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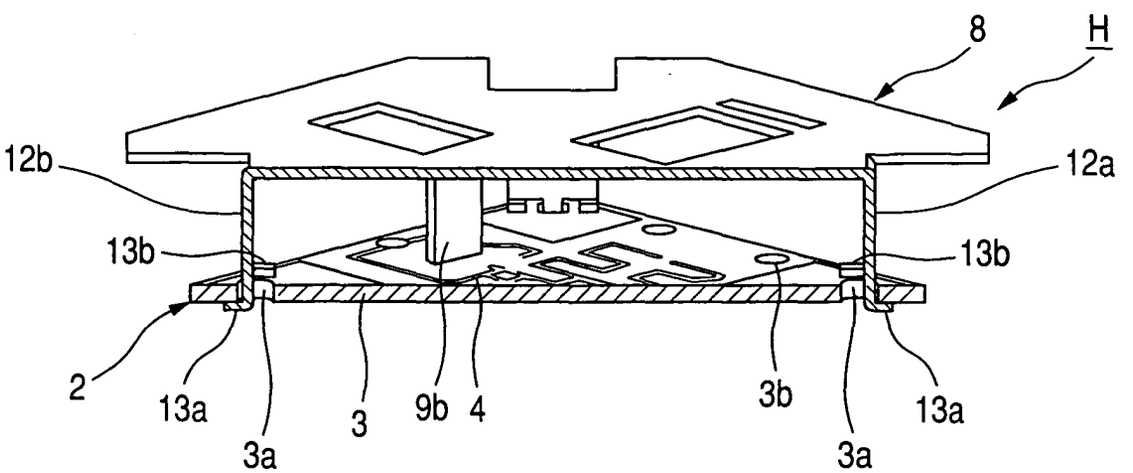
(54) Antenna device

(57) The antenna device according to the present invention comprises a dielectric substrate (3) formed on a ground conductor plate (1); a plurality of electrodes (5) provided on the dielectric substrate (3), each electrode forming a capacitor with the dielectric substrate (3); a radiating conductor plate (8) formed of a metal plate; a plurality of leg pieces (12) which are bent from pluralities of locations in the radiating conductor plate; wherein a locking portion (13) is provided at the front end portions of the leg pieces (12) and at the same time, a penetrating portion (3a) is formed in the dielectric substrate (3), and in the radiating conductor plate (8), the locking portion (13) is locked and half fixed to the penetrating hole (3a) while the leg pieces (12) are connected to the electrodes (5).

FIG. 18



EP 1 536 514 A1

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a patch antenna device which can be suitably used for a GPS (Global Positioning System) antenna or the like.

2. Description of the Related Art

[0002] With reference to the accompanying drawings, a conventional antenna device will be described. Fig. 22 is a plane view showing a conventional antenna device, and Fig. 23 is a sectional view showing major parts of the conventional antenna device.

[0003] Next, a construction of the conventional antenna device will be described with reference to Fig. 22 and Fig. 23. The conventional antenna device comprises a ground conductor plate 52 which is patterned on the top surface of an electrically isolated substrate 51, a radiating conductor plate 53 made of a metal plate which is disposed parallel to the ground conductor plate 52 with a predetermined space therebetween on the ground conductor plate 52, and four pieces of supporting member 54 which are made of dielectric materials and provided on the ground conductor plate 52.

[0004] Moreover, the radiating conductor plate 53 is formed of a square shape and is connected to a feeding means formed of a conductive line, while four corners of the radiating conductor plate 53 are supported by the supporting member 54. The feeding means 55 is inserted into a hole 56 penetrating through the ground conductor plate 52 and the electrically isolated substrate and connected to an antenna circuit not shown in the figures (for example, see Japanese Unexamined Patent Application Publication No. 2002-237714).

[0005] However, in the conventional antenna device as described above, the antenna efficiency is decreased due to the dielectric loss by the supporting member 54. Moreover, because four pieces of the supporting member 54, each made of dielectric materials, are provided between the ground conductor plate 52 and the radiating conductor plate 53, the cost of materials and the assembly expense increase, which results in increasing the overall manufacturing cost for the antenna.

[0006] The conventional antenna device has a problem in that because the antenna efficiency is decreased due to the dielectric loss by the supporting member 54 and four pieces of the supporting member 54 made of dielectric materials are provided between the ground conductor plate 52 and the radiating conductor plate 53, the cost of materials and the assembly expense increase, which results in increasing the overall manufacturing cost for the antenna.

[0007] To solve these problems in the conventional antenna device, it is an object of the present invention to provide an inexpensive antenna device capable of simply fitting a radiating conductor plate and which has a low dielectric loss.

SUMMARY OF THE INVENTION

[0008] According to a first aspect of the present invention, an antenna device comprises: a dielectric substrate formed on a ground conductor plate; a plurality of electrodes provided on the dielectric substrate, the electrodes forming a capacitor with the dielectric substrate; a radiating conductor plate formed of a metal plate which is disposed on the dielectric substrate with a predetermined space therebetween; and a plurality of leg pieces which are bent from pluralities of locations in the radiating conductor plate toward the dielectric substrate; wherein a locking portion is provided at the front end portions of the leg pieces while a penetrating portion penetrating through the locking portion is formed in the dielectric substrate, and in the radiating conductor plate, the locking portion is locked and half fixed to the dielectric substrate while the leg pieces are connected to the electrodes.

[0009] Moreover, according to a second aspect of the present invention, the ground conductor plate is formed of a metal plate larger than the radiating conductor plate.

[0010] Additionally, according to a third aspect of the present invention, the locking portion has a first locking piece locked at a back surface of the dielectric substrate and a second locking piece locked at a top surface of the dielectric substrate.

[0011] Also, according to a fourth aspect of the present invention, the first and second locking pieces are provided on bent portions which are bent in mutually opposite directions with respect to the leg pieces as a center.

[0012] Further, according to a fifth aspect of the present invention, the dielectric substrate is disposed within a plane area of the radiating conductor plate.

[0013] The antenna device according to the present invention comprises an dielectric substrate formed on a ground conductor plate; a plurality of electrodes provided on the dielectric substrate, the electrodes forming a capacitor with the dielectric substrate; a radiating conductor plate formed of a metal plate which is disposed on the dielectric substrate with a predetermined space therebetween; and a plurality of leg pieces which are bent from pluralities of locations in the radiating conductor plate toward the dielectric substrate; wherein a locking portion is provided at the end portions of the leg pieces while a penetrating portion penetrating through the locking portion is formed in the dielectric substrate, and in the radiating conductor plate, the locking portion is locked and half fixed to the dielectric substrate while the leg pieces are connected to the electrodes.

[0014] Accordingly, since the electrodes and the ground conductor plate form a capacitance, a resonance frequency is lowered and it is possible to make a

small sized radiating conductor plate. Further, since it is only necessary to lock the leg pieces at the dielectric substrate, it is possible to obtain a productive antenna device whose assembly work is simple.

[0015] Moreover, since it is only necessary that the dielectric substrate is a thin substrate like the circuit board, it is possible to suppress the influence of the dielectric loss. Further, since the radiating conductor plate is fitted by soldering the leg pieces to the electrodes, it is possible to obtain an inexpensive and productive antenna device.

[0016] Moreover, since the ground conductor plate is formed of a metal plate larger than the radiating conductor plate, it is possible to use an inexpensive metal plate such as a steel plate and the like as the ground conductor plate and thus to obtain an inexpensive antenna device.

[0017] Moreover, since the locking portion has a first locking piece locked at the back surface of the dielectric substrate and a second locking piece locked at the top surface of the dielectric substrate, it is possible to assure the lockage of the locking portion to the dielectric conductor plate and thus to obtain a secure lock state.

[0018] Moreover, since the first and second locking pieces are provided on bent portions that are bent in mutually opposite directions with respect to the leg pieces as a center, it is easy to insert the first locking piece into the penetrating portion and is possible to obtain an antenna device whose assembly work is simple.

[0019] Moreover, since the dielectric substrate is disposed within the plane area of the radiating conductor plate, it is possible to obtain an inexpensive and small antenna device that requires low material cost.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

Fig. 1 is a plan view showing the antenna device according to the present invention;
Fig. 2 is a plan view showing a state in which a cover is removed, in the antenna device according to the present invention;
Fig. 3 is a sectional view taken along a line 3-3 in Fig. 1;
Fig. 4 is a sectional view taken along a line 4-4 in Fig. 1;
Fig. 5 is an exploded perspective view showing the antenna device according to the present invention;
Fig. 6 a plan view showing a ground conductor plate of the antenna device according to the present invention;
Fig. 7 is a perspective view showing the ground conductor plate of the antenna device according to the present invention;
Fig. 8 is a plan view showing a circuit substrate of the antenna device according to the present invention;
Fig. 9 is a plan view showing a radiating conductor plate of the antenna device according to the present invention;
Fig. 10 is a front view showing the radiating conductor plate of the antenna device according to the present invention;
Fig. 11 is a bottom plan view showing the radiating conductor plate of the antenna device according to the present invention;
Fig. 12 is a plan view showing a cover of the antenna device according to the present invention;
Fig. 13 is a left side view showing the cover of the antenna device according to the present invention;
Fig. 14 is a sectional view showing major parts of the cover of the antenna device according to the present invention;
Fig. 15 is a bottom plan view showing the cover of the antenna device according to the present invention;
Fig. 16 is a diagram illustrating a first step of a mounting method of the radiating conductor plate on the circuit board, in the antenna device according to the present invention;
Fig. 17 is a diagram illustrating a second step of the mounting method of the radiating conductor plate on the circuit board, in the antenna device according to the present invention;
Fig. 18 is a diagram illustrating a third step of the mounting method of the radiating conductor plate on the circuit board, in the antenna device according to the present invention;
Fig. 19 is a perspective view showing a state in which the mounting of the radiating conductor plate on the circuit board is finished, in the antenna device according to the present invention;
Fig. 20 is a diagram illustrating a mounting method of a cable to the ground conductor plate, in the antenna device according to the present invention;
Fig. 21 is a perspective view showing a state in which the mounting of the cable to the ground conductor plate is finished, in the antenna device according to the present invention;
Fig. 22 is a plane view showing the conventional antenna device; and
Fig. 23 is a sectional view showing major parts of the conventional antenna device.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0021] An antenna device of the present invention will now be described with reference to the accompanying drawings. Fig. 1 is a plan view showing an antenna device according to the present invention, and Fig. 2 is a plan view showing a state in which a cover is removed, in the antenna device according to the present invention. Further, Fig. 3 is a cross-sectional view taken along a line 3-3 of Fig. 1, and Fig. 4 is a cross-sectional view taken along a line 4-4 of Fig. 1. In addition, Fig. 5 is an

exploded perspective view showing the antenna device according to the present invention.

[0022] Further, Fig. 6 is a plan view showing a ground conductor plate of the antenna device according to the present invention, and Fig. 7 is a perspective view showing the ground conductor plate of the antenna device according to the present invention. Further, Fig. 8 is a plan view showing a circuit board of the antenna device according to the present invention, and Fig. 9 is a plan view showing a radiating conductor plate of the antenna device according to the present invention. In addition, Fig. 10 is a front view showing the radiating conductor plate of the antenna device according to the present invention, and Fig. 11 is a bottom view showing the radiating conductor plate of the antenna device according to the present invention.

[0023] Further, Fig. 12 is a plan view showing a cover of the antenna device according to the present invention, and Fig. 13 is a left side view showing the cover of the antenna device according to the present invention. In addition, Fig. 14 is a cross-sectional view showing schematically the cover of the antenna device according to the present invention, and Fig. 15 is a bottom view showing the cover of the antenna device according to the present invention.

[0024] Further, Fig. 16 is a diagram illustrating a first step of a mounting method of the radiating conductor plate on the circuit board, in the antenna device according to the present invention, and Fig. 17 is a diagram illustrating a second step of the mounting method of the radiating conductor plate on the circuit board, in the antenna device according to the present invention. In addition, Fig. 18 is a diagram illustrating a third step of the mounting method of the radiating conductor plate on the circuit board, in the antenna device according to the present invention, and Fig. 19 is a perspective view showing a state in which the mounting of the radiating conductor plate on the circuit board is finished, in the antenna device according to the present invention.

[0025] Further, Fig. 20 is a diagram illustrating a mounting method of a cable to the ground conductor plate, in the antenna device according to the present invention, and Fig. 21 is a perspective view showing a state in which the mounting of the cable to the ground conductor plate is finished, in the antenna device according to the present invention.

[0026] Next, a configuration of the antenna device of the present invention will be described with reference to Figs. 1 to 21. A ground conductor plate 1 made of a metal plate, which serves as a ground conductor plate, has a plurality of hooking portions 1a, each being formed by cutting the ground conductor plate 1 and raising the cut portion upward in an arch shape in four directions, holes 1b arranged adjacent to the respective hooking portions 1a, a plurality of stopper portions 1c, each being positioned between adjacent two hooking portions 1a and being formed by cutting the ground conductor plate 1 and raising the cut portion upward in an arch shape, cut-out portions 1d, each being provided in a vicinity of a top portion of each stopper portion 1c and being made of a through hole, and insertion portions 1e provided below the respective stopper portions 1c, in particular, as shown in Figs. 6 and 7.

[0027] Further, the ground conductor plate 1 has a plurality of bent pieces 1f bent upward, and escape portions 1g provided a plurality of positions which include positions adjacent to the respective bent pieces 1f.

[0028] A rectangular circuit board 2 has a dielectric substrate 3 made of an insulating plate, a wiring pattern 4 provided in the dielectric substrate 3, and a plurality of electrodes 5a, 5b, 5c and 5d provided in four corners of the dielectric substrate 3, in particular, as shown in Fig. 8. Here, the electrodes 5a, 5b, 5c and 5d are referred to as first, second, third, and fourth electrodes, respectively.

[0029] Further, the first and second electrodes 5a and 5b or the third and fourth electrodes 5c and 5d, which face each other in an oblique direction, have the same area. Further, the first and second electrodes 5a and 5b have the areas smaller than those of the third and fourth electrodes 5c and 5d.

[0030] In addition, the dielectric substrate 3 has a plurality of penetrating portions 3a respectively provided at positions of the first to fourth electrodes 5a to 5d as through holes, a plurality of first holes 3b provided in vicinities of an outer circumferential edge, and a plurality of second holes 3c provided in a central portion.

[0031] And then, on the circuit board 2, electronic components 6 including a short-height chip condenser and so on, or a tall dielectric filter 6a and so on are mounted, so that a desired electrical circuit having a matching circuit, a filter circuit, an amplifying circuit and so on is formed.

[0032] Further, the tall components 6 including the dielectric filter 6a are being arranged in the vicinities of the outer circumferential edge of the circuit board 2.

[0033] Such a circuit board 2 is mounted on the ground conductor plate 1 such that a bottom surface of the circuit board 2 contacts the ground conductor plate 1 while the bent pieces 1f are inserted into the first holes 3b, in particular, as shown in Figs. 3 and 5. In this situation, the bent pieces 1f are soldered to the wiring pattern 4, so that the circuit board 2 is supported by the bent pieces 1f.

[0034] At this time, the bent pieces 1f pass through the first holes 3b, and front end portions thereof are projected upward. At the same time, since release holes 1g of the ground conductor plate 1 are positioned below the penetrating portions 3a and the second holes 3c of the circuit board 2, the bottom surface of the circuit board 2 is being relieved from the ground conductor plate 1.

[0035] Further, when the circuit board 2 is mounted on the ground conductor plate 1, the first to fourth electrodes 5a to 5d face the ground conductor plate 1 with the dielectric substrate 3 interposed therebetween, and then condensers are respectively formed.

[0036] A coaxial cable 7 has a central conductor 7a and a mesh-like outer conductor 7b provided by an insulating covered portion to cover an outside of the central conductor 7a. As regards the mounting of the cable 7, first, as shown in Fig. 20, a front end portion of the cable 7 is inserted into the insertion portion 1e of the stopper portion 1c to be in a state as shown in Fig. 21.

[0037] And then, under the state as shown in Fig. 21, the central conductor 7a is soldered to the wiring pattern 4. At the same time, at a position in the cut-out portion 1d, the outer conductor 7b and the stopper portion 1c are soldered, so that the cable 7 is supported by the stopper portion 1c.

[0038] An octagonal radiating conductor plate 8 made of a metal plate has two feeding portions of first and second feeding portions 9a and 9b, which are formed by cutting the radiating conductor plate 8 and bending the cut portion downward at positions which make a right angle, and adjusting means Z, provided on a line S1 passing through the first feeding portion 9a and a center C, and a line S2 passing through the second feeding portion 9b and the center C, for adjusting an electrical length, in particular, as shown in Figs. 9 to 11.

[0039] And then, directions of electric fields in the radiating conductor plate 8 become the directions of the lines S1 and S2. Further, there exist a first electrical length which generates in the direction of the line S1 and a second electrical length which generates in the direction of the line S2.

[0040] Further, the adjusting means Z are provided at the positions of the lines S1 and S2 which are the directions of the electric fields. At the same time, the adjusting means are provided at positions between the central portion and the outer circumferential edge, except for the central portion of the radiating conductor plate 8.

[0041] In addition, the adjusting means Z are provided at opposite sides to the first and second feeding portions 9a and 9b therefrom beyond the center C. Further, the adjusting means Z are formed by ladder-like portions which holes 10a and crosspiece portions 10b combine and form. Here, by cutting the crosspiece portions 10b, the electrical lengths extend.

[0042] Further, the radiating conductor plate 8 has a pair of opposing sides 11a and 11b, each being positioned on lines S3 and S4 which pass through the center C and are orthogonal to each other, and four leg pieces 12a, 12b, 12c and 12d provided at positions any where on the lines S3 and S4 up to the first and second opposing sides 11a and 11b, except for the central portion.

[0043] The four leg pieces 12a to 12d are respectively provided at positions spaced by the same distance from the center C to be bent downward. Further, the leg pieces 12a to 12d are provided at positions closer to the center than the first and second opposing sides 11a and 11b.

[0044] Further, the electric field intensity of the radiating conductor plate 8 is made strong in the outer circumferential portion on the lines S1 and S2. However, the leg pieces 12a to 12d are provided at positions, spaced apart from the lines S1 and S2, in which the electric field intensity is relatively weak.

[0045] Further, in each of end portions of the leg pieces 12a to 12d, a locking portion 13 having a first locking piece 13a positioned at the lowest portion and a second locking piece 13b spaced by a predetermined gap from the first locking piece is provided.

[0046] And then, the first and second locking pieces 13a and 13b are formed with bent portions which are bent in an opposite direction to each other with each leg piece 12a to 12d as a center.

[0047] As regards the mounting of the radiating conductor plate 8 having such a configuration, first, as shown in Fig. 16, the radiating conductor plate 8 is arranged on the circuit board 2, and then, against the resilience of the leg pieces 12a to 12d, the leg pieces 12a to 12d are bent inward respectively.

[0048] Next, as shown in Fig. 17, convex portions of front ends of the first and second feeding portions 9a and 9b are engaged with the second holes 3c, and simultaneously the locking portions 13 of the leg pieces 12a to 12d are inserted into the insertion portions 3a respectively.

[0049] Next, as shown in Fig. 18, if the inwardly bending forces of the leg pieces 12a to 12d are released, by means of the resilience of the leg pieces 12a to 12d themselves, the leg pieces 12a to 12d return to the original states. At this time, the first locking piece 13a is locked to a rear surface of the circuit board 2 and the second locking piece 13b is locked to a front surface of the circuit board 2. As a result, as shown in Fig. 19, the radiating conductor plate 8 is temporally retained to the circuit board 2.

[0050] And then, the leg pieces 12a to 12d are respectively soldered and connected to the first to fourth electrodes 5a to 5d, and then the first and second feeding portions 9a and 9b are soldered to the wiring pattern 4 which is provided in vicinities of the second holes 3c. With the circuit board 2 and the radiating conductor plate 8, an antenna main body portion H is formed.

[0051] At this time, the leg pieces 12a to 12d and the first and second feeding portions 9a and 9b are not connected to the ground conductor plate 1 by means of the release holes 1g.

[0052] The radiating conductor plate 8 mounted on the circuit board 2 in such a manner is arranged parallel to the ground conductor plate 1 and the circuit board 2 and is spaced by a predetermined gap therefrom. Further, the first electrical length of the radiating conductor plate 8 is determined by a length of the radiating conductor plate 8 on the line S1 and a capacitance of the condenser formed by the electrodes 5a and 5b. In addition, the second electrical length of the radiating conductor plate 8 is determined by a length of the radiating conductor plate 8 on the line S2 and a capacitance of the condenser formed by the electrodes 5c and 5d.

[0053] In this example, the length of the radiating con-

ductor plate 8 on the line S1 and the length of the radiating conductor plate 8 on the line S2 are the same, but the capacitance formed by the electrodes 5a and 5b is set to be smaller than the capacitance formed by the electrodes 5c and 5d. Thus, the first electrical length is smaller than the second electrical length, and then the difference between both electrical lengths is caused. As a result, a circularly polarized wave antenna device is obtained.

[0054] Further, when the radiating conductor plate 8 is mounted, below the radiating conductor plate 8, the ground conductor plate 1 having the area larger than that of the radiating conductor plate 8 exists, and further, between the radiating conductor plate 8 and the ground conductor plate 1, the circuit board 2 is positioned within a planar region of the radiating conductor plate 8.

[0055] In addition, when the radiating conductor plate 8 is mounted, upper surfaces of the hooking portions 1a, the stopper portions 1c and the tall electronic component 6a are arranged to face the vicinities of the circumferential edge portion of the radiating conductor plate 8. Further, the front end portions of the bent portions 1f are arranged to face the radiating conductor plate 8, and between the hooking portions 1a, the stopper portions 1c, the tall electronic component 6a and the bent portions 1f, and the radiating conductor plate 8, capacitances are generated.

[0056] In addition, when the radiating conductor plate 8 is mounted, the remaining portions 1a and the stopper portions 1c are arranged along the outer circumferential edge of the radiating conductor plate 8. Thus, the hooking portions 1a and the stopper portions 1c can be formed close to the center C of the radiating conductor plate 8. As a result, it is possible to plan the miniaturization of the antenna device.

[0057] Further, by providing the lengths of the radiating conductor plate 8 on the lines S1 and S2, the capacitances of the first to fourth electrodes 5a to 5d, or the capacitances between the hooking portions 1a, the stopper portions 1c, the tall electronic component 6a and the bent portions 1f, and the radiating conductor plate 8, it is possible to lower the frequency, and then it is possible to plan the miniaturization of the antenna device.

[0058] The cuplike cover 14 made of a mold of the insulating material has an octagonal upper wall 14a, eight side walls 14b extending downward from eight sidelines of the upper wall 14a, a receiving portion 14c surrounded by the upper wall 14a and the side walls 14b, a concave portion 14d provided in a lower portion of any one of the side walls 14b, hook-like locking portions 14e provided at insides of lower portions of the side walls 14b for every two side walls, and convex portions 14f projected downward from the lower portions of the side walls 14b on which the locking portions 14e are positioned, in particular, as shown in Figs. 12 to 15.

[0059] The cover 14 overall houses the antenna main body portion H having the radiating conductor plate 8 and the circuit board 2. Further, in the state in which the locking portions 14e are fitted to the remaining portions 1a, the cover 14 is pressed downward (the ground conductor plate 1 side), and then the locking portions 14e are locked to the lower portions of the hooking portions 1a in a snap-fit manner. As a result, the cover 14 is mounted on the ground conductor plate 1.

[0060] At this time, the convex portions 14f provided the lower portions of the side walls 14b are engaged with the holes 1b adjacent to the hooking portions 1a. Further, in the concave portion 14d, the cable 7 is positioned and pressed.

[0061] A sealing sheet 15 is formed with a label or the like on one side of which an adhesive is provided. The sealing sheet 15 is adhered to the rear surface of the ground conductor plate 1, and then the release holes 1g are blocked.

[0062] With such a configuration, the antenna device of the present invention is formed.

Claims

1. An antenna device, comprising:

a dielectric substrate formed on a ground conductor plate;
a plurality of electrodes provided on the dielectric substrate, the electrodes forming a capacitor with the dielectric substrate;
a radiating conductor plate formed of a metal plate which is disposed on the dielectric substrate with a predetermined space therebetween; and
a plurality of leg pieces which are bent from pluralities of locations in the radiating conductor plate toward the dielectric substrate;

wherein a locking portion is provided at the end portions of the leg pieces while a penetrating portion penetrating through the locking portion is formed in the dielectric substrate, and in the radiating conductor plate, the locking portion is locked and half fixed to the dielectric substrate while the leg pieces are connected to the electrodes.

2. The antenna device according to claim 1,
wherein the ground conductor plate is formed of a metal plate larger than the radiating conductor plate.

3. The antenna device according to claim 1 or 2,
wherein the locking portion has a first locking piece locked at a back surface of the dielectric substrate and a second locking piece locked at a top surface of the dielectric substrate.

4. The antenna device according to claim 3,

wherein the first and second locking pieces are provided on bent portions which are bent in mutually opposite directions with respect to the leg pieces as a center.

5. The antenna device according to any one of claims 1 to 4,
wherein the dielectric substrate is disposed within a plane area of the radiating conductor plate.

FIG. 1

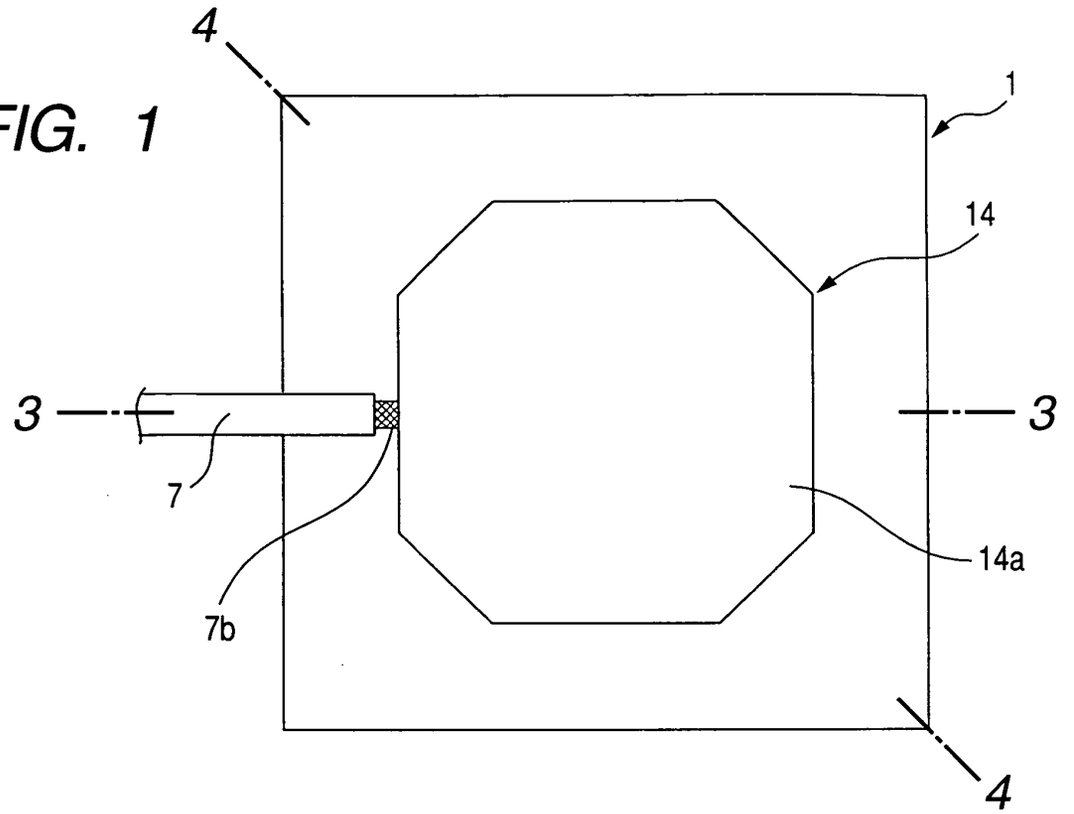
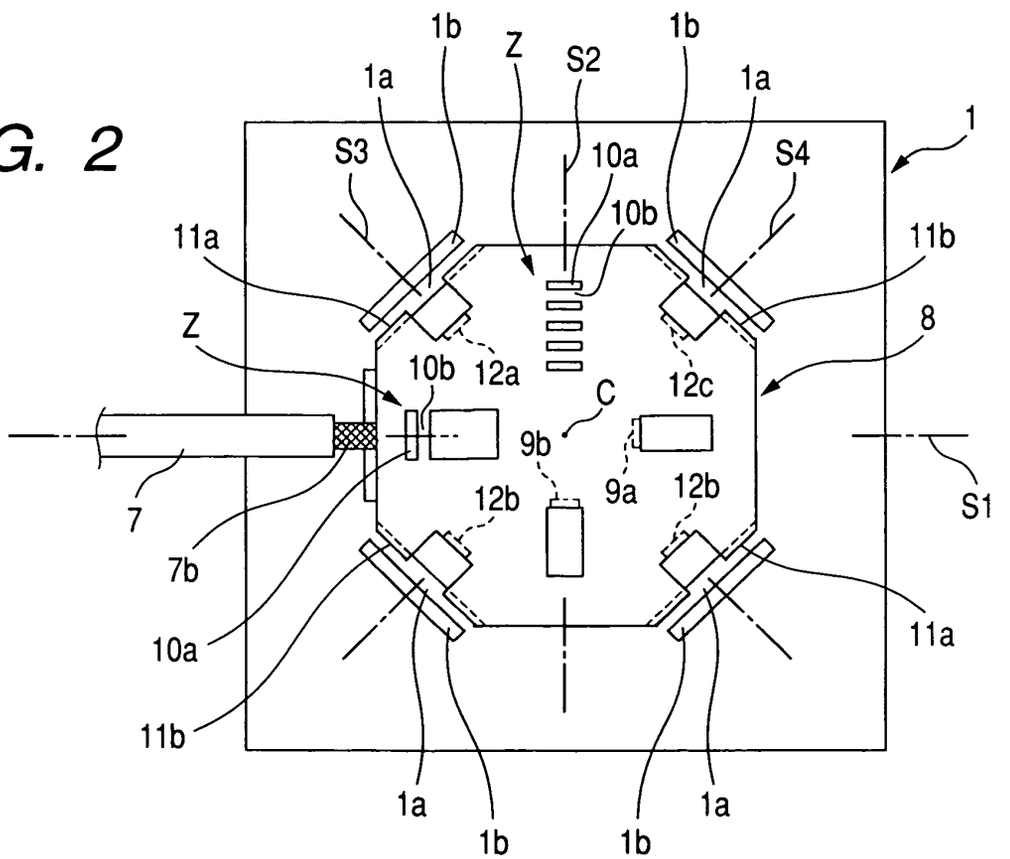

4
1
14
3
3
7
14a
7b
4

FIG. 2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12c
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FIG. 3

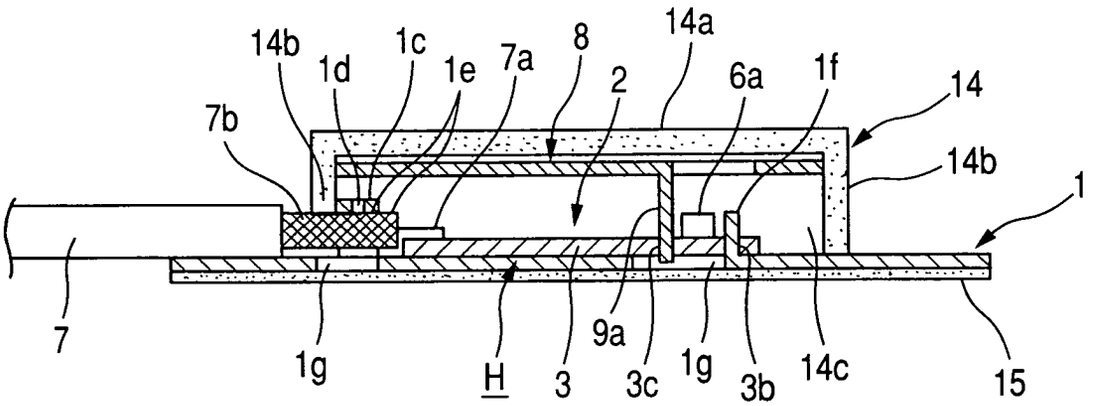
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FIG. 4

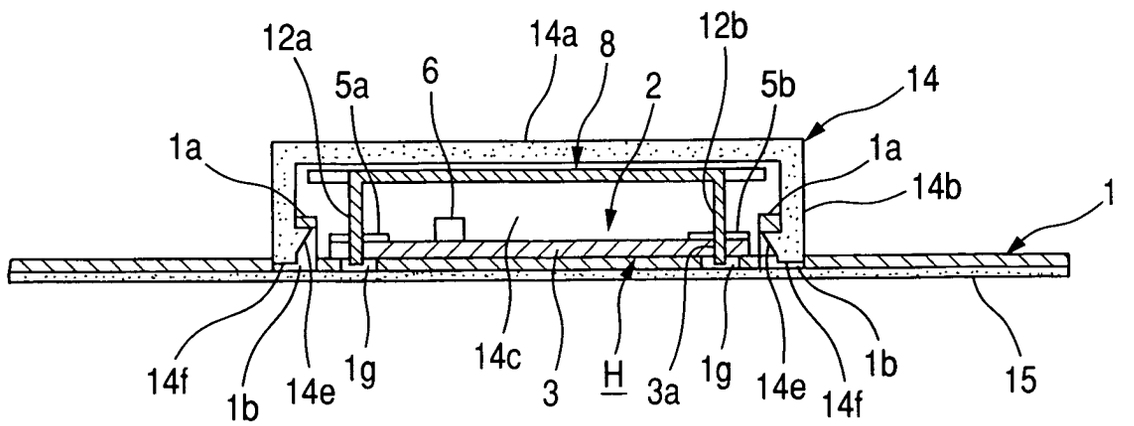
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FIG. 5

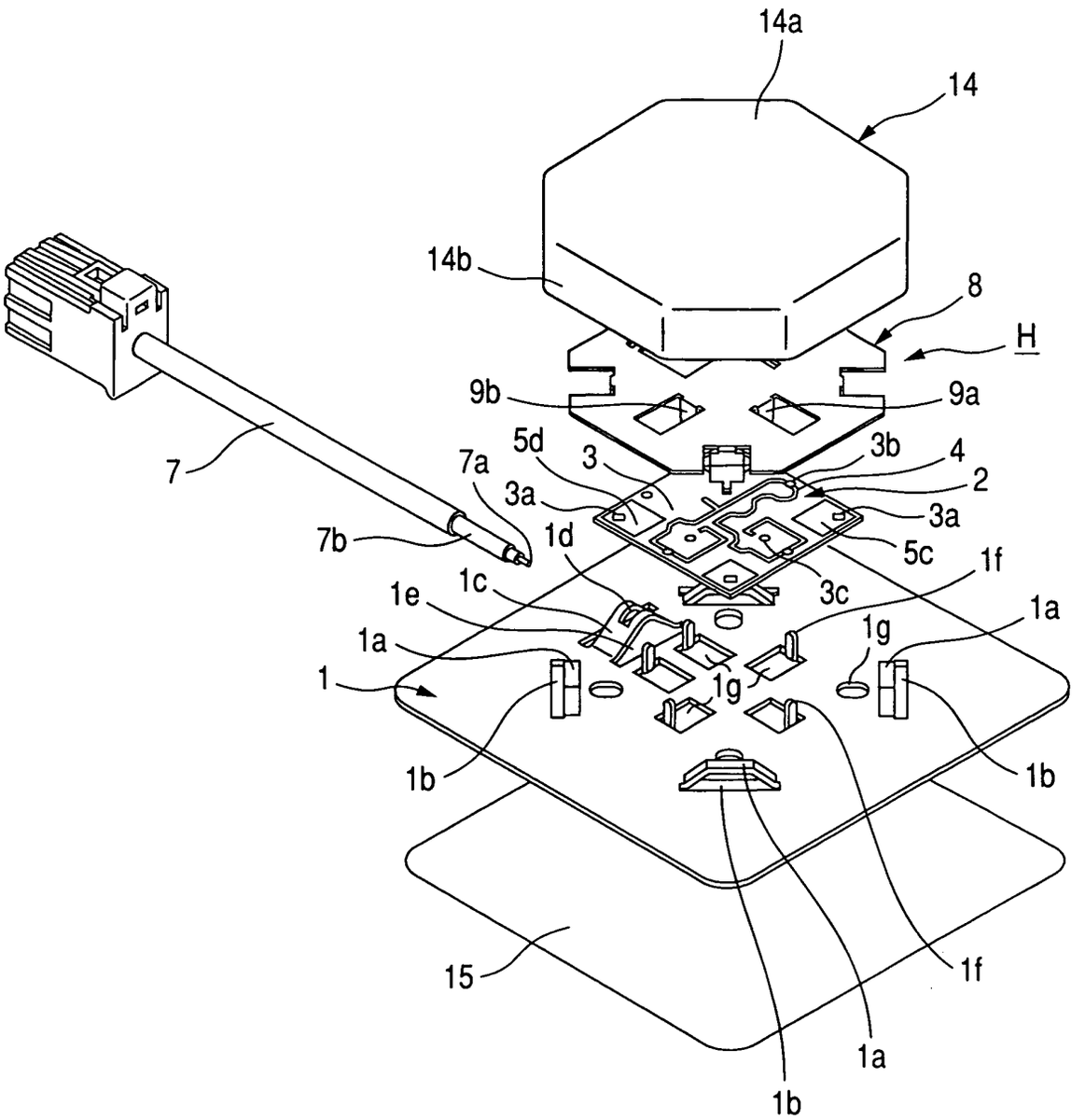
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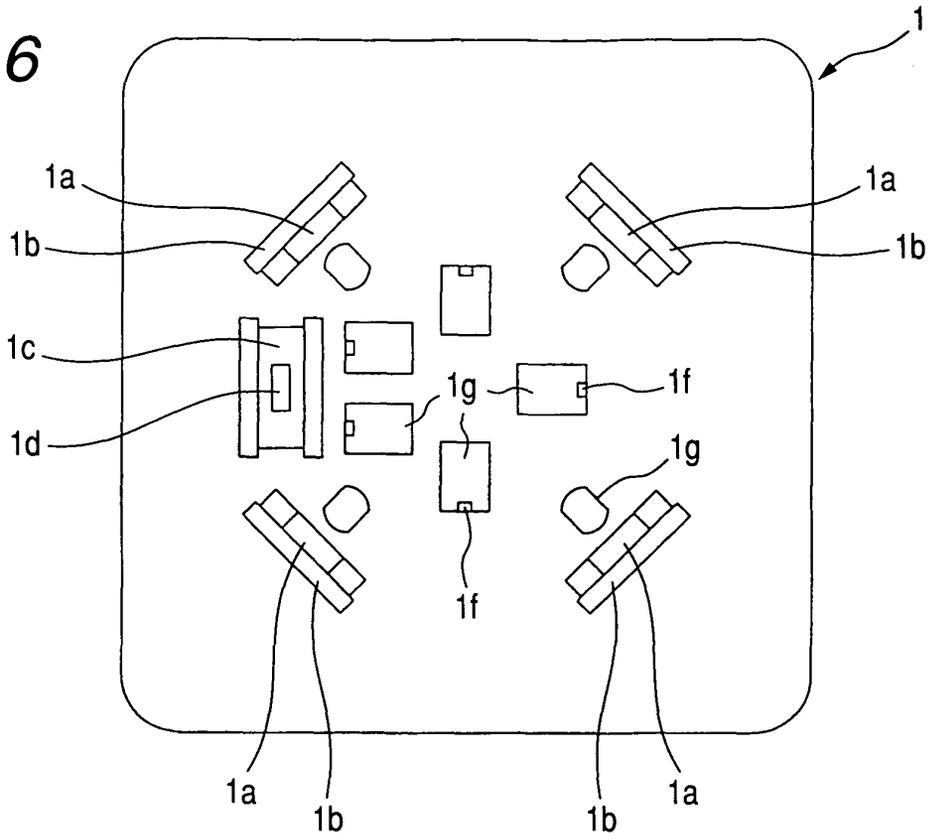
FIG. 6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1a

FIG. 7

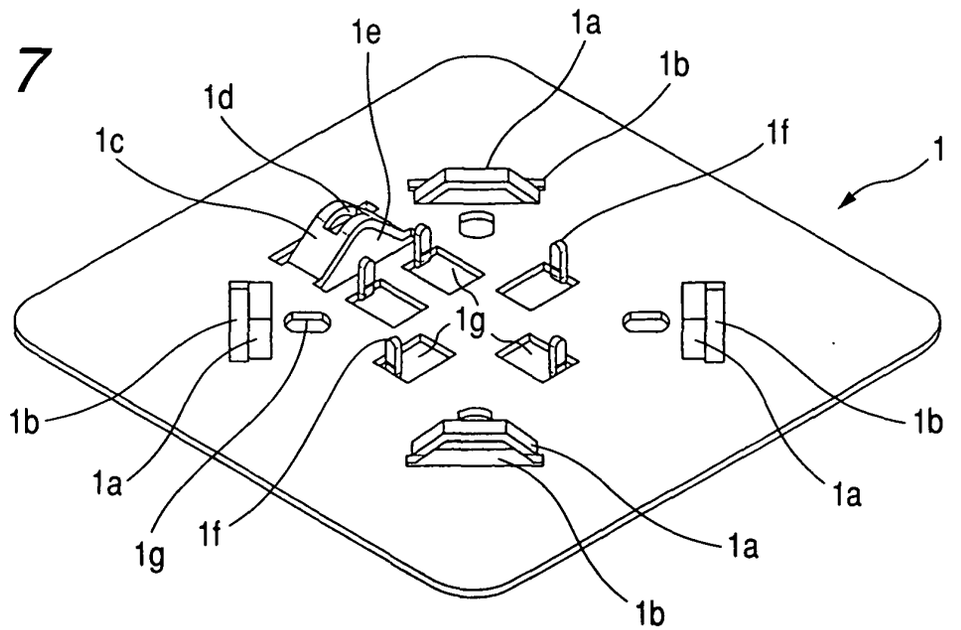

1e
1a
1b
1d
1c
1f
1
1g
1b
1a
1g
1f
1b
1a
1a
1b

FIG. 8

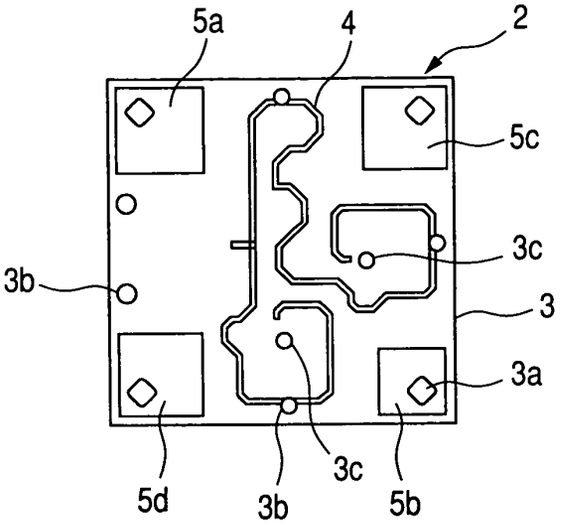


FIG. 9

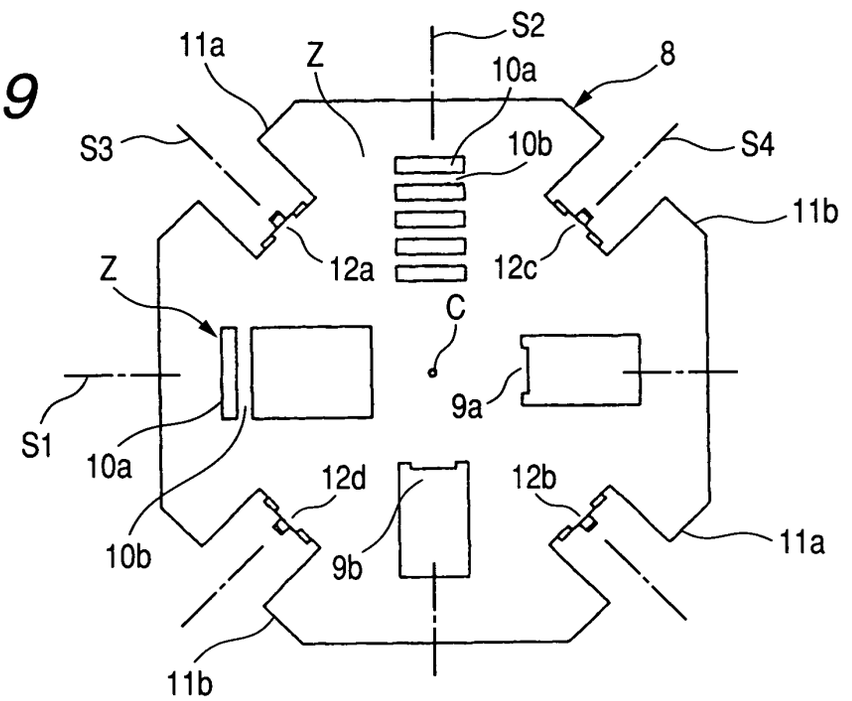


FIG. 10

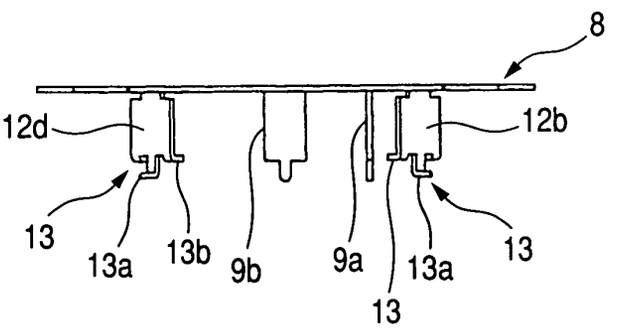


FIG. 11

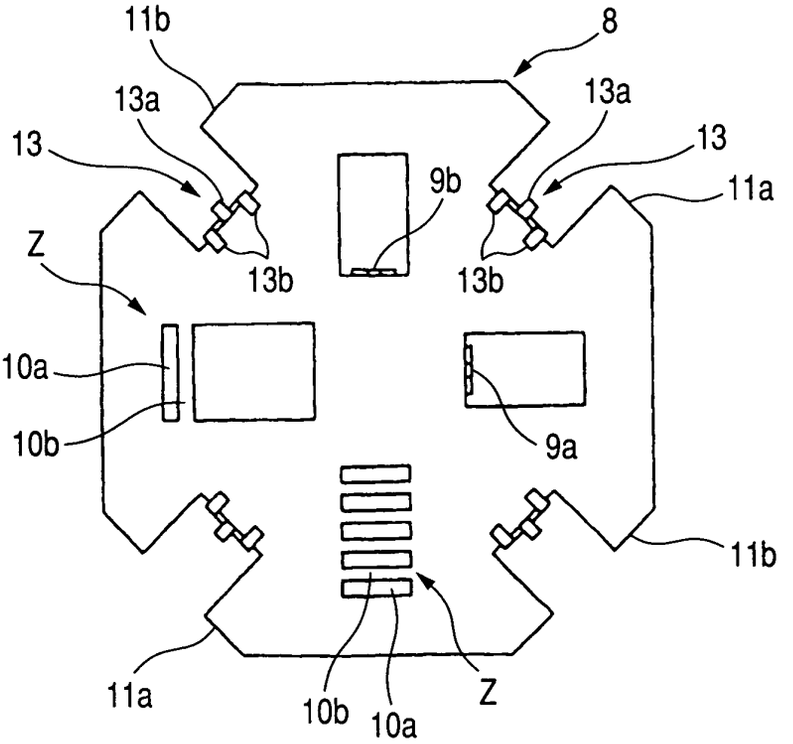

11b
8
13a
13a
13
13
9b
11a
Z
13b
13b
10a
10b
9a
11b
11a
10b
10a
Z

FIG. 12

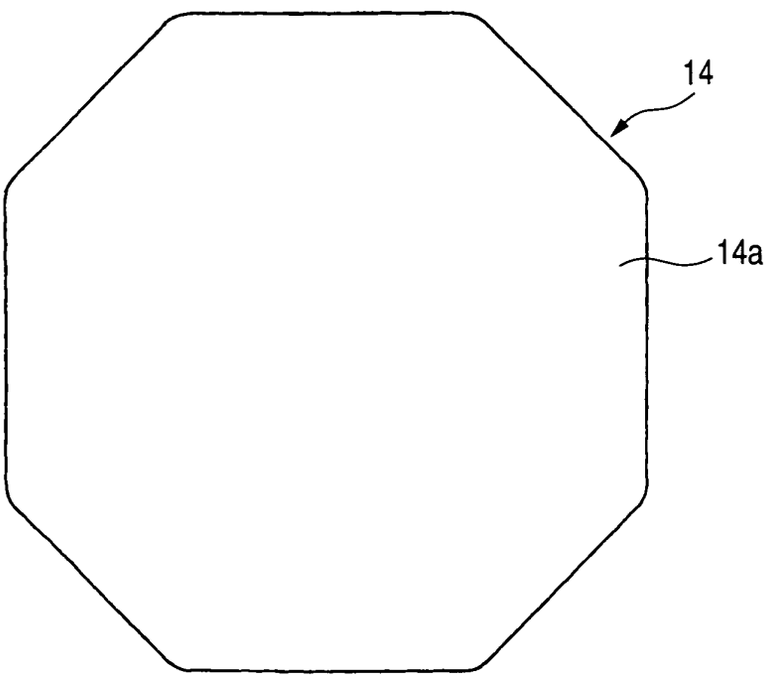

14
14a

FIG. 13

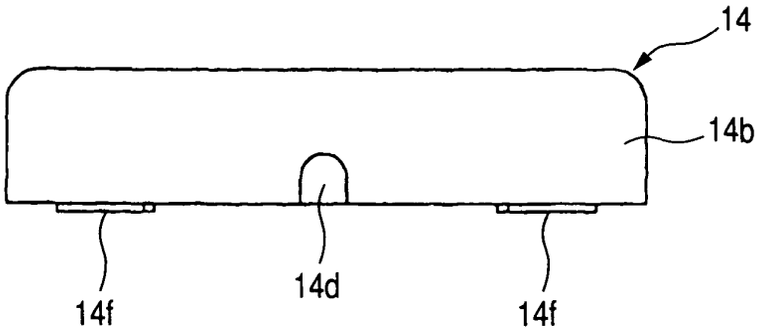


FIG. 14

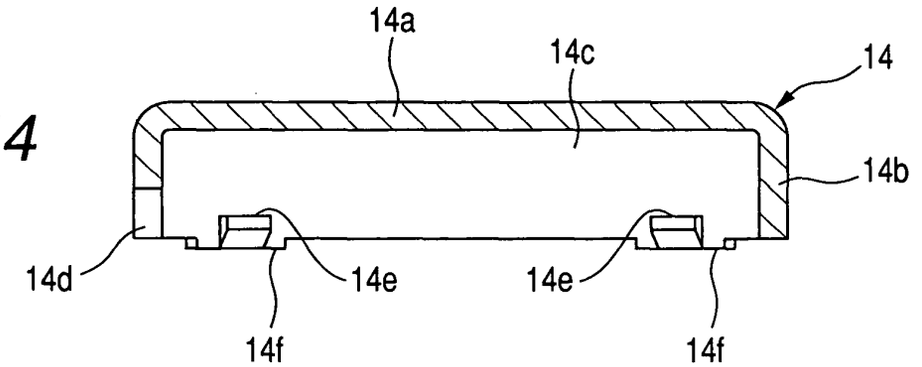


FIG. 15

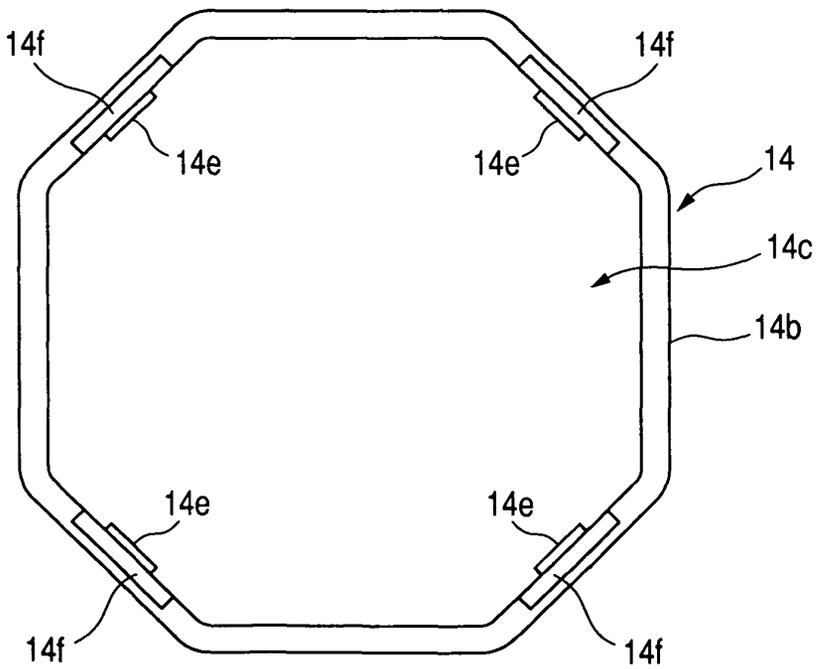
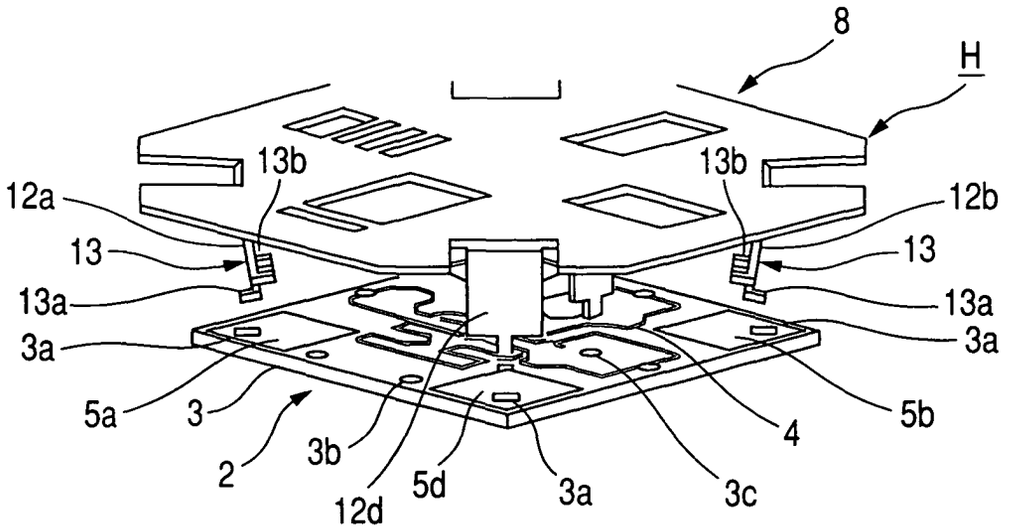


FIG. 16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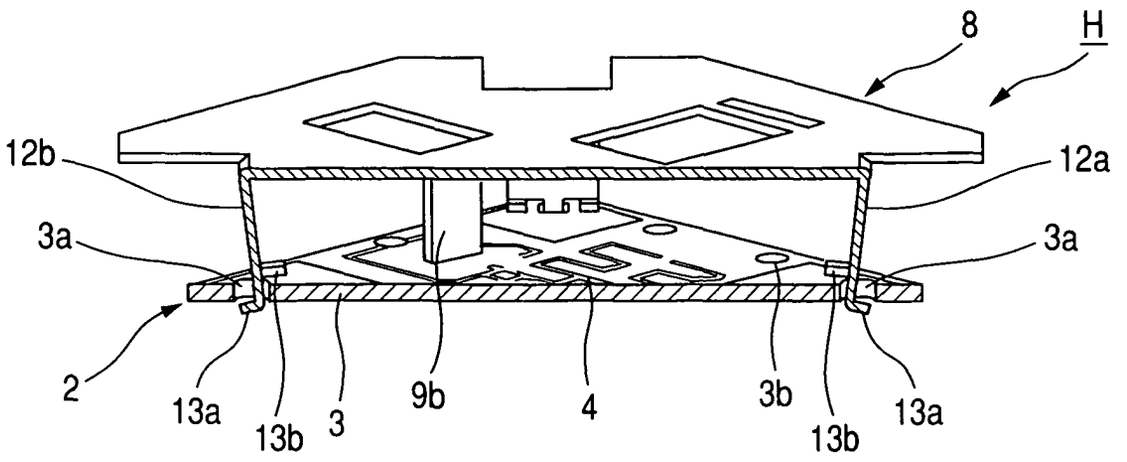
H
13b
13b
12a
12b
13
13
13a
13a
3a
3a
5a
3
2
3b
12d
5d
3a
3c
4
5b

FIG. 17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H
12b
12a
3a
3a
2
13a
13b
3
9b
4
3b
13b
13a

FIG. 18

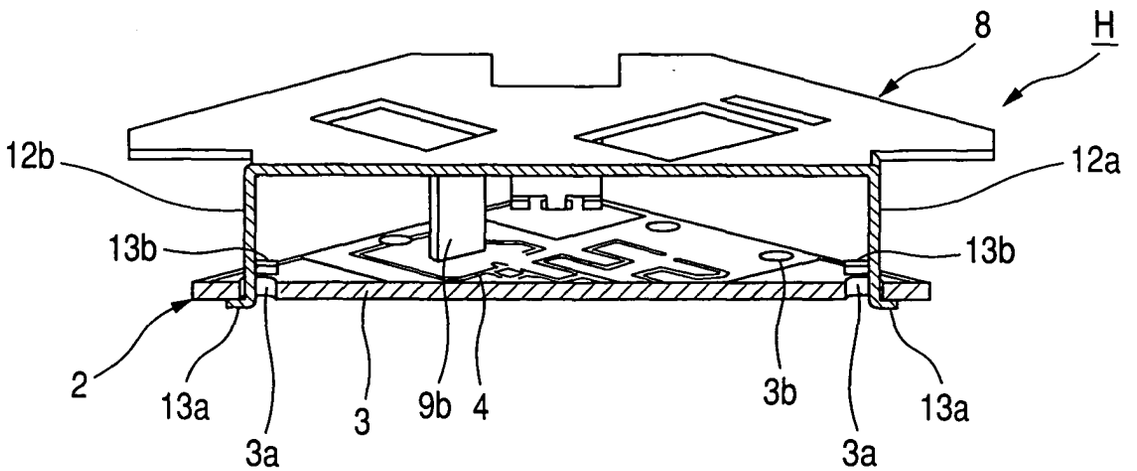

8
H
12b
12a
13b
13b
2
13a
3a
3
9b
4
3b
3a
13a

FIG. 19

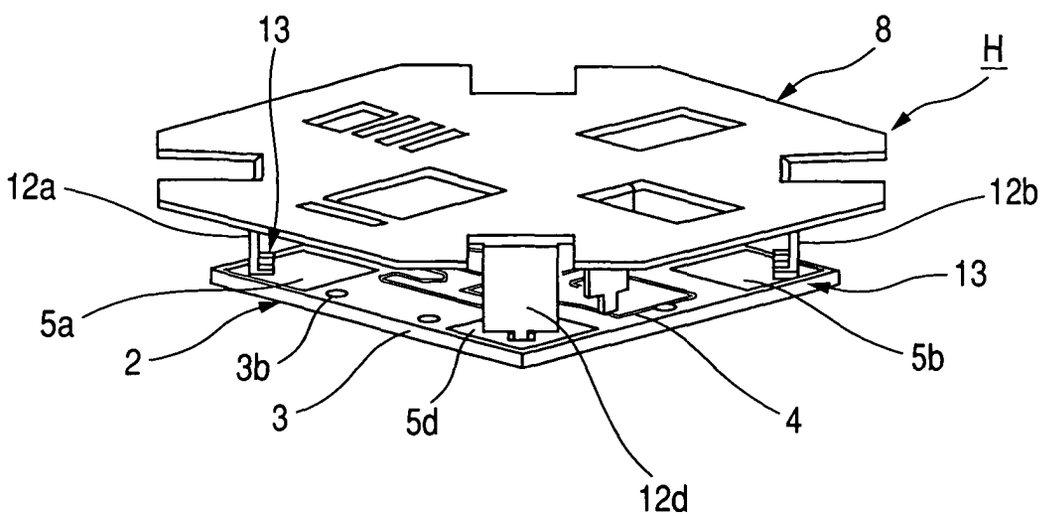

13
8
H
12a
12b
13
5a
2
3b
3
5d
4
5b
12d

FIG. 20

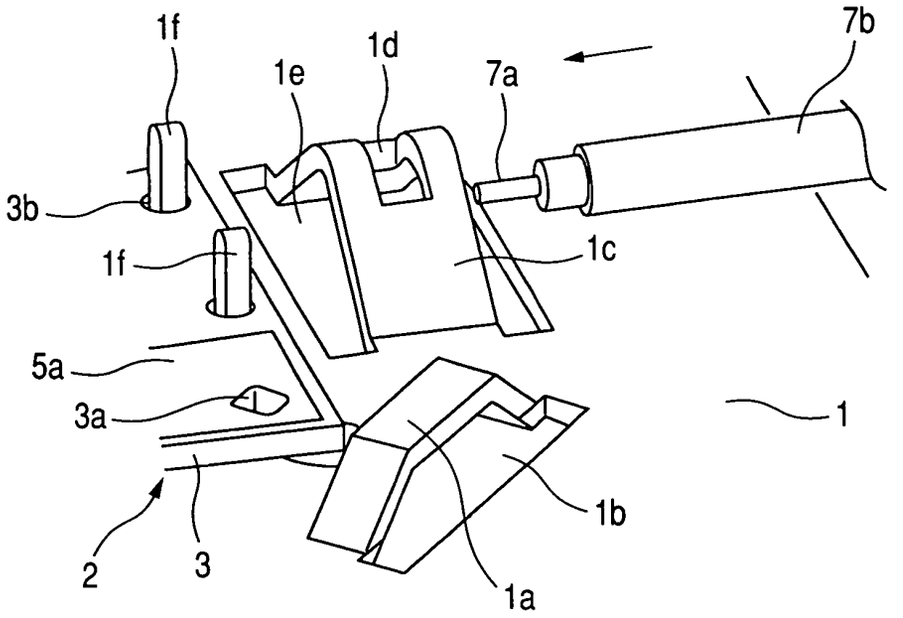

1f
1e
1d
7a
7b
3b
1f
1c
5a
3a
1
1b
2
3
1a

FIG. 21

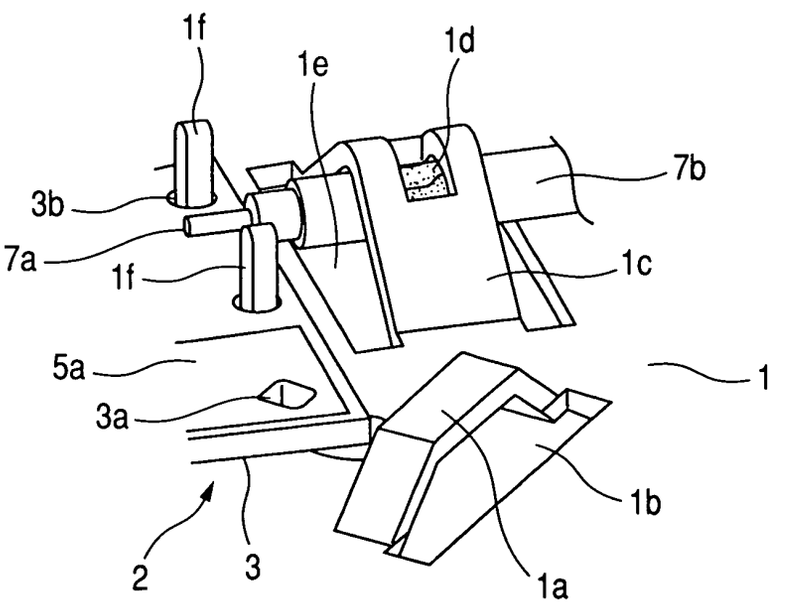

1f
1e
1d
7b
3b
7a
1f
1c
5a
1
3a
1b
2
3
1a

FIG. 22
PRIOR ART

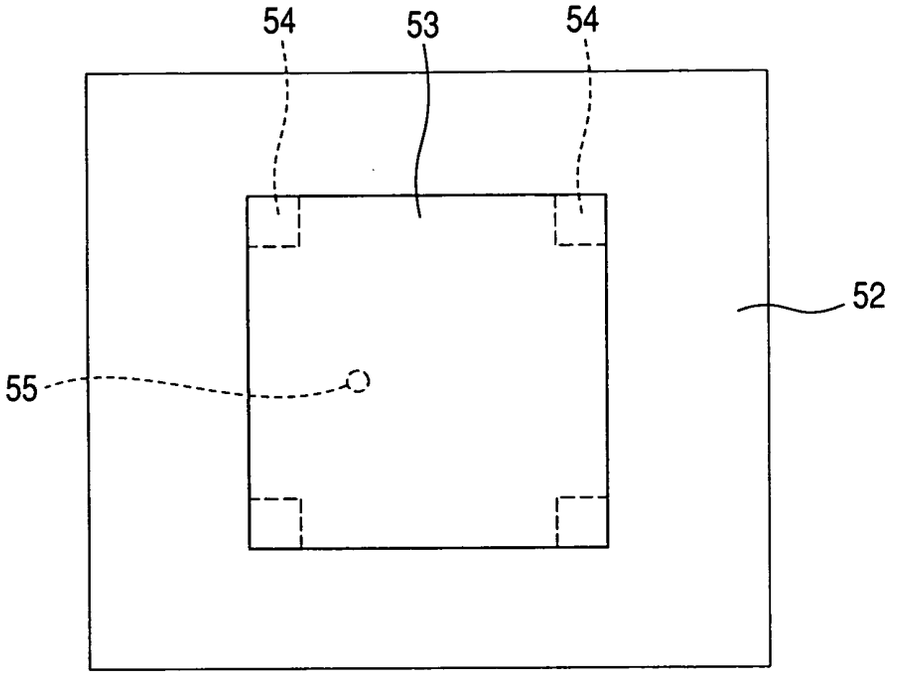
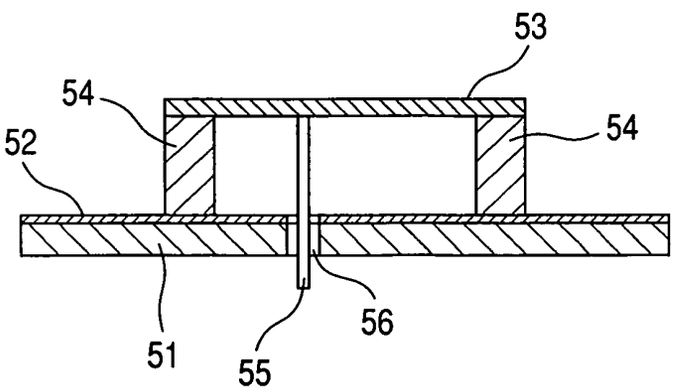


FIG. 23
PRIOR ART



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Application Number
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A	US 5 294 938 A (MATSUO MASAYUKI ET AL) 15 March 1994 (1994-03-15) * figure 5 *	1-5	
A	EP 0 684 661 A (MURATA MANUFACTURING CO) 29 November 1995 (1995-11-29) * abstract *	1-5	
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			H01Q

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
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