resonator comprises a cascaded resonator of a linear topology structure or a cascaded resonator of a staggered topology structure.

5. The dielectric filter according to claim 4, wherein the external dielectric resonator comprises a resonator body defined by a part of the dielectric body and a debug hole located on the resonator body, and the debug hole is a blind hole or a through hole.

6. The dielectric filter according to claim 3, wherein the second external dielectric resonator is coupled to a near-port internal dielectric resonator, and the near-port internal dielectric resonator is an internal dielectric resonator adjacent to a port that is on a side on which the second external dielectric resonator is located.

7. The dielectric filter according to any one of claims 1 to 6, wherein a coupling hole and/or a coupling groove are/is disposed between the external dielectric resonator and the near-port internal dielectric resonator; and the near-port internal dielectric resonator is an internal dielectric resonator adjacent to a port that is on a side on which the external dielectric resonator is located.

8. The dielectric filter according to claim 7, wherein the coupling hole is a blind hole or a through hole.

9. The dielectric filter according to claim 7, wherein the coupling groove is a blind groove.

10. The dielectric filter according to any one of claims 7 to 9, wherein the coupling groove is disposed between the internal dielectric resonator and the external dielectric resonator that are adjacent to the input port or the output port, and the coupling groove communicates with neither the internal dielectric resonator located at one end of the coupling groove nor the external dielectric resonator located at the other end of the coupling groove.

11. The dielectric filter according to any one of claims 7 to 9, wherein the coupling groove is disposed between the internal dielectric resonator and the external dielectric resonator that are adjacent to the input port or the output port, and one end of the coupling groove communicates with the internal dielectric resonator located at one end of the coupling groove or the external dielectric resonator located at the other end of the coupling groove.

12. The dielectric filter according to any one of claims 7 to 9, wherein a coupling groove is disposed between the internal dielectric resonator and the external dielectric resonator that are adjacent to the input port or the output port, and two ends of the coupling groove respectively communicate with the internal dielectric resonator located at one end of the coupling groove and the external dielectric resonator located at the other end of the coupling groove.

13. The dielectric filter according to any one of claims 7 to 12, wherein the coupling hole is disposed between the internal dielectric resonator and the external dielectric resonator that are adjacent to the input port or the output port, and an axis of the coupling hole, an axis of the internal dielectric resonator, and an axis of the external dielectric resonator are parallel to each other.

14. The dielectric filter according to any one of claims 1 to 13, wherein both an outer surface and an inner surface of the dielectric body are metalized.

15. A transceiver, comprising a receiver, a transmitter, an amplification unit, and the dielectric filter according to any one of claims 1 to 14.

16. A base station, comprising an antenna feeder component, a control component, and the transceiver according to claim 15.

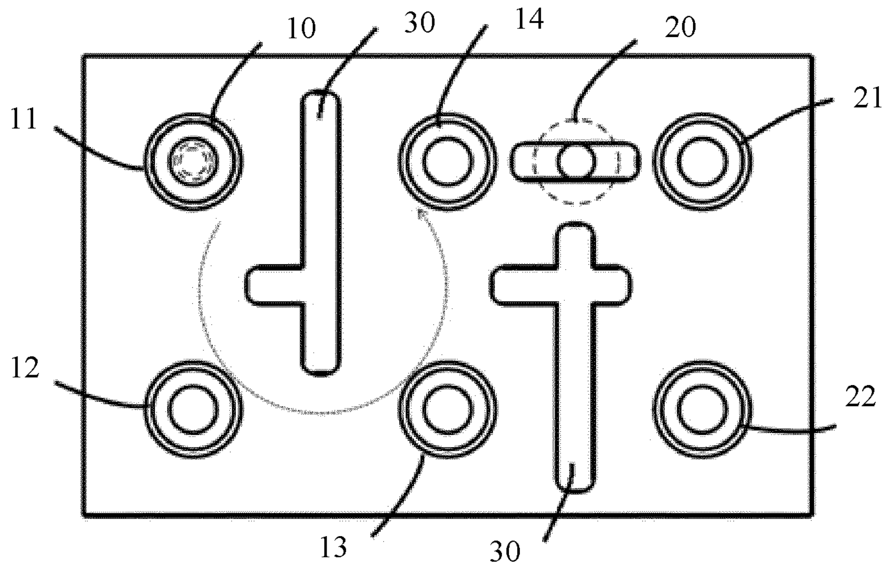

FIG. 1

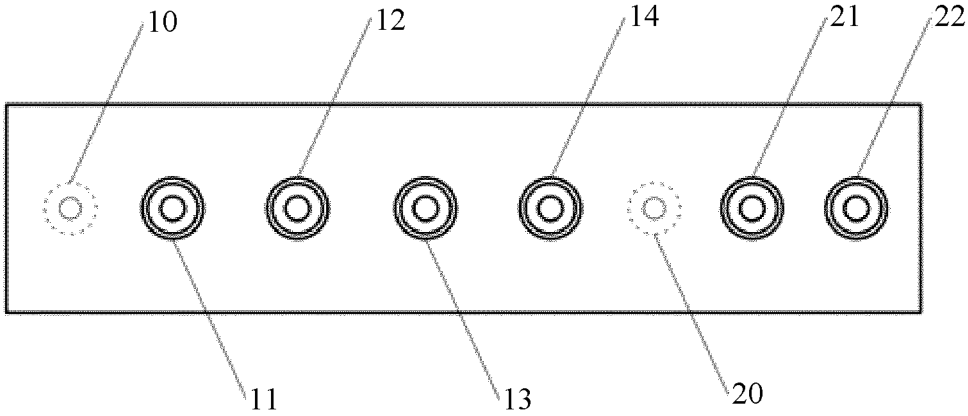

FIG. 2

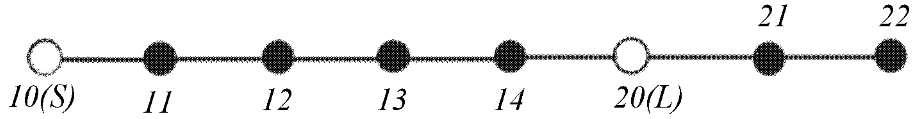

FIG. 3

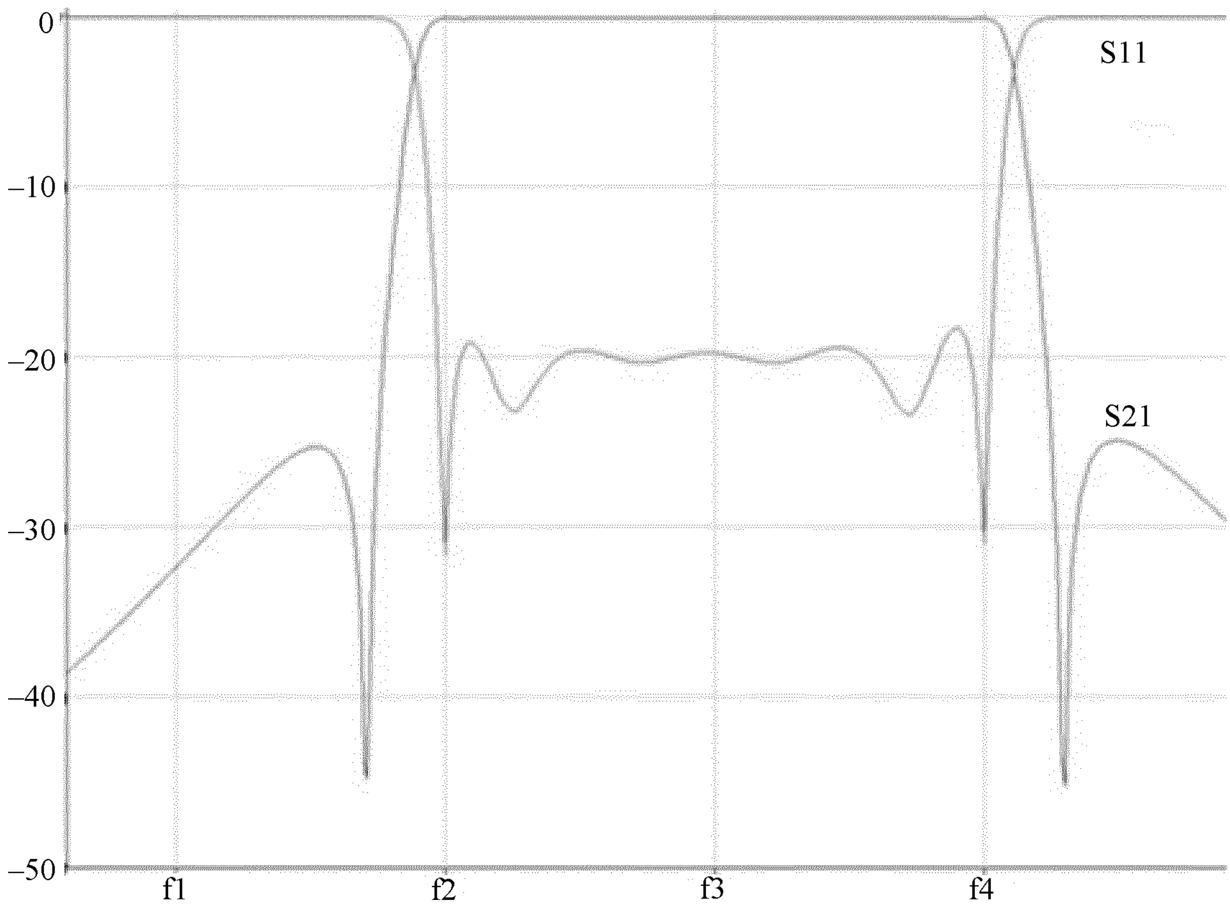

FIG. 4

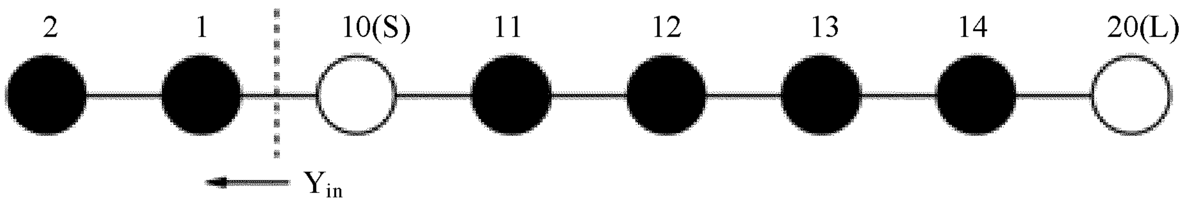

FIG. 5

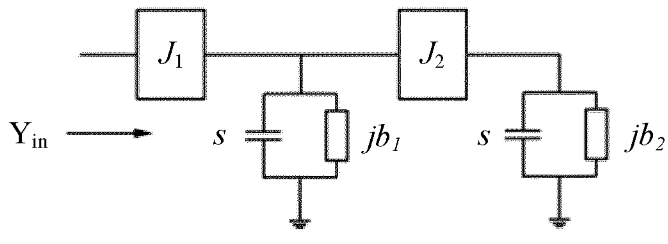

FIG. 6

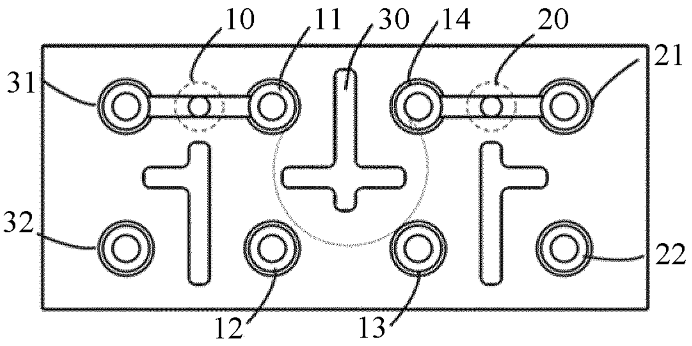

FIG. 7

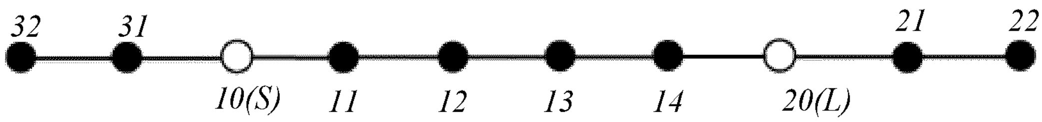

FIG. 8

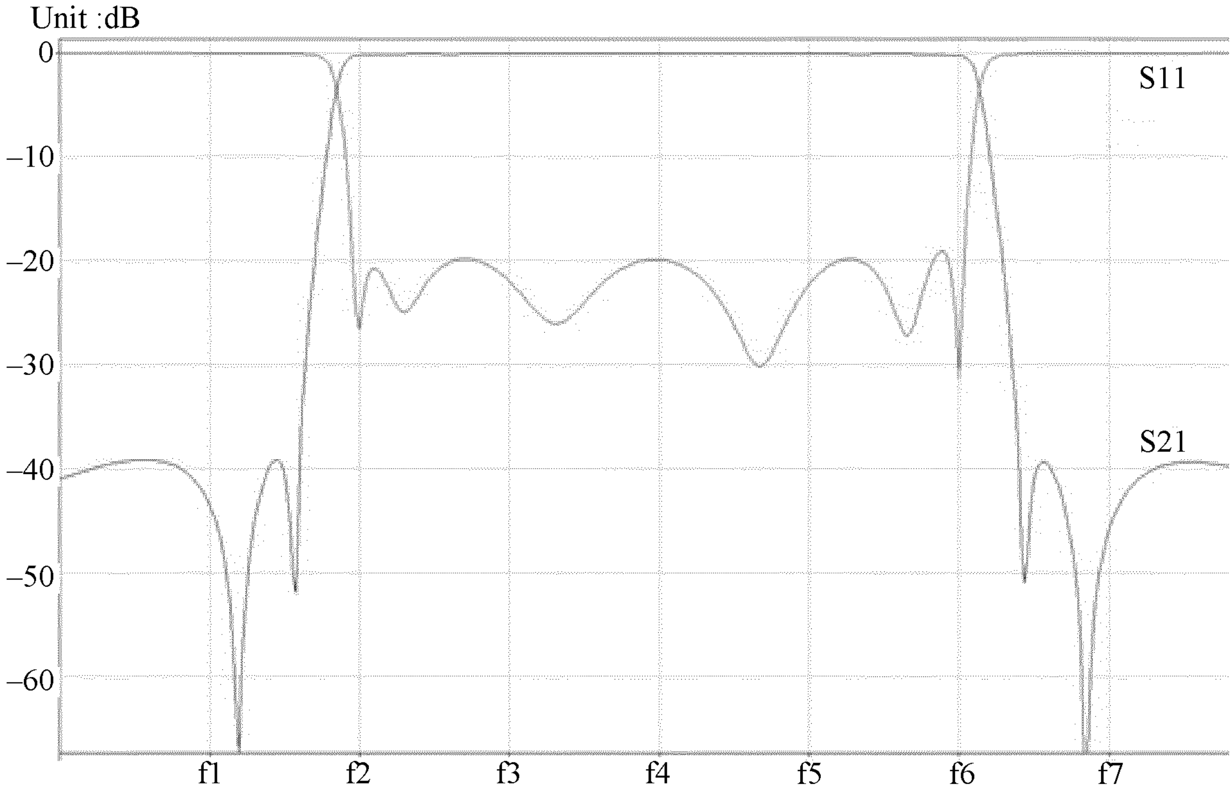

FIG. 9

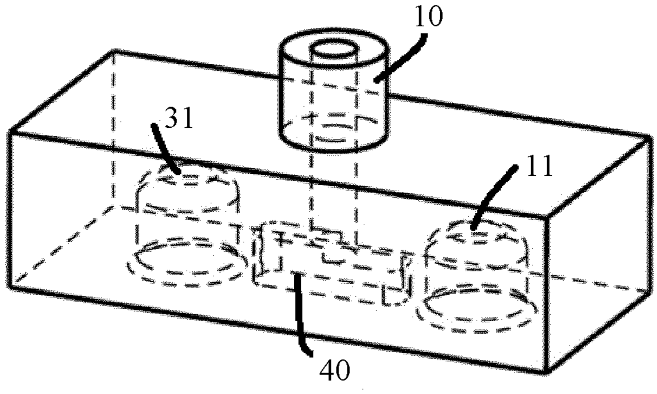

FIG. 10

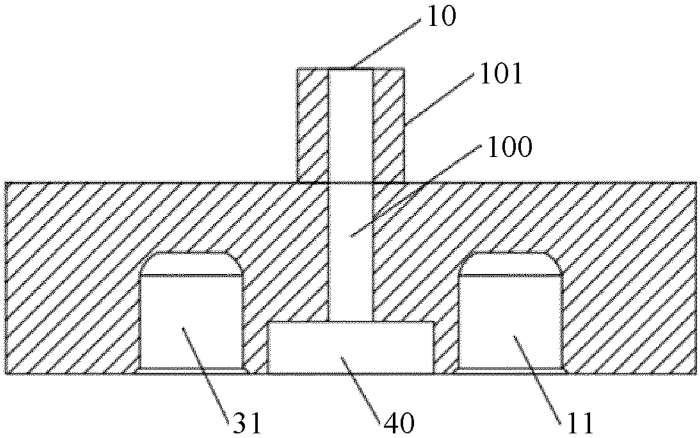

FIG. 11

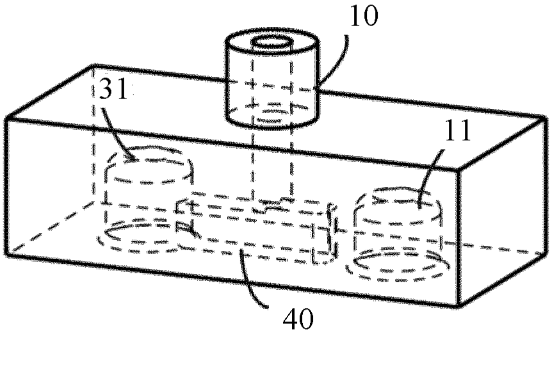

FIG. 12

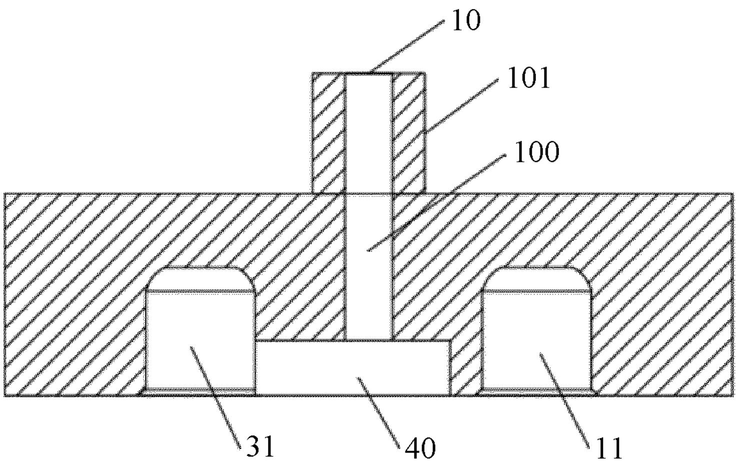

FIG. 13

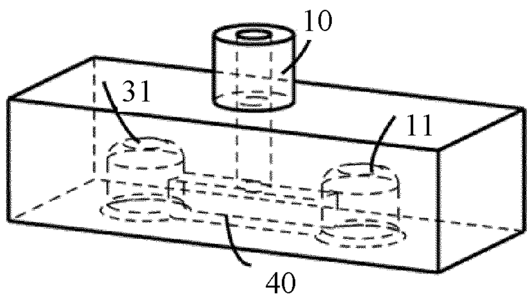

FIG. 14

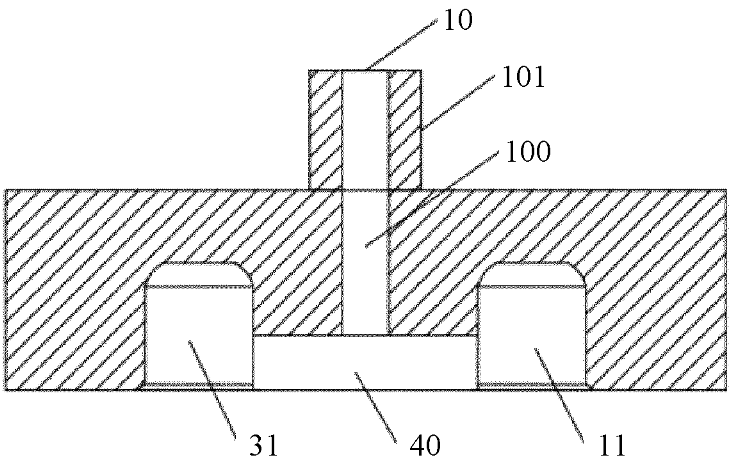

FIG. 15

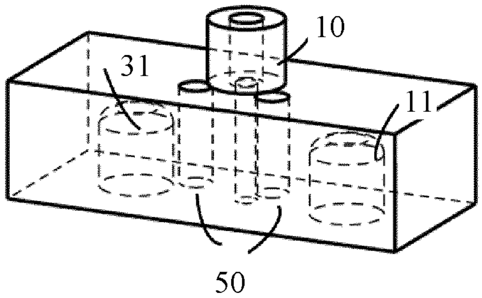

FIG. 16

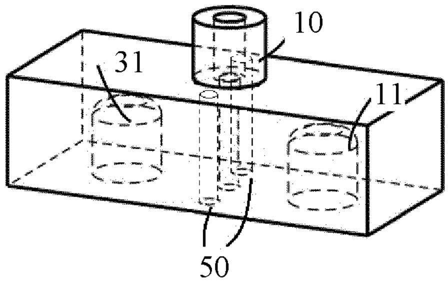

FIG. 17

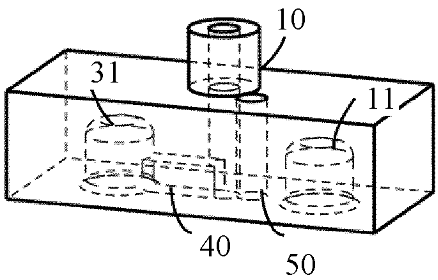

FIG. 18

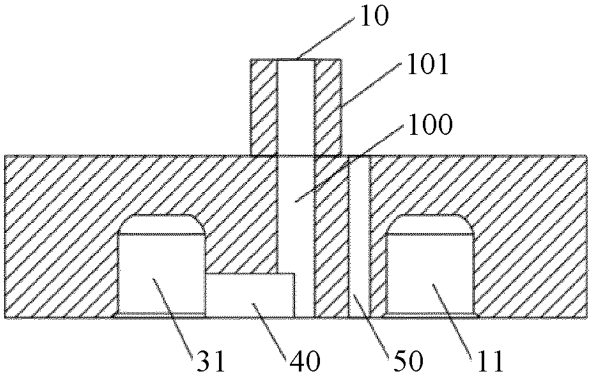

FIG. 19

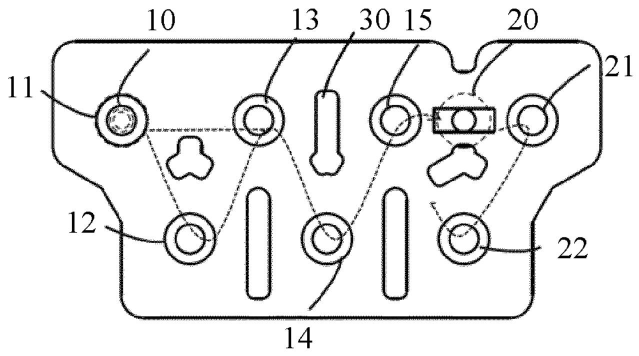

FIG. 20

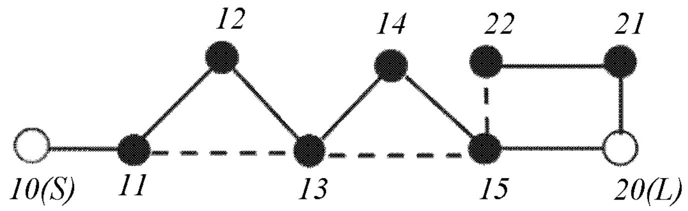

FIG. 21

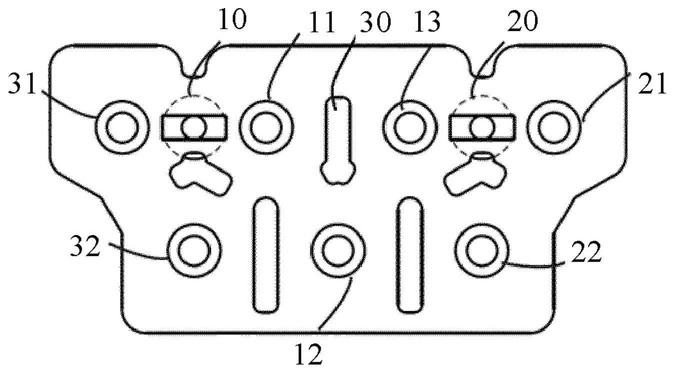

FIG. 22

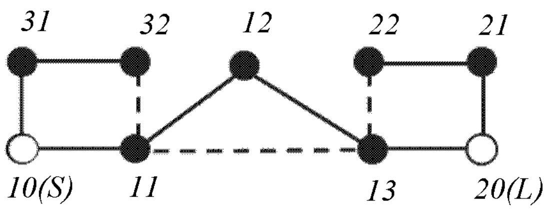

FIG. 23

INTERNATIONAL SEARCH REPORT

International application No. **PCT/CN2020/136616**

A. CLASSIFICATION OF SUBJECT MATTER

H01P 1/203(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)

H01P

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)

CNPAT, WPI, EPODOC, CNKI: 零点 陷波点 极点 带外 抑制 外置 外接 外部 耦合 输出 输入 端口 谐振 zero point pole out-of-band suppression external coupling output input port resonance

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 1797842 A (HUAWEI TECHNOLOGIES CO., LTD.) 05 July 2006 (2006-07-05) description page 7 line 4 to page 11 line 11	1-16
A	CN 111313131 A (TONGYU COMMUNICATION INC.) 19 June 2020 (2020-06-19) entire document	1-16
A	CN 212062649 U (HEFEI YUNZHIWEI ELECTRONIC CO., LTD.) 01 December 2020 (2020-12-01) entire document	1-16
A	CN 102800909 A (KUANG-CHI INNOVATION TECHNOLOGY LIMITED) 28 November 2012 (2012-11-28) entire document	1-16
A	CN 204927461 U (SOUTH CHINA UNIVERSITY OF TECHNOLOGY) 30 December 2015 (2015-12-30) entire document	1-16
A	US 2003222736 A1 (ALLISON, Robert C.) 04 December 2003 (2003-12-04) entire document	1-16

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

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "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
- "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
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "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
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 July 2021	**13 September 2021**

Name and mailing address of the ISA/CN	Authorized officer
China National Intellectual Property Administration (ISA/CN) **No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China**	
Facsimile No. **(86-10)62019451**	Telephone No.

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2020/136616

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CN 102800909 A	28 November 2012	None	
CN 204927461 U	30 December 2015	None	
US 2003222736 A1	04 December 2003	None	

Form PCT/ISA/210 (patent family annex) (January 2015)