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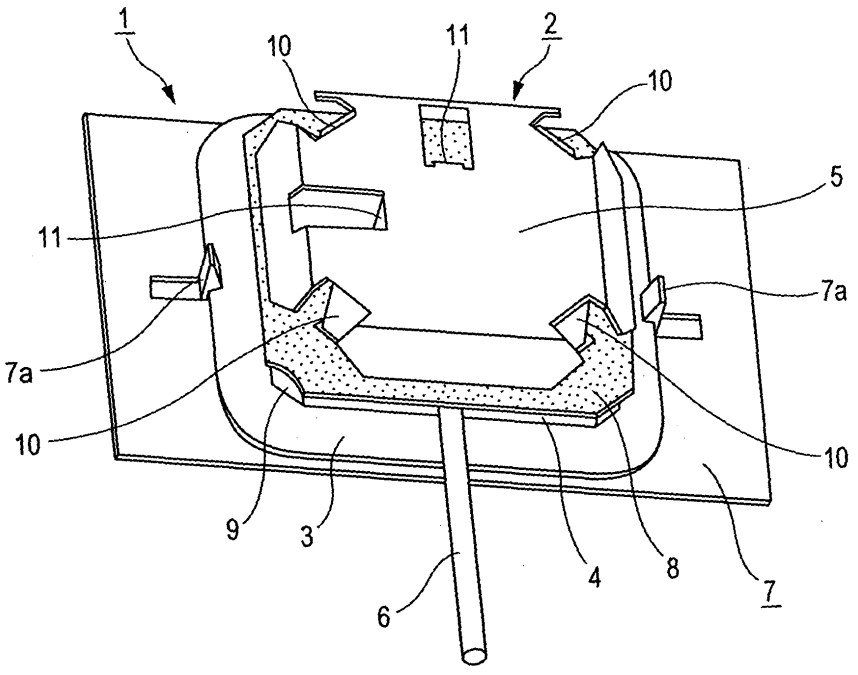
(54) Antenna device

(57) An antenna device includes a main antenna body having a patch antenna element; a feeder cable connected to and extending outward from the main antenna body; and a sheet-metal bracket which supports the main antenna body and is mounted to an installation base material, such as a dashboard. For example, the bracket has a shape of a rectangle. In order to increase the radiation gain at a low elevation angle in the cable-extending direction, the widthwise direction of the bracket is substantially aligned with the cable-extending direction. On the other hand, in order to reduce the radiation towards a back surface of the antenna device in a specific direction, the lengthwise direction of the bracket is substantially aligned with the cable-extending direction so that the lengthwise direction is aligned with this specific direction.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a small-size antenna device that is mountable by means of a sheet-metal bracket and is suitable as, for example, a GPS (Global Positioning System) antenna.

2. Description of the Related Art

[0002] In recent years, vehicles equipped with small-size antenna devices, such as GPS antennas, installed on dashboards have been increasing. In an antenna device of this type, a main antenna body having a patch antenna element, a feeder circuit, and the like is connected to a feeder cable, such as a coaxial cable. Via the feeder cable, the main antenna body is electrically connected to an external device, such as a receiver. Japanese Unexamined Patent Application Publication No. 2004-228802 (pp. 4 to 8, Fig. 6) discloses an example of an antenna device of this type. Generally, the feeder cable connected to the main antenna body extends toward a windshield and then downward. Moreover, in most cases, a magnet is used to magnetically support the main antenna body above a sheet-metal bracket fixed on an installation base material, such as a dashboard. Because the bracket also functions as a ground plate, the bracket contributes to higher radiation gain. In view of the fact that the main antenna body is set in the midsection of the bracket, the bracket is generally given a square shape to prevent the directional characteristics of a radiation pattern from being affected.

[0003] Although a square-shaped bracket is generally used for supporting the main antenna body as mentioned above, after a thorough examination on the radiation pattern of an antenna device of this type conducted by the inventors of the present invention, it was found that the feeder cable connected to the main antenna body and extending outward from the bracket acts as if a ground plate is extending from the bracket, thus having an effect on the radiation pattern. This led to problems in, for example, GPS antennas where sufficient radiation gain at a low elevation angle cannot be attained in the traveling direction of the vehicle, which is the same as the extending direction of the feeder cable.

[0004] Moreover, in a case where an antenna device is installed on a dashboard having various types of electronic devices stored in a space therebelow, the radiation towards the back surface of the antenna device may act as a noise source against the neighboring electronic devices. However, this point was not particularly taken into consideration in the prior art.

SUMMARY OF THE INVENTION

[0005] Accordingly, a first object of the present invention is to provide an antenna device that can attain high radiation gain at a low elevation angle in a cable-extending direction. Furthermore, a second object of the present invention is to provide an antenna device in which the radiation towards the back surface of the antenna device is prevented from acting as a noise source against neighboring electronic devices.

[0006] In order to achieve the first object, the present invention provides an antenna device including a main antenna body having a patch antenna element; a feeder cable connected to and extending outward from the main antenna body; and a sheet-metal bracket which supports the main antenna body and is mounted to an installation base material, such as a dashboard. The bracket has a shape having a long axis and a short axis, such as a rectangular shape, the two axes being perpendicular to each other and both extending through a center of the bracket. A direction in which the short axis of the bracket extends is substantially aligned with a direction in which the feeder cable extends.

[0007] In the antenna device having this configuration, in view that the feeder cable connected to the main antenna body and extending in one direction may affect the radiation pattern, the length of the bracket in the cable-extending direction is made shorter than the length of the bracket in a direction perpendicular to the cable-extending direction. This allows for a less effect of the ground on a radiation conductor included in the patch antenna element in the cable-extending direction, thereby achieving higher radiation gain at a low elevation angle in that direction.

[0008] In order to achieve the second object, the present invention provides an antenna device including a main antenna body having a patch antenna element; a feeder cable connected to and extending outward from the main antenna body; and a sheet-metal bracket which supports the main antenna body and is mounted to an installation base material, such as a dashboard. The bracket has a shape having a long axis and a short axis, such as a rectangular shape, the two axes being perpendicular to each other and both extending through a center of the bracket. A direction in which the long axis of the bracket extends is substantially aligned with a direction in which the feeder cable extends.

[0009] In the antenna device having this configuration, since the extending direction of the feeder cable connected to the main antenna body is substantially aligned with the long-axis direction of the bracket, the effect of the ground on a radiation conductor included in the patch antenna element increases in this specific direction, thereby reducing the radiation towards the back surface of the antenna device. Consequently, in a case where an electronic device that is susceptible to antenna noise

is disposed near the antenna device, a possibility that the radiation towards the back surface of the antenna device becomes a noise source against the electronic device can be significantly lowered by aligning the long-axis direction of the bracket with a direction extending towards the electronic device as viewed from the antenna device.

[0010] Furthermore, in one of the above configurations, the bracket is preferably provided with a louvered segment for positioning the main antenna body. This allows for an easy and proper setting process for aligning the extending direction of the feeder cable connected to the main antenna body with the short-axis or long-axis direction of the bracket, and also reduces the risk of positional displacement of the main antenna body after it has been installed on the bracket.

[0011] According to the antenna device of one aspect of the present invention, the bracket for supporting the main antenna body is not square-shaped, and moreover, the short-axis direction of the bracket is substantially aligned with the extending direction of the feeder cable connected to the main antenna body. Consequently, this allows for a less effect of the ground on a radiation conductor in the cable-extending direction, thereby achieving higher radiation gain at a low elevation angle in that direction.

[0012] Furthermore, according to the antenna device of another aspect of the present invention, the bracket for supporting the main antenna body is not square-shaped, and moreover, the long-axis direction of the bracket is substantially aligned with the extending direction of the feeder cable connected to the main antenna body. Consequently, the effect of the ground on a radiation conductor increases in this specific direction, thereby reducing the radiation towards the back surface of the antenna device. Therefore, in a case where an electronic device that is susceptible to antenna noise is disposed near the antenna device, a possibility that the radiation towards the back surface of the antenna device becomes a noise source against the electronic device can be significantly lowered by aligning the long-axis direction of the bracket with a direction extending towards the electronic device as viewed from the antenna device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Fig. 1 is a perspective view of an antenna device according to a first embodiment of the present invention;

Fig. 2 is a characteristic diagram showing radiation gain of the antenna device at a low elevation angle;

Fig. 3 is a schematic diagram showing a radiation pattern in a vertical plane taken in a widthwise direction of a bracket included in the antenna device;

Fig. 4 is a perspective view of an antenna device according to a second embodiment of the present invention; and

Fig. 5 is a schematic diagram showing a radiation pattern in a vertical plane taken in a lengthwise direction of a bracket included in the antenna device.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] Embodiments of the present invention will now be described with reference to the drawings. Fig. 1 is a perspective view of an antenna device according to a first embodiment of the present invention. Fig. 2 is a characteristic diagram showing radiation gain of the antenna device at a low elevation angle. Fig. 3 is a schematic diagram showing a radiation pattern in a vertical plane taken in a widthwise direction of a bracket included in the antenna device.

[0015] Referring to Fig. 1, an antenna device 1 is a GPS antenna installed on a dashboard (installation base material) provided inside a vehicle. The antenna device 1 mainly includes a main antenna body 2 having a sheet-metal radiation conductor plate 5 supported above a circuit board 4 within a radar dome 3 (only a bottom plate thereof is shown); a feeder cable 6 connected to the circuit board 4 of the main antenna body 2 and extending outward therefrom; and a sheet-metal bracket 7 which is mounted on the dashboard (not shown) and supports the main antenna body 2.

[0016] The circuit board 4 in the main antenna body 2 has its entire top surface substantially covered with a ground conductor layer 8. On the other hand, the bottom surface of the circuit board 4 has an electronic component (not shown) mounted thereon, which defines an electronic circuit portion, such as a feeder circuit. The electronic circuit portion is covered with a sheet-metal shield cover 9 for electromagnetically shielding the electronic circuit portion. The radiation conductor plate 5 has a substantially square-shape with cutouts at the four corners thereof. The four corners are provided with mounting leg segments 10 that are formed by bending. The mounting leg segments 10 are soldered to lands provided on the bottom surface of the circuit board 4, such that the radiation conductor plate 5 is stably supported facing the ground conductor layer 8 while being separated therefrom by a predetermined distance. Moreover, the radiation conductor plate 5 is also provided with two feeder leg segments 11 that are formed by bending. The feeder leg segments 11 are connected to the feeder circuit provided on the bottom surface of the circuit board 4 so that the antenna device 1 functions as a two-point-feeding-type circularly polarized antenna. In other words, the radiation conductor plate 5, the mounting leg segments 10, and the feeder leg segments 11, which are formed by processing a single metal plate, and the ground conductor layer 8 on the circuit board 4 constitute a patch antenna element for circular polarization.

[0017] The feeder cable 6 is a common coaxial cable, and has an inner conductor that is electrically connected to the pair of feeder leg segments 11 via the feeder circuit

and an outer conductor that is electrically connected to the ground conductor layer 8 and the shield cover 9. The feeder cable 6 extends linearly from the main antenna body 2 towards a windshield (not shown), that is, in the traveling direction of the vehicle, and then downward so as to be connected to, for example, a receiver.

[0018] The bracket 7 has a shape of a rectangle and has the main antenna body 2 disposed in the midsection of the rectangle. Thus, the opposite ends of the bracket 7 in the lengthwise direction (i.e. long-axis direction) thereof are projected outward from the main antenna body 2 by a large amount. These projected sections are provided with louvered segments 7a for positioning and securing the main antenna body 2. Because the widthwise direction (short-axis direction) of the bracket 7 is substantially aligned with the extending direction of the feeder cable 6 connected to the main antenna body 2, the feeder cable 6 protrudes from the bracket 7 immediately after extending outward from the main antenna body 2.

[0019] In the antenna device 1 having the above-described configuration, since the widthwise direction of the rectangular bracket 7 is substantially aligned with the extending direction of the feeder cable 6 connected to the main antenna body 2 (i.e. the traveling direction of the vehicle), the effect of the ground on the radiation conductor plate 5 of the patch antenna element can be reduced in the cable-extending direction. In other words, since the feeder cable 6 protruding from the bracket 7 acts as if a ground plate is extending therefrom, if the bracket 7 is supposedly square-shaped, for example, the effect of the ground will increase in the extending direction of the feeder cable 6. This will undesirably lead to less radiation gain at a low elevation angle towards the front of the vehicle. In contrast, according to the first embodiment of the present invention, the bracket 7 is given a rectangular shape and the widthwise direction thereof is aligned with the extending direction of the feeder cable 6. This allows for a less effect of the ground in the widthwise direction so that the radiation gain at a low elevation angle is increased, as shown in Fig. 3. Accordingly, referring to Fig. 2, sufficient radiation gain at a low elevation angle (i.e. an elevation angle of 10°) can be attained towards the front of the vehicle (i.e. an azimuth near 0°). This enhances the effective sensitivity of the antenna device 1 for GPS signals.

[0020] Furthermore, in the antenna device 1, the bracket 7 is provided with the louvered segments 7a for positioning and securing the main antenna body 2. This allows for an easy and proper setting process for aligning the extending direction of the feeder cable 6 connected to the main antenna body 2 with the widthwise direction of the bracket 7, and also reduces the risk of positional displacement of the main antenna body 2 after it has been installed on the bracket 7.

[0021] Fig. 4 is a perspective view of an antenna device according to a second embodiment of the present invention. Fig. 5 is a schematic diagram showing a radiation pattern in a vertical plane taken in a lengthwise direction of a bracket included in the antenna device. Components shown in these drawings that correspond to those shown in Fig. 1 are given the same reference numerals as in Fig. 1, and the descriptions of these components will not be repeated.

[0022] Referring to Fig. 4, an antenna device 20 is similar to that of the first embodiment in that it is installed on a dashboard provided inside a vehicle, but differs greatly from that of the first embodiment in that the lengthwise direction of the rectangular bracket 7, instead of the widthwise direction thereof, is substantially aligned with the cable-extending direction. In other words, the antenna device 20 is configured in view that an electronic device (not shown) that is susceptible to antenna noise is disposed within a close range of the back surface of the antenna device 20 (namely, a space below the dashboard), the back surface being in a direction opposite to the extending direction of the feeder cable 6 connected to the main antenna body 2. Thus, the antenna device 20 is given a configuration such that the radiation towards the back surface of the antenna device 20 is prevented from acting as a noise source against the electronic device. Specifically, the lengthwise direction (i.e. the long-axis direction) of the bracket 7 is substantially aligned with the extending direction of the feeder cable 6 connected to the main antenna body 2 so that the radiation towards the back surface of the antenna device 20 is reduced in the lengthwise direction of the bracket 7, as shown in Fig. 5. Accordingly, this avoids adverse effects of antenna noise on the electronic device.

[0023] As an alternative to having a rectangular shape, the bracket 7 may have a polygonal or elliptical shape having a long axis and a short axis. Furthermore, although the above embodiments are directed to a case where a circular-polarization antenna element having a sheet-metal patch antenna structure is used, the present invention is also applicable to a case where the antenna element has a dielectric patch antenna structure or a case where the antenna element is for linear polarization.

Claims

1. An antenna device comprising:

a main antenna body having a patch antenna element;
a feeder cable connected to and extending outward from the main antenna body; and
a sheet-metal bracket which supports the main antenna body and is mounted to an installation base material,
wherein the bracket has a shape having a long axis and a short axis, the two axes being perpendicular to each other and both extending through a center of the bracket, and

wherein a direction in which the short axis of the bracket extends is substantially aligned with a direction in which the feeder cable extends.

2. An antenna device comprising:

a main antenna body having a patch antenna element;
a feeder cable connected to and extending outward from the main antenna body; and
a sheet-metal bracket which supports the main antenna body and is mounted to an installation base material,
wherein the bracket has a shape having a long axis and a short axis, the two axes being perpendicular to each other and both extending through a center of the bracket, and

wherein a direction in which the long axis of the bracket extends is substantially aligned with a direction in which the feeder cable extends.

3. The antenna device according to one of Claims 1 and 2, wherein the bracket is provided with a louvered segment for positioning the main antenna body.

4. The antenna device according to any one of Claims 1 to 3, wherein the shape of the bracket comprises a rectangular shape.

FIG. 1

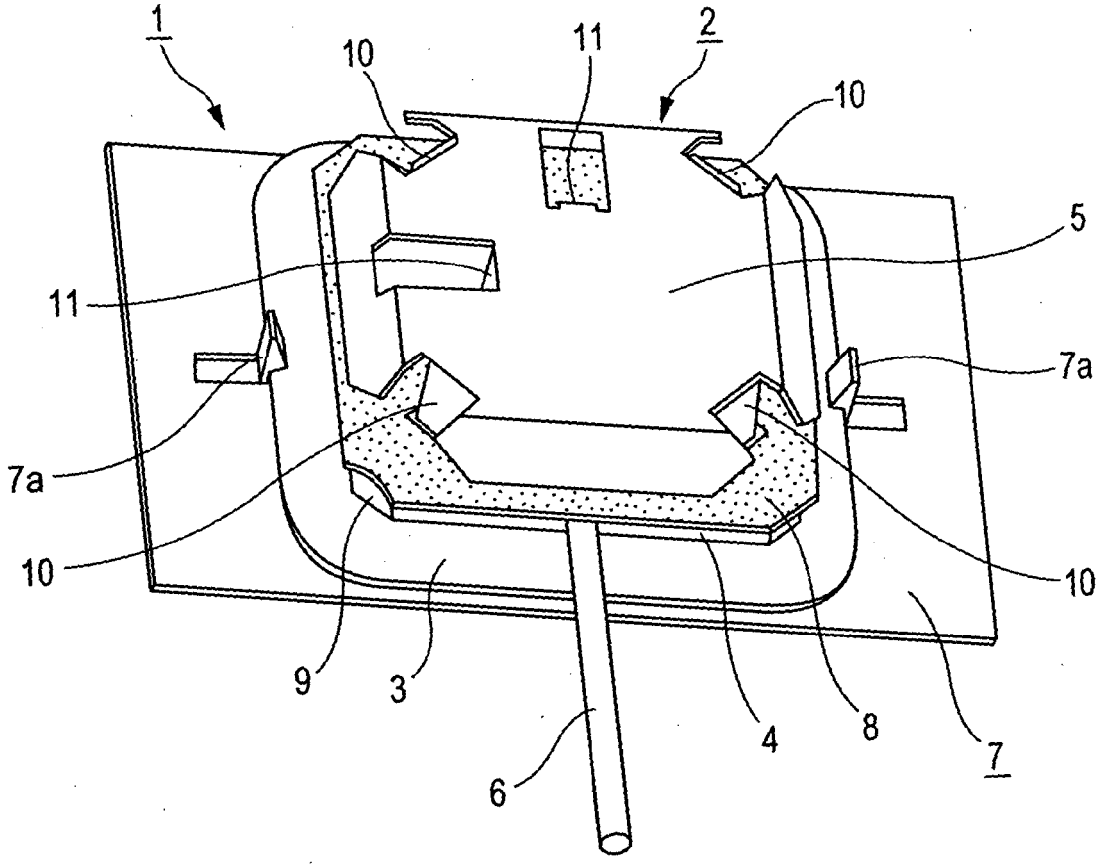

FIG. 2

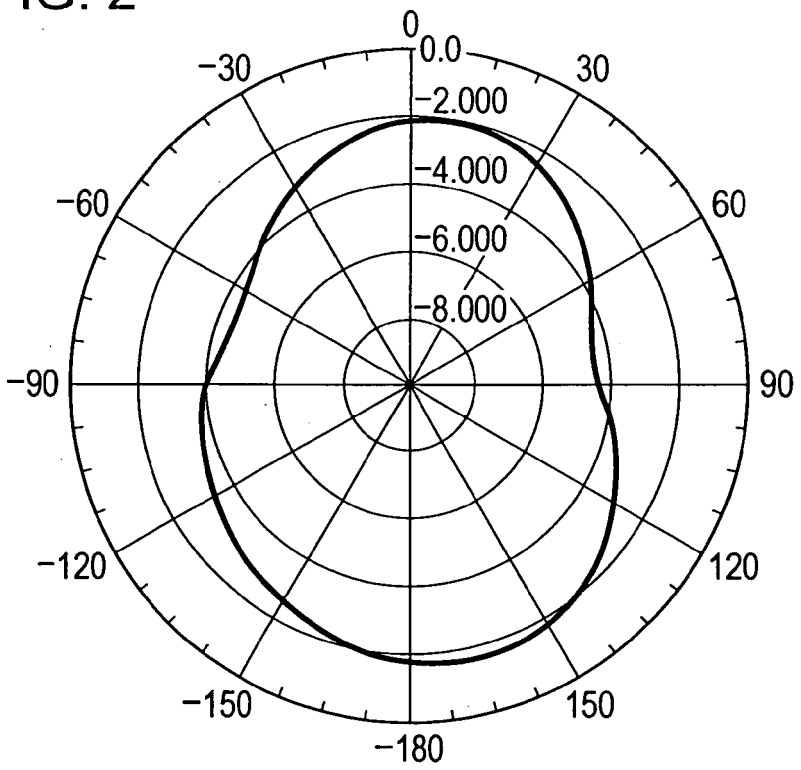
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FIG. 3

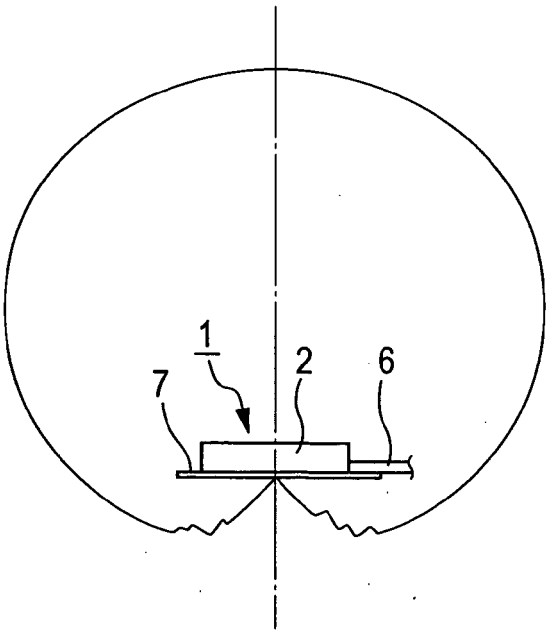
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FIG. 4

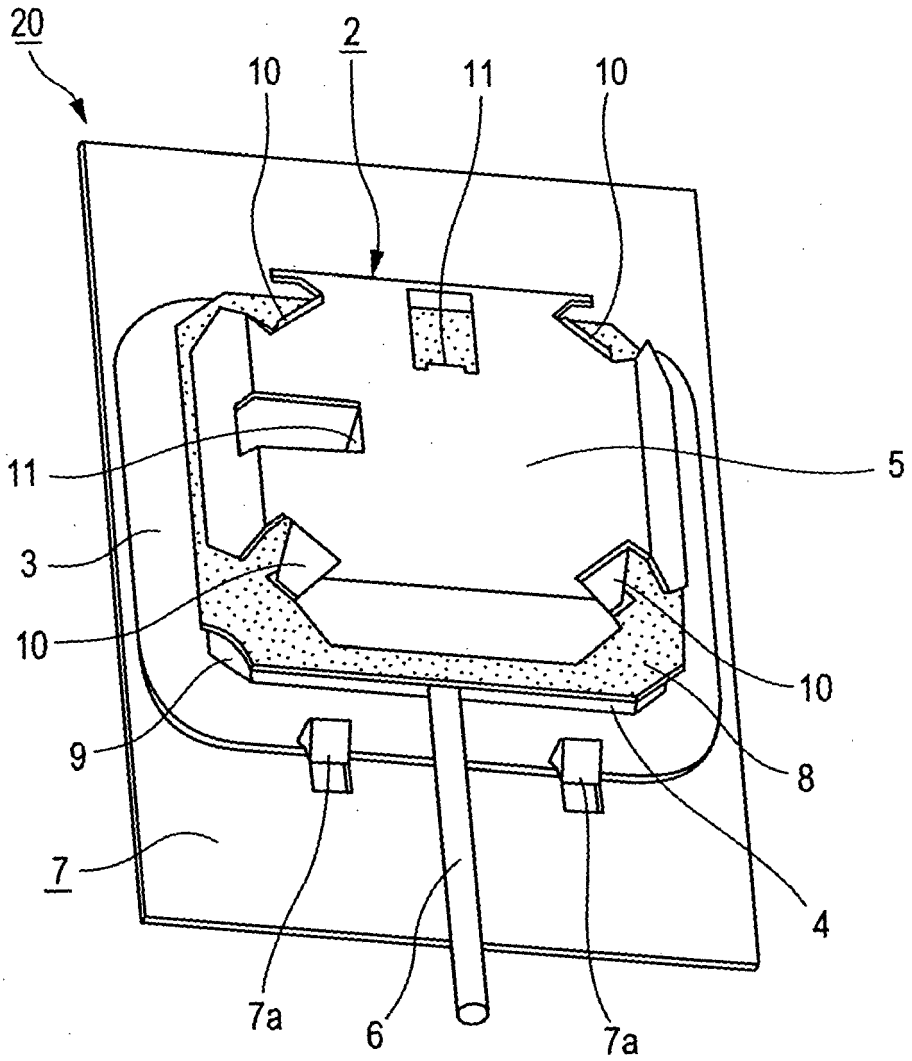
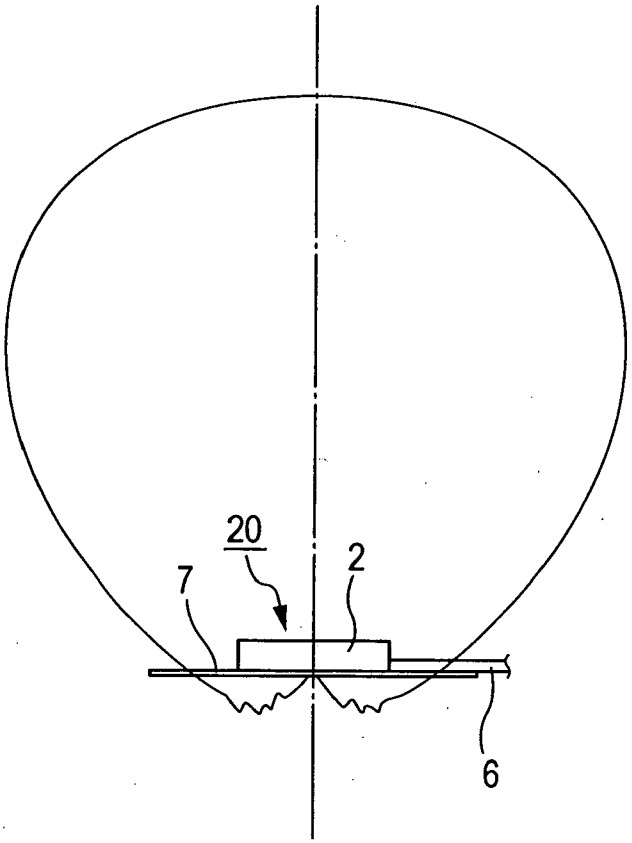


FIG. 5



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EUROPEAN SEARCH REPORT

Application Number
EP 06 02 5244

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP 2003 060414 A (FURUKAWA ELECTRIC CO LTD) 28 February 2003 (2003-02-28) * abstract *	1,4	INV. H01Q1/12 H01Q1/32
X	WO 00/35045 A (SIHN JR KG WILHELM [DE]; HOLOCHER ROBERT [DE]) 15 June 2000 (2000-06-15) * page 7, line 20 - page 8, line 16; figures 1,6 *	1	
X	DE 195 43 625 C1 (BOSCH GMBH ROBERT [DE]) 30 January 1997 (1997-01-30) * abstract; figure 2 *	2	
X	EP 0 989 629 A (NIPPON ANTENA KABUSHIKI KAISHA [JP]) 29 March 2000 (2000-03-29) * paragraph [0018] - paragraph [0023]; figures 2,3 *	2,3	
X	WO 2004/036686 A (CALEARO S R L [IT]; IACOVELLA FEDERICO [IT]; RONZANI ROBERTO [IT]) 29 April 2004 (2004-04-29) * page 3, line 31 - page 4, line 10; figures 1-3 *	2-4	TECHNICAL FIELDS SEARCHED (IPC) H01Q
A	WO 99/27762 A (LK PRODUCTS OY [FI]; MIKKONEN ESA [FI]; PESONEN KALEVI [FI]; LOHTANDER) 3 June 1999 (1999-06-03) * figure 3 *	3	
A	EP 1 536 515 A (ALPS ELECTRIC CO LTD [JP]) 1 June 2005 (2005-06-01) * figures 1-5 *	1-4	
A,D	JP 2004 228802 A (TOKAI RIKA CO LTD) 12 August 2004 (2004-08-12) * abstract *	1-4	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	15 March 2007	Kaleve, Abraham

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 02 5244

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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15-03-2007

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2003060414 A	28-02-2003	NONE	
WO 0035045 A	15-06-2000	DE 19958481 A1	10-08-2000
		EP 1135829 A1	26-09-2001
DE 19543625 C1	30-01-1997	CN 1168197 A	17-12-1997
		CZ 9702116 A3	15-10-1997
		WO 9719487 A2	29-05-1997
		EP 0806060 A2	12-11-1997
		HU 9702160 A2	28-04-1998
		JP 2000500629 T	18-01-2000
		JP 3727351 B2	14-12-2005
		US 5959585 A	28-09-1999
EP 0989629 A	29-03-2000	JP 2000077923 A	14-03-2000
WO 2004036686 A	29-04-2004	AU 2003280372 A1	04-05-2004
		EP 1554775 A1	20-07-2005
		US 2006038726 A1	23-02-2006
WO 9927762 A	03-06-1999	AU 1240399 A	15-06-1999
		DE 69826314 D1	21-10-2004
		DE 69826314 T2	20-10-2005
		EP 1034693 A2	13-09-2000
		FI 974315 A	26-05-1999
		US 6614405 B1	02-09-2003
EP 1536515 A	01-06-2005	JP 2005159836 A	16-06-2005
JP 2004228802 A	12-08-2004	JP 3866664 B2	10-01-2007

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2004228802 A **[0002]**