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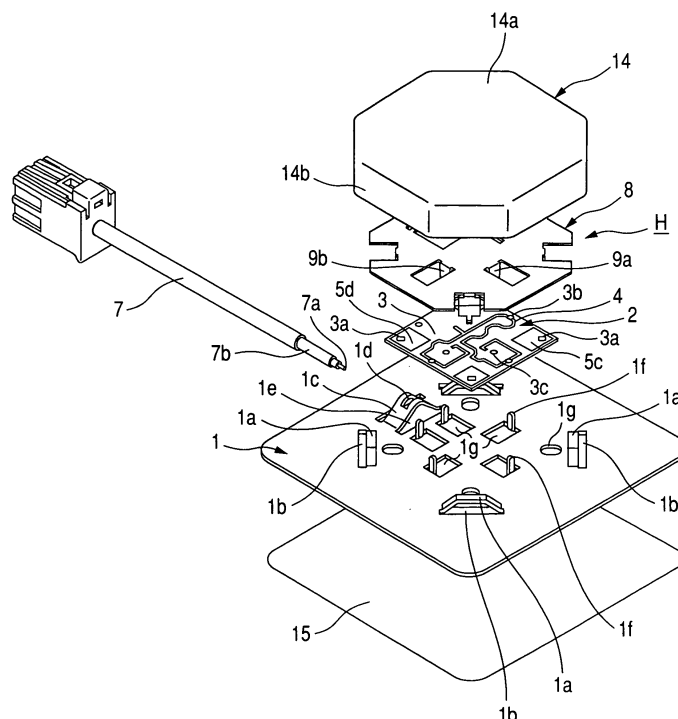
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(54) **Antenna device**

(57) The antenna device comprises an antenna main body portion (H) having a circuit board (2) on which a ground conductor plate (1) made of a metal plate, a radiating conductor plate (8) made of a metal plate, and an electronic component (6) are installed to form a desired electrical circuit. Further, the device also has a cable (7) connected to the electrical circuit. The ground conductor plate (1) has a stopper portion (1c) formed by

cutting the ground conductor plate (1) and raising the cut portion toward the radiating conductor plate (8), the stopper portion having an insertion portion (1e) provided therebelow. The cable (7) is inserted into the insertion portion (1e) and supported by the stopper portion (1c). Thus, the cable (7) can be supported by the stopper portion (1c) which is incorporated into the ground conductor plate (1).

FIG. 5



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 antenna or the like.

2. Description of the Related Art

[0002] A conventional antenna device will be described with reference to the accompanying drawings. Fig. 22 is a cross-sectional view showing schematically an overall configuration of a conventional antenna device, and Fig. 23 is an expanded cross-sectional view showing essential parts of the conventional antenna device.

[0003] Next, a configuration of the conventional antenna device will be described with reference to Figs. 22 and 23. On a top surface of a boxlike case 51, a ground conductor plate 52 is mounted. At the same time, to an upper end portion of a post 51a which is provided to project into the case 51, an antenna element 53 is mounted.

[0004] Further, on a bottom surface of the ground conductor plate 52, a shield cover 54 is mounted, and a coaxial cable 55 is inserted in a cavity of the shield cover 54. An outer conductor 56 of the coaxial cable 55 is soldered to the shield cover 54, and simultaneously a central conductor 57 of the coaxial cable 55 is bent upward and then supported by a holding member 58.

[0005] And then, the central conductor 57 supported by the holding member 58 is connected to the antenna element 53. At the same time, a cuplike cover 59 is mounted on the case 51 to cover the antenna element 53, so that the conventional antenna device is constructed (for example, see Japanese Unexamined Patent Application Publication No. 2003-60414).

[0006] However, in such a conventional antenna device, since the outer conductor 56 is soldered to the shield cover 54, the coaxial cable 55 can be stably mounted. In this case, however, the shield cover 54, separated from the ground conductor plate 52, is needed, which results in increasing the number of components. Consequently, the manufacturing cost increases, the mounting work becomes complicated, and the productivity decreases.

SUMMARY OF THE INVENTION

[0007] Accordingly, it is an object of the present invention to provide an inexpensive antenna device has decreased number of components and favorable assembling quality.

[0008] In order to solve the above problems, according to a first aspect of the present invention, there is provided an antenna device comprising an antenna main body portion having a circuit board on which a ground conductor plate made of a metal plate, a radiating conductor plate made of a metal plate and an electronic component are installed to form a desired electrical circuit, and a cable connected to the electrical circuit, in which the ground conductor plate has a stopper portion which is formed by cutting the ground conductor plate and raising the cut portion toward the radiating conductor plate, the stopper portion having an insertion portion provided therebelow, and the cable is inserted into the insertion portion and supported by the stopper portion.

[0009] Further, according to a second aspect of the present invention, the cable is a coaxial cable having a central conductor and an outer conductor covering an outside of the central conductor, and the outer conductor is soldered to the stopper portion.

[0010] Further, according to a third aspect of the present invention, a cut-out portion is provided in the stopper portion, and the outer conductor is soldered to the stopper portion at a position in the cut-out portion.

[0011] Further, according to a fourth aspect of the present invention, at least a portion of a top surface of the stopper portion is arranged to face the radiating conductor plate in its vicinity of a circumferential edge portion of the radiating conductor plate.

[0012] Further, according to a fifth aspect of the present invention, the stopper portion is arranged along a circumferential edge of the radiating conductor plate.

[0013] The antenna device of the present invention comprises the antenna main body portion having the circuit board on which the ground conductor plate made of the metal plate, the radiating conductor plate made of the metal plate, and the electronic component are mounted to form the desired electrical circuit, and the cable connected to the electrical circuit. Further, in the antenna device of the present invention, the ground conductor plate has the stopper portion which is formed by cutting the ground conductor plate and raising the cut portion toward the radiating conductor plate, the stopper portion having an insertion portion provided therebelow, and the cable is inserted into the insertion portion and supported by the stopper portion. According to this configuration, the cable can be supported by the stopper portion which is incorporated into the ground conductor plate. Therefore, an additional component for supporting the cable is not needed, and thus an inexpensive antenna device having decreased number of components and the favorable assembling quality can be obtained.

[0014] Further, the cable is the coaxial cable having the central conductor and the outer conductor covering the outside of the central conductor, and the outer conductor is soldered to the stopper portion. Thus, the cable can be securely supported.

[0015] Further, a cut-out portion is provided in the stopper portion, and the outer conductor is soldered to the stopper portion at a position in the cut-out portion.

Thus, the soldering of the stopper portion and the outer conductor can be advantageously carried out to securely support the cable.

[0016] Further, at least a portion of a top surface of the stopper portion is arranged to face the radiating conductor plate in the vicinity of a circumferential edge portion of the radiating conductor plate. Thus, an additional capacitance is generated between the stopper portion and the radiating conductor plate, which makes it possible to reduce a resonant frequency. Further, it is also possible to plan the miniaturization of the radiating conductor plate.

[0017] Further, the stopper portion is arranged along the outer circumferential edge of the radiating conductor plate. Thus, it is possible to arrange a position of the stopper portion even at a center of the radiating conductor plate, to miniaturize the device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

Fig. 1 is a plan view showing an 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 cross-sectional view taken along a line 3-3 of Fig. 1;

Fig. 4 is a cross-sectional view taken along a line 4-4 of Fig. 1;

Fig. 5 is an exploded perspective view showing the antenna device according to the present invention;

Fig. 6 is 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 board 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 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 cross-sectional view showing schematically the cover of the antenna device according to the present invention;

Fig. 15 is a bottom 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 cross-sectional view showing schematically an overall configuration of a conventional antenna device; and

Fig. 23 is an expanded cross-sectional view showing essential parts of the conventional antenna device.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0019] 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.

[0020] 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.

[0021] 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.

[0022] 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.

[0023] 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.

[0024] 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, 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.

[0025] 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.

[0026] 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.

[0027] 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.

[0028] 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.

[0029] 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.

[0030] 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.

[0031] 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.

[0032] 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.

[0033] 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.

[0034] 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.

[0035] And then, under the state of 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.

[0036] 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.

[0037] 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.

[0038] 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.

[0039] 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.

[0040] 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.

[0041] 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.

[0042] 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.

[0043] 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.

[0044] 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.

[0045] 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 re-

silience of the leg pieces 12a to 12d, the leg pieces 12a to 12d are bent inward respectively.

[0046] 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.

[0047] 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.

[0048] 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.

[0049] 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.

[0050] 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.

[0051] In this example, the length of the radiating conductor 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.

[0052] 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.

[0053] 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.

[0054] 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.

[0055] 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.

[0056] 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.

[0057] 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.

[0058] 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.

[0059] 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.

[0060] With such a configuration, the antenna device of the present invention is formed.

Claims

1. An antenna device comprising:

an antenna main body portion having a circuit board on which a ground conductor plate made of a metal plate, a radiating conductor plate made of a metal plate, and an electronic component are provided to form a desired electrical circuit; and
a cable connected to the electrical circuit,

wherein the ground conductor plate has a stopper portion formed by cutting the ground conductor plate and raising the cut portion toward the radiating conductor plate, the stopper portion having an insertion portion provided therebelow, and the cable is inserted into the insertion portion and supported by the stopper portion.

2. The antenna device according to claim 1,

wherein the cable is a coaxial cable having a central conductor and an outer conductor covering the central conductor, and the outer conductor is soldered to the stopper portion.

3. The antenna device according to claim 2,

wherein a cut-out portion is provided in the stopper portion, and the outer conductor is soldered to the stopper portion at a position in the cut-out portion.

4. The antenna device according to any one of claims 1 to 3,

wherein at least a portion of a top surface of the stopper portion is arranged to face the radiating conductor plate in a vicinity of a circumferential edge portion of the radiating conductor plate.

5. The antenna device according to any one of claims 1 to 4,

wherein the stopper portion is arranged along the circumferential edge of the radiating conductor plate.

FIG. 3

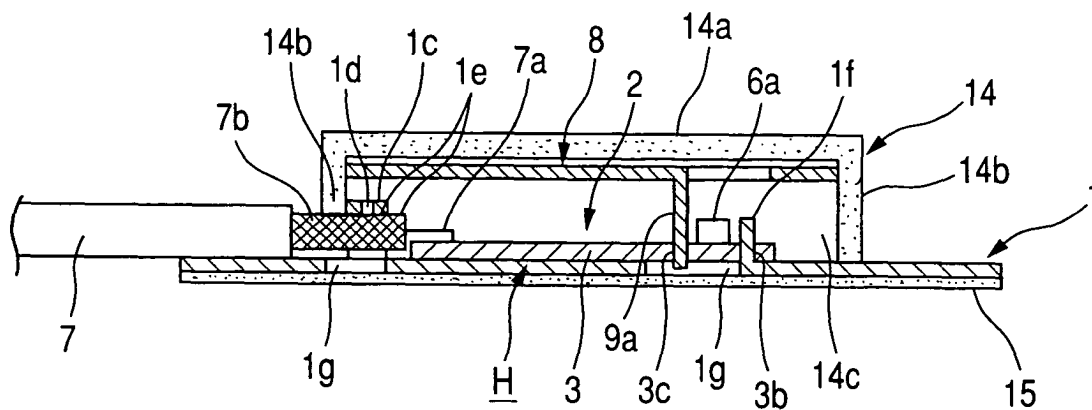


FIG. 4

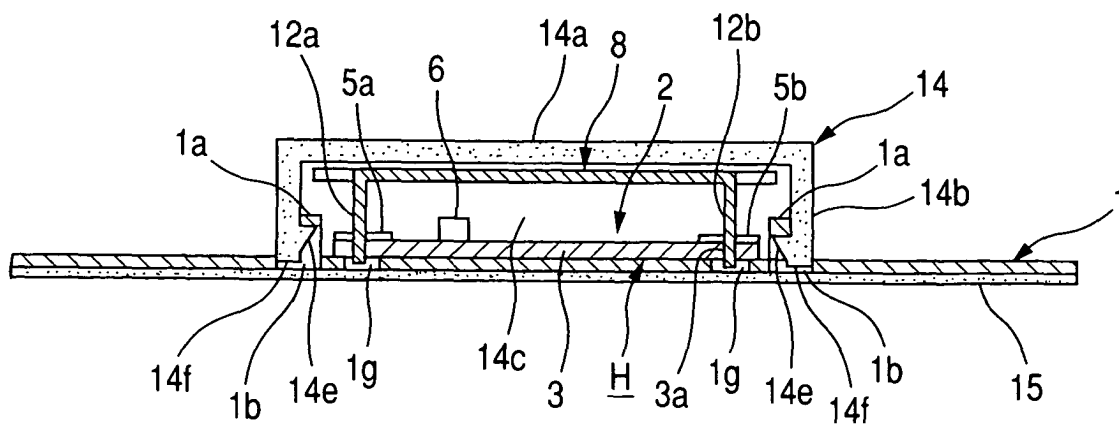


FIG. 5

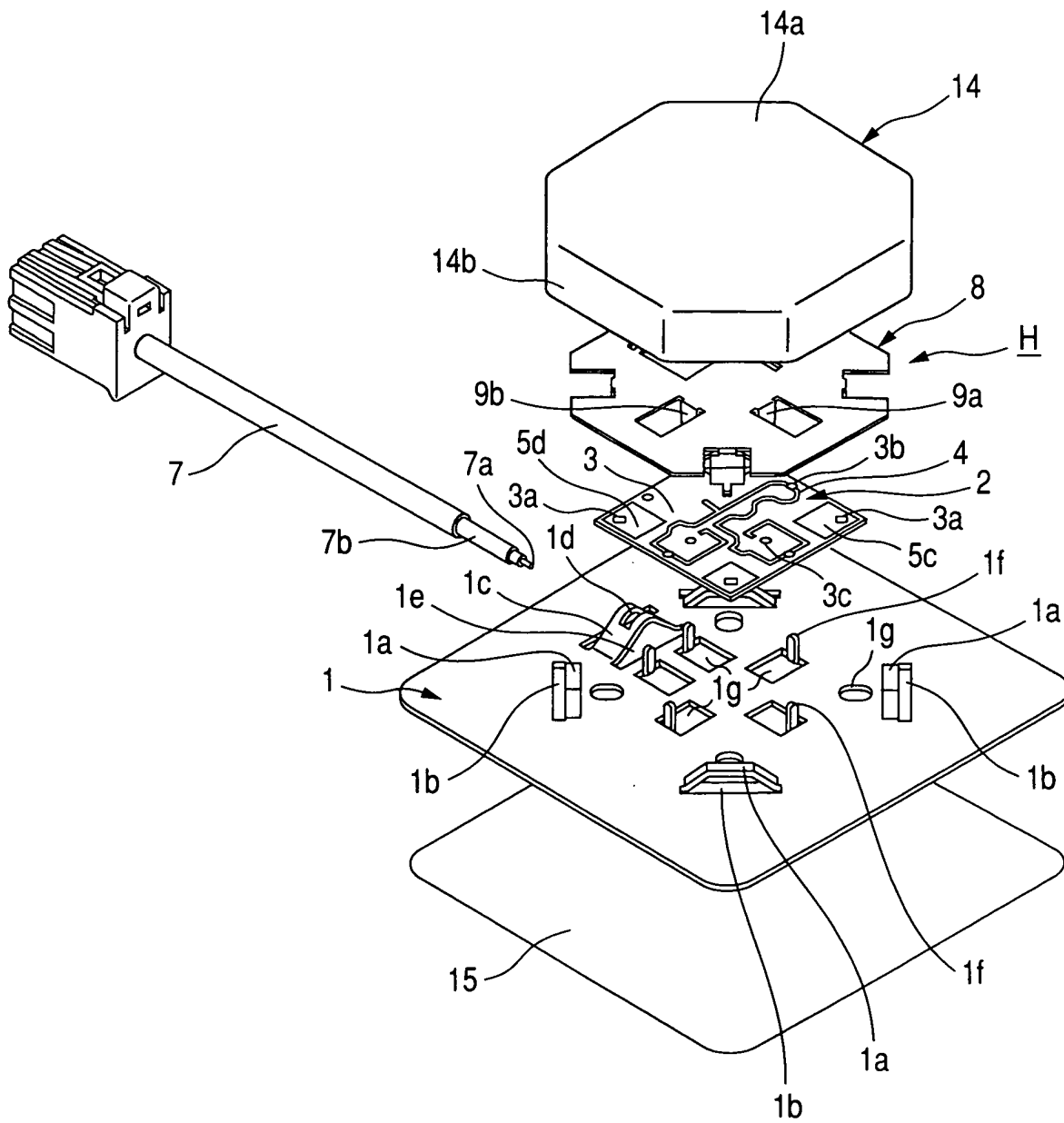


FIG. 6

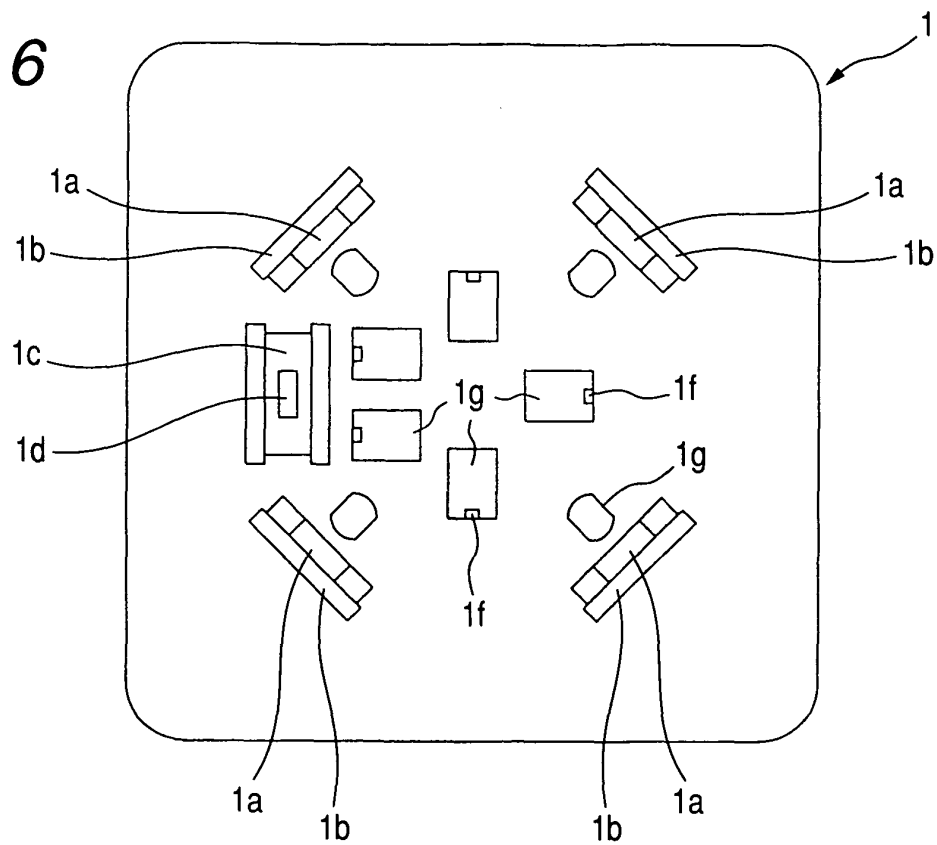


FIG. 7

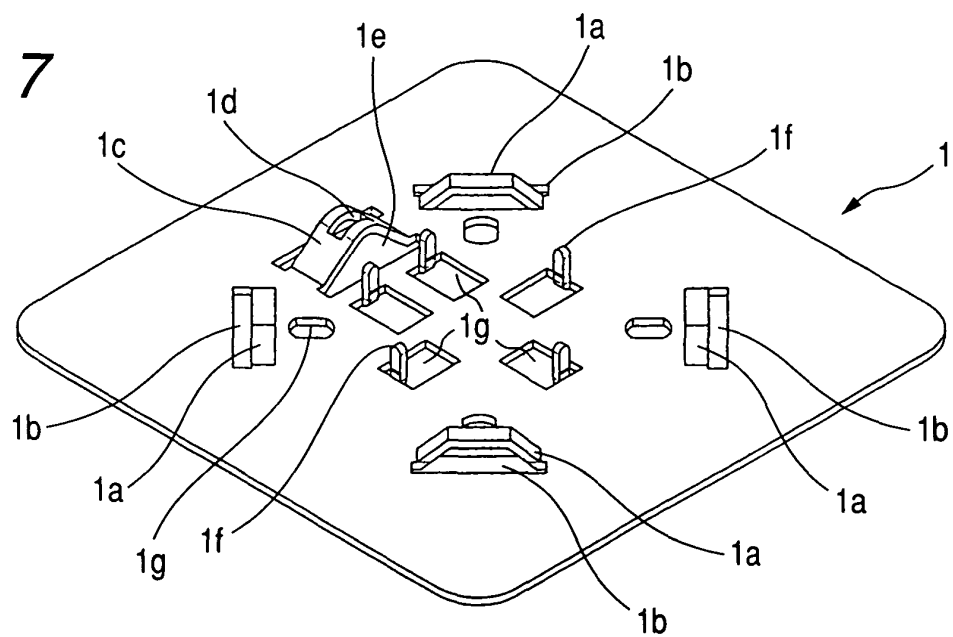


FIG. 8

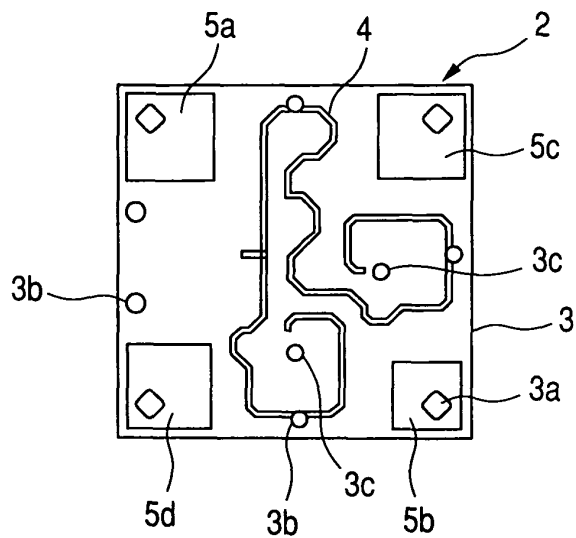


FIG. 9

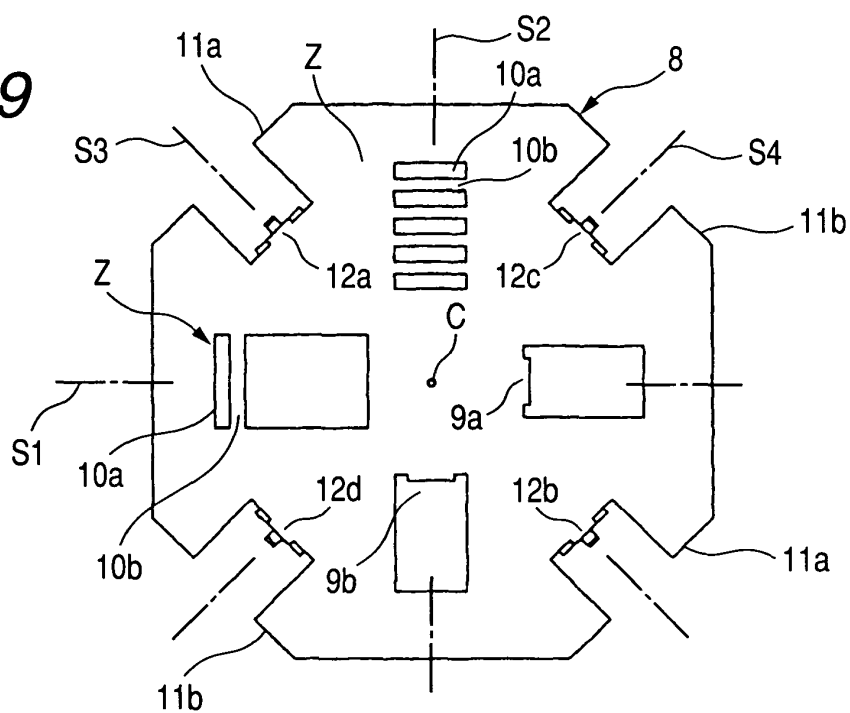


FIG. 10

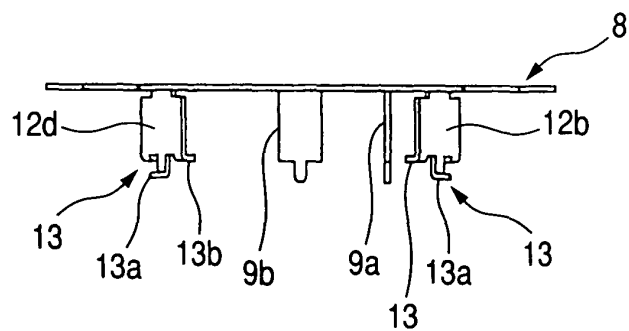


FIG. 11

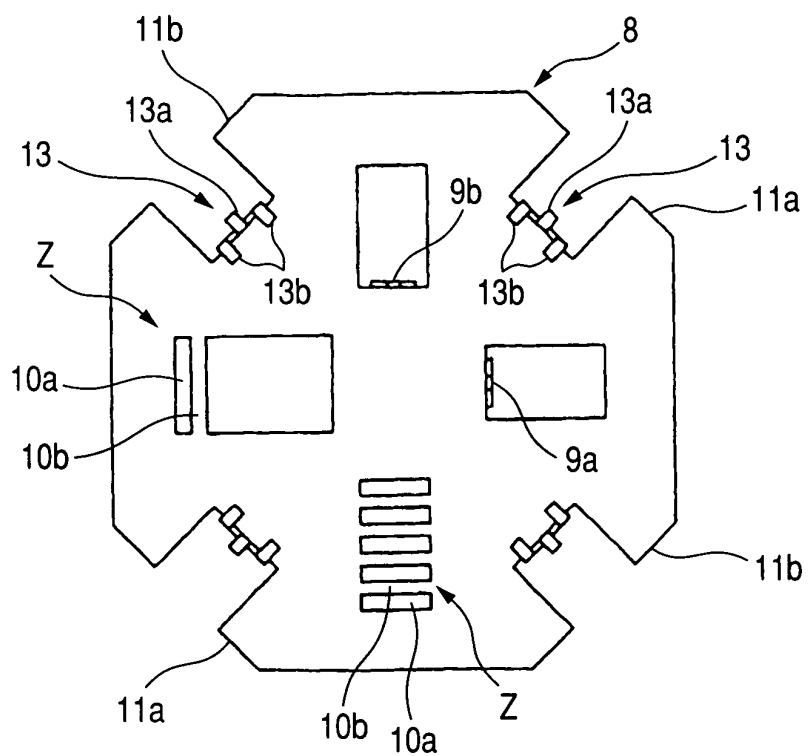


FIG. 12

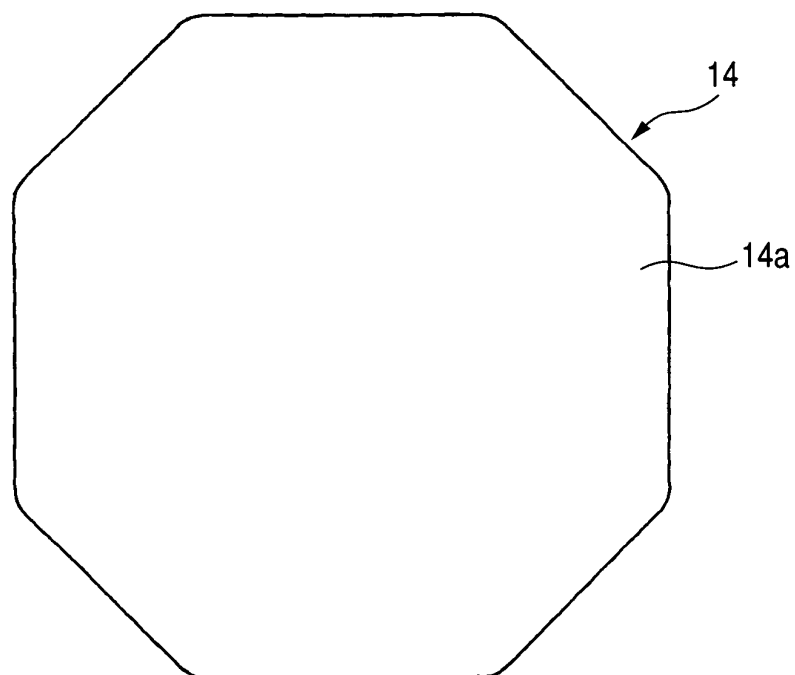


FIG. 13

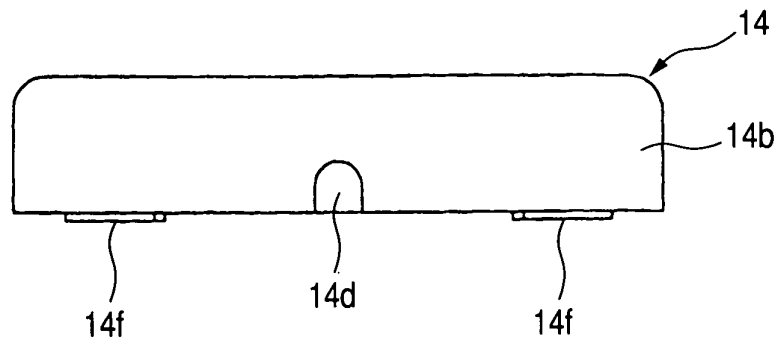


FIG. 14

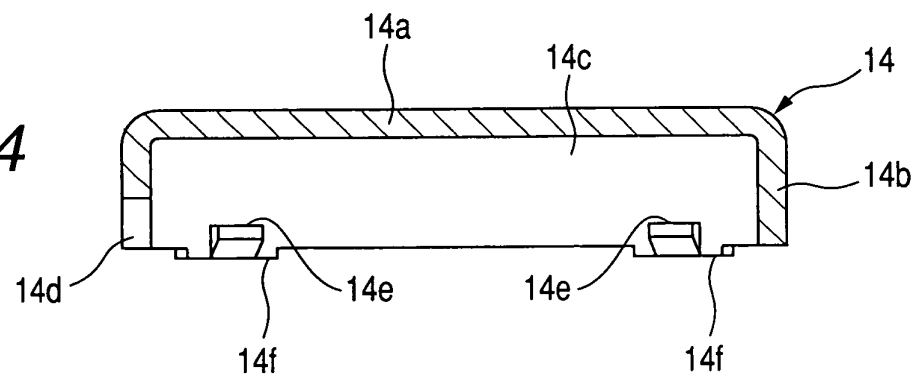


FIG. 15

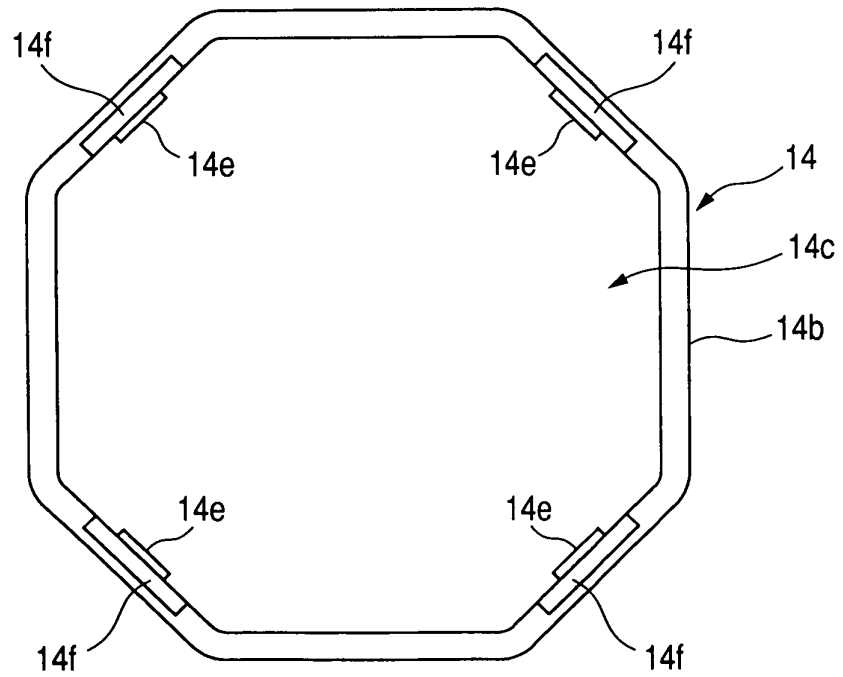


FIG. 16

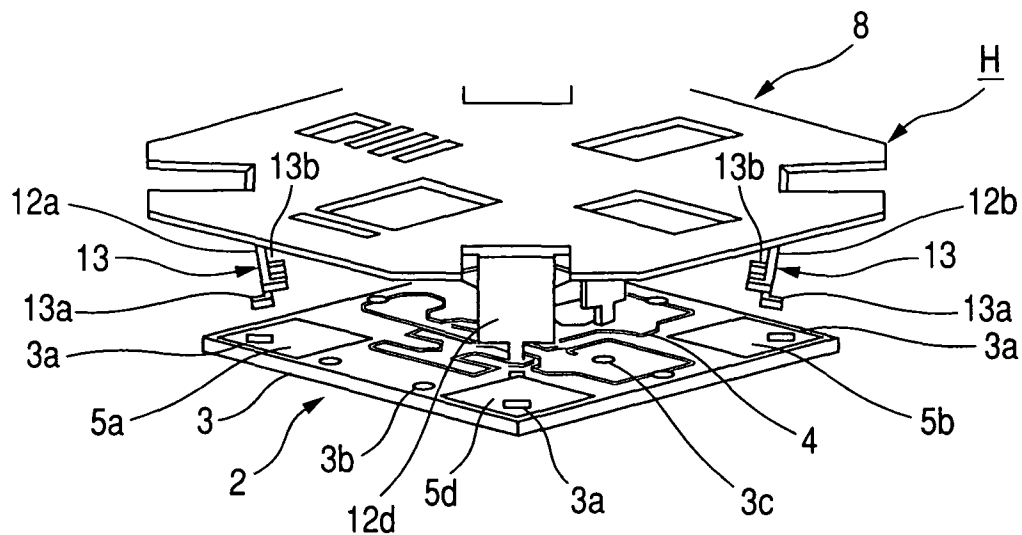


FIG. 17

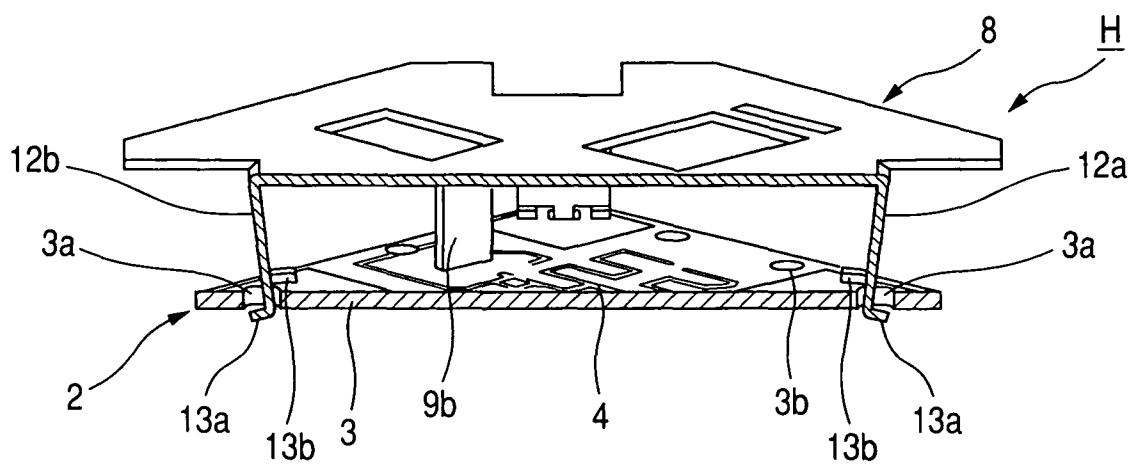


FIG. 18

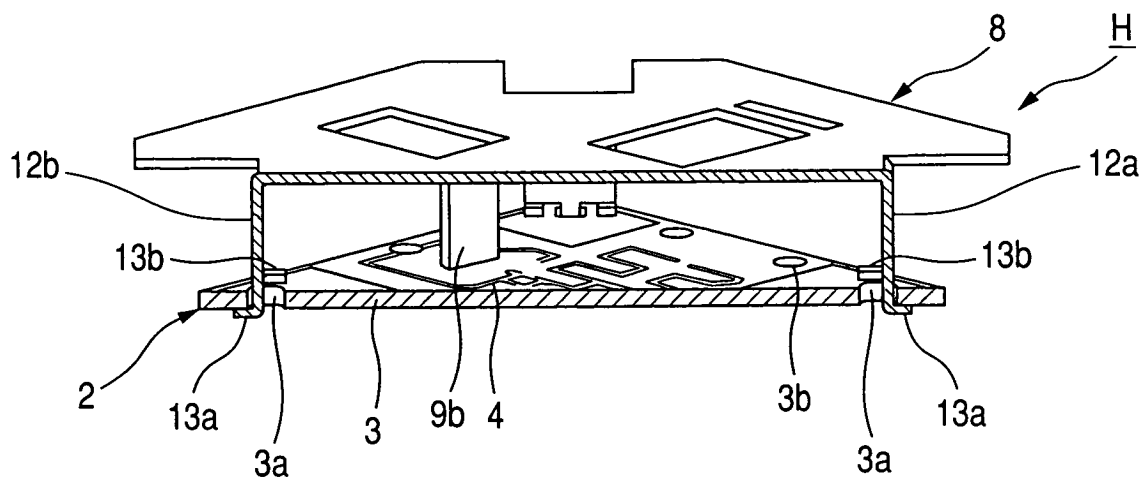


FIG. 19

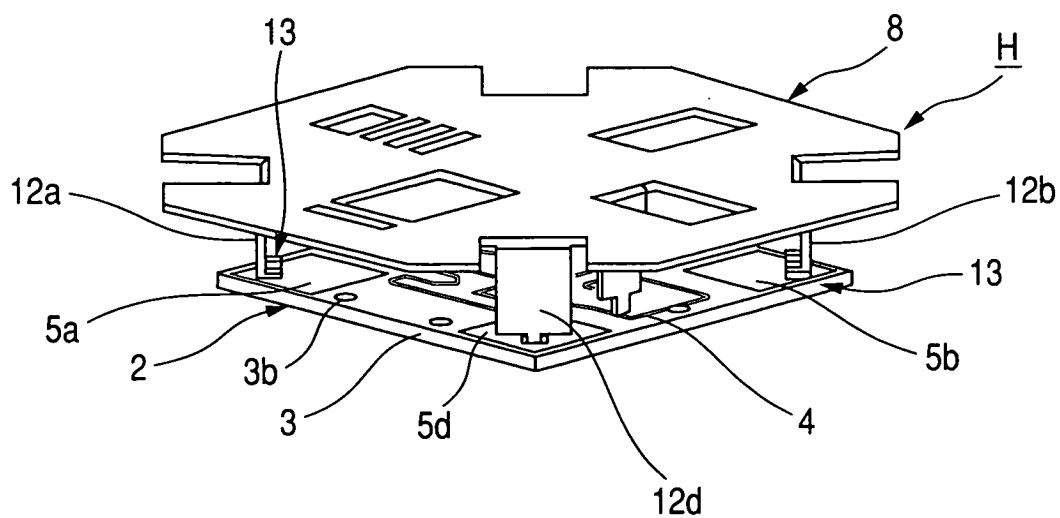


FIG. 20

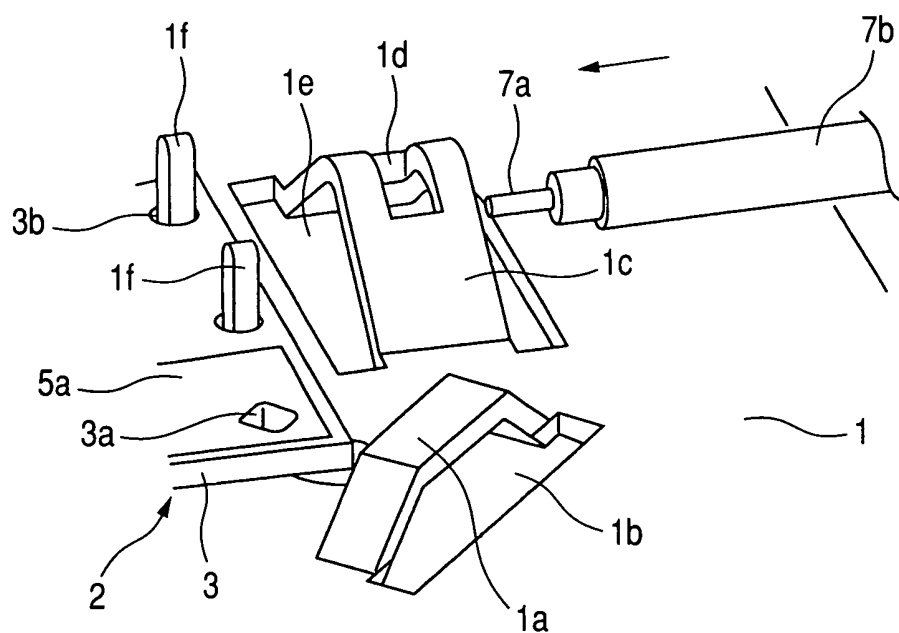


FIG. 21

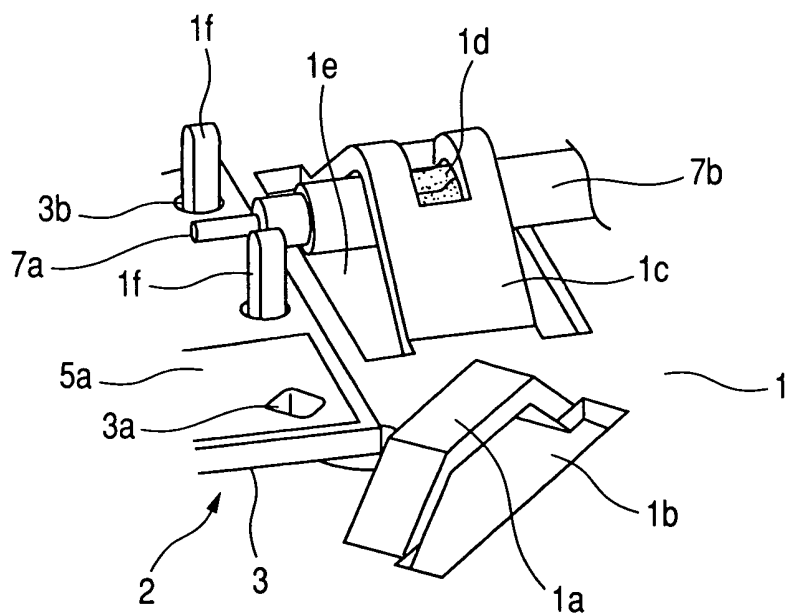


FIG. 22
PRIOR ART

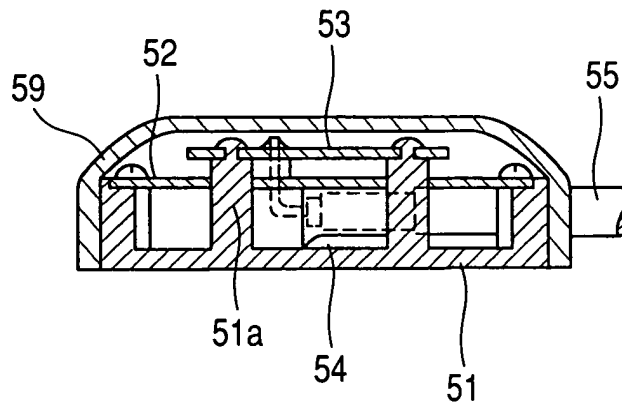
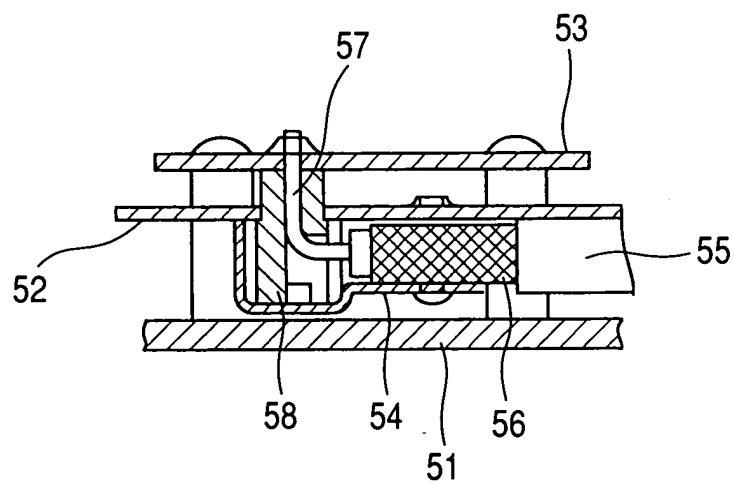


FIG. 23
PRIOR ART





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 02 7521

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 6 222 497 B1 (SKOGSFORS OLA ET AL) 24 April 2001 (2001-04-24) * column 7, lines 1-16; figures 3,11 * * column 6, lines 32,33 * -----	1-5	H01Q9/04 H01Q1/32
X	US 5 294 938 A (MATSUO MASAYUKI ET AL) 15 March 1994 (1994-03-15) * column 3, line 45 - column 4, line 21; figures 1,2 * -----	1-3	
X	US 5 402 136 A (GOTO NAOHISA ET AL) 28 March 1995 (1995-03-28) * column 6, line 30 - line 44; figures 6,7 * -----	1-5	
A	US 6 342 860 B1 (SIMMONS KENNETH D ET AL) 29 January 2002 (2002-01-29) * figure 7 * -----	1-5	
A	WO 02/084800 A (HRL LAB LLC ; SIEVENPIPER DANIEL (US)) 24 October 2002 (2002-10-24) * page 16, line 9 - page 18, line 14; figures 7b,7c * -----	1	TECHNICAL FIELDS SEARCHED (Int.Cl.7) H01Q
A	US 5 757 327 A (YAMADA SHINYA ET AL) 26 May 1998 (1998-05-26) * column 1, line 24 - line 34; figures 4,5 * -----	1	
A	WO 97/41619 A (DORNE & MARGOLIN INC) 6 November 1997 (1997-11-06) * page 13, line 30 - page 14, line 10; figures 1,2 * ----- -/--	1	
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 13 January 2005	Examiner Kaleve, A
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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EPO FORM 1503 03.82 (P04C01)



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 02 7521

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
D,A	PATENT ABSTRACTS OF JAPAN vol. 2003, no. 06, 3 June 2003 (2003-06-03) -& JP 2003 060414 A (FURUKAWA ELECTRIC CO LTD:THE), 28 February 2003 (2003-02-28) * abstract; figures 4b,c,f * -----	3	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		13 January 2005	Kaleve, A
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			

4
EPO FORM 1503 03.82 (P04C01)

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

EP 04 02 7521

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

13-01-2005

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 6222497	B1	24-04-2001	SE 513525 C2	25-09-2000
			AU 1902400 A	13-06-2000
			DE 19983744 T0	22-11-2001
			SE 9803983 A	21-05-2000
			WO 0031825 A1	02-06-2000
US 5294938	A	15-03-1994	JP 2527054 Y2	26-02-1997
			JP 4112511 U	30-09-1992
			JP 2966553 B2	25-10-1999
			JP 4286405 A	12-10-1992
			JP 5003445 A	08-01-1993
US 5402136	A	28-03-1995	JP 3283046 B2	20-05-2002
			JP 5102897 A	23-04-1993
			JP 2044300 C	09-04-1996
			JP 6112732 A	22-04-1994
			JP 7070914 B	31-07-1995
US 6342860	B1	29-01-2002	NONE	
WO 02084800	A	24-10-2002	US 2003174095 A1	18-09-2003
			GB 2391712 A	11-02-2004
			WO 02084800 A2	24-10-2002
US 5757327	A	26-05-1998	JP 3206319 B2	10-09-2001
			JP 8046531 A	16-02-1996
			JP 8125425 A	17-05-1996
			JP 8125426 A	17-05-1996
			JP 3379248 B2	24-02-2003
			JP 8125427 A	17-05-1996
			JP 3379249 B2	24-02-2003
			JP 8130405 A	21-05-1996
			JP 9008517 A	10-01-1997
			JP 9008518 A	10-01-1997
			US 5900840 A	04-05-1999
WO 9741619	A	06-11-1997	AU 3116197 A	19-11-1997
			CA 2253265 A1	06-11-1997
			WO 9741619 A1	06-11-1997
			US 5864318 A	26-01-1999
JP 2003060414	A	28-02-2003	NONE	

EPO FORM P0459

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