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(54) **MICROSTRIP ANTENNA**

(57) A microstrip antenna (100) includes an insulating carrier (1), a circular body (2), two circular feeding points (3), a grounding element (4), and a power divider (6). The circular body (2) has a first center (C1) and a radius (R). The two circular feeding points (3) are surrounded by the circular body (2) and are not connected. The two circular feeding points (3) can produce a capacitive effect with the circular body (2). Each of the two

circular feeding points (3) has a second center (C2), and a shortest distance (T1) between the second center (C2) and the first center (C1) is less than 1/2 of the radius (R). The grounding element (4) is disposed on the insulating carrier (1). The power divider (6) can generate a phase difference of 90 degrees between the two circular feeding points (3).

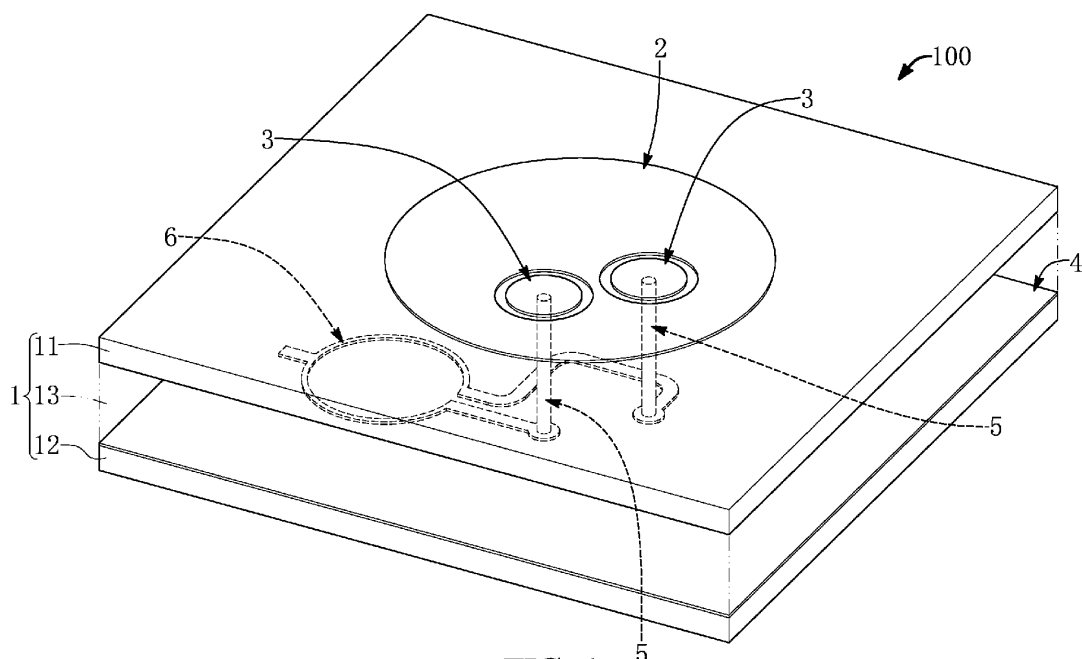


FIG. 1

Description

FIELD OF THE DISCLOSURE

[0001] The present disclosure relates to an antenna, and more particularly to a microstrip antenna.

BACKGROUND OF THE DISCLOSURE

[0002] Since microstrip antennas can be printed directly on a circuit board and are low in cost, microstrip antennas are widely used in electronic products (e.g., mobile phones). In order to optimize an operation of a conventional dual-feed microstrip antenna (e.g., to avoid interference from components within the electronic product), the conventional dual-feed microstrip antenna is designed with factors such as isolation and axial ratio in mind. However, since the development of the conventional dual-feed microstrip antenna has reached maturity, it is difficult for the conventional dual-feed microstrip antenna to provide better isolation and a reduced axial ratio.

SUMMARY OF THE DISCLOSURE

[0003] In response to the above-referenced technical inadequacy, the present disclosure provides a microstrip antenna.

[0004] In order to solve the above-mentioned problems, one of the technical aspects adopted by the present disclosure is to provide a microstrip antenna. The microstrip antenna includes an insulating carrier, a circular body, two circular feeding points, a grounding element, and a power divider. The circular body is disposed on the insulating carrier. The circular body has a first center and a radius. The two circular feeding points are surrounded by the circular body and are not connected to each other, and the two circular feeding points are configured to produce a capacitive effect with the circular body. Each of the two circular feeding points has a second center, and a shortest distance between the second center and the first center is less than $1/2$ of the radius of the circular body. The grounding element is disposed on the insulating carrier. The power divider is electrically coupled to the two circular feeding points. The power divider is configured to generate a phase difference of 90 degrees between the two circular feeding points.

[0005] In one of the possible or preferred embodiments, the insulating carrier includes a first layer, a second layer and at least one interlayer that is located between the first layer and the second layer. The circular body is disposed on the first layer, the power divider is disposed on the second layer, and the grounding element is disposed on the second layer or the at least one interlayer.

[0006] In one of the possible or preferred embodiments, each of the first layer and the second layer is a circuit board, and the at least one interlayer is an air medium.

[0007] In one of the possible or preferred embodiments, each of the first layer and the second layer and the at least one interlayer is a circuit board.

[0008] In one of the possible or preferred embodiments, the at least one interlayer has two through holes, and each of the four microstrip antennas includes two conductive posts. The two conductive posts pass through the two through holes, so that two ends of each of the two conductive posts are electrically coupled to the power divider and one of the two circular feeding points.

[0009] In one of the possible or preferred embodiments, a first extension line is configured to pass through the second center of one of the two circular feeding points and the first center of the circular body, a second extension line is configured to pass through the second center of another of the two circular feeding points and the first center of the circular body, and the first extension line and the second extension line have a 90 degree angle there-between.

[0010] In one of the possible or preferred embodiments, an area of each of the two circular feeding points is less than or equal to $1/4$ of an area of the circular body.

[0011] Therefore, in the microstrip antenna provided by the present disclosure, by virtue of "the two circular feeding points being configured to produce a capacitive effect with the circular body," and "each of the two circular feeding points having a second center, and a shortest distance between the second center and the first center being less than $1/2$ of the radius," the microstrip antenna can effectively have both an improved isolation and a reduced the axial ratio.

[0012] These and other aspects of the present disclosure will become apparent from the following description of the embodiment taken in conjunction with the following drawings and their captions, although variations and modifications therein may be affected without departing from the spirit and scope of the novel concepts of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The described embodiments may be better understood by reference to the following description and the accompanying drawings, in which:

FIG. 1 is a schematic perspective view of an antenna array according to a first embodiment of the present disclosure;

FIG. 2 is another schematic perspective view of the antenna array according to the first embodiment of the present disclosure;

FIG. 3 is a schematic top view of the antenna array according to the first embodiment of the present disclosure;

FIG. 4 is a schematic bottom view of the antenna array according to the first embodiment of the present disclosure;

FIG. 5 is a schematic cross-sectional view taken

along line V-V of FIG. 3;

FIG. 6 is a diagram of axial ratio data of the antenna array according to the first embodiment of the present disclosure;

FIG. 7 is a diagram of peak gain data of the antenna array according to the first embodiment of the present disclosure;

FIG. 8 is a schematic cross-sectional view of the antenna array according to a second embodiment of the present disclosure;

FIG. 9 is a schematic top view of the antenna array according to a third embodiment of the present disclosure;

FIG. 10 is a schematic bottom view of the antenna array according to the third embodiment of the present disclosure; and

FIG. 11 is a schematic view showing a circuit being connected to the antenna array according to the third embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

[0014] The present disclosure is more particularly described in the following examples that are intended as illustrative only since numerous modifications and variations therein will be apparent to those skilled in the art. Like numbers in the drawings indicate like components throughout the views. As used in the description herein and throughout the claims that follow, unless the context clearly dictates otherwise, the meaning of "a," "an" and "the" includes plural reference, and the meaning of "in" includes "in" and "on." Titles or subtitles can be used herein for the convenience of a reader, which shall have no influence on the scope of the present disclosure.

[0015] The terms used herein generally have their ordinary meanings in the art. In the case of conflict, the present document, including any definitions given herein, will prevail. The same thing can be expressed in more than one way. Alternative language and synonyms can be used for any term(s) discussed herein, and no special significance is to be placed upon whether a term is elaborated or discussed herein. A recital of one or more synonyms does not exclude the use of other synonyms. The use of examples anywhere in this specification including examples of any terms is illustrative only, and in no way limits the scope and meaning of the present disclosure or of any exemplified term. Likewise, the present disclosure is not limited to various embodiments given herein. Numbering terms such as "first," "second" or "third" can be used to describe various components, signals or the like, which are for distinguishing one component/signal from another one only, and are not intended to, nor should be construed to impose any substantive limitations on the components, signals or the like.

[First Embodiment]

[0016] Referring to FIG. 1 to FIG. 7, a first embodiment of the present disclosure provides a microstrip antenna 100 that is suitable for a broadband. As shown in FIG. 1 and FIG. 2, the microstrip antenna 100 includes an insulating carrier 1, a circular body 2, two circular feeding points 3, a grounding element 4, and two conductive posts 5 disposed on the insulating carrier 1, and a power divider that is electrically coupled to the two circular feed points 3. The following description describes the structure and connection relationship of each component of the microstrip antenna 100.

[0017] Referring to FIG. 1, FIG. 2, and FIG. 5, the insulating carrier 1 in the present embodiment is a printed circuit board with a multilayer structure, and the insulating carrier 1 includes a first layer 11, a second layer 12, and an interlayer 13 that is located between the first layer 11 and the second layer 12.

[0018] In a practical application, the first layer 11 and the second layer 12 may be physical components (e.g., circuit boards), and the first layer 11 and the second layer 12 can be supported by an insulating support (not shown), so that the first layer 11 and the second layer 12 are spaced apart from each other to have the interlayer 13 as an air medium.

[0019] Referring to FIG. 1, FIG. 3, and FIG. 5, the circular body 2 in the present embodiment is a conductive material that is in a shape of a sheet (e.g., a copper foil). The circular body 2 is disposed on a side of the first layer 11 away from the second layer 12, and the circular body 2 has a first center C1 and a radius R.

[0020] In addition, the circular body 2 also has two circular through holes H21, and a part of the first layer 11 can be exposed from the two circular through holes H21. Areas of the two circular through holes H21 must be greater than areas of the two circular feeding points 3, so that the two circular through holes H21 can be respectively used to accommodate the two circular feeding points 3. Moreover, the two circular feeding points 3 are respectively arranged at central regions of the two circular through holes H21, so that the two circular feeding points 3 are surrounded by the circular body 2 and are not connected, and the two circular feeding points 3 can produce a capacitive effect with the circular body 2.

[0021] It should be noted that each of the two circular feeding points 3 in the present embodiment is also a conductive material that is in the shape of a sheet (e.g., a copper foil). In order to ensure that an isolation of the capacitive effect can be improved and an axial ratio of the capacitive effect can be reduced, a positional relationship between the two circular feeding points 3 and the circular main body 2 is particularly important. Specifically, each of the circular feeding points 3 has a second center C2, and the second center C2 of each of the two circular feeding points 3 and the first center C1 of the circular body 2 have a shortest distance T1 therebetween that is preferably less than 1/2 of the radius R. In

other words, positions of the two circular feeding points 3 are adjacent to the center of the circular body 2.

[0022] In a preferred implementation, an area of each of the two circular feeding point 3 is preferably less than or equal to 1/4 of an area of the circular body 2, so as to ensure that the capacitive effect between the two circular feeding points 3 and the circular body 2 is appropriate. Furthermore, a first extension line L1 can pass through the second center C2 of one of the two circular feeding points 3 and the first center C1 of the circular body 2, a second extension line L2 can pass through the second center C2 of another of the two circular feeding points 3 and the first center C1 of the circular body 2, and the first extension line L1 and the second extension line L2 have a 90 degree angle there-between.

[0023] Referring to FIG. 1 and FIG. 5, the two conductive posts 5 in the present embodiment are cylindrical structures, and the two conductive posts 5 are installed between the first layer 11 and the second layer 12. The two conductive posts 5 correspond in position to the two circular feeding points 3, one of two ends of the two conductive posts 5 can pass through the first layer 11 to electrically couple to the two circular feeding points 3, and another of the two ends of the two conductive posts 5 can pass through the second layer 12 to electrically couple to the power divider 6.

[0024] The grounding element 4 in the present embodiment is also a conductive material that is in the shape of a sheet (e.g., a copper foil), and the grounding element 4 is disposed on a side of the second layer 12 facing the first layer 11. The grounding member 4 has two avoidance holes H4, and the two avoidance holes H4 correspond in position to the two conductive posts 5, so that the grounding element 4 does not connected to the two conductive posts 5. In addition, the ground element 4 may preferably completely cover the side of the second layer 12 facing the first layer 11, but the present disclosure is not limited thereto.

[0025] Referring to FIG. 2, FIG. 4, and FIG. 5, the power divider 6 in the present embodiment may be a Wilkinson power divider, and can be used to receive signals from a beamforming integrated circuit (i.e., BFIC). The power divider 6 is disposed on the side of the second layer 12 away from the first layer 11, and the power divider 6 can be electrically coupled to the two circular feeding points 3 by another of the two ends of the two conductive posts 5, so as to generate a phase difference of 90 degrees between the two circular feeding points 3. Accordingly, the microstrip antenna 100 can generate a circularly polarized field pattern, and can also cooperate with the beamforming integrated circuit to realize beam control.

[0026] It should be noted that, FIG. 6 is a diagram of axial ratio data of the antenna array according to the first embodiment of the present disclosure, and

[0027] FIG. 7 is a diagram of peak gain data of the antenna array according to the first embodiment of the present disclosure. It can be known from the axial ratio

data that when the microstrip antenna 100 is within a range from 10.6 MHz to 14 MHz, an axial ratio of the microstrip antenna 100 can be less than 3dB. In addition, when the microstrip antenna 100 is within a range from 11.6 MHz to 13.6 MHz, the axial ratio of the microstrip antenna 100 can be less than 1.2 dB. Moreover, it can be known from the peak gain data that when the microstrip antenna 100 is within a range from 10.9 MHz to 13 MHz, a peak gain of the microstrip antenna 100 can be greater than 2dB. In other words, the microstrip antenna 100 of the present disclosure not only has an advantage of low axial ratio, but also has an effect of increasing the gain value.

15 [Second Embodiment]

[0028] Referring to FIG. 8, the second embodiment provides a microstrip antenna 100'. The present embodiment is similar to the first embodiment, and the similarities therebetween will not be repeated herein. The main differences between the present embodiment and the first embodiment are described as follows.

[0029] As shown in FIG. 8, each of the first layer 11, the second layer 12 and the interlayer 13 in the present embodiment is a circuit board, and the grounding element 4 is disposed on a surface of the interlayer 13 facing the first layer 11. In addition, the interlayer 13 also has two through holes H13, and the two through holes H13 correspond in position to the two conductive posts 5, so that the two conductive posts 5 can penetrate the interlayer 13. Each of the conductive posts 5 in the present embodiment may also be a via hole, but the present disclosure is not limited thereto.

[0030] Accordingly, when the interlayer 13 is a (high-frequency) circuit board, the interlayer 13 can be used as a power supply and a control circuit. In addition, the microstrip antenna 100' of the present embodiment is directly formed by stacking multiple circuits during a manufacturing process, so that the microstrip antenna 100' can also be more convenient to manufacture than the microstrip antenna 100 of the first embodiment (especially, a manufacture of an array antenna).

[0031] In addition, it should be noted that, in another embodiment of the present disclosure (not shown), the insulating carrier 1 may also include a plurality of interlayers 13 and a plurality of grounding elements 4, a part of the interlayers 13 may be a circuit board, and another part of the interlayers 13 may be an air medium. The grounding elements 4 are disposed on the interlayers 13 that are the circuit boards.

[0032] Naturally, the interlayers 13 may all be circuit boards, but the present disclosure is not limited thereto. In other words, the quantity of the interlayer 13 of the insulating carrier 1 and the ground member 4 may be at least one.

[Third Embodiment]

[0033] Referring to FIG. 9 to FIG. 11, a third embodiment of the present disclosure provides an antenna array 1000, and the antenna array 1000 includes a common carrier SC and four microstrip antennas 100" disposed on the common carrier SC. The following description describes the structure and connection relation of each component of the antenna array 1000.

[0034] Referring to FIG. 9 and FIG. 10, the common carrier SC including a first plate surface S 1 and a second plate surface S2 opposite to each other, and the common carrier SC has a first direction D1 and a second direction D2 that is perpendicular to the first direction D1. In the present embodiment, the common carrier SC can be exemplified to be a plurality of insulating carriers 1 of the first embodiment or the second embodiment. That is to say, the common carrier SC of the present embodiment is similar to the insulating carriers 1 of the first embodiment or the second embodiment, and the similarities between the present embodiment and the first embodiment or the second embodiment will not be repeated herein.

[0035] In other words, the common carrier SC also includes the first layer 11, the second layer 12, and the interlayer 13 between the first layer 11 and the second layer 12 (as shown in FIG. 5 or FIG. 8). The surface of the first layer 11 that is away from the second layer 12 is defined as the first plate surface S1, and the surface of the second layer 12 that is away from the first layer 11 is defined as the second plate surface S2.

[0036] Referring to FIG. 9 and FIG. 10, each of the four microstrip antennas 100" in the present embodiment can be exemplified to be the microstrip antennas 100, 100' of the first embodiment or the second embodiment. That is to say, each of the four microstrip antennas 100" of the present embodiment is similar to the microstrip antennas 100, 100' of the first embodiment or the second embodiment, and the similarities between the present embodiment and the first embodiment or the second embodiment will not be repeated herein. For convenience of description, the circular body 2 and the two circular feeding points 3 of each of the four microstrip antennas 100" can be further defined as an antenna structure AS.

[0037] It should be noted that, in order to reduce an area that is occupied by a circuit 200 connected to the four microstrip antennas 100" on the common carrier SC (as shown in FIG. 11), the four microstrip antennas 100" can be configured in a manner described below.

[0038] Specifically, the four microstrip antennas 100" are spaced apart from each other on the common carrier SC, and the four microstrip antennas 100" are arranged in a matrix along the first direction D1 and the second direction D2. In addition, in the first plate surface S1, any two adjacent ones of the antenna structures AS

along the second direction D2 have a two-fold rotational symmetry relationship. In the second plate surface S2, any two adjacent ones of the power dividers 6 along the first direction D1 or the second direction D2 have a mirror symmetrical relationship.

[0039] For example, as shown in FIG. 9, the first plate surface S1 has a first centerline CL1 parallel to the second direction D2. The first plate surface S1 has a first rotation point CP1 between two microstrip antennas 100" in a first column CO1, and the first centerline CL1 (and a connecting line of the centers of two circular bodies 2) passes through the first rotation point CP1. Moreover, the first plate surface S1 also has a second rotation point CP2 between two microstrip antennas 100" in a second column CO2, and the first centerline CL1 (and a connecting line of the centers of two circular bodies 2) passes through the second rotation point CP2.

[0040] When the two circular feeding points 3 of the two microstrip antennas 100" in a first row RO1 respectively rotate 180 degrees with the first rotation point CP1 and the second rotation point CP2, the two circular feeding points 3 of the two microstrip antennas 100" in the first row RO1 can be overlapped with the two circular feeding points 3 of the two microstrip antennas 100" in a second row RO2.

[0041] Furthermore, as shown in FIG. 10, the second plate surface S2 has two second centerline CL2 parallel to the first direction D1 and the second direction D2. The two power dividers 6 in the first row RO1 and the two power dividers 6 in the second row RO2 are arranged symmetrically with one of the two second center line CL2 parallel to the second direction D2 as the axis of symmetry, and the two power dividers 6 in the first column CO1 and the two power dividers 6 in the second column CO2 are arranged symmetrically with one of the two second center line CL2 parallel to the first direction D1 as the axis of symmetry.

[0042] Naturally, in another embodiment of the present disclosure (not shown), the antenna array 1000 may include a 4M number of microstrip antennas 100", where M is a positive integer.

[Beneficial Effects of the Embodiments]

[0043] In conclusion, in the microstrip antenna provided by the present disclosure, by virtue of "the two circular feeding points being configured to produce a capacitive effect with the circular body," and "each of the two circular feeding points having a second center, and a shortest distance between the second center and the first center being less than 1/2 of the radius," the microstrip antenna can effectively have both an improved isolation and a reduced the axial ratio.

[0044] The foregoing description of the exemplary embodiments of the disclosure has been presented only for the purposes of illustration and description and is not intended to be exhaustive or to limit the disclosure to the precise forms disclosed. Many modifications and varia-

tions are possible in light of the above teaching.

[0045] The embodiments were chosen and described in order to explain the principles of the disclosure and their practical application so as to enable others skilled in the art to utilize the disclosure and various embodiments and with various modifications as are suited to the particular use contemplated. Alternative embodiments will become apparent to those skilled in the art to which the present disclosure pertains without departing from its spirit and scope.

Claims

1. A microstrip antenna (100), **characterized by** comprising:

an insulating carrier (1);
 a circular body (2) disposed on the insulating carrier (1), wherein the circular body (2) has a first center (C1) and a radius (R);
 two circular feeding points (3), wherein the two circular feeding points (3) are surrounded by the circular body (2) and are not connected to each other, and the two circular feeding points (3) are configured to produce a capacitive effect with the circular body (2), wherein each of the two circular feeding points (3) has a second center (C2), and a shortest distance (T1) between the second center (C2) and the first center (C1) is less than 1/2 of the radius (R) of the circular body (2);
 a grounding element (4) disposed on the insulating carrier (1); and
 a power divider (6) electrically coupled to the two circular feeding points (3), wherein the power divider (6) is configured to generate a phase difference of 90 degrees between the two circular feeding points (3).

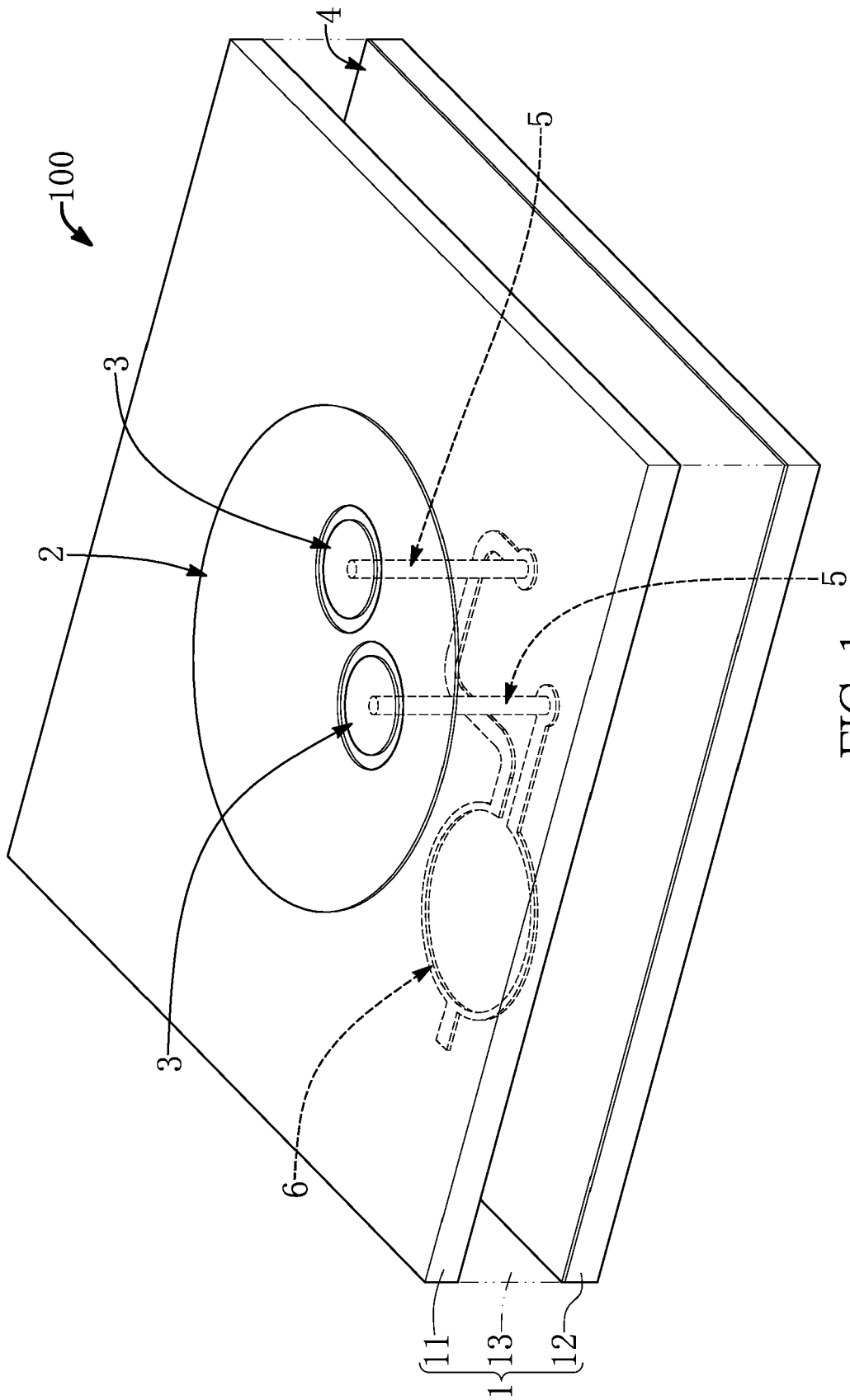
2. The microstrip antenna (100) according to claim 1, wherein the insulating carrier (1) includes a first layer (11), a second layer (12), and at least one interlayer (13) that is located between the first layer (11) and the second layer (12), wherein the circular body (2) is disposed on the first layer (11), the power divider (6) is disposed on the second layer (12), and the grounding element (4) is disposed on the second layer (12) or the at least one interlayer (13).

3. The microstrip antenna (100) according to claim 2, wherein each of the first layer (11) and the second layer (12) is a circuit board, and the at least one interlayer (13) is an air medium.

4. The microstrip antenna (100) according to claim 2, wherein each of the first layer (11) and the second layer (12) and the at least one interlayer (13) is a

circuit board.

5. The microstrip antenna (100) according to claim 4, wherein the at least one interlayer (13) has two through holes (H13), and the microstrip antenna (100) includes two conductive posts (5), wherein the two conductive posts (5) pass through the two through holes (H13), so that two ends of each of the two conductive posts (5) are electrically coupled to the power divider (6) and one of the two circular feeding points (3).
6. The microstrip antenna (100) according to claim 1, wherein a first extension line (L1) is configured to pass through the second center (C2) of one of the two circular feeding points (3) and the first center (C1) of the circular body (2), a second extension line (L2) is configured to pass through the second center (C2) of another of the two circular feeding points (3) and the first center (C1) of the circular body (2), and the first extension line (L1) and the second extension line (L2) have a 90 degree angle there-between.
7. The microstrip antenna (100) according to claim 1, wherein an area of each of the two circular feeding points (3) is less than or equal to 1/4 of an area of the circular body (2).



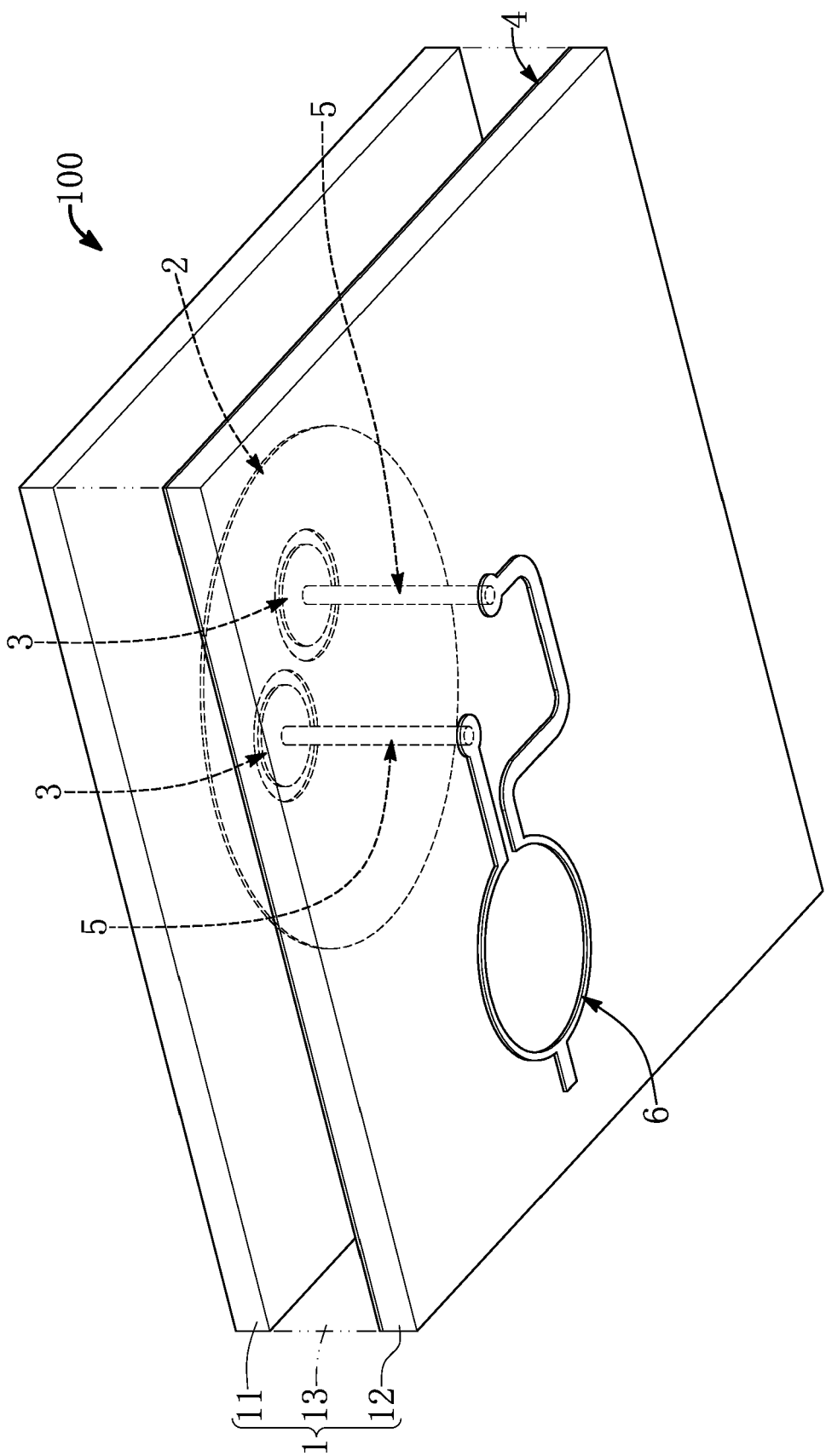


FIG. 2

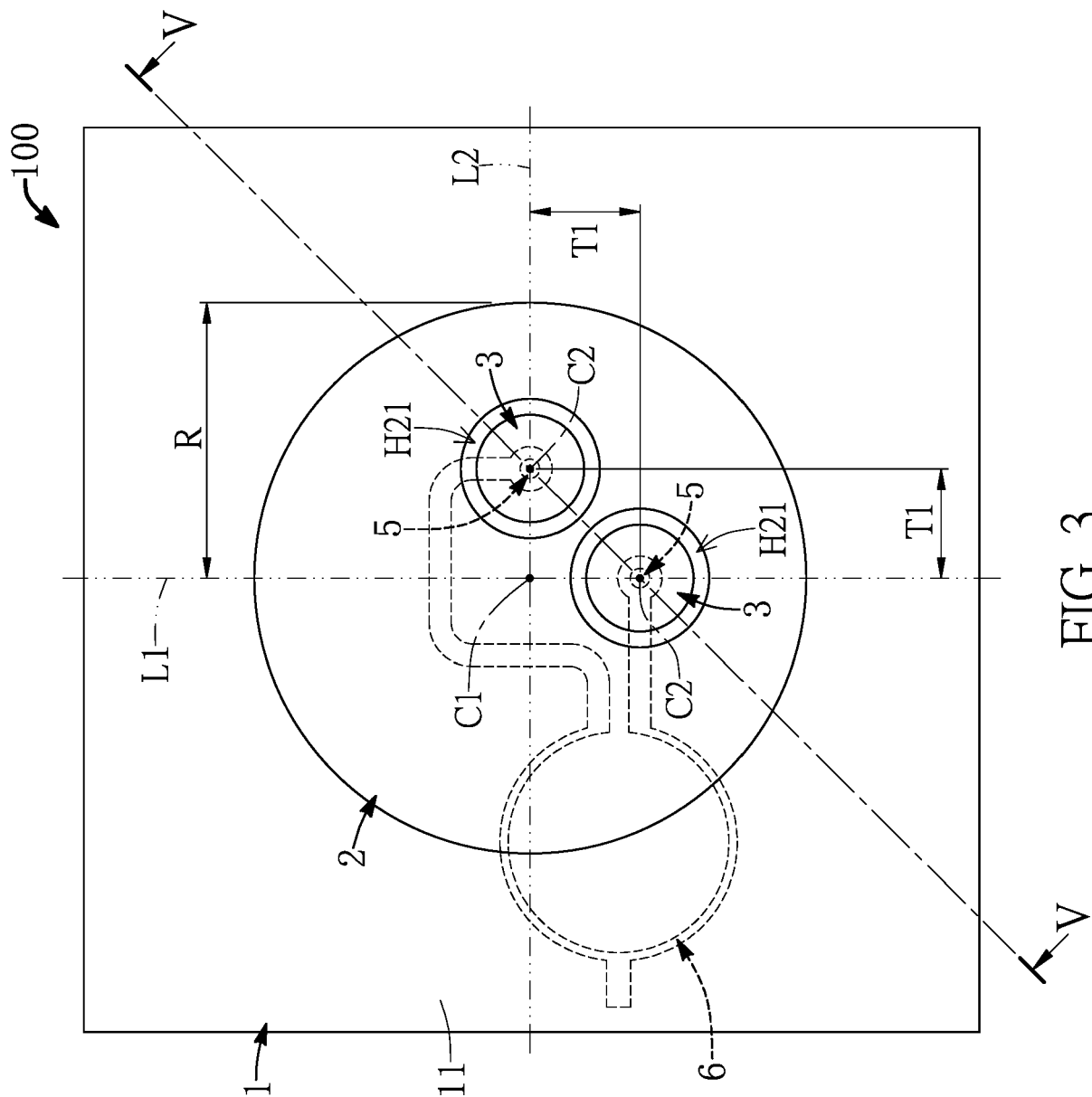


FIG. 3

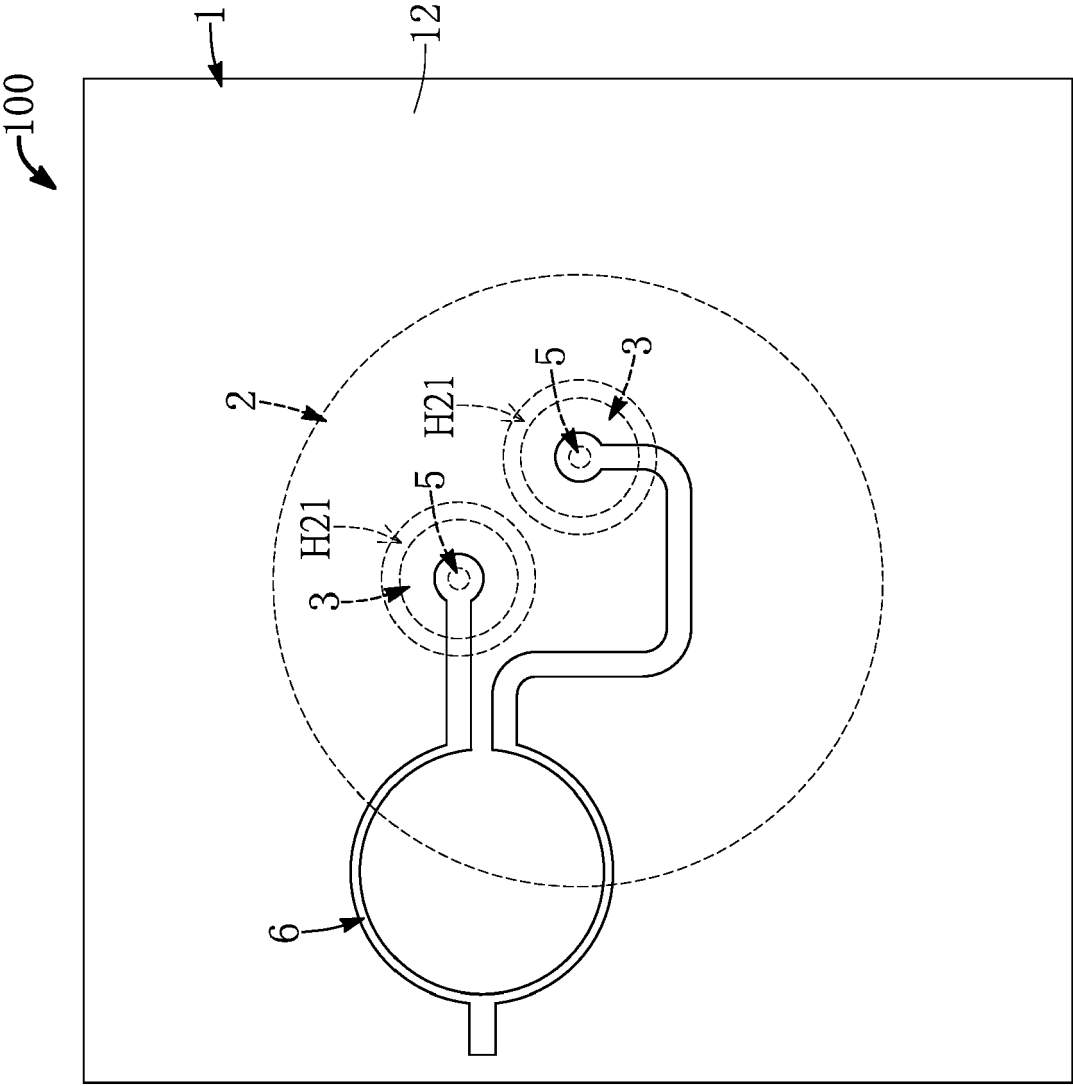


FIG. 4

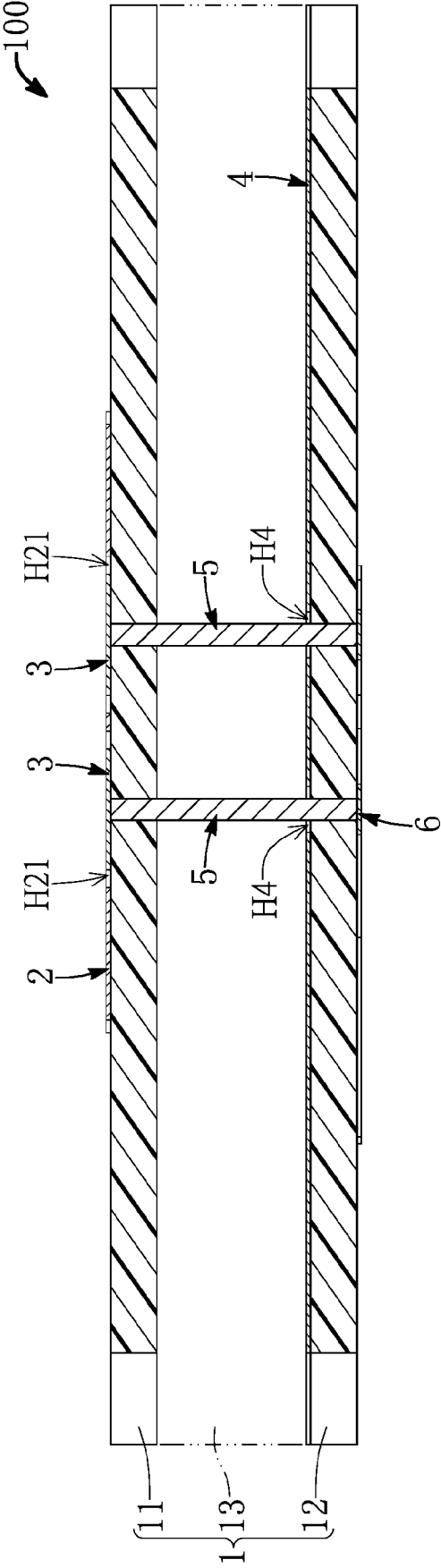


FIG. 5

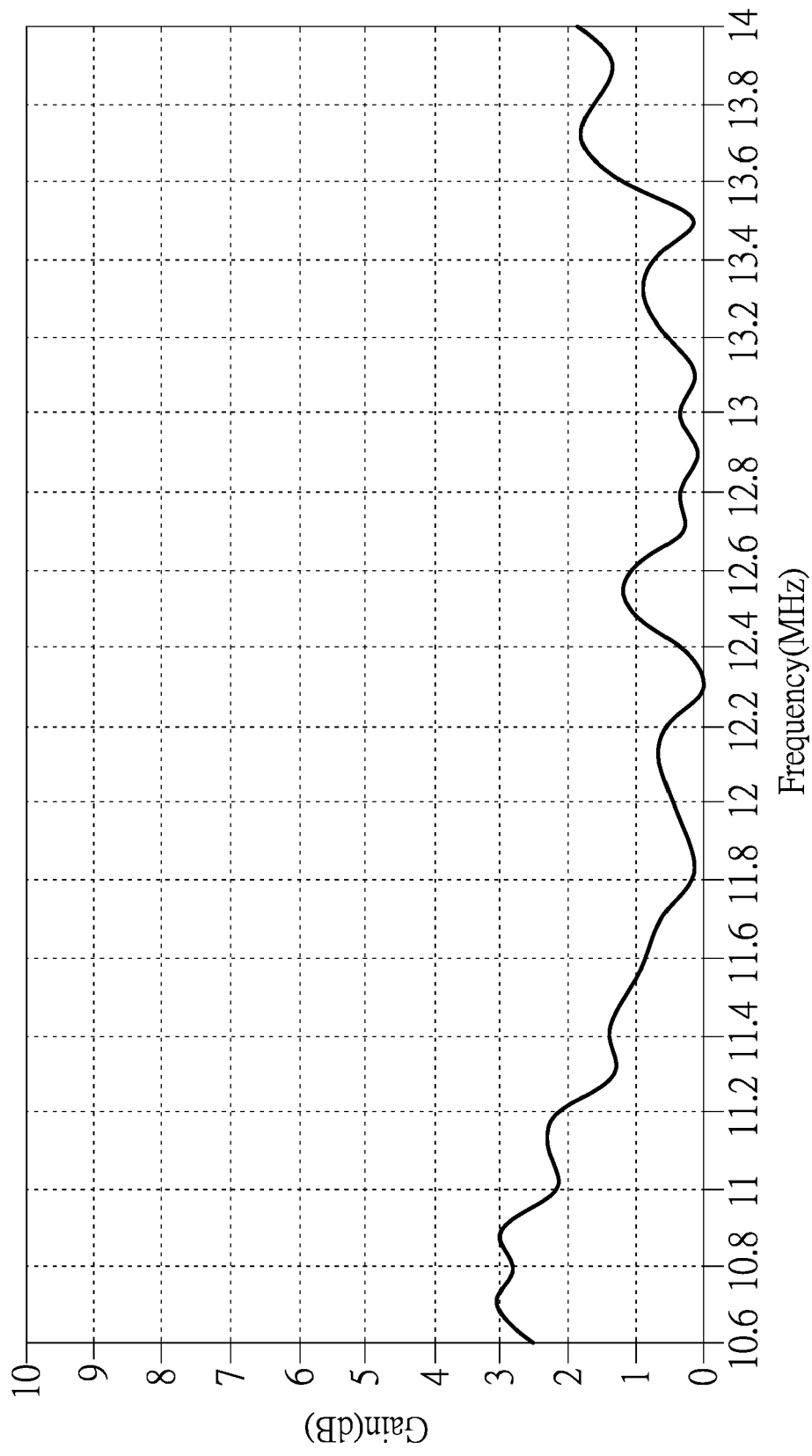


FIG. 6

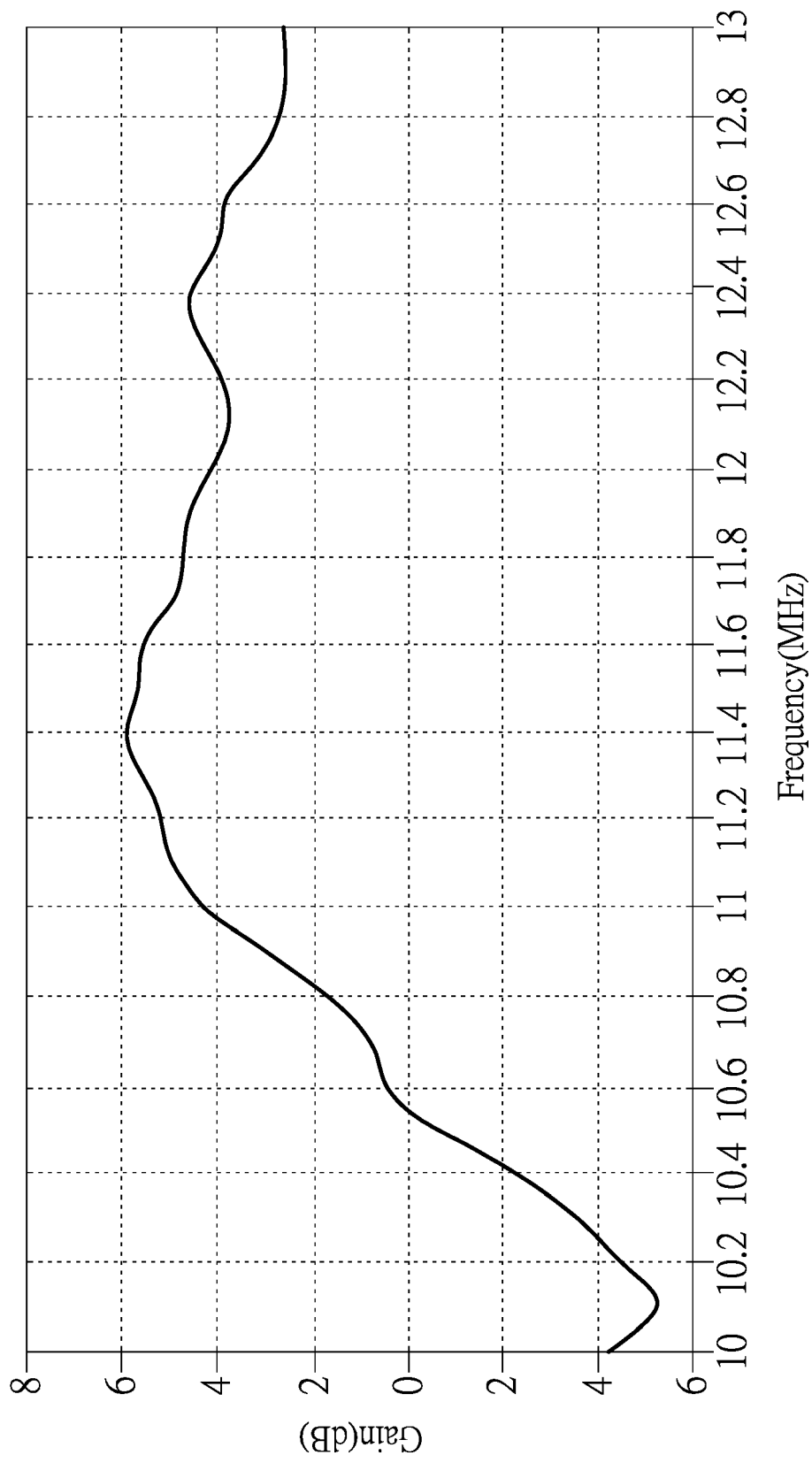


FIG. 7

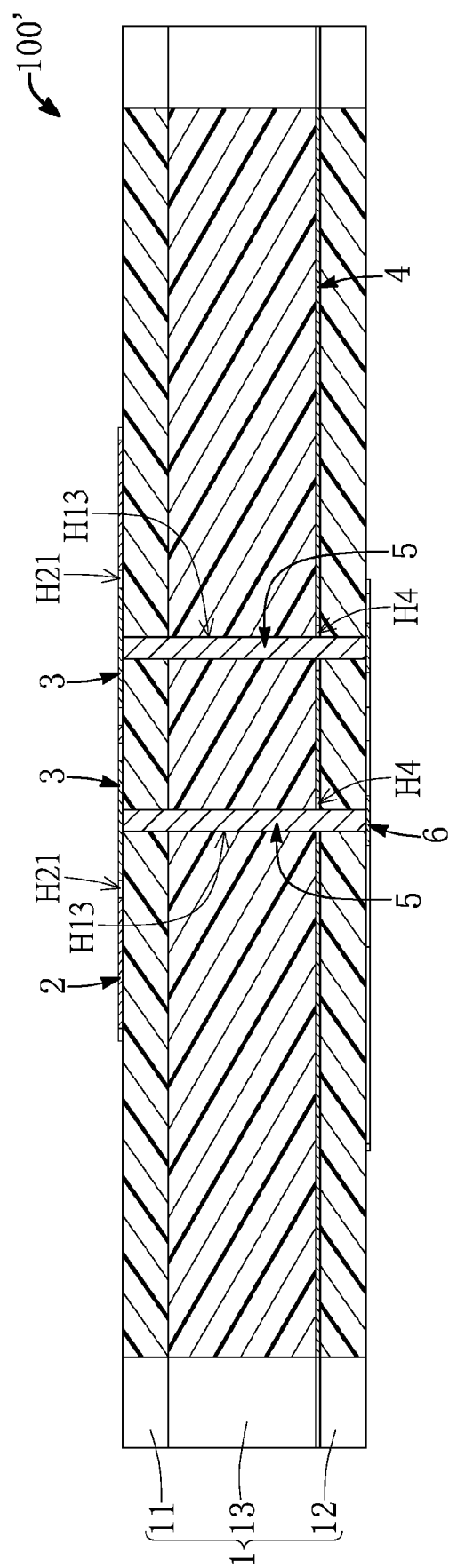


FIG. 8

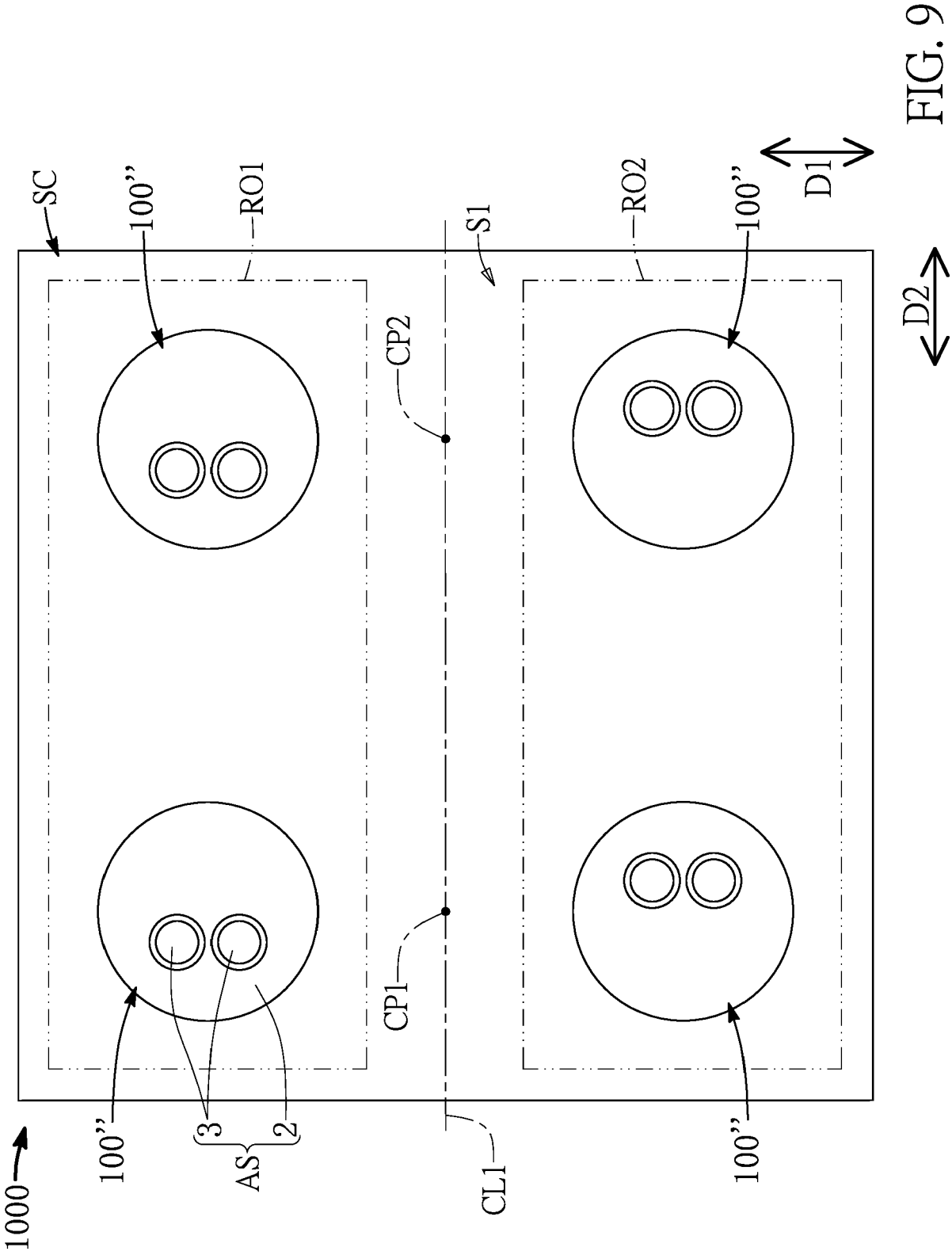
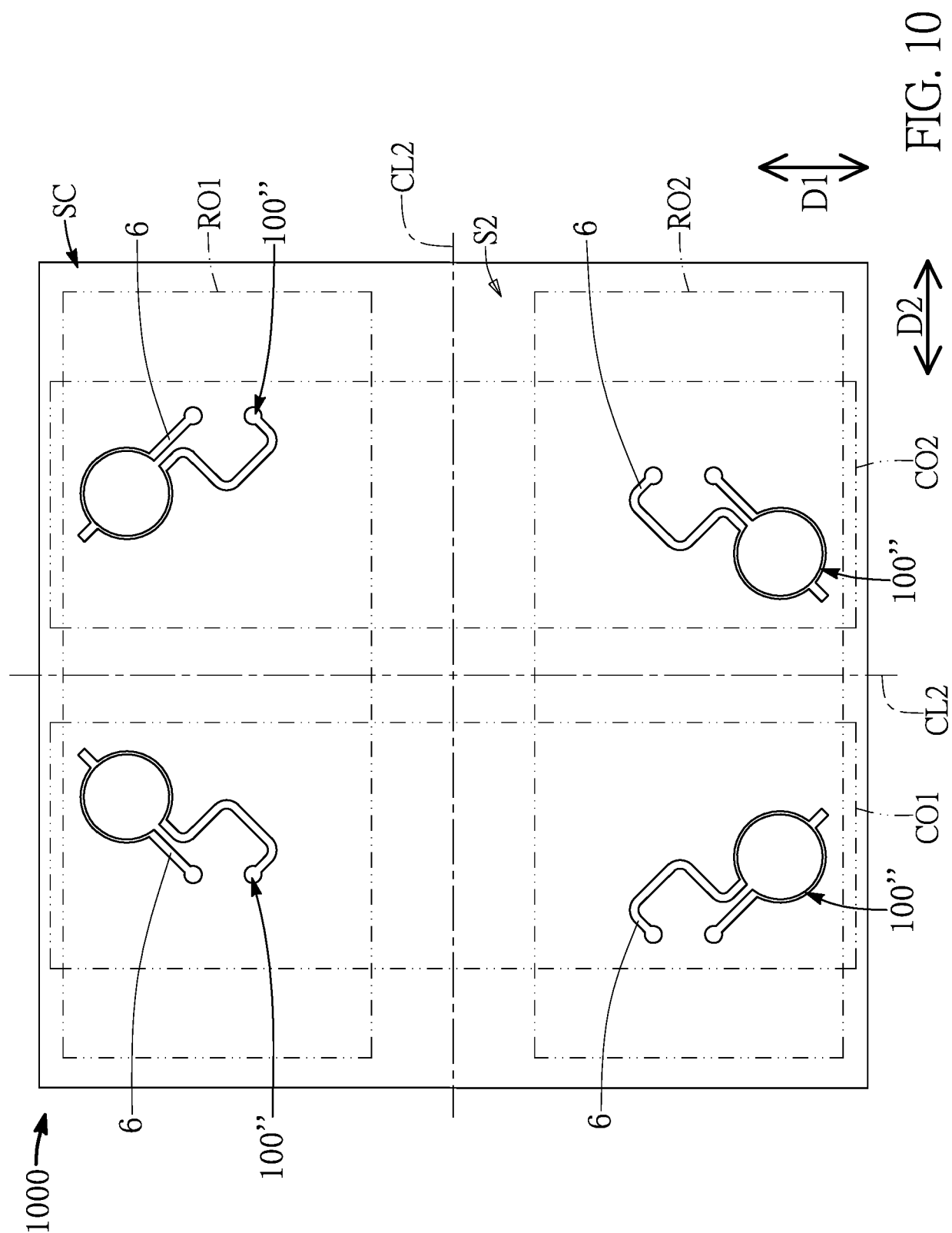


FIG. 9



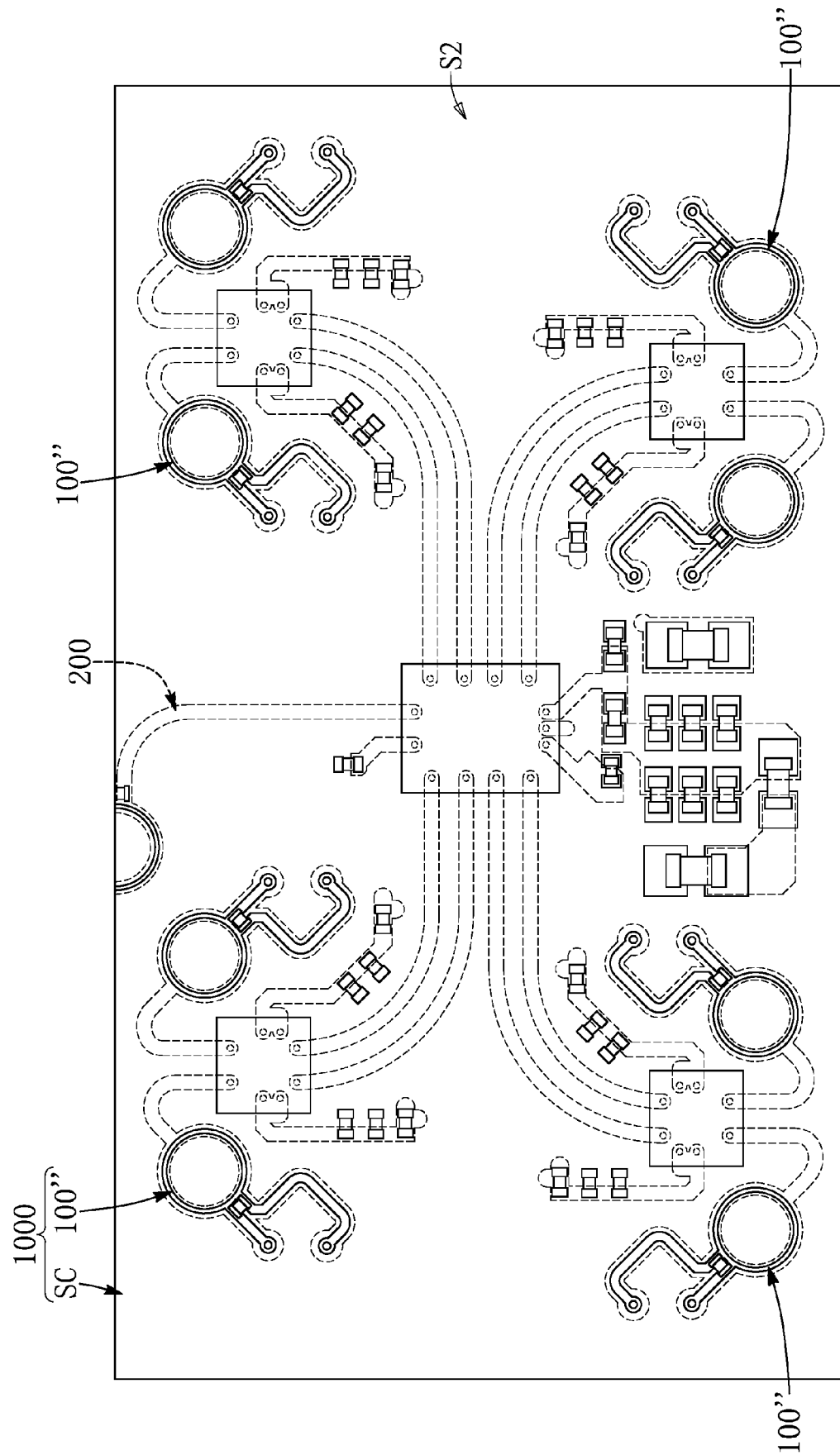


FIG. 11



EUROPEAN SEARCH REPORT

Application Number

EP 23 16 9252

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	RAMADAN ALI ET AL: "A directional polarization reconfigurable microstrip antenna", HIGH PERFORMANCE COMPUTING AND SIMULATION (HPCS), 2011 INTERNATIONAL CONFERENCE ON, 1 July 2011 (2011-07-01), pages 739-743, XP093085700, DOI: 10.1109/HPCSim.2011.5999902 ISBN: 978-1-61284-380-3 Retrieved from the Internet: URL:https://ieeexplore.ieee.org/stampPDF/getPDF.jsp?tp=&arnumber=5999902&ref=aHR0cHM6Ly9pZWVleHBsb3JlLmllZWUub3JnL2RvY3VtZW50LzIxMDUyNy9jaXRhdGlvbnM/dGFiRmlsdGVyPXBhcGVycw==> * section 2.; page 740; figures 1, 2 * -----	1-3, 6, 7	INV. H01Q9/04 ADD. H01Q1/52 H01Q21/06
X	LIU QIANG ET AL: "Design of a compact wideband circularly polarized microstrip antenna", MICROWAVE AND OPTICAL TECHNOLOGY LETTERS, vol. 55, no. 11, 26 August 2013 (2013-08-26), pages 2531-2536, XP093085701, US ISSN: 0895-2477, DOI: 10.1002/mop.27909 Retrieved from the Internet: URL:https://api.wiley.com/onlinelibrary/tdm/v1/articles/10.1002%2Fmop.27909> * sections 2. and 3.; page 2531 - page 2535; figure 4 * ----- -/--	1-3, 6, 7	TECHNICAL FIELDS SEARCHED (IPC) H01Q
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		9 October 2023	Blech, Marcel
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	

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EUROPEAN SEARCH REPORT

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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 2020/227831 A1 (PANTHER GYLES [CA] ET AL) 16 July 2020 (2020-07-16) * page 2, paragraph 29; figures 5A, 5B * * page 4, paragraph 100 - page 5, paragraph 118; figures 7A, 8A, 9-11 * * page 7, paragraph 155; figure 21 * -----	1,2,4-7	
Y	DAVIDSON KYLE ET AL: "A wideband via fed circularly polarized microstrip antenna on a multi-layer substrate", 2013 IEEE ANTENNAS AND PROPAGATION SOCIETY INTERNATIONAL SYMPOSIUM (APSURSI), IEEE, 7 July 2013 (2013-07-07), pages 1468-1469, XP032556757, ISSN: 1522-3965, DOI: 10.1109/APS.2013.6711393 ISBN: 978-1-4799-3538-3 [retrieved on 2014-01-13] * section I.; page 1468; figure 1; table 1 * -----	1,2,4-7	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
Place of search The Hague			Date of completion of the search 9 October 2023
Examiner Blech, Marcel			
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document			

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ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

EP 23 16 9252

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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09-10-2023

10	Patent document cited in search report	Publication date	Patent family member(s)	Publication date
15	US 2020227831	A1	16-07-2020	NONE
20	-----			
25				
30				
35				
40				
45				
50				
55				

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82