(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 369 855 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
07.05.2014 Bulletin 2014/19

(51) Int Cl.:
H04R 19/01 *(2006.01)*

(21) Application number: **11162045.6**

(22) Date of filing: **02.09.2009**

(54) **Electronic device with electret electro-acoustic transducer**

Elektronische Vorrichtung mit elektroakustischem Elektretwandler

Dispositif électronique avec transducteur électro-acoustique à électret

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR

(30) Priority: **31.10.2008 TW 097141921**

(43) Date of publication of application:
28.09.2011 Bulletin 2011/39

(62) Document number(s) of the earlier application(s) in accordance with Art. 76 EPC:
09169282.2 / 2 182 737

(73) Proprietor: **HTC Corporation**
Taoyuan County 330 (TW)

(72) Inventors:
- **Cheng, Yi Tsung**
  Taoyuan City (TW)
- **Lee, Fang Ching**
  Taoyuan City (TW)
- **Hsieh, Chih Chao**
  Taoyuan City (TW)

(74) Representative: **Kirschner, Klaus Dieter et al**
Puschmann Borchert Bardehle
Patentanwälte Partnerschaft
Bajuwarenring 21
82041 Oberhaching (DE)

(56) References cited:
EP-A1- 1 722 596
WO-A-2004/062318
WO-A1-2006/118680
WO-A2-00/27166
US-A- 3 935 397
US-A1- 2004 170 291

EP 2 369 855 B1

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The invention relates to a portable electronic device with an electro-acoustic transducer, and more particularly, to a portable electronic device with an electret electro-acoustic transducer.

[0002] Loudspeakers are a kind of device to make sound. The principle of making sound for the loudspeakers is to move the diaphragms thereof by electrical signals to push the air. Nowadays, the loudspeakers have been broadly used in electronic devices with the function of making sound, such as mobile phones, personal digital assistants (PDAs) and laptop computers.

[0003] One of the common loudspeakers is so-called dynamic loudspeaker. The principle of making sound for the dynamic loudspeaker is to drive a current through the voice coil to produce a magnet field. This magnetic field causes the voice coil to react to the magnetic field from a permanent magnet fixed to the frame of the loudspeaker thereby moving the diaphragm attached with the voice coil. Although such dynamic loudspeaker can provide very good quality of sound, the loudspeaker has a considerable thickness because its sound chamber is large. When such dynamic loudspeakers are used in the above-mentioned portable electronic devices, the thickness of these electronic devices cannot be reduced.

[0004] EP 1722 596 A1 discloses an electret condenser microphone includes: a substrate in which an opening is formed; an electret condenser connected to one face of the substrate so as to close the opening and having an acoustic hole and a cavity; a drive circuit element connected to the one face of the substrate; and a case mounted over the substrate so as to cover the electret condenser and the drive circuit element . Electric contact is established at a joint part between the electret condenser and the substrate. The acoustic hole communicates with an external space through the opening. The cavity and an internal region of the case serve as a back air chamber for the electret condenser.

[0005] US 20041170291 is directed to a mobile device with improved acoustic porting. The mobile device includes a housing that has at least one sound hole, a transducer for converting an electrical signal into an acoustical signal, and a grommet that engages the housing and the transducer to form an interior cavity. A passage acoustically couples the interior cavity with the interior of the housing. The transducer emits sound into the interior cavity. The sound travels from the interior cavity through the passage into the interior of the housing and then to the user's ear via the sound hole(s) in the housing. The passage may be any channel, tube, passageway, or pathway that allows an acoustical signal to travel from the interior cavity to the interior of the housing.; The transducer may also emit sound into the interior of the housing that mixes with the sound traveling from the interior cavity through the passage into the interior of the housing.

[0006] It is an object of the invention to provice a portable electronic device with an electret electro-acoustic transducer wherein the electret electro-acoustic transducer of the portable electronic devices has a greatly smaller thickness than the traditional dynamic loudspeakers.

[0007] For this purpose, the portable electronic device of the invention comprises the features of claim 1.

[0008] Preferred embodiments are characterized in the sub-claims.

[0009] The portable electret electro-acoustic transducer of the portable electronic devices has a greatly smaller thickness than the traditional dynamic loudspeakers, and, therefore, the available space inside the electronic device can be increased.

[0010] Embodiments of the invention will be more readily apparent from the following detailed description, which proceeds with reference to the accompanying drawings.

FIG. 1 is a perspective view of the electronic device of the present invention.

FIG. 2a is a cross-sectional view of the electronic device with an electro-acoustic transducer, wherein the back cover is separated from the body of the electronic device.

FIG. 2b is a cross-sectional view of the electronic device with an electro-acoustic transducer, wherein the back cover is attached to the body of the electronic device.

FIG. 3a is a cross-sectional view of the electronic device with an electro-acoustic transducer, wherein the back cover is separated from the body of the electronic device.

FIG. 3b is a cross-sectional view of the electronic device with an electro-acoustic transducer, wherein the back cover is attached to the body of the electronic device.

FIG, 4a is a cross-sectional view of the electronic device with an electro-acoustic transducer, wherein the back cover is separated from the body of the electronic device.

FIG. 4b is a cross-sectional view of the electronic device with an electro-acoustic transducer, wherein the back cover is attached to the body of the electronic device.

FIG. 5a is a cross-sectional view of the electronic device with an electro-acoustic transducer according to an embodiment of the present invention, wherein the back cover is separated from the body of the electronic device.

FIG. 5b is a cross-sectional view of the electronic de-

vice with an electro-acoustic transducer according to the embodiment of the present invention, wherein the back cover is attached to the body of the electronic device.

[0011] Referring to FIGS.1, 2a and 2b, the electronic device 100 with an electro-acoustic transducer includes a housing 110 having a plurality of openings 114 penetrating between the inner surface 112 and the outer surface 118 thereof. An electro-acoustic transducer 180 is disposed on the inner surface 112 of the housing 110. The electro-acoustic transducer 180 includes an electret diaphragm 120 positioned on the inner surface 112 of the housing 110. In addition, the electret diaphragm 120 includes a film body 122 and an electrode layer 124 formed on the lower surface of the film body 122. The film body 122 is made of dielectric material and has static charges. The film body 122 has a thickness of 7 to 25 μm and the electrode layer 124 has a thickness of 0.05 to 1 μm. A conductive plate 140 functioning as an electrode is stacked on the upper surface of the film body 122 and has a plurality of openings 142 corresponding to the openings 114. The conductive plate 140 has a thickness of 0.1 to 1 mm, and an aperture ratio of the openings 142 on the conductive plate 140 is greater than 20%. Furthermore, at least one spacer 150 is disposed between the electret diaphragm 120 and the conductive plate 140 to keep a predetermined distance between the electret diaphragm 120 and the conductive plate 140. The spacer 150 is spaced 5 to 20 mm apart from each other and has a height of 100 to 400 μm.

[0012] In order to make the film body 122 carry static charges, the film body 122 originally without static charges carried thereon is required to be subjected to a polarizing process. For example, a corona charging process can be used to polarize the film body 122 to generate static charges therein and thereon after the electrode layer 124 is formed on the film body 122. The material suitable for the film body 122 can be fluorinated ethylene propylene (FEP), Polytetrafluoroethene (PTFE), Polyvinylidene Fluoride (PVDF), silicon dioxide (SiO2) or other fluoride polymers. Furthermore, the edge of the electret diaphragm 120 is required to be fixed to prevent the electret diaphragm 120 from movement. To have the electro-acoustic transducer 180 of the present embodiment work, electrical signals having the same phase and opposite phase with the original sound signal, i.e. differential signals have to be applied to the conductive plate 140 and electrode layer 124, respectively so that the electret diaphragm 120 is subject to the Coulomb forces from the conductive plate 140 and electrode layer 124 to bring about a push-pull effect. The push-pull effect will cause the electret diaphragm 120 to vibrate in accordance with the electrical signals. The vibration of the electret diaphragm 120 pushes the air to make sounds. The sounds can travel through the openings 114 to the outside of the housing 110 thereby a user can hear the sounds.

[0013] In addition, since the sounds made by the electret diaphragm 120 can also travel through the openings 142 of the conductive plate 140 and be bounced back by the elements above the conductive plate 140, the upper surface of the conductive plate 140 is spaced a predetermined distance, said more that 1 mm apart from the elements above the conductive plate 140 to prevent the echo from degrading the performance of the electro-acoustic transducer 180. Alternatively, a sound absorbing layer 160 made of, such as glass fiber, sponge or non-woven can be attached to the upper surface of the conductive plate 140 to absorb the sounds traveling through the openings 142. The sound absorbing layer 160 has a thickness of 1 to 5 mm. Moreover, at least one spacer 170 with a thickness of 30 to 50 μm and corresponding to the spacer 150 is positioned between the electrode layer 124 and the inner surface 112 of the housing 110 to keep the electrode layer 124 from contact with the housing 110. Furthermore, the spacer 150 can be made of adhesive material, such as double-sided tape to attach the conductive plate 140 and film body 122 together.

[0014] Referring to FIGS. 1, 3a and 3b, the electronic device 200 with an electro-acoustic transducer has all the elements of the electronic device 100, that is, the housing 110 and the electret diaphragm 120, conductive plate 140, spacers 150, 170 and sound absorbing layer 160 of the electro-acoustic transducer 180. In addition to the above elements, the electro-acoustic transducer 280 of the electronic device 200 further includes a conductive plate 240 functioning as an electrode that is stacked on the conductive plate 140 and has a plurality of openings 242 corresponding to the openings 142 of the conductive plate 140. The conductive plate 240 has a thickness of 0.1 to 1 mm. An isolation layer 290 made of porous air-permeable membrane has a thickness of 20 to 200 μm and is disposed between the conductive plates 140 and 240. In addition, an electret diaphragm 220 is positioned on the conductive plate 240 and includes a film body 222 and an electrode layer 224 formed on the upper surface of the film body 222, wherein the sound absorbing layer 160 is attached to the electrode layer 224. The film body 222 is made of dielectric material and has static charges. The film body 222 has a thickness of 7 to 25 μm and the electrode layer 224 has a thickness of 0.05 to 1 μm. Furthermore, at least one spacer 250 made of, such as adhesive material and corresponding to the spacer 150 is disposed between the electret diaphragm 220 and the conductive plate 240 to keep a predetermined distance between the electret diaphragm 220 and the conductive plate 240. The spacer 250 has a height of 100 to 400 μm.

[0015] Similarly, the film body 222 originally without static charges carried thereon is also required to be polarized in order to generate static charges therein and thereon. The material suitable for the film body 222 can be FEP, PTFE, PVDF, silicon dioxide or other fluoride polymers. Furthermore, the edge of the electret diaphragm 220 is also required to be fixed to prevent the electret diaphragm 220 from movement. To have the

electro-acoustic transducer 280 of the present embodiment work, a first electrical signal having the same phase with the original sound signal have to be applied to the conductive plate 140 and the electrode layer 224 and a second electrical signal having opposite phase with the original sound signal is applied to the electrode layer 124 and the conductive plate 240. In this manner, the electret diaphragms 120 and 220 will be subject to the Coulomb forces from the conductive plates 140, 240 and electrode layers 124, 224 to vibrate and make sounds in accordance with the first and second electrical signals. The sounds made by the electret diaphragm 220 can travel through the isolation layer 290 and openings 114 to the outside of the housing 110. The electro-acoustic transducer 280 with double electret diaphragms can make double (3dB) sounds than the electro-acoustic transducer 180 with only a single electret diaphragm.

[0016] Referring to FIGS. 1,4a and 4b, the electronic device 300 with an electro-acoustic transducer includes a housing 110 and an electro-acoustic transducer 380 disposed on the inner surface 112 of the housing 110. The electro-acoustic transducer 380 includes a conductive plate 340 functioning as an electrode disposed on the inner surface 112 of the housing 110. The conductive plate 340 has a plurality of openings 342 corresponding to the openings 114. An electret diaphragm 320 is stacked on the conductive plate 340 and includes a film body 322 and an electrode layer 324 formed on the upper surface of the film body 322. The film body 322 is made of dielectric material and has static charges. The film body 322 has a thickness of 7 to 25 μm and the electrode layer 324 has a thickness of 0.05 to 1 μm, In addition, at least one spacer 350 made of, such as adhesive material is disposed between the electret diaphragm 320 and the conductive plate 340 to keep a predetermined distance between the electret diaphragm 320 and the conductive plate 340. The spacer 350 is spaced 5 to 20 mm apart from each other and has a height of 100 to 400 μm. Moreover, at least one spacer 370 made of, such as adhesive material and corresponding to the spacer 350 is positioned between the conductive plate 340 and the inner surface 112 of the housing 110 to keep the conductive plate 340 from contact with the housing 110. The spacer 370 has a thickness of 30 to 50 μm. Furthermore, a sound absorbing layer 360 is attached to the electrode layer 324 to prevent the echo from degrading the performance of the electro-acoustic transducer 380.

[0017] Similarly, the film body 322 originally without static charges carried thereon is also required to be polarized in order to generate static charges therein and thereon. The material suitable for the film body 322 can be FEP, PTFE, PVDF, silicon dioxide or other fluoride polymers. Furthermore, the edge of the electret diaphragm 320 is also required to be fixed to prevent the electret diaphragm 320 from movement. To have the electro-acoustic transducer 380 of the present embodiment work, an electrical signal has to be applied to the conductive plate 340 and electrode layer 324 thereby the electret diaphragm 320 can vibrate to make sounds in accordance with the electrical signal.

[0018] Referring to FIGS. 1, 5a and 5b, the electronic device 400 with an electro-acoustic transducer according to an embodiment of the present invention is substantially the same as the electronic device 300 of FIG. 4, where identical reference numerals have been used when designating substantially identically elements that are common to the figures. Any further illustrations of the identical elements are omitted herein. The difference between them is in that the electro-acoustic transducer 480 of the electronic device 400 includes a conductive layer 440 coated on the inner surface 112 of the housing 110 to replace the conductive plate 340 and does not have the spacer 370. Similarly, to have the electro-acoustic transducer 480 of the present embodiment work, an electrical signal has to be applied to the conductive layer 440 and electrode layer 324 thereby the electret diaphragm 320 can vibrate to make sounds in accordance with the electrical signal.

[0019] The electro-acoustic transducers 180, 280, 380 and 480 of the electronic devices 100, 200, 300 and 400 are disposed on the housing 110 and the housing 110 can be a front cover, side cover or back cover of the electronic devices 100, 200, 300 and 400. It will be appreciated that the electro-acoustic transducers 180, 280, 380 and 480 have to be electrically connected to other elements, such as circuit boards in the electronic devices 100, 200, 300 and 400 in order to work. Referring back to FIGS. 2a, 2b, 3a, 3b, 4a, 4b, 5a and 5b, when the electro-acoustic transducers 180, 280, 380 and 480 are mounted on a detachable back covers 110, electrical terminals 116a are disposed on the inner surfaces 112 of the back covers 110 to electrically connect to the conductive plates 140, 340 and conductive layer 440, and the electrical terminals 116b disposed on the inner surfaces 112 of the back covers 110 are electrically connected to the electrode layers 124 and 324. In addition, the electrical terminals 119a and 119b disposed on the inner surface 112 of the back cover 110 of the electronic device 200 are electrically connected to the conductive plate 240 and electrode layer 224 of the electro-acoustic transducer 280, respectively. As shown in FIGS. 2b, 3b, 4b and 5b, when the back cover 110 are attached to the body of the electronic devices 100, 200, 300 and 400, the electrical terminals 116a and 116b are respectively brought into electrical contact with the electrical terminals 197a and 197b on the circuit boards 195 of the electronic devices 100, 200, 300 and 400, and the electrical terminals 119a and 119b (shown in FIG. 3b) are respectively brought into electrical contact with the electrical terminals 198a and 198b on the circuit board 195 of the electronic device 200. In this way, the electrical signals can be applied to the conductive plates 140, 240, 340, conductive layer 440 and electrode layers 124, 224, 324 thereby the electret diaphragms 120, 220, 320 can vibrate to make sounds in accordance with the electrical signals.

[0020] According to the present invention, the spacers

of the electro-acoustic transducers can be discrete spacers. However, it should be understood that the above discrete spacers can be replaced with the sheets formed with a plurality of openings thereon.

[0021] The electronic devices of the present invention can be portable electronic devices, such as mobile phones, personal digital assistants (PDAs) or laptop computers. Since the electro-acoustic transducers of the electronic devices according to the present invention have a greatly smaller thickness than the traditional dynamic loudspeakers, the available space inside the electronic device can be increased. In addition, the electro-acoustic transducers of the electronic devices according to the present invention can be mounted on the back covers. Therefore, the thickness of the electronic devices can be further reduced and the available space inside the electronic device can also be further increased. Moreover, since the electret surfaces of the electret diaphragms of the electro-acoustic transducers according to the first and second embodiments of the present invention face the insides of the electronic devices, the electret surfaces therefore get rid of the contamination of the dust and moisture to avoid the malfunction of the electret diaphragms.

[0022] Although a preferred embodiment of the invention has been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope of the invention as disclosed in the accompanying claims.

Claims

1. A portable electronic device, which is a mobile phone, a personal digital assistant (PDA) or a laptop computer, comprising:

   a housing (110) having an inner surface (112), an outer surface (118) and a plurality of openings (114) penetrating between the inner surface (112) and the outer surface (118) thereof;
   a circuit board (195); and
   an electro-acoustic transducer (480) disposed on the inner surface (112) of the housing (110) and electrically connected to the circuit board (195), comprising:
   a conductive layer (440) coated on the inner surface (112) of the housing (110);
   an electret diaphragm (320) adapted to make sounds in accordance with an electrical signal, the electret diaphragm (320) being stacked on the conductive layer (440) and having a film body (322) and an electrode layer (324), wherein the film body (322) has static charges and the electrode layer (324) is formed on the film body (322); and
   at least one spacer (350) disposed between the electret diaphragm (320) and the conductive layer (440) to keep a predetermined distance between the electret diaphragm (320) and the conductive layer (440),

   the device further comprising:

   a first electrical terminal (116a) and a second electrical terminal (116b) disposed on the inner surface (112) of the housing (110) for electrically connecting the electrical signal to the electrode layer (324) of the electret diaphragm (320) and the conductive layer (440), respectively;
   a third electrical terminal (197a) and a fourth electrical terminal (197b) on the circuit board (195), wherein the first electrical terminal (116a) and the second electrical terminal (116b) are respectively electrically coupled with the third electrical terminal (197a) and the fourth electrical terminal (197b) whereby the electrical signal is applied to the electrode layer (324) of the electret diaphragm (320) and the conductive layer (440).

2. The portable electronic device as claimed in claim 1, wherein the electro-acoustic transducer (480) further comprises a sound absorbing layer (360) attached to the electrode layer (324) of the electret diaphragm (320).

3. The portable electronic device as claimed in claim 1, wherein the at least one spacer (350) is made of adhesive material.

4. The portable electronic device as claimed in claim 1, wherein the electrode layer (324) of the electret diaphragm (320) and the conductive layer (440) are electrically connected to the electrical signal.

Patentansprüche

1. Tragbare elektronische Vorrichtung, die ein Mobiltelefon, ein persönlicher digitaler Assistent (PDA) oder ein Laptop-Computer ist, umfassend:

   ein Gehäuse (110) mit einer Innenfläche (112), einer Außenfläche (118) und einer Vielzahl von Öffnungen (114), die zwischen der Innenfläche (112) und der Außenfläche (118) davon durchdringend angeordnet sind;
   eine Schaltungsplatine (195); und
   ein elektroakustischer Wandler (480), der auf der Innenfläche (112) des Gehäuses (110) angeordnet ist und elektrisch mit der Schaltungsplatine (195) verbunden ist, umfassend:

   eine leitfähige Schicht (440), die auf der In-

nenfläche (112) des Gehäuses (110) aufgeschichtet ist;
eine Elektretmembran (320), die geeignet ist, einen Schall entsprechend einem elektrischen Signal zu erzeugen, wobei die Elektretmembran (320) auf der leitfähigen Schicht (440) aufgebracht ist und einen Filmkörper (322) und eine Elektrodenschicht (324) aufweist, wobei der Filmkörper (322) statische Ladungen trägt und die Elektrodenschicht (324) auf dem Filmkörper (322) ausgebildet ist; und
wenigstens ein Abstandsstück (350), das zwischen der Elektretmembran (320) und der leitfähigen Schicht (440) angeordnet ist, um einen vorgegebenen Abstand zwischen der Elektretmembran (320) und der leitfähigen Schicht (440) beizubehalten;

wobei die Vorrichtung ferner umfasst:

einen ersten elektrischen Anschluss (116a) und einen zweiten elektrischen Anschluss (116b), die auf der Innenfläche (112) des Gehäuses (110) angeordnet sind, um das elektrische Signal an die Elektrodenschicht (324) der Elektretmembran (320) und die leitfähige Schicht (440) respektive elektrisch anzuschließen;
einen dritten elektrischen Anschluss (197a) und einen vierten elektrischen Anschluss (197b) auf der Schaltungsplatine (195), wobei der erst elektrische Anschluss (116a) und der zweite elektrische Anschluss (116b) respektive elektrisch mit dem dritten elektrischen Anschluss (197a) und dem vierten elektrischen Anschluss (197b) gekoppelt ist, wobei das elektrische Signal an die Elektrodenschicht (324) der Elektretmembran (320) und die leitfähige Schicht (440) angelegt wird.

2. Tragbare elektronische Vorrichtung nach Anspruch 1, worin der elektroakustische Wandler (480) ferner eine schallabsorbierende Schicht (360) aufweist, die an der Elektrodenschicht (324) der Elektretmembran (320) befestigt ist.

3. Tragbare elektronische Vorrichtung nach Anspruch 1, worin das wenigstens ein Abstandsteil (350) aus einem Klebematerial hergestellt ist.

4. Tragbare elektronische Vorrichtung nach Anspruch 1, worin die Elektrodenschicht (324) der Elektretmembran (320) und die leitfähige Schicht (440) elektrisch mit dem elektrischen Signal verbunden sind.

Revendications

1. Dispositif électronique portable, qui est un téléphone mobile, un assistant numérique personnel (PDA) ou un ordinateur portable, comprenant:

- un boîtier (110) ayant une surface intérieure (112), une surface extérieure (118) et une pluralité d'ouvertures (114) pénétrant entre la surface intérieure (112) et la surface extérieure (118) de celui;
- une plaque de circuit (195); et
- un transducteur électro-acoustique (480) disposé sur la surface intérieure (112) du boîtier (110) et connecté par voie électrique à la plaque de circuit (195), comprenant:

  - une couche conductrice (440) revêtue sur la surface intérieure (112) du boîtier (110);
  - un diaphragme à électret (320) adapté pour produire des sons conforme à un signal électrique, le diaphragme à électret (320) étant empilé sur la couche conductrice (440) et ayant un corps de film (322) et une couche d'électrodes (324), où le corps de film (322) présente des charges statiques et la couche d'électrodes (324) est formée sur le corps de film (322); et
  - au moins une pièce de distance (350) disposée entre le diaphragme à électret (320) et la couche conductrice (440) pour maintenir une distance prédéterminée entre le diaphragme à électret (320) et la couche conductrice (440),

- le dispositif comprenant de plus:

  - une première borne électrique (116a) et une seconde borne électrique (116b) disposées sur la surface intérieure (112) du boîtier (110) pour connecter par voie électrique le signal électrique à la couche d'électrodes (324) du diaphragme à électret (320) et, respectivement, à la couche conductrice (440);
  - une troisième borne électrique (197a) et une quatrième borne électrique (197b) sur la plaque de circuit (195), où la première borne électrique (116a) et la seconde borne électrique (116b) sont couplées par voie électrique avec la troisième borne électrique (197a) et respectivement la quatrième borne électrique (197b) au moyen desquelles le signal électrique est appliqué à la couche d'électrodes (324) du diaphragme à électret (320) et à de la couche conductrice (440).

2. Dispositif électronique portable selon la revendication 1, où le transducteur électro-acoustique (480) comprend de plus une couche d'absorption de son (360) attachée à la couche d'électrodes (324) du diaphragme à électret (320).

3. Dispositif électronique portable selon la revendication 1, où au moins une pièce de distance (350) est faite en matière adhésive.

4. Dispositif électronique portable selon la revendication 1, où la couche d'électrodes (324) du diaphragme à électret (320) et la couche conductrice (440) sont connectées par voie électrique au signal électrique.

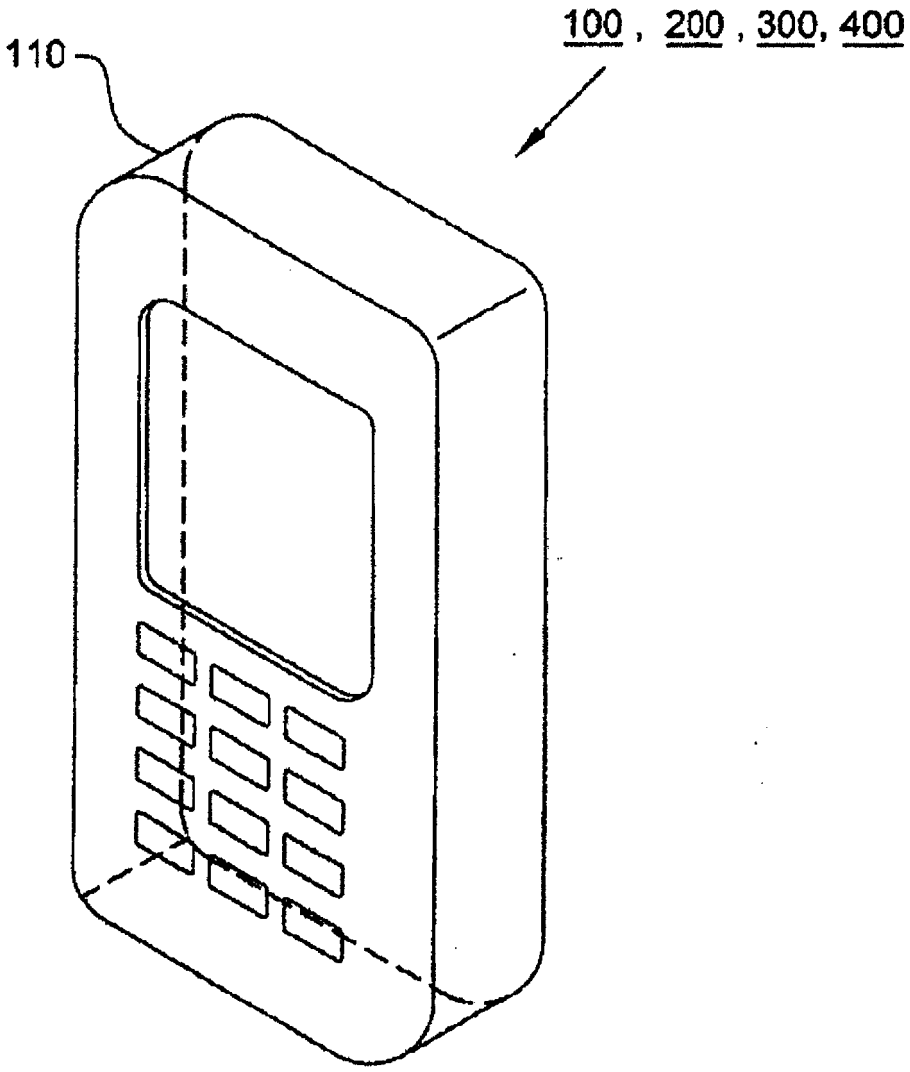

FIG. 1

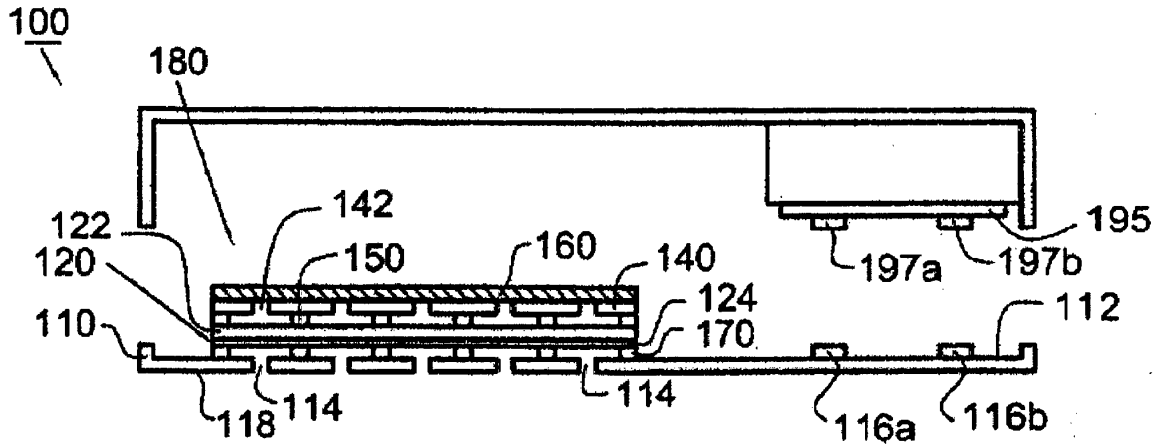
100
180
142
122
150
160
140
120
124
110
170
112
195
197a
197b
118
114
114
116a
116b

FIG. 2a

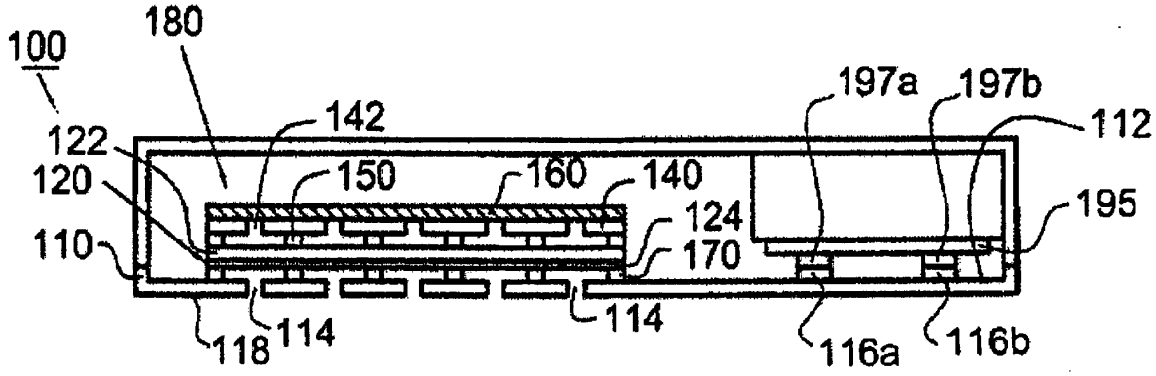
100
180
197a
197b
142
112
122
150
160
140
120
124
195
110
170
118
114
114
116a
116b

FIG. 2b

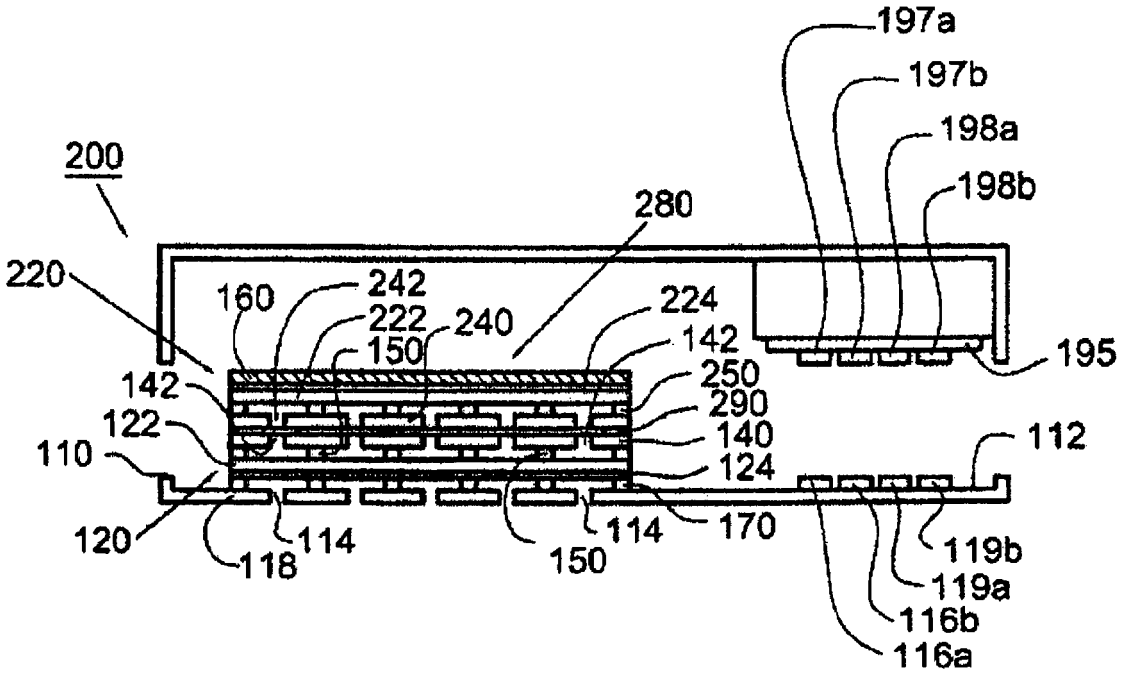
200
220
160
242
222
150
240
280
224
142
250
290
140
124
142
122
110
120
118
114
150
114
170
197a
197b
198a
198b
195
112
119b
119a
116b
116a

FIG. 3a

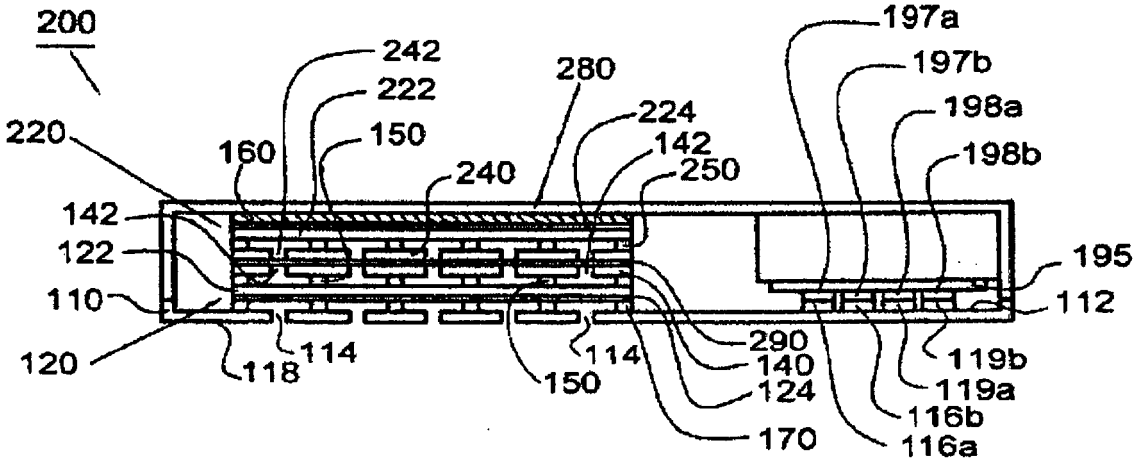
200
220
160
242
222
150
240
280
224
142
250
142
122
110
120
118
114
150
114
290
140
124
170
197a
197b
198a
198b
195
112
119b
119a
116b
116a

FIG. 3b

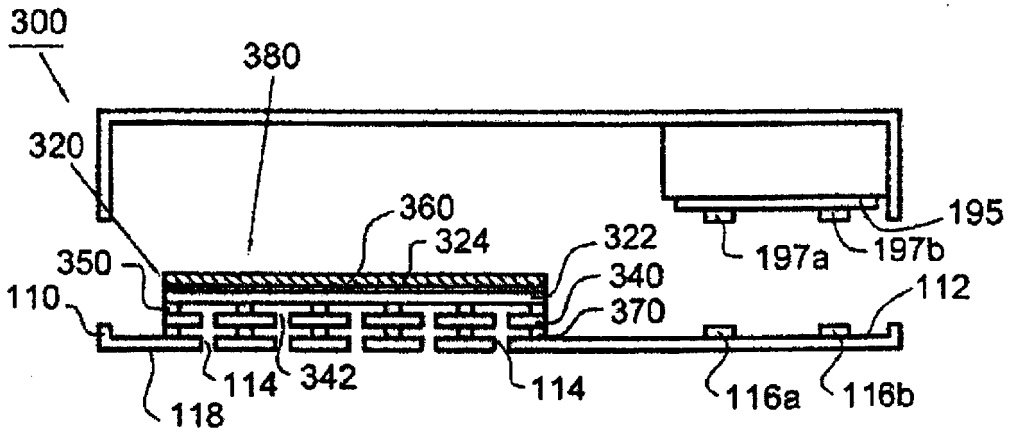
300
380
320
360
324
322
340
370
350
110
112
195
197a
197b
114
342
114
118
116a
116b

FIG. 4a

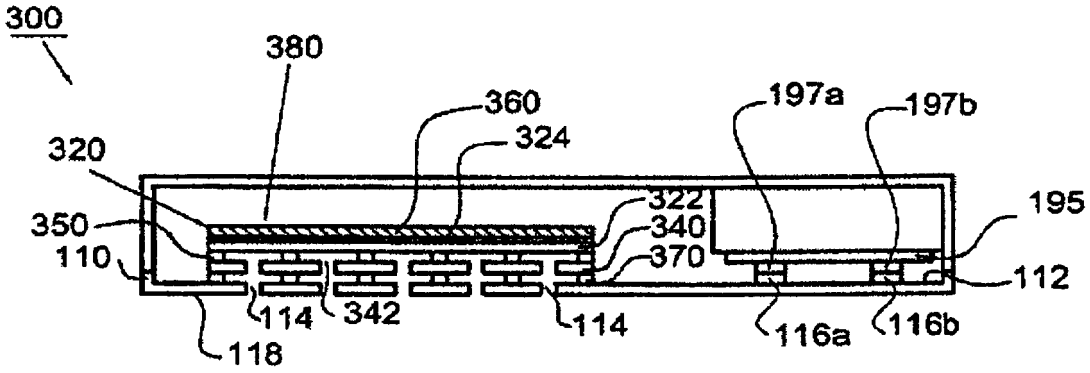
300
380
360
197a
197b
320
324
322
340
370
350
110
195
112
114
342
114
118
116a
116b

FIG. 4b

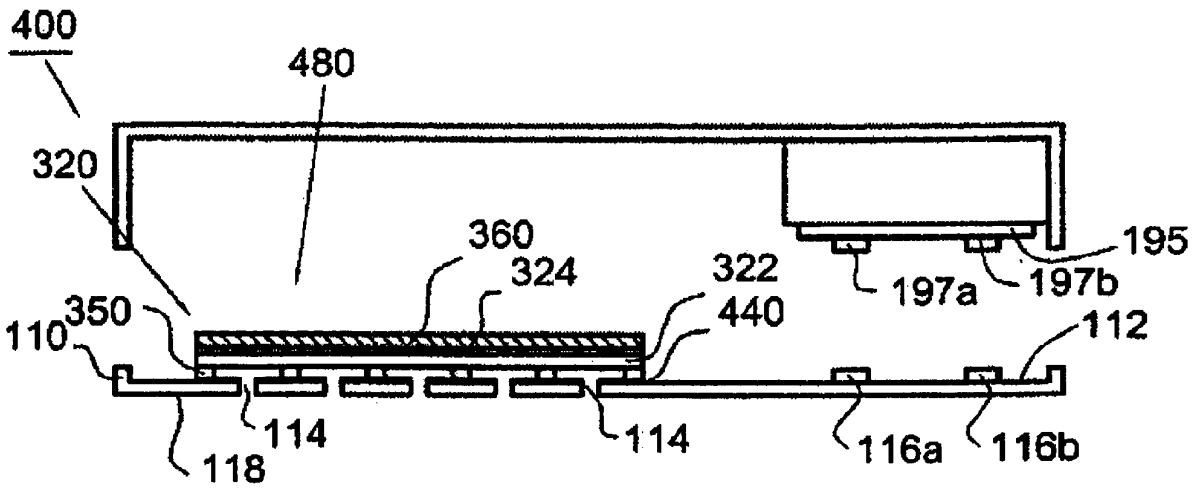
400
480
320
360
324
322
440
195
197a
197b
110
350
112
114
114
116a
116b
118

FIG. 5a

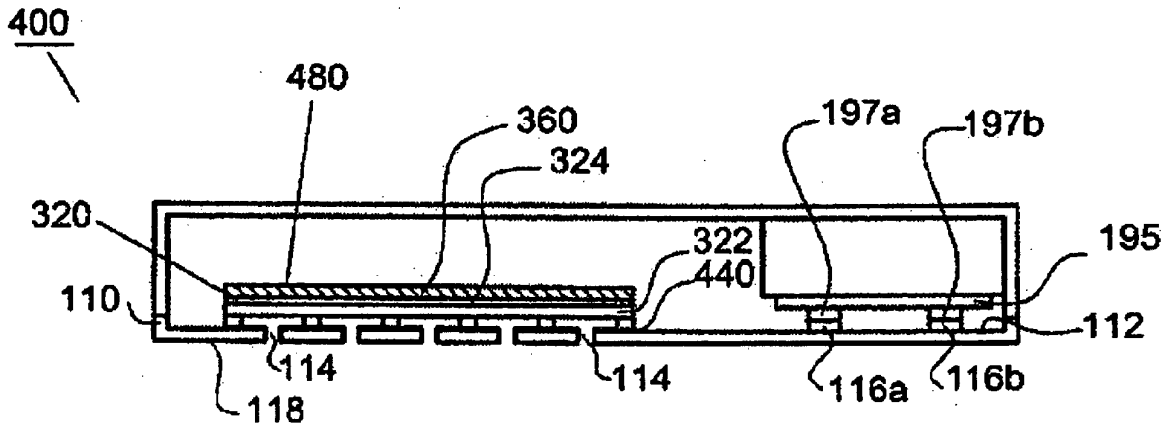
400
480
360
324
197a
197b
320
322
440
195
110
112
114
114
116a
116b
118

FIG. 5b

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 1722596 A1 **[0004]**
- US 20041170291 A **[0005]**