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(71) Applicant: **BSE Co., Ltd.**
Namdong-gu
Incheon 405-817 (KR)

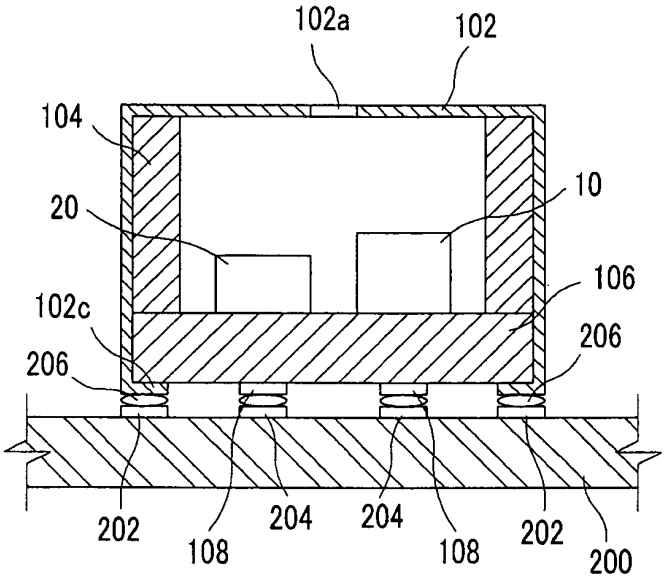
(72) Inventor: **Song, Chung-Dam**
Seoul 157-801 (KR)

(74) Representative: **Mollekopf, Gerd Willi**
Kahler Käck Mollekopf,
Vorderer Anger 239
86899 Landsberg a. Lech (DE)

(54) MEMS microphone package

(57) Provided is a MEMS microphone package (100) that can shield a MEMS microphone chip (10) from noise to greatly improve sound quality and reduce manufacturing costs, by inserting a PCB substrate (106) to which the MEMS microphone chip (10) is mounted into a metal case (102), and then by ground-connecting the metal case to a main board (200) using an assembly process including bending and clamping an end of the case. The MEMS microphone package (100) includes a tetragonal container-shaped metal case (102) having an open-side to insert components into an inner space, and a chamfered end on the open-side to easily perform a curling operation, a PCB substrate (106) to which a MEMS microphone chip (10) and an ASIC chip (20) are mounted, the PCB substrate (106) being inserted into the case (102), and a support configured to support the PCB substrate and define a space between the case and the PCB substrate.

FIG.3



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a micro electro mechanical systems (MEMS) microphone package, and more particularly, to a MEMS microphone package that can shield a MEMS microphone chip from noise to greatly improve sound quality and reduce manufacturing costs, by ground-connecting a metal case to a main board using an assembly process including bending and clamping an end of the case.

Description of the Related Art

[0002] Generally, a condenser microphone includes a diaphragm and a back plate. The diaphragm has a flexible membrane attached to a side electrode and is vibrated by an acoustic pressure. The back plate is spaced apart from the diaphragm through a spacer and faces each other. The diaphragm and the back plate form parallel electrode plates of a condenser and provide electric charges between the both electrode plates by applying a DC voltage to the both electrode plates or forming an electret at one of the both electrode plates. Such a general condenser microphone is assembled in a curling manner where a diaphragm, a spacer, a base 1, a back plate, a base 2, and a PCB to which an electric circuit is mounted are sequentially stacked on a cylindrical case and then an end of the case is bent and clamped toward the PCB.

[0003] In a completed condenser microphone assembly, a distance between the diaphragm and the back plate is changed by an external acoustic pressure, and then capacitance of a condenser is also changed, and this change of the capacitance is processed by an electric circuit so that electrical signals are provided according to the change of the acoustic pressure.

[0004] A condenser microphone used in communication products includes an electret that is formed on a back plate with a high molecular membrane. Such condenser microphones are economical, but there is a limit to miniaturization. Thus, for extreme miniaturization of a microphone, an electrical capacity structure is realized on a silicon wafer in a die shape using a semiconductor-manufacturing technology and a micromachining technology. This electrical capacity structure is referred to as a silicon condenser microphone chip or a MEMS microphone chip. Such MEMS microphone chips must be packaged for protection against exterior interference.

[0005] A technology of packaging a MEMS microphone chip is disclosed in U.S. Patent No. 6,781,231, entitled "MICROELECTROMECHANICAL SYSTEM PACKAGE WITH ENVIRONMENTAL AND INTERFERENCE SHIELD", issued on August 24, 2004. Referring to FIG. 1, such a MEMS microphone package is achieved in the manner where a housing is formed by attaching a case 34 including a conductive layer or a conductor to a PCB substrate 32 through a conductive adhesive 36. A MEMS microphone chip 10 and an application specific integrated circuit (ASIC) 20 are mounted to the PCB substrate 32. The ASIC 20 is configured to electrically drive the MEMS microphone chip 10 and process signals. The case 34 including a sound hole 34a is attached to the PCB substrate 32 through the adhesive 36 to protect the MEMS microphone chip 10 therein.

[0006] In packaging a MEMS microphone chip and manufacturing a MEMS microphone package according to a related art, in the case of a method of attaching a case to a PCB substrate with an adhesive or welding, when the microphone package is mounted to a main board, external noise is introduced into a PCB of a dielectric between the case and the main board to reduce shielding effect for blocking the external noise. Particularly, in the case of cellular phones having a built-in antenna, which is widely used in these days, since the antenna is very close to a microphone because of mechanical conditions thereof, a RF noise of the antenna is easily introduced into the microphone. Thus, shielding of the microphone against the RF noise is more important. However, there is a limitation for related art MEMS microphone packages to meet this requirement.

[0007] Also, a MEMS microphone packaging method including attaching a case to a PCB substrate with an adhesive or welding is different from a cheap curling operation where a metal case is bent and components are fixed in the metal case to assemble a microphone. Thus, new mechanical equipment is required for the attaching or the welding, thereby increasing building cost for a new manufacturing line.

SUMMARY OF THE INVENTION

[0008] Accordingly, the present invention is directed to a MEMS microphone package that substantially obviates one or more problems due to limitations and disadvantages of the related art.

The invention is defined in claim 1. Particular embodiments are set out in the dependent claims.

[0009] The present invention provides a MEMS microphone package that can improve noise-blocking characteristics and reduce manufacturing costs without an additional manufacturing facility, by directly mounting a metal case of the MEMS microphone package to a main board using a curling process where an end of the metal case is bent and clamped in a condenser microphone-assembling process.

[0010] Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly

pointed out in the written description and claims hereof as well as the appended drawings.

[0011] While a typical condenser microphone has a circular shape, the MEMS microphone package is generally tetragonal such that a direction is easily recognized in a process of mounting the MEMS microphone package to a main substrate using a surface mounting technology (SMT). While a curling process, where components are inserted into a case and then an end of the case is bent and clamped, is easily performed on the circular microphone, an edge of the tetragonal microphone is difficult to bend. Thus, in the case of a related art MEMS microphone package, a case is just attached to a PCB substrate with an adhesive or welding.

[0012] The MEMS microphone package of the present invention allows a curling process to be performed even on a tetragonal microphone by chamfering an end of a tetragonal case of the tetragonal microphone and includes a support to form a space between the tetragonal case and a PCB to which the MEMS microphone is mounted. To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, there is provided a MEMS microphone package including: a tetragonal container-shaped metal case having an open-side to insert components into an inner space, and a chamfered end on the open-side to easily perform a curling operation; a PCB substrate to which a MEMS microphone chip and an ASIC chip are mounted, the PCB substrate being inserted into the case; and a support configured to support the PCB substrate and define a space between the case and the PCB substrate.

[0013] The tetragonal container-shaped case having the open-side may include: four chamfered edges on the open-side, for preventing ends of respective surfaces of the case from overlapping ends of adjacent surfaces of the case in the curling operation. Also, a sound hole for introducing an external sound is disposed in at least one of a bottom of the case and the PCB substrate.

[0014] The MEMS microphone chip and the ASIC chip may be mounted to a surface of the PCB substrate, and a conductive pattern for connection to the metal case may be provided to a boundary of another surface, and connection terminals including a power (Vdd) terminal, an output terminal, and a ground (GND) terminal may be provided to a center of the surface having the boundary.

[0015] The MEMS microphone package may further include a metal mesh for preventing a foreign object and a noise from being introduced into the inner space through the sound hole of the case.

[0016] It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings:

[0018] FIG. 1 is a cross-sectional view illustrating a related art MEMS microphone package;

[0019] FIG. 2 is a cut-away perspective view illustrating a MEMS microphone package according to an embodiment of the present invention;

[0020] FIG. 3 is a cross-sectional view illustrating a MEMS microphone package according to an embodiment of the present invention;

[0021] FIG. 4 is a bottom view illustrating a MEMS microphone package according to an embodiment of the present invention;

[0022] FIG. 5 is a perspective view illustrating a case used in a MEMS microphone package according to an embodiment of the present invention;

[0023] FIG. 6 is a perspective view illustrating a support used in a MEMS microphone package according to an embodiment of the present invention;

[0024] FIG. 7 is a cut-away perspective view illustrating a MEMS microphone package according to another embodiment of the present invention; and

[0025] FIG. 8 is a cross-sectional view illustrating a MEMS microphone package according to another embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0026] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

[0027] FIG. 2 is a cut-away perspective view illustrating a MEMS microphone package 100 according to an embodiment of the present invention. FIG. 3 is a cross-sectional view illustrating the MEMS microphone package 100 according to the embodiment of the present invention. FIG. 4 is a bottom view illustrating the MEMS microphone package 100 according to the embodiment of the present invention.

[0028] Referring to FIGs. 2 through 4, a tetragonal condenser microphone according to the present invention includes a tetragonal container-shaped case 102, a PCB substrate 106, and a support 104. The tetragonal container-shaped case 102 has an open-side for receiving parts and open-side ends 102c having chamfered edges for easy curling. The PCB substrate 106 is inserted into the case 102, and a MEMS microphone chip 10 and an ASIC chip 20 are mounted to the PCB substrate 106. The support 104 supports the PCB substrate 106 to de-

fine a space between the case 102 and the PCB substrate 106.

[0029] Referring to FIG. 5, the metal case 102, used in the microphone package 100 according to the present invention, has a tetragonal shape with the open side. The case 102 includes the four edges 102b of the open side and a sound hole 102a. The four edges 102b are chamfered to prevent the respective ends 102c from overlapping the adjacent ends 102c when curling. The sound hole 102a is disposed in a bottom of the case 102. The sound hole 102a may be disposed in the PCB substrate 106, not the case 102, according to sound introduction structure of a condenser microphone.

[0030] Referring to Fig. 6, the support 104 has a tetragonal ring shape and is disposed between the bottom of the case 102 and the PCB substrate 106 and defines an inner space and supports the PCB substrate 106 when curling the ends 102c. That is, the microphone package 100 according to the present invention is configured to prevent the respective ends 102c from overlapping the adjacent ends 102c when curling, thereby providing an easy curling operation and preventing deformation of the case 102 due to the support 104 during the curling.

[0031] The MEMS microphone chip 10 and the ASIC chip 20 are mounted to a surface of the PCB substrate 106. A conductive pattern for connection to the case 102 is provided to a boundary of another surface, and connection terminals 108 including a power (Vdd) terminal, an output terminal and a ground (GND) terminal are provided to a center of the surface for the conductive pattern. Although the four connection terminals 108 are exemplified in this embodiment, the number of the connection terminals 108 may be 2 or more according to application. The MEMS microphone chip 10 includes a back plate and a diaphragm. The back plate is formed on a silicon wafer using a MEMS technology, and then a spacer is formed between the diaphragm and the back plate. The ASIC chip 20 is connected to the MEMS microphone chip 10 to process electrical signals. The ASIC chip 20 includes a voltage pump and a buffer amplifier. The voltage pump provides a bias voltage such that the MEMS microphone chip 10 serves as a condenser microphone. The buffer amplifier amplifies or impedance-matches electrical sound signals detected through the MEMS microphone chip 10 to provide the signals through the connection terminals 108 to the outside. The protruding connection terminals 108 are adapted for surface mounting to a main substrate 200.

[0032] The tetragonal ring-shaped support 104 is inserted into the tetragonal container-shaped metal case 102 having the open-side, then the PCB substrate 106 having the MEMS microphone chip 10 and the ASIC chip 20 that are surface-mounted is inserted and disposed on the support 104, and then the ends 102c are bent toward the PCB substrate 106 through the curling to closely contact the conductive pattern, so that the MEMS microphone package 100 is completed.

[0033] In the completed MEMS microphone package 100 according to this manner as illustrated in FIGs. 2 through 4, the support 104 is inserted in the case 102 and supports the PCB substrate 106 to which circuit components are surface-mounted and defines the inner space, and the ends 102c are in close contact with the PCB substrate 106 through the curling.

[0034] As illustrated in FIG. 3, the MEMS microphone package 100 is mounted to the main substrate 200 through a surface mounting technology (SMT) or a soldering method. Thus, the MEMS microphone package 100 is connected to pads 204 of the main substrate 200 corresponding to the connection terminals 108 of the PCB substrate 106, and the ends 102c are connected to ground patterns 202 of the main substrate 200 to electrically shield the entire microphone as a Faraday cup that prevents the outside noise from being introduced into the microphone. Thus, in the case where the MEMS microphone package 100 is applied to a cellular phone, even when an antenna and the microphone are adjacent to each other, a RF noise of the antenna is prevented from being introduced into the antenna, to maintain good sound quality characteristics of a product.

[0035] Referring to FIG. 3, power is supplied through the power terminal and the ground terminal from the main substrate 200 to the MEMS microphone package 100 mounted to the main substrate 200, an appropriate bias voltage generated by the voltage pump of the ASIC chip 20 is applied to the MEMS microphone chip 10 to generate electric charges between the back plate and the diaphragm of the MEMS microphone chip 10.

[0036] When an exterior acoustic pressure is introduced into the inner space through the sound hole 102a, the diaphragm of the MEMS microphone chip 10 vibrates and capacitance changes between the diaphragm and the back plate. The change of the capacitance is amplified as electrical signals in the buffer amplifier of the ASIC chip 20 and output to the main substrate 200 through the output terminal.

[0037] FIG. 7 is a cut-away perspective view illustrating a MEMS microphone package according to another embodiment of the present invention. FIG. 8 is a cross-sectional view illustrating the MEMS microphone package according to the embodiment of FIG. 7.

[0038] Referring to FIGs. 7 and 8, the MEMS microphone package according to this embodiment, includes a tetragonal container-shaped case 102, a metal mesh 110, a support 104, and a PCB substrate 106. The tetragonal container-shaped metal case 102 has an open-side for receiving parts and open-side ends 102c having chamfered edges for easy curling. A sound hole 102a is disposed in a bottom of the case 102. The metal mesh 110 prevents a foreign object from being introduced into an inner space through a sound hole 102a. The support 104 supports the PCB substrate 106 to define a space between the case 102 and the PCB substrate 106.

[0039] The MEMS microphone package according to this embodiment can further improve shielding performance and prevent a foreign object and a RF noise from

being introduced through the sound hole 102a into the inner space, by adding the metal mesh 110 for preventing a foreign object from being introduced through the sound hole 102a into the inner space and blocking outside noise, to the structure of the embodiment illustrated in FIG. 2.

[0040] The microphone package of this embodiment is the same as that of the previous embodiment except that the metal mesh 110 is added to prevent a foreign object or the RF noise from being introduced into the inner space through the sound hole 102a. Thus, the same part as those in the description of the previous embodiment will be omitted.

[0041] The MEMS microphone package according to the present invention, manufactured through the curling process where the end of the metal case is chamfered and clamped, shields the MEMS microphone chip therein against external noise to greatly improve the sound quality, by directly connecting the bent ends of the case to the main board to form a Faraday cup when mounting the microphone package to the main board.

[0042] Particularly, when the MEMS microphone package of the present invention is applied to communication fields, the noise-blocking performance is improved by preventing the RF noise of the antenna from being introduced into the antenna even when the antenna and the microphone are adjacent to each other, thereby maintaining the excellent sound quality.

[0043] Also, according to the present invention, when the MEMS microphone chip is packaged, manufacturing costs are reduced without an additional manufacturing facility, and when the curling operation is performed, the ends of the tetragonal container-shaped case are prevented from overlapping the adjacent ends, so that the curling operation is easily performed and the deformation of the case due to the support in the curling operation is prevented.

[0044] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

Claims

1. A micro electro mechanical systems (MEMS) microphone package (100) comprising:

   a tetragonal container-shaped metal case (102) having an open-side to insert components (10, 20) into an inner space, and a chamfered end (102c) on the open-side to easily perform a curling operation;
   a printed circuit board (PCB) substrate (106) to which a MEMS microphone chip (10) and an application specific integrated circuit (ASIC) chip (20) are mounted, the PCB substrate (106) being inserted into the metal case (102); and
   a support (104) configured to support the PCB substrate (106) in the curling operation and define a space between the metal case (102) and the PCB substrate (106).

2. The MEMS microphone package of claim 1, wherein the tetragonal container-shaped metal case (102) having the open-side comprises:

   four chamfered edges (102b) on the open-side, for preventing ends of respective surfaces of the case (102) from overlapping ends of adjacent surfaces of the case in the curling operation; and
   a sound hole (102a) in a bottom, top or side face of the case (102).

3. The MEMS microphone package of claim 2, further comprising a metal mesh (110) for preventing a foreign object and an electromagnetic wave from being introduced into the inner space through the sound hole (102a) of the case (102).

4. The MEMS microphone package of claim 1, 2 or 3, wherein the MEMS microphone chip (10) and the ASIC chip (20) are mounted to a surface of the PCB substrate (106), and
   wherein a conductive pattern (202) for connection to the metal case (106) is provided at another surface, in particular to a boundary of the another surface, and connection terminals (108) including a power (Vdd) terminal, an output terminal, and a ground (GND) terminal are provided to a center of the another surface.

5. The MEMS microphone package of one of the preceding claims,
   wherein the MEMS microphone chip (10) comprises:

   a back plate disposed on a silicon wafer using a MEMS technology; and
   a diaphragm with a spacer disposed between the diaphragm and the back plate, and wherein the ASIC chip (20) comprises:

   a voltage pump providing a bias voltage such that the MEMS microphone chip (10) serves as a condenser microphone; and
   a buffer amplifier amplifying or impedance-matching an electrical sound signal detected through the MEMS microphone chip (10) to provide the signals through the connection terminals (108) to an outside.

FIG.1 (Prior Art)

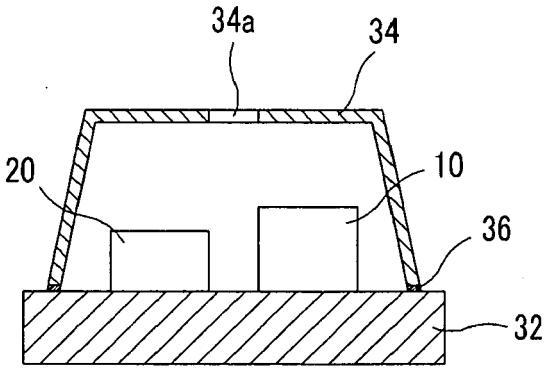


FIG.2

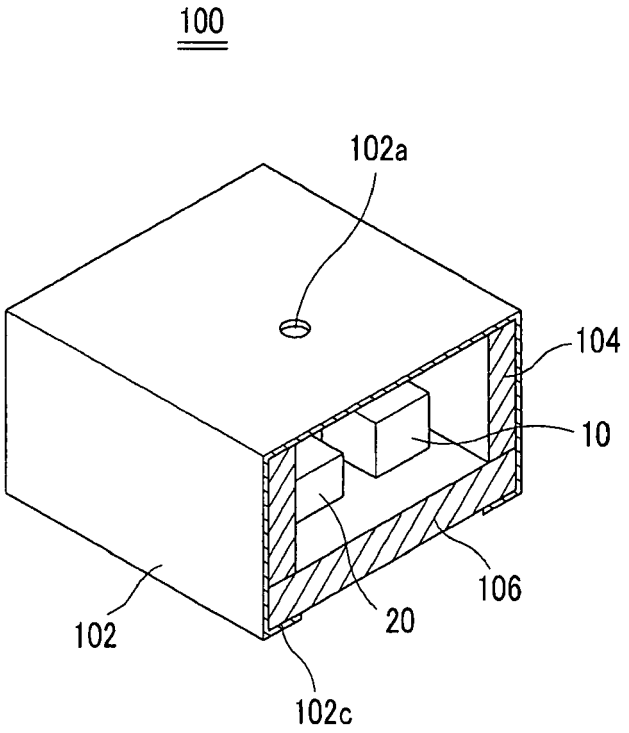


FIG. 3

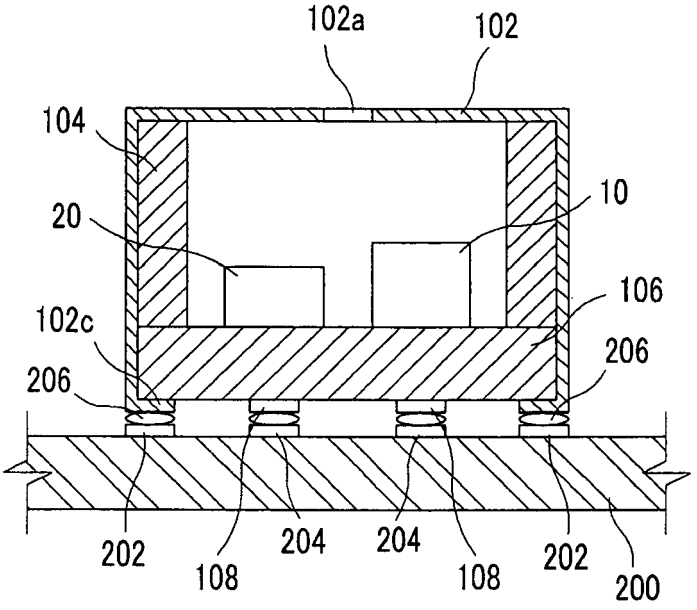

102a
102
104
10
20
106
102c
206
206
202
108
204
204
108
202
200

FIG. 4

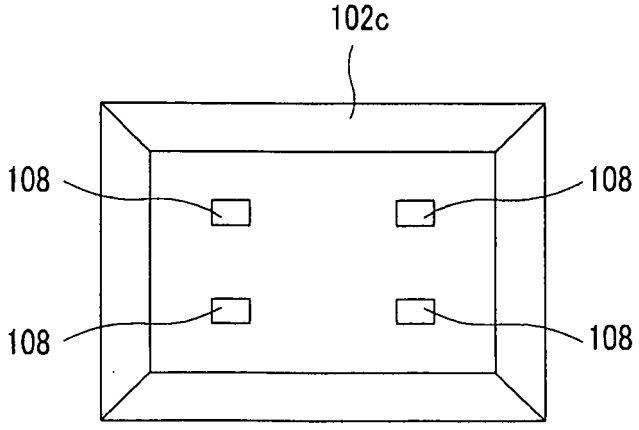

102c
108
108
108
108

FIG. 5

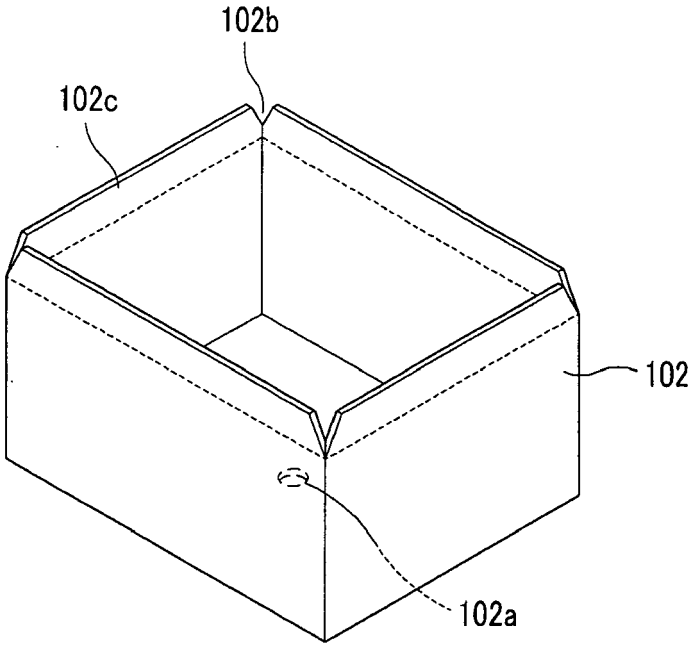


FIG. 6

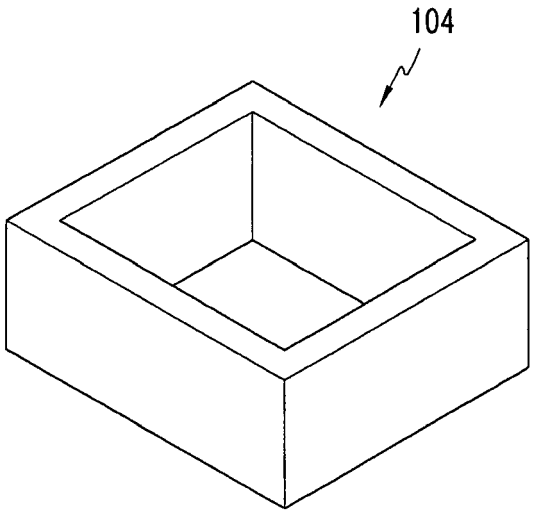


FIG. 7

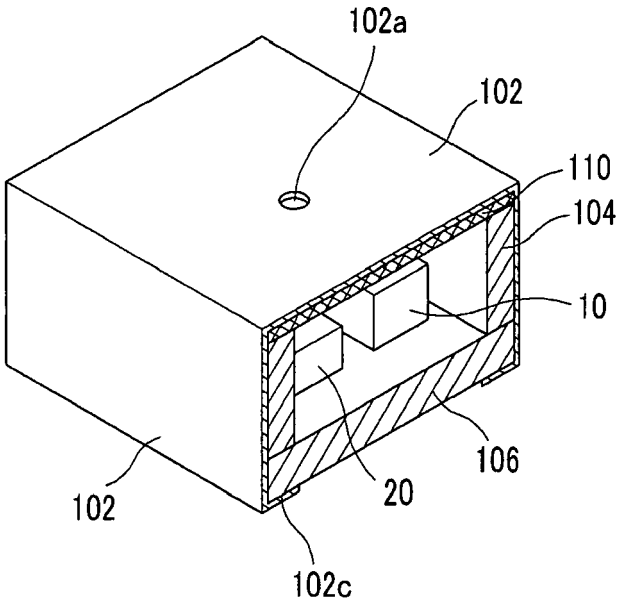
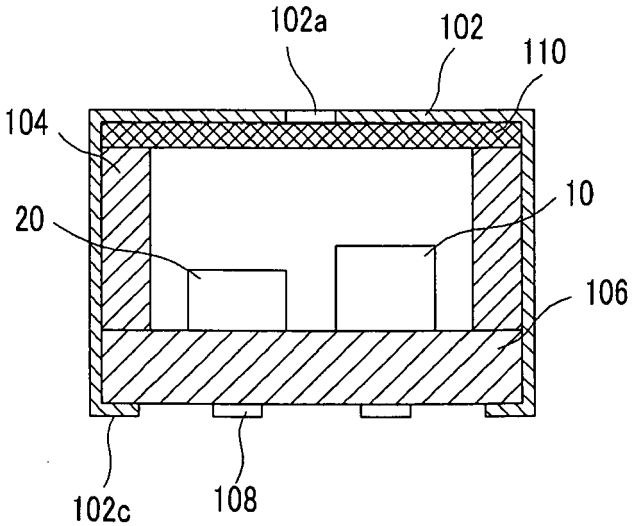

102a
102
110
104
10
106
20
102
102c

FIG. 8


102a
102
110
104
10
20
106
102c
108

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EUROPEAN SEARCH REPORT

Application Number
EP 08 01 7149

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	9 February 2009	Navarri, Massimo

CATEGORY OF CITED DOCUMENTS

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

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