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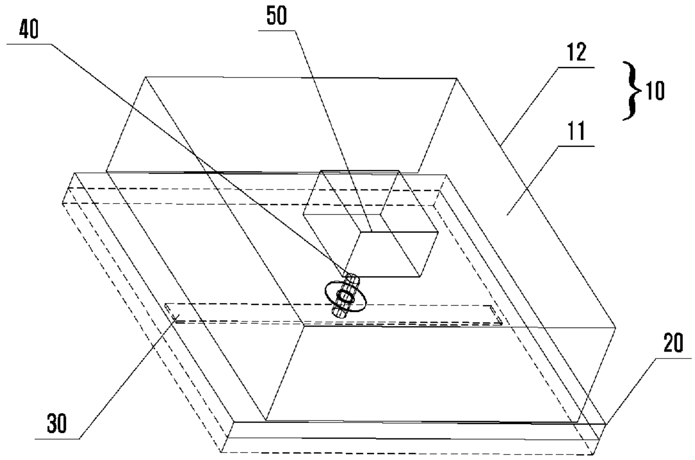

(57) Abstract: The application provides a dielectric filter, including a dielectric resonant cavity, a metal transmission line and a coupling structure, wherein the dielectric resonant cavity includes a solid dielectric body, and a metal plating layer, which covers an outer surface of the dielectric body; the metal transmission line and the dielectric resonant cavity are separated by a dielectric material; the coupling structure is connected between the dielectric resonant cavity and the metal transmission line, the dielectric resonant cavity is coupled with the metal transmission line through the coupling structure, so as to form a transmission zero point on either side of a transmission channel. The application also provides a dielectric filter and a cascade filter, which may implement a transmission zero point, by using a direct coupling between one dielectric resonant cavity and the metal transmission line, without a cross-coupling among multiple cavities, thereby greatly simplifying the structure of the dielectric filter.

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Description

Title of Invention: DIELECTRIC FILTER AND CASCADE FILTER

Technical Field

[1] The application relates to filter technologies, and more particularly, to a dielectric filter and a cascade filter.

Background Art

[2] Existing dielectric filters use the coupling between dielectric resonators to achieve transmission zero points. In this method, the structural design between non-adjacent resonators in the filter needs to generate cross-coupling, so as to realize the transmission zero point.

Disclosure of Invention

Technical Problem

[3] Therefore, to achieve this method, at least the coupling of two dielectric resonant cavities (usually negative coupling) is needed, which results in a complex structure and a large volume, thereby having great limitations on the overall structure of a machine.

Solution to Problem

[4] To solve foregoing technical problems, the application provides a dielectric filter and a cascade filter, which uses a direct coupling between a dielectric resonant cavity and a metal transmission line to achieve a transmission zero point. Cross-coupling between multiple cavities is not needed, which can greatly simplify the structure of the dielectric filter.

[5] In an embodiment, a dielectric filter is provided, which includes a dielectric resonant cavity, a metal transmission line and a coupling structure, wherein the dielectric resonant cavity includes a dielectric body, and a metal plating layer covering an outer surface of the dielectric body; the metal transmission line and the dielectric resonant cavity are separated by a dielectric material; and, the coupling structure is connected between the dielectric resonant cavity and the metal transmission line, wherein the dielectric resonant cavity is coupled with the metal transmission line through the coupling structure, so as to form a transmission zero point on either side of a transmission channel.

[6] In a preferred embodiment, a first end of the coupling structure is embedded into the dielectric body; the first end is not electrically connected to the metal plating layer on a surface of the dielectric resonant cavity, so as to form a capacitive transmission zero point; or, the first end is electrically connected to the metal plating layer on the surface of the dielectric resonant cavity, so as to form an inductive transmission zero point.

[7] In a preferred embodiment, the metal transmission line is arranged on a side surface of the dielectric resonant cavity away from a circuit board.

[8] In a preferred embodiment, a second end of the coupling structure penetrates the circuit board from a side surface of the circuit board facing the dielectric resonant cavity, so as to electrically connect to the metal transmission line.

[9] In a preferred embodiment, the side surface of the circuit board facing the dielectric resonant cavity further comprises an insulating layer, the insulating layer surrounds the second end, so as to insulate the coupling structure from a signal of the circuit board.

[10] In a preferred embodiment, the circuit board further includes a metal hole penetrating the circuit board, the second end of the coupling structure is electrically connected to the side surface of the circuit board facing the dielectric resonant cavity, so as to be in a signal connection with the metal transmission line through the metal hole.

[11] In a preferred embodiment, the second end of the coupling structure is connected with a midpoint of the metal transmission line.

[12] In a preferred embodiment, the dielectric filter further includes a debug hole, wherein the debug hole is opened on a side surface of the dielectric resonant cavity, the debug hole and the circuit board are respectively located on opposite surfaces of the dielectric resonant cavity.

[13] In a preferred embodiment, the debug hole is opened on a top surface of the dielectric body, the first end of the coupling structure extends into the dielectric body from a bottom surface of the dielectric body.

[14] The application also provides a cascade filter, including multiple above-mentioned dielectric filters; wherein the dielectric resonant cavities of multiple dielectric filters are arranged at intervals along a straight line, one end or both ends of a metal transmission line of each dielectric filter is electrically connected with a metal transmission line of other dielectric filters, so as to form multiple transmission zero points, the number of transmission zero points of the cascade filter corresponds to the number of transmission zero points of the dielectric filter.

[15] Based on foregoing technical solutions, it can be seen that, in the dielectric filter of the embodiment, only one dielectric resonant cavity is included. The coupling method is not to establish cross-coupling between different resonant cavities, but to use a mutual coupling between such resonant cavity and a non-resonant cavity, by coupling the dielectric resonant cavity with the metal transmission line (microstrip line, etc). The metal transmission line is open at both ends to form a non-closed resonance node. A resonance peak is formed in the transmission channel, and a transmission zero point is formed on either side of the transmission channel.

[16] In the embodiment, the metal transmission line is usually a metalized line set on the surface of the circuit board, which may be formed on the same circuit board with the

input and output circuits of the dielectric filter, etc. That is, in the embodiment, the dielectric filter may form an independent transmission zero point, by using a dielectric resonant cavity and its auxiliary circuit. Subsequently, the filtering performance of the filter may be optimized. In the embodiment, the dielectric filter has a simple structure, and the transmission zero point may be achieved without cross-coupling structure. Thus, the volume and structure of the dielectric filter may be simplified to a great extent. And, the whole machine space can be reasonably arranged, based on the single cavity structure.

[17] Furthermore, in the embodiment, an independent transmission zero point is generated, by using the single resonant cavity. Subsequently, the frequency and position of the transmission zero point are not affected by the characteristics of the resonant cavity of other filters. Each resonant cavity may be manufactured separately, so as to improve the performance of each dielectric filter, reduce the processing accuracy requirements of each dielectric filter. Subsequently, the product performance may be improved, while reducing costs thereof.

Brief Description of Drawings

[18] The following drawings only schematically illustrate and explain the application, and do not limit the scope of the application.

[19] FIG.1 is a schematic diagram illustrating structure of a dielectric filter, in accordance with a first embodiment of the application.

[20] FIG.2 is a section view of the dielectric filter, in accordance with the first embodiment of the application.

[21] FIG.3 is a schematic diagram illustrating structure of a dielectric filter, in accordance with a second embodiment of the application.

[22] FIG.4 is a section view of the dielectric filter, in accordance with the second embodiment of the application.

[23] FIG.5 is a schematic diagram illustrating structure of a cascade filter, in accordance with an embodiment of the application.

[24] FIG.6 is a waveform diagram of the cascade filter illustrated with FIG.5.

Mode for the Invention

[25] In order to have a clearer understanding of the technical features, objectives and effects of the application, specific embodiments of the application will now be described with reference to the accompanying drawings. In each figure, the same reference numeral represents the same part.

[26] In the specification, "schematic" means "serving as an example, instance, or illustration". Any diagram or embodiment described as "schematic" in this specification should not be interpreted as a more preferred or more advantageous technical solution.

[27] In order to make the drawings concise, each figure only schematically shows relevant parts of the application, which does not represent the actual structure of the product. In addition, to make the figures simple and easy to understand, for some figures with the same structure or function, only one of them is shown schematically, or only one of them is marked.

[28] In the specification, "up", "down", "front", "back", "left", "right", etc. are only used to indicate the relative position relationship between related parts, but are not used to limit the absolute position of these related parts.

[29] In the specification, "first", "second", etc. are only used to distinguish each other, not used to indicate the degree of importance and order, and the premise of mutual existence, etc.

[30] In the specification, "equal", "same", etc. are not strictly mathematical and/or geometrical limitations, but also include errors that can be understood by those skilled in the art and allowed for manufacturing or use. Unless otherwise stated, the numerical range herein includes not only the entire range with its two endpoints, but also several sub-ranges therein.

[31] The exemplary embodiments will now be described more fully with reference to the accompanying figures.

[32] To solve the problems in the prior art, the application provides a dielectric filter and a cascade filter, which may implement a transmission zero point, by using a direct coupling between a dielectric resonant cavity and a metal transmission line. Cross-coupling among multiple cavities is not needed, thereby greatly refining the structure of the dielectric filter.

[33] FIG.1 is a schematic diagram illustrating structure of a dielectric filter, in accordance with a first embodiment of the application. FIG.2 is a section view of the dielectric filter, in accordance with the first embodiment of the application.

[34] As shown in FIG.1 and FIG.2, an embodiment of the application provides a dielectric filter 1, which includes a dielectric resonant cavity 10, a metal transmission line 30 and a coupling structure 40.

[35] The dielectric resonant cavity 10 includes a dielectric body 11 and a metal plating layer 12, which covers the outer surface of the dielectric body 11.

[36] The metal transmission line 30 and the dielectric resonant cavity 10 are separated by a dielectric material.

[37] The coupling structure 40 is connected between the dielectric resonant cavity 10 and the metal transmission line 30. The dielectric resonant cavity 10 is coupled with the metal transmission line 30 through the coupling structure 40, so as to form a transmission zero point on either side of the transmission channel.

[38] The space between the metal transmission line 30 and the dielectric resonant cavity

10 may be an air layer or a plate of a circuit board.

[39] In the embodiment, the dielectric filter 1 only includes one dielectric resonant cavity 10. The coupling method adopts a mutual coupling between such resonant cavity and a non- resonant cavity, by coupling the dielectric resonant cavity 10 and the metal transmission line 30 (microstrip line, etc), instead of establishing a cross-coupling between different resonant cavities. The two ends of the metal transmission line 30 are open to form a non-closed resonance node. A resonance peak is formed in the transmission channel, and a transmission zero point is formed on either side of the transmission channel.

[40] In the traditional dielectric filter, a transmission zero point may be achieved, by using a coupling structure between non-adjacent resonant cavities. That is, one transmission zero point needs to be implemented, by using a dielectric filter with three resonant cavities and a cross-coupling structure (mostly negative coupling) set between resonant cavities. Since the transmission zero point needs to be implemented between two non-adjacent resonant cavities, most of the resonant cavities of traditional dielectric filters are arranged in a Z-shaped, S-shaped, or U-shaped form. Taking a dielectric filter with three resonant cavities as an example, three resonant peaks can be formed in the transmission channel, but there is only one transmission zero point.

[41] In the embodiment, the metal transmission line 30 is usually a metallized line arranged on the surface of the circuit board 20, which may be formed on the same circuit board 20 as the filter circuit of the dielectric filter 1, etc. That is, in the embodiment, the dielectric filter 1 may form an independent transmission zero point, by using the dielectric resonant cavity 10 and its auxiliary circuit, so as to optimize the filtering performance of the filter. In the embodiment, the dielectric filter 1 has a simple structure, and may implement a transmission zero point without cross-coupling structure. Subsequently, the volume and structure of the dielectric filter 1 may be simplified to a great extent. Besides, the whole machine space may be reasonably arranged, based on the single cavity structure.

[42] Furthermore, in the embodiment, since an independent transmission zero point is generated by using a single resonant cavity, the frequency and position of the transmission zero point are not affected by the characteristics of the resonant cavity of other filters. Each resonant cavity may be manufactured separately, so as to improve the performance of each dielectric filter, and reduce processing accuracy requirements of each dielectric filter. Subsequently, the product performance may be improved while reducing costs thereof.

[43] In a preferred embodiment, the dielectric body 11 of the dielectric resonant cavity 10 is a solid structure, and its surface is covered with a metal plating layer. The dielectric body 11 is made of solid dielectric material.

[44] In the embodiments illustrated with FIG.1 and FIG.2, a first end 41 of the coupling structure 40 is embedded in the dielectric body 11. Besides, the first end 41 is not electrically connected to the metal plating layer 12 on the surface of the dielectric resonant cavity 10, so as to form a capacitive transmission zero point on the left side of the transmission channel.

[45] The coupling structure 40 may be a columnar solid metal structure, or may be in the form of a metalized blind hole formed in the dielectric body 11.

[46] The first end 41 of the coupling structure 40 is embedded in the dielectric body 11, and is not electrically connected to the metal plating layer 12 on the surface of the dielectric resonant cavity 10. A second end 42 of the coupling structure 40 is connected to the metal transmission line 30 (electrical connection or signal connection). Subsequently, the dielectric resonant cavity 10 and the metal transmission line 30 may implement a negative coupling (electrical coupling), by using the coupling structure 40, so as to form the capacitive transmission zero point on the left side of the transmission channel.

[47] As shown in FIG.2, the dielectric resonant cavity 10 further includes a debug hole 50. The debug hole 50 is opened on the surface at one side of the dielectric resonant cavity 10. The metal plating layer 12 also covers the surface of the debug hole 50. The debug hole 50 is a blind hole used to adjust the resonance frequency.

[48] In a preferred embodiment, the debug hole 50 and the circuit board 20 are respectively located on opposite surfaces of the dielectric resonant cavity 10. For example, as shown in FIG.2, the debug hole 50 is opened on the top surface of the dielectric body 11. The first end 41 of the coupling structure 40 extends into the dielectric body 11 from the bottom surface of the dielectric body 11.

[49] As shown in FIG.2, the metal transmission line 30 is arranged on the surface of the circuit board 20 away from the dielectric resonant cavity 10. Subsequently, the dielectric resonant cavity 10 may fix its bottom surface to the circuit board 20. The dielectric material of the circuit board 20 may form a gap between the dielectric resonant cavity 10 and the metal transmission line 30. The bottom surface of the dielectric resonant cavity 10 is also covered with a metal plating layer 12, and the gap between it and the circuit board or metal transmission line 30 may be filled with solder.

[50] In the embodiment, the second end 42 of the coupling structure 40 penetrates the circuit board 20 from the side surface of the circuit board 20 facing the dielectric resonant cavity 10, so as to from an electrical connection with the metal transmission line 30.

[51] In a preferred embodiment, the surface of the circuit board 20 facing the dielectric resonant cavity 10 further includes an insulating layer 21. The insulating layer 21 surrounds the second end 42, so as to insulate the coupling structure 40 from the signal

of the circuit board 20.

[52] FIG.3 is a schematic diagram illustrating structure of a dielectric filter, in accordance with a second embodiment of the application. FIG.4 is a section view of the dielectric filter, in accordance with the second embodiment of the application.

[53] As shown in FIG.3 and FIG.4, one embodiment of the application provides a dielectric filter 1, including: one dielectric resonant cavity 10, a metal transmission line 30 and a coupling structure 40.

[54] The dielectric resonant cavity 10 includes a solid dielectric body 11, and a metal plating layer 12 covering the outer surface of the dielectric body 11.

[55] The metal transmission line 30 and the dielectric resonant cavity 10 are separated by a dielectric material.

[56] The coupling structure 40 is connected between the dielectric resonant cavity 10 and the metal transmission line 30. The dielectric resonant cavity 10 couples with the metal transmission line 30 through the coupling structure 40, so as to form a transmission zero point on either side of the transmission channel.

[57] The space between the metal transmission line 30 and the dielectric resonant cavity 10 may be an air layer or a plate of the circuit board

[58] In the embodiments illustrated with FIG.3 and FIG.4, a first end 41 of the coupling structure 40 is embedded in the dielectric body 11. Besides, the first end 41 is electrically connected with the metal plating layer 12 on the surface of the dielectric resonant cavity 10, so as to form an inductive transmission zero point on the right side of the transmission channel.

[59] The coupling structure 40 may be a columnar solid metal structure, or may be in the form of a metalized hole formed in the dielectric body 11.

[60] The first end 41 of the coupling structure 40 is embedded in the dielectric body 11, and is grounded by being electrically connected to the metal plating layer 12 on the surface of the dielectric resonant cavity 10. The second end 42 of the coupling structure 40 is connected to the metal transmission line 30 (electrical connection or signal connection). Subsequently, the dielectric resonant cavity 10 and the metal transmission line 30 may form a positive coupling (magnetic coupling) through the coupling structure 40, so as to form an inductive transmission zero point on the right side of the transmission channel.

[61] As shown in FIG.4, the dielectric resonant cavity 10 may further include a debug hole 50. The debug hole 50 is opened on one side surface of the dielectric resonant cavity 10, and the metal plating layer 12 also covers the surface of the debug hole 50. The debug hole 50 is a blind hole used to adjust the resonance frequency.

[62] In a preferred embodiment, the debug hole 50 and the circuit board 20 are respectively located on opposite surfaces of the dielectric resonant cavity 10. For

example, as shown in FIG.2, the debug hole 50 is opened on the top surface of the dielectric body 11. The first end 41 of the coupling structure 40 extends into the dielectric body 11 from the bottom surface of the dielectric body 11.

[63] Thus, the first end 41 of the coupling structure 40 is not electrically connected to the metal plating layer 12 covering the top surface of the dielectric resonant cavity 10. Instead, the first end 41 of the coupling structure 40 is electrically connected to the metal plating layer 12, which covers the side surface of the dielectric resonant cavity 10. Thus, the first end 41 of the coupling structure 40 may have a bend in the dielectric body 11.

[64] As shown in FIG.4, the metal transmission line 30 is arranged on the surface of the circuit board 20 away from the dielectric resonant cavity 10. Subsequently, the dielectric resonant cavity 10 may fix its bottom surface to the circuit board 20, while the dielectric material of the circuit board 20 may form a gap between the dielectric resonant cavity 10 and the metal transmission line 30. The bottom surface of the dielectric resonant cavity 10 is also covered with the metal plating layer 12. And the gap between the bottom surface of the dielectric resonant cavity 10 and the circuit board, or metal transmission line 30 may be filled with solder.

[65] In the embodiment, the circuit board 20 may further include a metal hole 22 penetrating the circuit board 20. The second end 42 of the coupling structure 40 is electrically connected to the surface of the circuit board 20 facing the dielectric resonant cavity 10, so as to be in a signal connection with the metal transmission line 30 through the metal hole 22.

[66] In a preferred embodiment, the surface of the circuit board 20 facing the dielectric resonant cavity 10 further includes an insulating layer 21. The insulating layer 21 surrounds the second end 42, so as to insulate the coupling structure 40 from the signals of a side surface of the circuit board 20 facing the dielectric resonant cavity 10.

[67] In the two embodiments illustrated with FIG.1 to FIG.4, preferably, the second end 42 of the coupling structure 40 may be connected (electrical connection or signal connection) to a specific position (for example, the midpoint) of the metal transmission line 30. The shape, width, and extension direction of the metal transmission line 30 may affect the amplitude and frequency of the resulting transmission zero point. Thus, the shape of the metal transmission line 30 is not limited to the shape shown in FIG. 1 and FIG. 3.

[68] In the embodiments of the application, an independent transmission zero point is generated, by using a single resonant cavity. Subsequently, the frequency and position of the transmission zero point is not affected by the characteristics of resonant cavity of other filters. Each resonant cavity may be manufactured independently, so as to improve the performance of each dielectric filter, and reduce the processing accuracy

requirements of each dielectric filter. Subsequently, the product performance may be improved while reducing costs thereof. However, the dielectric filter of the application is not limited to a single resonant cavity solution. As shown in FIG.5, the application also provides a cascade filter 2, which includes the dielectric filter provided by the application.

[69] Specifically, the cascade filter 2 includes multiple dielectric filters 1 as show in FIG.1 to FIG.4.

[70] The dielectric resonant cavities 10 of multiple dielectric filters 1 are arranged at intervals along a straight line. One end or both ends of the metal transmission line 30 of each dielectric filter 1 are electrically connected to the metal transmission lines 30 of other dielectric filters 1, so as to form multiple transmission zero points. The number of transmission zero points of the cascade filter 2 corresponds to that of the dielectric filter 1.

[71] Since the dielectric filter 1 may generate an independent transmission zero point by using the single resonant cavity, and may adjust the position of the transmission zero point, by adjusting the connection method between the coupling structure and the resonant cavity. Subsequently, it is convenient to combine dielectric filters 1, so as to form the cascade filter 2 with multiple transmission zero points.

[72] Specifically, the connection method of the dielectric filter 1 is to connect the metal transmission line 30 of each dielectric filter 1, while the dielectric resonant cavity 10 of each dielectric filter 1 is independent of each other. Thus, each dielectric filter 1 forming the cascade filter 2 may form the transmission zero point independently.

[73] FIG.5 is a schematic diagram illustrating structure of a cascade filter, in accordance with an embodiment of the application. FIG.6 is a waveform diagram of the cascade filter illustrated with FIG.5.

[74] Besides, as shown in FIG.5, it can be seen that, in the embodiment, the cascade filter 2 may arrange multiple dielectric filters 1 in a straight line. A convenient connection may be achieved, by arranging the end of the metal transmission line 30 at a corresponding position. Besides, the type of the dielectric filter 1 may be selected, according to requirements. For example, the number of dielectric filters 1, which generate capacitive transmission zero points and inductive transmission zero points, may be selected, based on the frequency of the transmission zero point.

[75] In FIG.5, the cascade filter 2 further includes a dual cavity filter 3, which includes a first resonant cavity 31 and a second resonant cavity 32. The first resonant cavity 31 and the second resonant cavity 31 are coupled through a window. The dual cavity filter 3 does not generate a transmission zero point, due to the limitations of the number and setting positions of the cavities.

[76] As shown in FIG.5 and FIG.6, the cascade filter 2 in FIG.5 includes three dielectric

filters generating the capacitive transmission zero point, a dielectric filter generating the inductive transmission zero point, and a dual cavity filter not generating the transmission zero point. Correspondingly, three capacitive transmission zero points are generated on the left side of the transmission channel, and one inductive transmission zero point is generated on the right side of the transmission channel.

[77] Based on comparison, it can be seen that, in the embodiment, the dielectric filter 1 and cascade filter 2 formed by the dielectric filter 1 may have the following advantages, such as, a simple structure, an independent transmission zero point without interference, and a compact layout, which are especially suitable for equipment with small space in the whole machine, and may be arranged at the long and narrow edge. When using a traditional band pass filter, in order to generate four transmission zero points as shown in FIG.6, a solution of more than four resonant cavities is needed. Besides, the arrangement of resonant cavities needs to meet the cross-coupling solution. And, it is necessary to set a cross-coupling structure between two non-adjacent resonant cavities.

[78] Based on foregoing technical solutions, it can be seen that, in the embodiment, the dielectric filter only includes one dielectric resonant cavity. The coupling method is not to establish cross-coupling between different resonant cavities, but to use a mutual coupling between such resonant cavity and a non-resonant cavity, by coupling the dielectric resonant cavity with the metal transmission line (microstrip line, etc). The metal transmission line is open at both ends to form a non-closed resonance node. A resonance peak is formed in the transmission channel, and a transmission zero point is formed on either side of the transmission channel.

[79] In the embodiment, the metal transmission line is usually a metallized line set on the surface of the circuit board, which may be formed on the same circuit board as the filter circuit of the dielectric filter, etc. That is, in the embodiment, the dielectric filter may form an independent transmission zero point, by using a dielectric resonant cavity and its auxiliary circuit, so as to optimize filtering performance of the filter. In the embodiment, the dielectric filter has a simple structure, which may implement the transmission zero point without the cross-coupling structure. Thus, the volume and structure of the dielectric filter may be simplified to a great extent. And, the whole machine space may be reasonably arranged, based on the single cavity structure

[80] Furthermore, in the embodiment, since the independent transmission zero point is generated with the single resonant cavity, the frequency and position of the transmission zero point are not affected by the characteristics of resonant cavities of other filters. Each resonant cavity may be manufactured separately, so as to improve the performance of each dielectric filter, reduce the processing accuracy requirements of each dielectric filter. Subsequently, the product performance may be improved,

while reducing costs thereof.

[81] In the embodiment, the dielectric filter and the cascade filter formed by the dielectric filter have the advantages, such as, a simple structure, an independent transmission zero point without interference, and a compact layout, which are especially suitable for equipment with small space in the whole machine, and may be arranged at the long and narrow edge.

[82] The series of detailed descriptions listed above are only specific descriptions of feasible implementations of the application, and are not intended to limit the protection scope of the application. Any equivalent implementations or changes made without departing from the technical spirit of the application, such as combination, division or repetition of features should be covered by the protection scope of the application.

Claims

[Claim 1] A dielectric filter (1), comprising a dielectric resonant cavity (10), a metal transmission line (30) and a coupling structure (40), wherein
the dielectric resonant cavity (10) comprises a dielectric body (11), and a metal plating layer (12) covering an outer surface of the dielectric body (11);
the metal transmission line (30) and the dielectric resonant cavity (10) are separated by a dielectric material; and,
the coupling structure (40) is connected between the dielectric resonant cavity (10) and the metal transmission line (30), wherein the dielectric resonant cavity (10) is coupled with the metal transmission line (30) through the coupling structure (40), so as to form a transmission zero point on either side of a transmission channel.

[Claim 2] The dielectric filter of claim 1, wherein a first end (41) of the coupling structure (40) is embedded into the dielectric body (11);
the first end (41) is not electrically connected to the metal plating layer (12) on a surface of the dielectric resonant cavity (10), so as to form a capacitive transmission zero point; or,
the first end (41) is electrically connected to the metal plating layer (12) on the surface of the dielectric resonant cavity (10), so as to form an inductive transmission zero point.

[Claim 3] The dielectric filter of claim 2, wherein the metal transmission line (30) is arranged on a side surface of the dielectric resonant cavity (10) away from a circuit board (20).

[Claim 4] The dielectric filter of claim 3, wherein a second end (42) of the coupling structure (40) penetrates the circuit board (20) from a side surface of the circuit board (20) facing the dielectric resonant cavity (10), so as to electrically connect to the metal transmission line (30).

[Claim 5] The dielectric filter of claim 4, wherein the side surface of the circuit board (20) facing the dielectric resonant cavity (10) further comprises an insulating layer (21), the insulating layer (21) surrounds the second end (42), so as to insulate the coupling structure (40) from a signal of the circuit board (20).

[Claim 6] The dielectric filter of claim 3, wherein the circuit board (20) further comprises a metal hole (22) penetrating the circuit board (20), the second end (42) of the coupling structure (40) is electrically connected to the side surface of the circuit board (20) facing the dielectric resonant cavity (10), so as to be in a signal connection with the metal transmission line (30) through the metal hole (22).

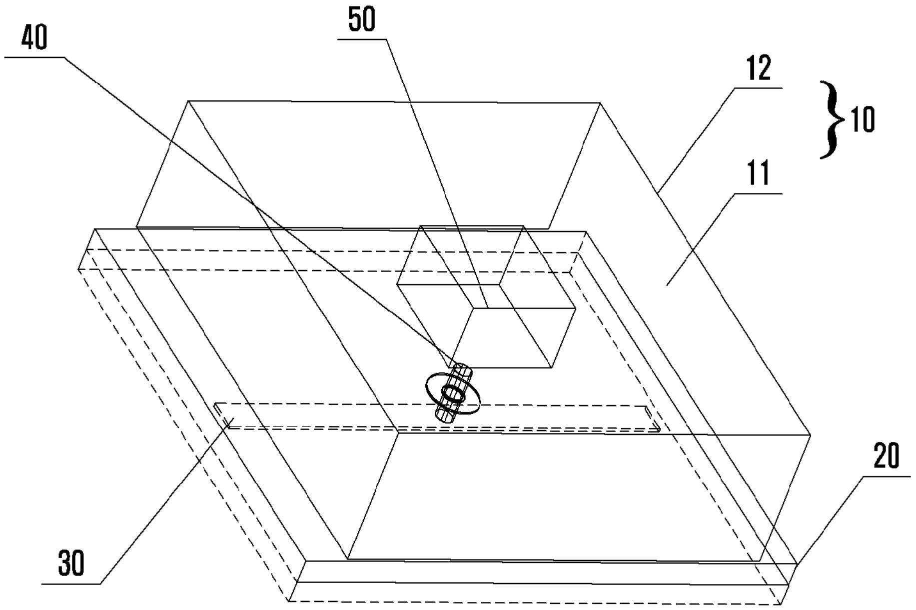
[Claim 7] The dielectric filter of claims 2 to 6, wherein the second end (42) of the coupling structure (40) is connected with a midpoint of the metal transmission line (30).

[Claim 8] The dielectric filter of claims 2 to 6, further comprising a debug hole (50), wherein the debug hole (50) is opened on a side surface of the dielectric resonant cavity (10), the debug hole (50) and the circuit board (20) are respectively located on opposite surfaces of the dielectric resonant cavity (10).

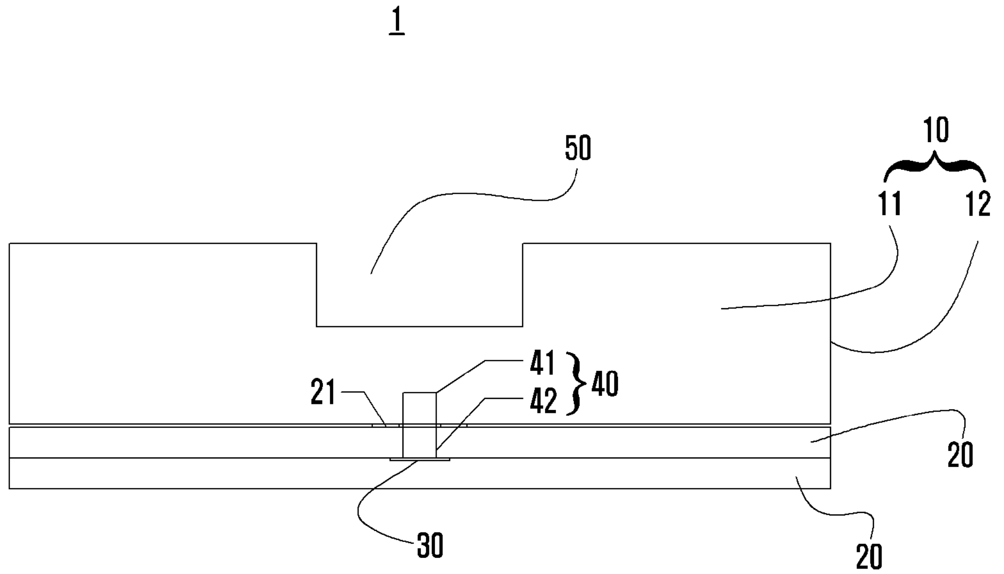
[Claim 9] The dielectric filter of claim 8, wherein the debug hole (50) is opened on a top surface of the dielectric body (11), the first end (41) of the coupling structure (40) extends into the dielectric body (11) from a bottom surface of the dielectric body (11).

[Claim 10] A cascade filter (2), comprising:
multiple dielectric filters (1) as claimed in any of claims 1 to 9;
wherein the dielectric resonant cavities of multiple dielectric filters (1) are arranged at intervals along a straight line, one end or both ends of a metal transmission line (30) of each dielectric filter (1) is electrically connected with a metal transmission line (30) of other dielectric filters (1), so as to form multiple transmission zero points, the number of transmission zero points of the cascade filter (2) corresponds to the number of transmission zero points of the dielectric filter (1).

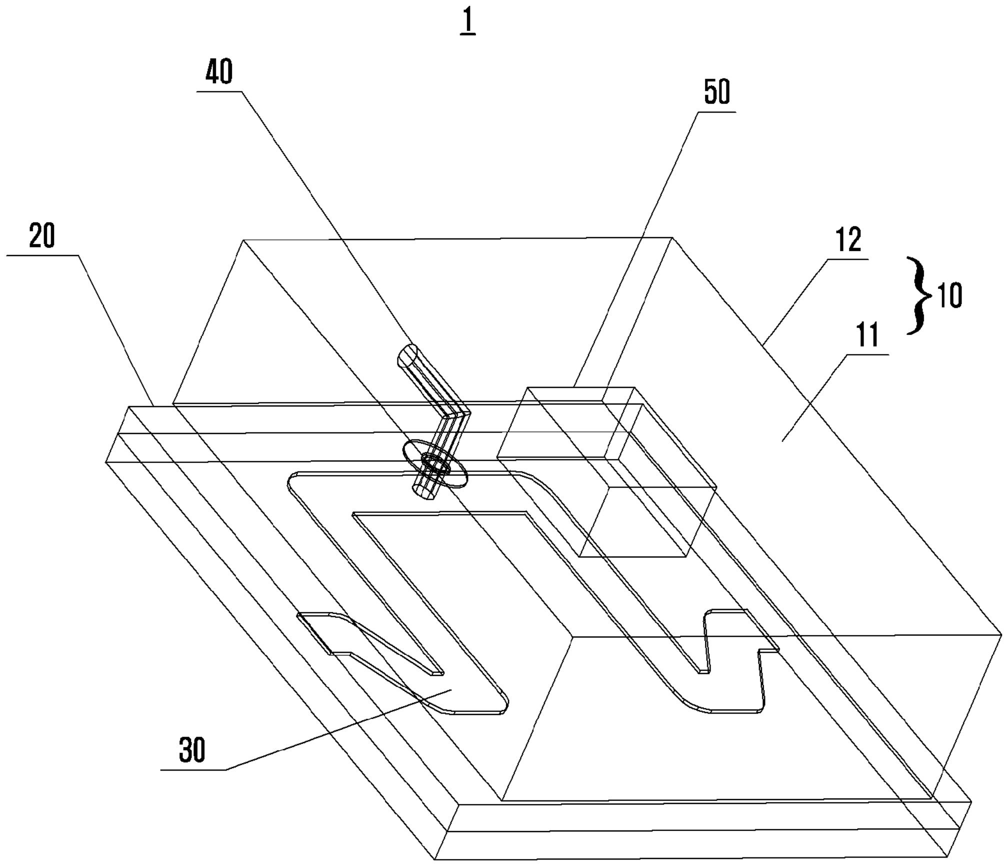
[Fig. 1]



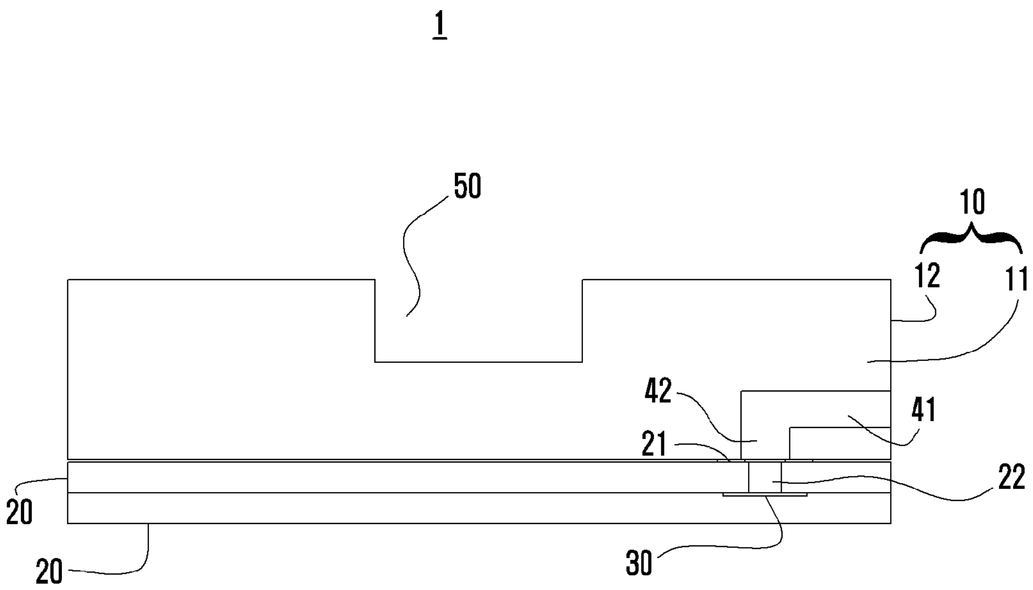
[Fig. 2]



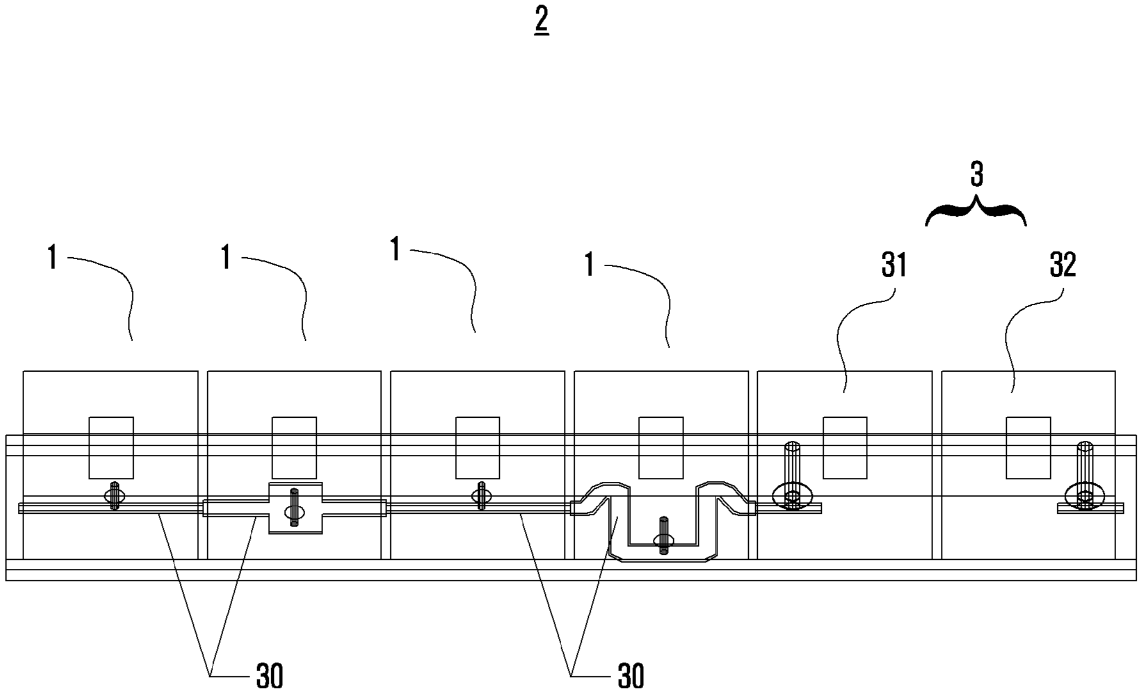
[Fig. 3]



[Fig. 4]



[Fig. 5]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31
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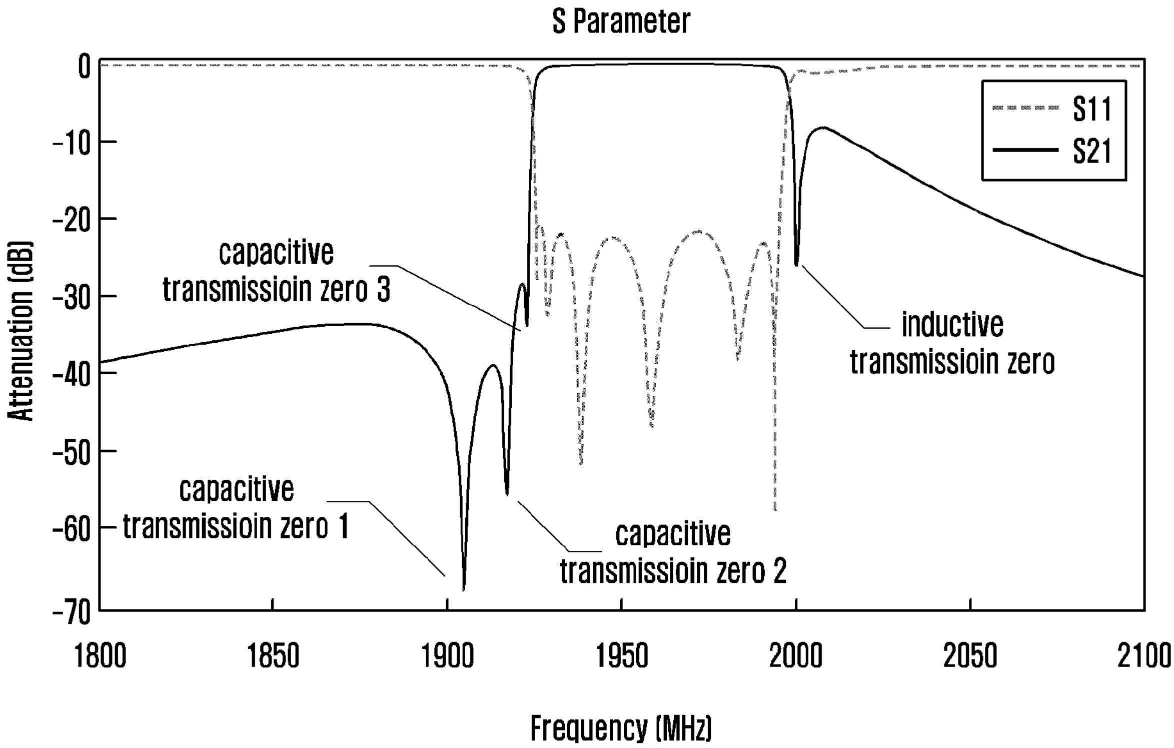
30

[Fig. 6]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-20
-30
-40
-50
-60
-70
Attenuation (dB)
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S21
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transmissioin zero 3
inductive
transmissioin zero
capacitive
transmissioin zero 1
capacitive
transmissioin zero 2
1800
1850
1900
1950
2000
2050
2100
Frequency (MHz)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2021/010712

A. CLASSIFICATION OF SUBJECT MATTER

H01P 1/20(2006.01)i; **H01P 7/10**(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 1/20(2006.01); H01P 1/208(2006.01); H01P 11/00(2006.01); H04B 1/38(2006.01)

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

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & keywords: dielectric filter, dielectric resonant cavity, metal transmission line, coupling structure, transmission zero point

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2013-0053104 A1 (DAVID ROBERT HENDRY et al.) 28 February 2013 (2013-02-28) paragraphs [0068]-[0090]; and figures 1A-1E	1-10
A	CN 110739510 A (MOBI TECHNOLOGY (SHENZHEN) CO., LTD. et al.) 31 January 2020 (2020-01-31) paragraphs [0026]-[0041]; and figure 1	1-10
A	CN 108183292 A (CHENGDU HUAWEI TECHNOLOGIES CO., LTD.) 19 June 2018 (2018-06-19) paragraphs [0060]-[0063]; and figure 11	1-10
A	CN 111384555 A (SHENZHEN TATFOOK TECHNOLOGY CO., LTD.) 07 July 2020 (2020-07-07) paragraphs [0027]-[0035]; and figure 1	1-10
A	CN 210074110 U (SUZHOU JIEPIN ELECTRONIC TECHNOLOGY CO., LTD.) 14 February 2020 (2020-02-14) paragraphs [0042]-[0049]; and figure 2	1-10

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

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- "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
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- "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
11 November 2021	**12 November 2021**

Name and mailing address of the ISA/KR	Authorized officer
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2021/010712

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