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(54) ANTENNA

(57) An antenna is provided, which may include a main radiation body, a signal feed-in end, a connection section, a ground section and an impedance matching adjustment section. The main radiation body may include a base side, a lateral side, a first inclined side and a second inclined side; the included angle between the first inclined side and the lateral side may be obtuse; the included angle between the first inclined side and the second inclined side may be obtuse; the included angle between the second inclined side and the base side may be acute. The signal feed-in end may be coupled to the main radiation body. The connection section may be coupled to the main radiation body. The ground section may be coupled to the connection section. The impedance matching adjustment section may be coupled to the ground section.

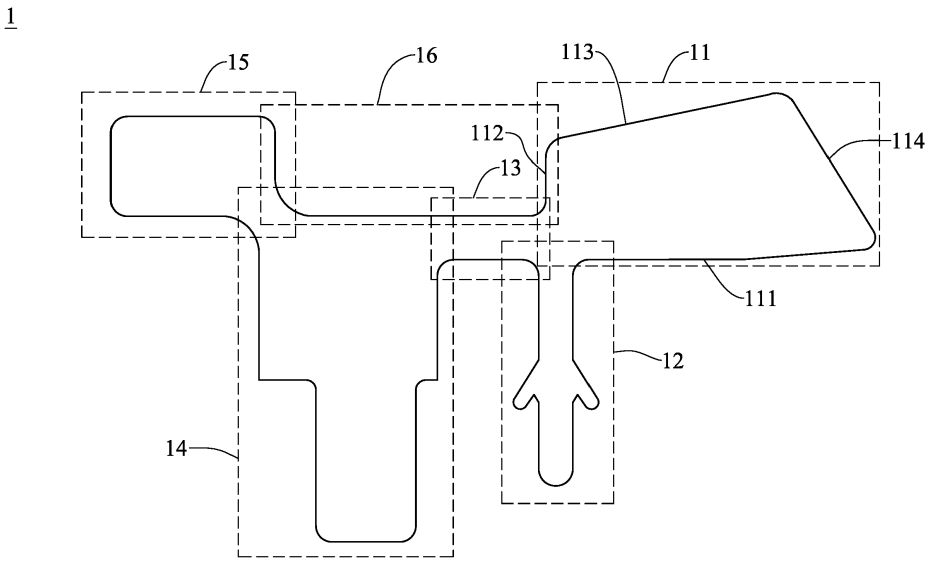

FIG. 1

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Description

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application also claims priority to Taiwan Patent Application No. 105123301 filed in the Taiwan Patent Office on July 22, 2016, the entire content of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] The present invention relates to an antenna, in particular to an inverse-F antenna.

BACKGROUND

[0003] For the purpose of applying antennas to various hand-held electronic devices (such as smart phone and notebook computer, etc.) or wireless transmission devices (such as access point, etc.), various compact and high-performance antennas are developed. In particular, planar inverse-F antenna (PIFA) is of small size and can achieve high performance, so is very suitable for various hand-held electronic devices and wireless transmission devices; for the reason, planar inverse-F antenna is the most popular antenna for now. However, conventional planar inverse-F antenna still has a lot of shortcomings to be overcome.

[0004] For example, the connection area between some conventional planar inverse-F antennas and the circuit board is insufficient, so the antennas tend to overturn, which increases the failure rate of the antennas.

[0005] Also, the design of some conventional planar inverse-F antennas is improper, so the structure of these antennas is too complicated; therefore, these antennas tend to be deformed, which further increases the failure rate of the antennas.

[0006] Besides, some conventional planar inverse-F antennas are compact, but the height of these antennas is still too high; therefore, these antennas occupy a lot of space, which limits the application range of these antennas.

[0007] Furthermore, some conventional planar inverse-F antennas need to use transmission line to feed in signals instead of microstrip line, which occupies more space, so the cost of these antennas will increase.

[0008] Accordingly, it has become an important issue to provide an antenna capable of improving the problems that the conventional inverse-F antennas are of high failure rate, high cost and limited application range.

SUMMARY

[0009] The present invention is related to an antenna. In one embodiment of the present invention, the antenna may include a main radiation body, a signal feed-in end, a connection section, a ground section and an impedance matching adjustment section. The main radiation body may include a base side, a lateral side, a first inclined side and a second inclined side; the included angle between the first inclined side and the lateral side may be obtuse; the included angle between the first inclined side and the second inclined side may be obtuse; the included angle between the second inclined side and the base side may be acute. The signal feed-in end may be coupled to the main radiation body. The connection section may be coupled to the main radiation body. The ground section may be coupled to the connection section. The impedance matching adjustment section may be coupled to the ground section.

[0010] In a preferred embodiment, the main radiation body may be an asymmetric sector in shape.

[0011] In a preferred embodiment, the length of the main radiation body may be related to the operating frequency of the antenna.

[0012] In a preferred embodiment, the included angle between the signal feed-in end and the connection section may be a right angle.

[0013] In a preferred embodiment, the include angle between the lateral side and the base side may be a right angle.

[0014] In a preferred embodiment, the size of the impedance matching adjustment section may be related to an impedance matching of the antenna.

[0015] In a preferred embodiment, the impedance matching adjustment section may be rectangular.

[0016] In a preferred embodiment, one end of the ground section may be coupled to the main radiation body, and the other end of the ground section may be coupled to the connection section.

[0017] In a preferred embodiment, the signal feed-in end, the main radiation body, the connection section, the ground section and the impedance matching adjustment section may be on the same plane.

[0018] In a preferred embodiment, a recess may be formed between the main radiation body, the connection section, the ground section and the impedance matching adjustment section.

[0019] In a preferred embodiment, the width of the main radiation body may be related to a bandwidth of the antenna.

[0020] In a preferred embodiment, the base side may be parallel to a horizontal plane.

[0021] In a preferred embodiment, the recess may overlap the ground section and the connection section in the vertical direction.

[0022] In a preferred embodiment, the size of the recess may be related to the impedance matching of the antenna.

[0023] In a preferred embodiment, the base side may overlap the bottom of the connection section in the horizontal direction.

[0024] In a preferred embodiment, the recess may extend toward the horizontal direction and contact the signal feed-in end in the vertical direction.

[0025] The antennas in accordance with the embodi-

ments of the present invention may have the following advantages:

(1) According to one embodiment of the present invention, the ground section of the antenna may include a bent portion, which allows the antenna can be stably fixed on the circuit board, so the antenna does not tend to overturn, which significantly reduce the failure rate of the antenna.

(2) According to one embodiment of the present invention, the main radiation body, the signal feed-in end, the connection section, the ground section and the impedance matching adjustment section of the antenna may be on the same plane, so the structure of the antenna is very simple; thus, the antenna does not tend to be deformed, which can further reduce the failure rate of the antenna.

(3) According to one embodiment of the present invention, the antenna is properly designed, so the height of the antenna can be reduced; therefore, the antenna does not occupy a lot of space, so the application range of the antenna can be more comprehensive.

(4) According to one embodiment of the present invention, signals can be fed in the antenna by microstrip line rather than transmission line, which does not occupy a lot of space, so the cost of the antenna can decrease.

(5) According to one embodiment of the present invention, the main radiation body may be an asymmetric sector in shape, so the operating frequency and the bandwidth of the antenna are easily to be adjusted; further, the antenna has an independent impedance matching adjustment section and a special recess structure for adjusting the impedance matching of the antenna; therefore, the antenna is easily to be optimized, so is very flexible in use.

[0026] Further scope of applicability of the present application will become more apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating exemplary embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] The present invention will become more fully understood from the detailed description given herein below and the accompanying drawings which are given by way of illustration only, and thus are not limitative of the present invention and wherein:

FIG. 1 is a schematic view of a first embodiment of an antenna in accordance with the present invention.

FIG. 2 is a return loss diagram of the first embodiment of the antenna in accordance with the present invention.

FIG. 3 is an antenna efficiency diagram of the first embodiment of the antenna in accordance with the present invention.

FIG. 4 is a schematic view of a second embodiment of an antenna in accordance with the present invention.

FIG. 5 is a schematic view of a third embodiment of an antenna in accordance with the present invention.

FIG. 6 is a schematic view of a fourth embodiment of an antenna in accordance with the present invention.

DETAILED DESCRIPTION

[0028] In the following detailed description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the disclosed embodiments. It will be apparent, however, that one or more embodiments may be practiced without these specific details. In other instances, well-known structures and devices are schematically shown in order to simplify the drawing.

[0029] With reference to FIG. 1 for a schematic view of a first embodiment of an antenna in accordance with the present invention, the antenna 1 may include a main radiation body 11, a signal feed-in end 12, a connection section 13, a ground section 14 and an impedance matching adjustment section 15.

[0030] The main radiation body 11 may include a base side 111, a lateral side 112, a first inclined side 113 and a second inclined side 114. The included angle between the first inclined side 113 and the lateral side 112 may be an obtuse angle; the included angle between the first inclined side 113 and the second inclined side 114 may be an obtuse angle; the included angle between the second inclined side 114 and the base side 111 may be an acute angle. Besides, the included angle between the lateral side 112 and the base side 111 may be a right angle, and the base side111 may be parallel to the horizontal plane. The length of the main radiation body 11 may be related to the operating frequency of the antenna 1, and the width of the main radiation body 11 may be related to the bandwidth of the antenna 1, so the operating frequency and the bandwidth of the antenna 1 may be adjusted by modifying the length and the width of the main radiation body 11.

[0031] The signal feed-in end 12 may be coupled to the main radiation body 11; in the embodiment, the included angel of the signal feed-in end 12 and the connection section 14 may be a right angle.

[0032] One end of the ground section 13 may be coupled to the main radiation body 11, and the other end of the ground section 13 may be coupled to the connection section 13; in the embodiment, the base side 111 may overlap the bottom of the connection section 13 in the vertical direction.

[0033] The impedance matching adjustment section 15 may be coupled to the ground section 14, and the size of the impedance matching adjustment section 15 may be related to the impedance matching of the antenna 1; in the embodiment, the impedance matching adjustment section 15 may be rectangular in shape.

[0034] The ground section 14 may be coupled to the ground section 13, and the ground section 14 may include a bent portion (not shown in FIG. 1), so the antenna 1 can be stably fixed on the circuit board; in this way, the antenna 1 does not tend to overturn, which can significantly reduce the failure rate of the antenna 1.

[0035] The above structure of the embodiment can allow the main radiation body 11, the signal feed-in end 12, the connection section 13, the ground section 14 and the impedance matching adjustment section 15 to be on the same plane, so the structure of the antenna can be significantly simplified; therefore, the antenna 1 does not tend to be deformed.

[0036] Furthermore, according to FIG. 1, a recess 16 may be formed between the main radiation body 11, the connection section 13, the ground section 14 and the impedance matching adjustment section 15; the special recess 16 structure may be related to the impedance matching of the antenna 1, so the impedance matching of the antenna 1 can be adjusted by modifying the size of the recess 16. In the embodiment, the recess 16 may overlap the ground section 14 and the connection section 13 in the vertical direction, and may contact the signal feed-in end 12 in the vertical direction.

[0037] As described above, the antenna 1 has a special structure design, so all parts of the antennas can be located on the same plane, which can significantly simplify the structure of the antenna 1, and effectively reduce the failure rate of the antenna 1. In addition, the height of the antenna 1 can be reduced, so the application range of the antenna 1 may be more comprehensive. Moreover, the main radiation body 11 of the antenna 1 has a special geometric shape, so the operating frequency and the bandwidth of the antenna 1 are very easily to be adjusted; furthermore, the antenna 1 can further have an independent impedance matching adjustment section 15 and a special recess 16 structure, so the antenna 1 can be very easily to be optimized; therefore, the antenna 1 is very flexible in use.

[0038] The embodiment just illustrates a preferred structure of the antenna instead of limiting the scope of the present invention; the structure of the antenna can be modified according to actual requirements.

[0039] With reference to FIG. 2 and FIG. 3 for a return loss diagram and an antenna efficiency diagram of the first embodiment of the antenna in accordance with the present invention, the embodiment illustrates that the antenna 1 is applied to a wireless transmission device whose operating frequency is 5150MHz~5850MHz.

[0040] The structure of the antenna 1 is specially designed, so very suitable to be applied to various handheld electronic devices (such as smart phone and notebook computer, etc.) or wireless transmission devices (such as access point, etc.), and can achieve excellent performance. FIG. 2 shows the return loss diagram of a wireless transmission device having the antenna 1 and its operating frequency is 5150MHz~5850MHz; FIG. 3 shows the antenna efficiency diagram of the wireless transmission device. According to FIG. 2 and FIG. 3, the antenna 1 can achieve great performance in both return loss and antenna efficiency.

[0041] With reference to FIG. 4 for a schematic view of a second embodiment of an antenna in accordance with the present invention, the antenna 1 may include a main radiation body 11, a signal feed-in end 12, a connection section 13, a ground section 14 and an impedance matching adjustment section 15.

[0042] As the detailed structure of the antenna 1 of the embodiment is similar to that of the previous embodiment, so will not be described again therein.

[0043] The difference between the embodiment and the previous embodiment is that the recess 16 of the antenna 1 in the embodiment may overlap the ground section 14 and the connection section 13 in the vertical direction, but fail to contact the signal feed-in end 12 in the vertical direction; in this way, the impedance matching of the antenna 1 can be adjusted without increasing the height of the antenna 1.

[0044] The embodiment just illustrates a preferred structure of the antenna instead of limiting the scope of the present invention; the structure of the antenna can be modified according to actual requirements.

[0045] With reference to FIG. 5 for a schematic view of a third embodiment of an antenna in accordance with the present invention, the antenna 1 may include a main radiation body 11, a signal feed-in end 12, a connection section 13, a ground section 14 and an impedance matching adjustment section 15.

[0046] As the detailed structure of the antenna 1 of the embodiment is similar to that of the previous embodiment, so will not be described again therein.

[0047] The difference between the embodiment and the previous embodiment is that the impedance matching adjustment section 15 of the antenna 1 in the embodiment may extend toward the horizontal direction, so the impedance matching of the antenna 1 can be adjusted without increasing the height of the antenna 1.

[0048] The embodiment just illustrates a preferred structure of the antenna instead of limiting the scope of the present invention; the structure of the antenna can

be modified according to actual requirements.

[0049] It is worthy to point out that some conventional antennas are not properly designed, so the structure of these antennas is too complicated; therefore, these antennas tend to be deformed, which further increases the failure rate of the antennas. On the contrary, according to one embodiment of the present invention, the main radiation body, the signal feed-in end, the connection section, the ground section and the impedance matching adjustment section of the antenna may be on the same plane, so the structure of the antenna is very simple; thus, the antenna does not tend to be deformed, which can further reduce the failure rate of the antenna.

[0050] Besides, some conventional planar inverse-F antennas are compact, but the height of these antennas is still too high; therefore, these antennas occupy a lot of space, which limits the application range of these antennas. On the contrary, according to one embodiment of the present invention, the antenna is properly designed, so the height of the antenna can be reduced; therefore, the antenna does not occupy a lot of space, so the application range of the antenna can be more comprehensive.

[0051] Further, some conventional antennas need to use transmission line to feed in signals instead of microstrip line, which occupies more space, so the cost of these antennas will increase. On the contrary, according to one embodiment of the present invention, signals can be fed in the antenna by microstrip line rather than transmission line, which does not occupy a lot of space, so the cost of the antenna can decrease.

[0052] Moreover, according to one embodiment of the present invention, the main radiation body may be an asymmetric sector in shape, so the operating frequency and the bandwidth of the antenna are easily to be adjusted; further, the antenna has an independent impedance matching adjustment section and a special recess structure for adjusting the impedance matching of the antenna; therefore, the antenna is easily to be optimized, so is very flexible in use. Accordingly, the present invention definitely has an inventive step.

[0053] With reference to FIG. 6 for a schematic view of a fourth embodiment of an antenna in accordance with the present invention, the ground section 14 of the antenna 1 may further include a bent portion 14, which allows the antenna to be stably fixed on the circuit board P, so the antenna 1 does not tend to overturn, which can significantly reduce the failure rate of the antenna 1.

[0054] It is worthy to point out that the connection area between some conventional planar inverse-F antennas and the circuit board is insufficient, so the antennas tend to overturn, which increases the failure rate of the antennas. On the contrary, according to one embodiment of the present invention, the ground section of the antenna may include a bent portion, which allows the antenna can be stably fixed on the circuit board, so the antenna does not tend to overturn, which significantly reduce the failure rate of the antenna.

[0055] To sum up, according to one embodiment of the present invention, the ground section of the antenna may include a bent portion, which allows the antenna can be stably fixed on the circuit board, so the antenna does not tend to overturn, which significantly reduce the failure rate of the antenna.

[0056] According to one embodiment of the present invention, the main radiation body, the signal feed-in end, the connection section, the ground section and the impedance matching adjustment section of the antenna may be on the same plane, so the structure of the antenna is very simple; thus, the antenna does not tend to be deformed, which can further reduce the failure rate of the antenna.

[0057] Also, according to one embodiment of the present invention, the antenna is properly designed, so the height of the antenna can be reduced; therefore, the antenna does not occupy a lot of space, so the application range of the antenna can be more comprehensive.

[0058] Besides, according to one embodiment of the present invention, signals can be fed in the antenna by microstrip line rather than transmission line, which does not occupy a lot of space, so the cost of the antenna can decrease.

[0059] Moreover, according to one embodiment of the present invention, the main radiation body may be an asymmetric sector in shape, so the operating frequency and the bandwidth of the antenna are easily to be adjusted; further, the antenna has an independent impedance matching adjustment section and a special recess structure for adjusting the impedance matching of the antenna; therefore, the antenna is easily to be optimized, so is very flexible in use.

[0060] It will be apparent to those skilled in the art that various modifications and variations can be made to the disclosed embodiments. It is intended that the specification and examples be considered as exemplary only, with a true scope of the invention being indicated by the following claims and their equivalents.

Claims

1. An antenna, comprising:

a main radiation body, comprising a base side, a lateral side, a first inclined side and a second inclined side;

a signal feed-in end, coupled to the main radiation body;

a connection section, coupled to the main radiation body;

a ground section, coupled to the connection section; and

an impedance matching adjustment section, coupled to the ground section;

wherein an included angle between the first inclined side and the lateral side is obtuse, an in-

cluded angle between the first inclined side and the second inclined side is obtuse, and an included angle between the second inclined side and the base side is acute.

2. The antenna of claim 1, wherein the main radiation body is an asymmetric sector in shape and a length of the main radiation body is related to an operating frequency of the antenna.

3. The antenna of claim 1, wherein an included angle between the signal feed-in end and the connection section is a right angle.

4. The antenna of claim 1, wherein an include angle between the lateral side and the base side is a right angle.

5. The antenna of claim 1, wherein a size of the impedance matching adjustment section is related to an impedance matching of the antenna.

6. The antenna of claim 1, wherein the impedance matching adjustment section is rectangular.

7. The antenna of claim 1, wherein one end of the ground section is coupled to the main radiation body, and the other end of the ground section is coupled to the connection section.

8. The antenna of claim 1, wherein the signal feed-in end, the main radiation body, the connection section, the ground section and the impedance matching adjustment section is on the same plane.

9. The antenna of claim 1, wherein a recess is formed between the main radiation body, the connection section, the ground section and the impedance matching adjustment section.

10. The antenna of claim 2, wherein a width of the main radiation body is related to a bandwidth of the antenna.

11. The antenna of claim 4, wherein the base side is parallel to a horizontal plane.

12. The antenna of claim 9, wherein the recess overlaps the ground section and the connection section in a vertical direction.

13. The antenna of claim 9, wherein a size of the recess is related to an impedance matching of the antenna.

14. The antenna of claim 11, wherein the base side overlaps a bottom of the connection section in a horizontal direction.

15. The antenna of claim 12, wherein the recess extends toward a horizontal direction and contacts the signal feed-in end in the vertical direction.

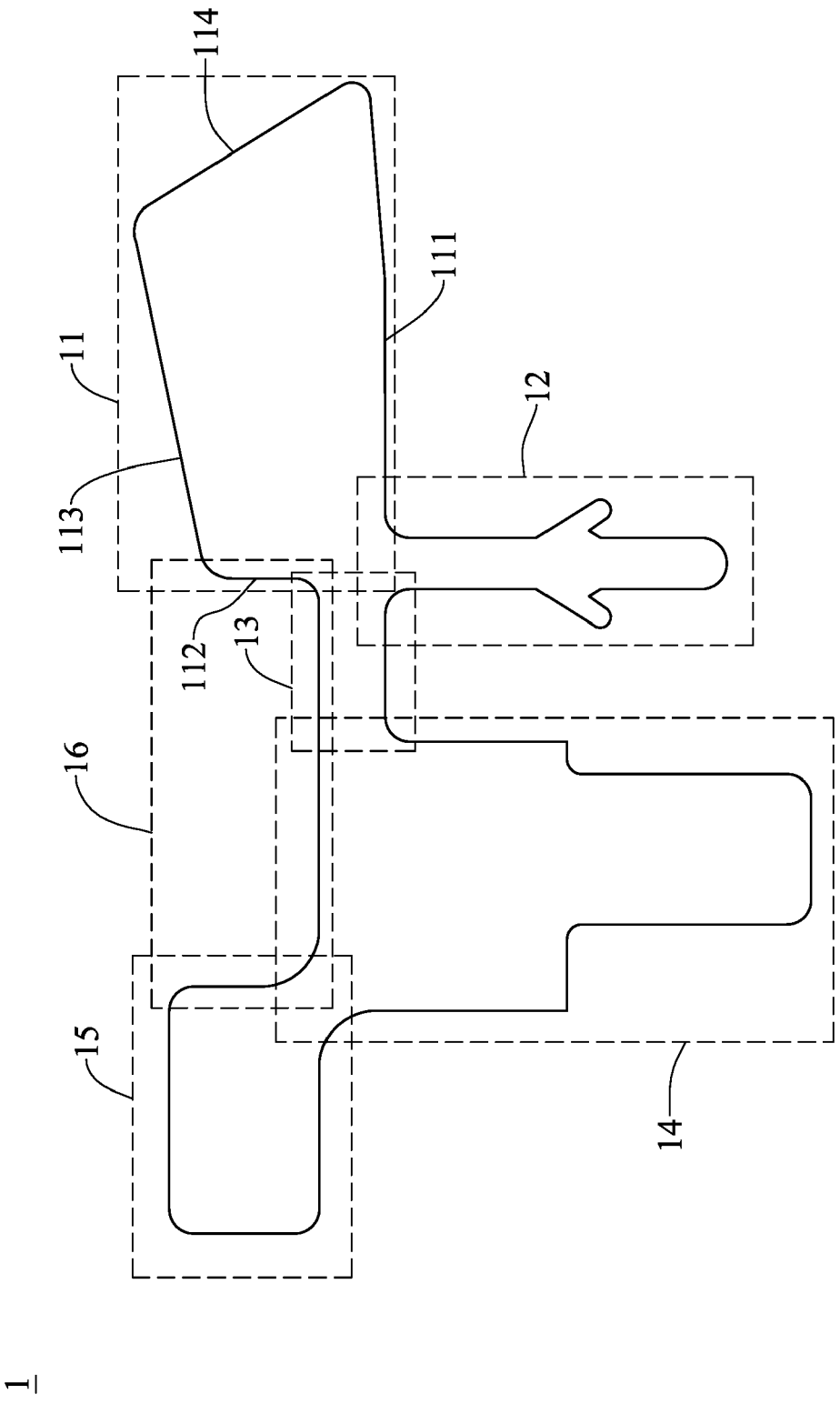

FIG. 1

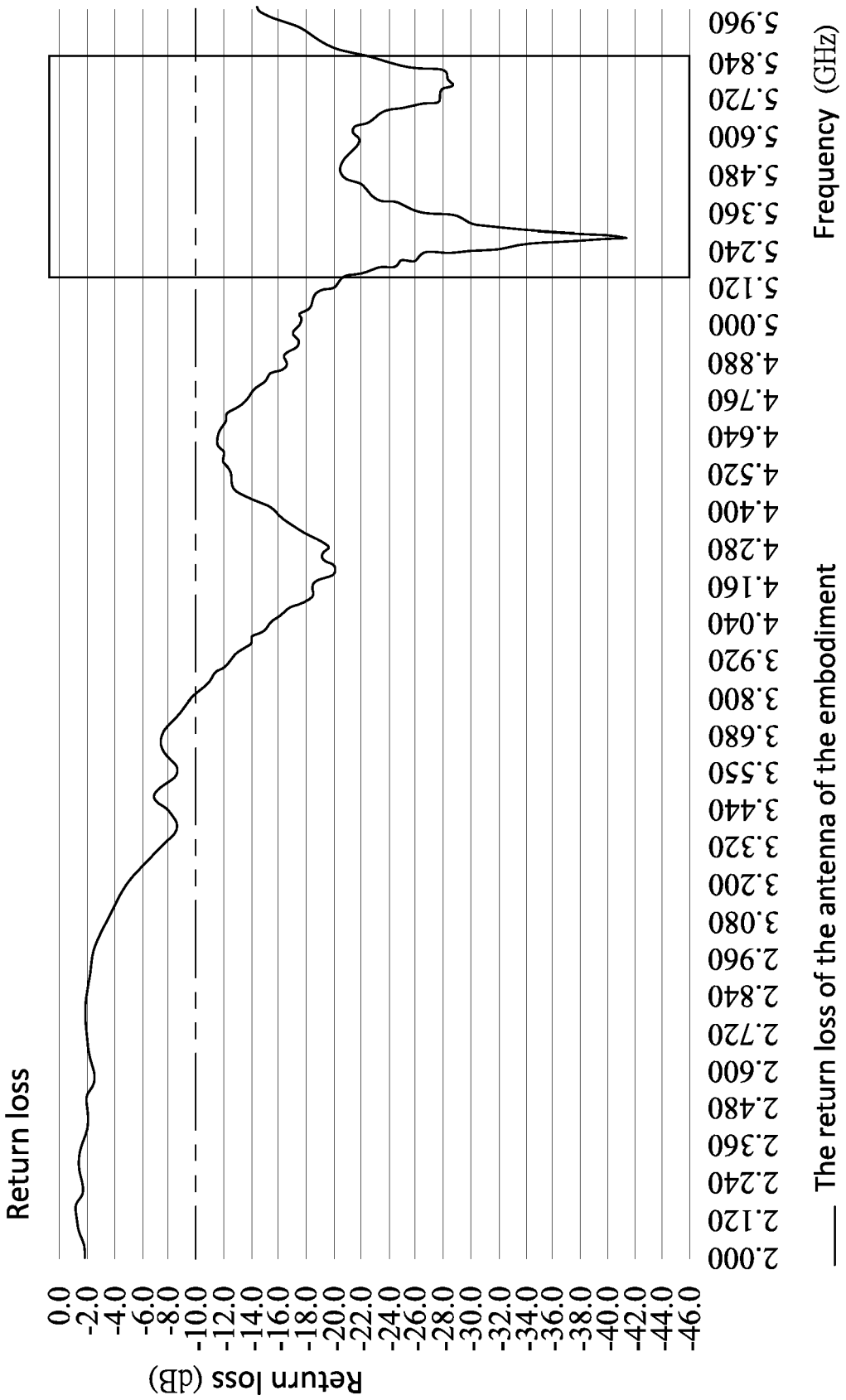
Return loss
Return loss (dB)
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
-12.0
-14.0
-16.0
-18.0
-20.0
-22.0
-24.0
-26.0
-28.0
-30.0
-32.0
-34.0
-36.0
-38.0
-40.0
-42.0
-44.0
-46.0
Frequency (GHz)
2.000
2.120
2.240
2.360
2.480
2.600
2.720
2.840
2.960
3.080
3.200
3.320
3.440
3.550
3.680
3.800
3.920
4.040
4.160
4.280
4.400
4.520
4.640
4.760
4.880
5.000
5.120
5.240
5.360
5.480
5.600
5.720
5.840
5.960
The return loss of the antenna of the embodiment
Return loss =-10dB

FIG. 2

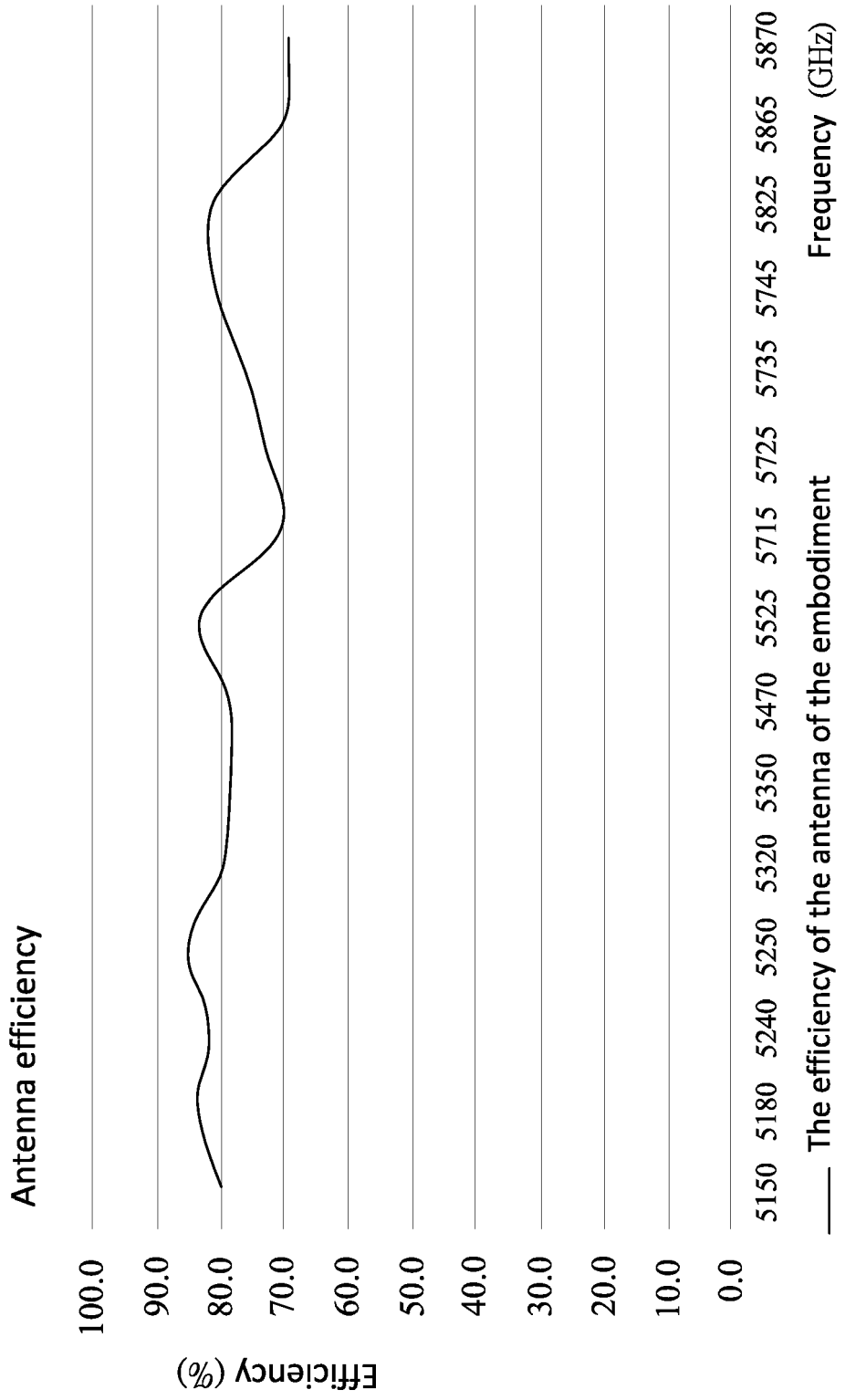
Antenna efficiency
Efficiency (%)
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
5150 5180 5240 5250 5320 5350 5470 5525 5715 5725 5735 5745 5825 5865 5870
Frequency (GHz)
The efficiency of the antenna of the embodiment

FIG. 3

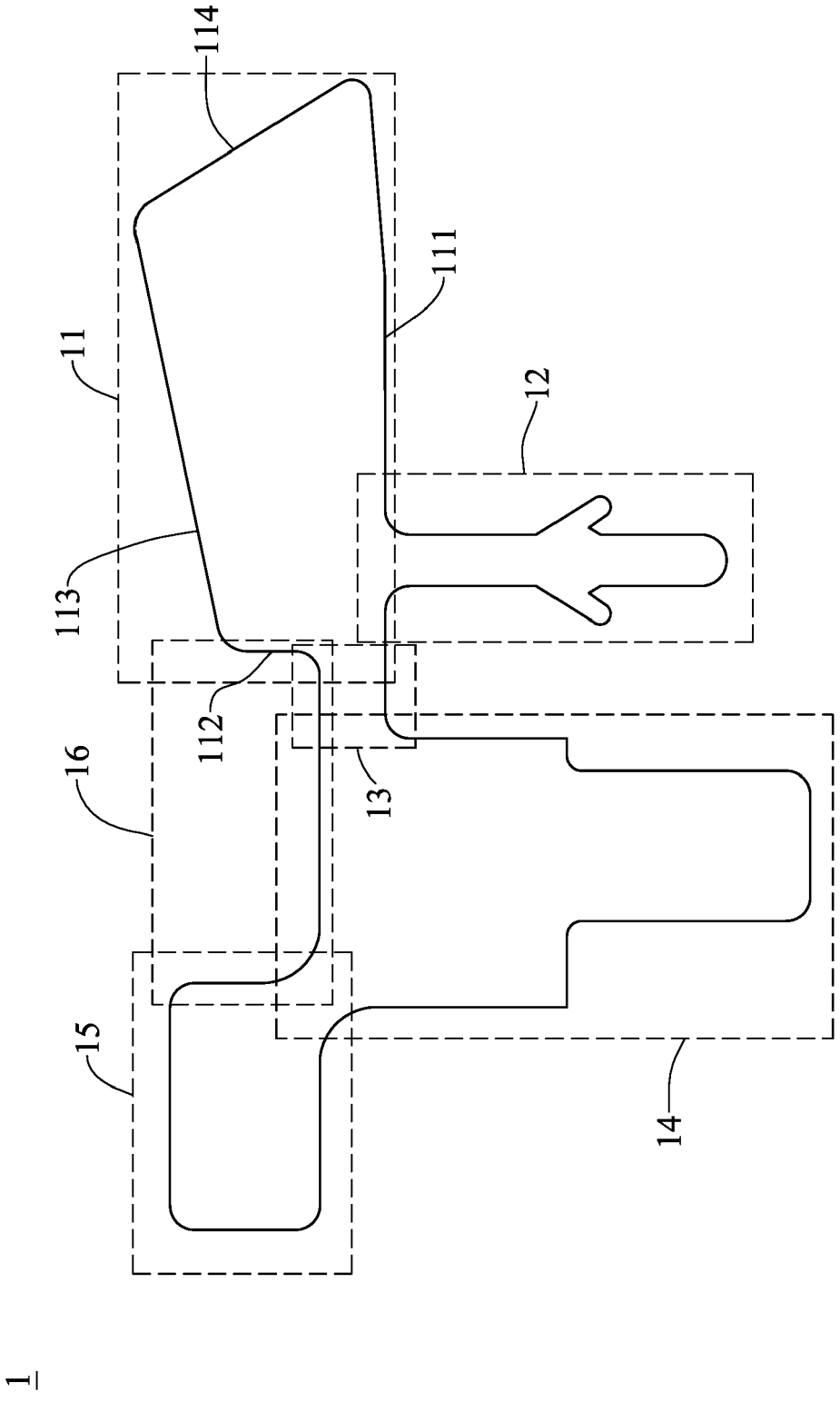

FIG. 4

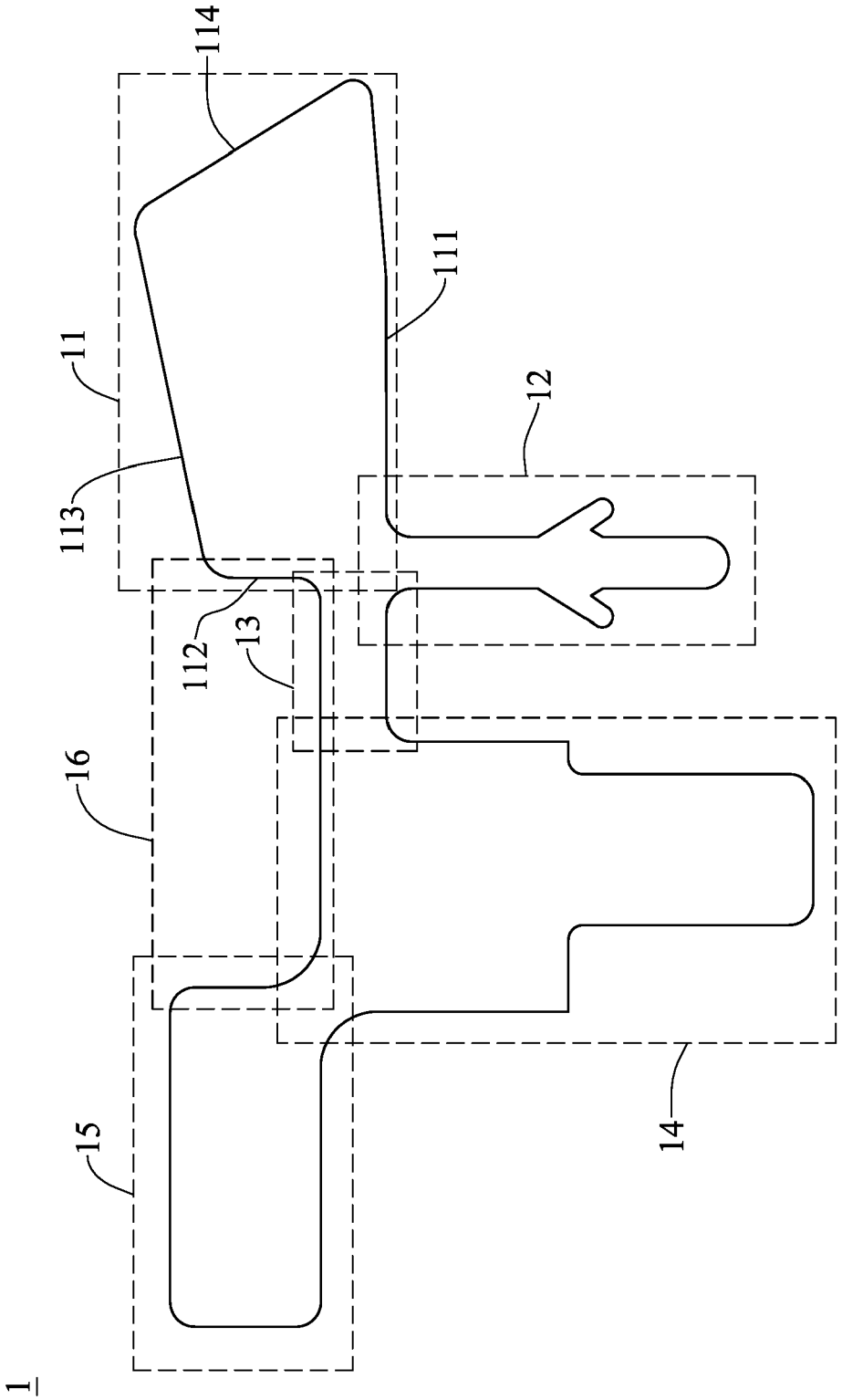

FIG. 5

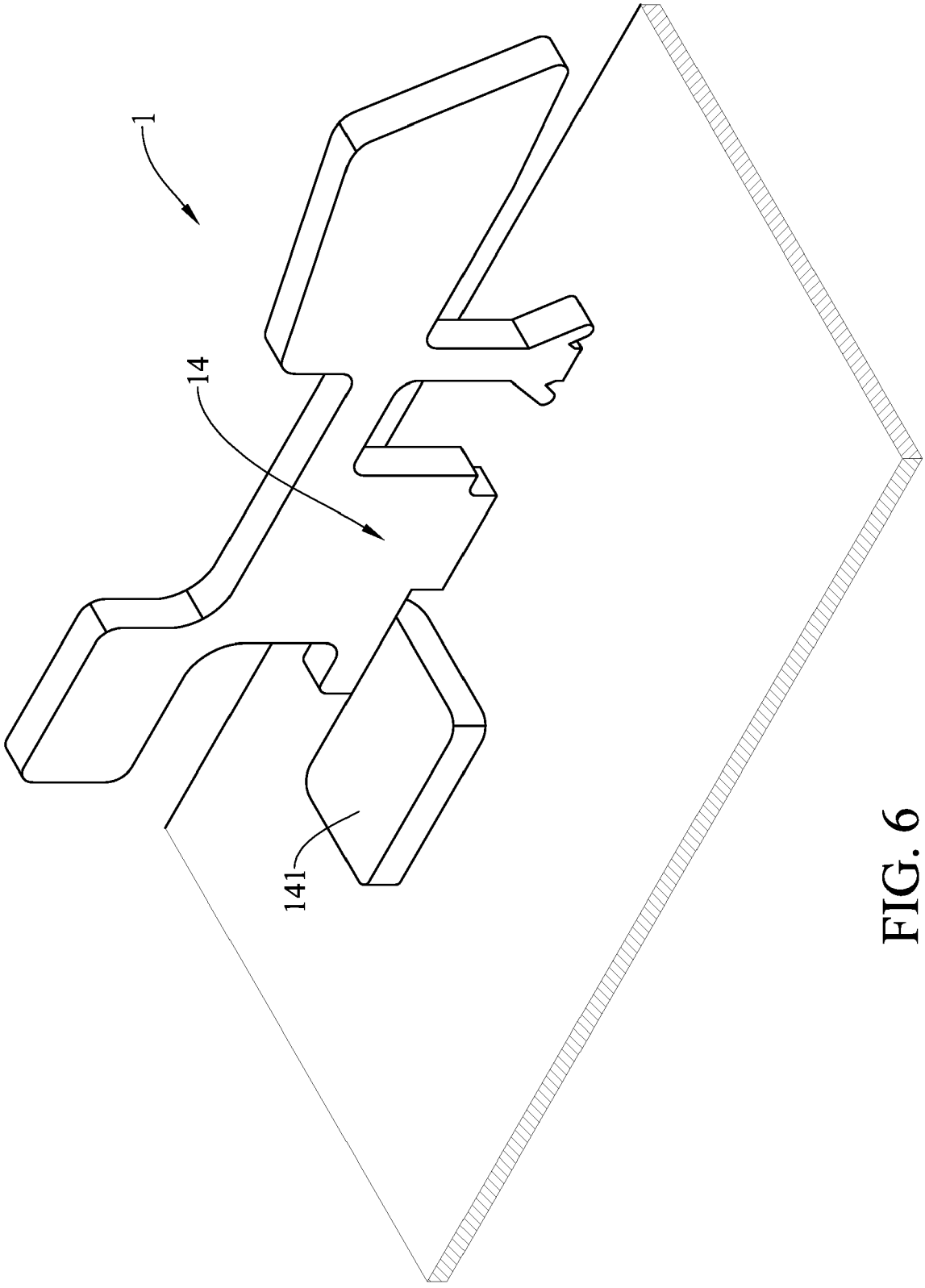

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 17 15 1525

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A	US 2005/200556 A1 (LIN HSIEN-CHU [TW] ET AL) 15 September 2005 (2005-09-15) * abstract; figure 1 *	1-15	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	25 August 2017	Vial, Antoine

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 17 15 1525

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

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