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MEMBRANE SHIELD**Field of the Invention**

- 5 The present invention pertains to shielding, and more particularly to shielding in the contact area of a membrane.

Background of the Invention

- 10 A variety of devices are known that include RF circuitry, such as transmitters, receivers, or transceivers, for communicating with other compatible devices. Examples of such devices include radiotelephones, which may be cordless or cellular telephones, two-way radios, pagers, personal digital assistants (PDA), or the like. These devices typically include user actuable keys to manually close respective
15 switches mounted on a circuit board. The switches are coupled to a controller that is responsive to key actuation to control the operation of the RF circuitry.

- Shielding is often employed in the area near the keys (the "key area") in these devices, in addition to other areas of the housing. The shielding isolates the RF circuitry from noise signals that can reduce performance of these devices. In the past,
20 shielding has been provided by spraying a conductive material on the interior surface of the device housing around the key openings. Shielding has also been provided using a conductor layer on a printed circuit board. By connecting the conductor layers to ground, they become a shield by conducting RF signals to ground.

- Although each of these shielding techniques provides an effective RF shield in
25 existing devices, it is desirable to provide smaller devices having technological improvements. These new devices have experienced even greater susceptibility to noise signals. One particularly advantageous new device includes an antenna in a cover that pivots between an open position and a closed position. In the closed position, the cover antenna is positioned over the keys in close proximity to the
30 circuitry in the housing. A passive radiator is attached to the interior of the housing to tune the cover antenna when the cover is closed. This close proximity of the cover antenna makes it highly susceptible to receipt of noise from the circuitry in the housing. This noise is particularly difficult to shield against because the key openings make shielding difficult, and the passive radiator is positioned near the key openings.

- 35 Accordingly, there is a need for improved shielding for the key area of a device.

Brief Description of the Drawings

FIG. 1 shows a front elevation view illustrating a radiotelephone including a
5 cover in an open position.

FIG. 2 shows an exploded, fragmentary, front, side and top perspective view illustrating the radiotelephone according to FIG. 1.

FIG. 3 shows a fragmentary rear elevation view illustrating the rear of the front housing of the telephone according to FIG. 2 with the cover in the open
10 position.

FIG. 4 is a top plan view illustrating a membrane in the radiotelephone according to FIG. 1.

FIG. 5 is a bottom plan view illustrating the membrane according to FIG. 4.

FIG. 6 is a cross-sectional view taken along plane 6-6 in FIG. 4.

FIG. 7 is a top, rear, and side perspective view illustrating a clip for the radiotelephone according to FIG. 2.
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FIG. 8 is rear elevation view illustrating the clip according to FIG. 7.

FIG. 9 is a top plan view illustrating the clip according to FIG. 7.

FIG. 10 is a fragmentary cross-sectional view taken along plane 10-10 in
20 FIG. 1.

FIG. 11 is a top, front, and right side perspective view illustrating an assembled membrane and logic circuit board.

FIG. 12 is a fragmentary cross-sectional view taken along plane 12-12 in
FIG. 1.

FIG. 13 is a side elevation view illustrating the relative positioning of a cover antenna, a passive radiator, a membrane, a display circuit board, a clip, a shield, and an RF circuit board, for the radiotelephone according to FIG. 1, when the cover is in the closed position.
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FIG. 14 is a circuit diagram partially in block diagram form illustrating electrical components of the radiotelephone.
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FIG. 15 is an enlarged fragmentary view of a section of FIG. 10 and illustrating the connection of the clip, the membrane shield, and the ground conductor.

FIG. 16 is a bottom perspective view of a membrane according to an alternate embodiment of the invention.
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FIG. 17 is a cross sectional view of the membrane according to FIG. 16 mounted to a circuit board and taken along a plane similar to that of FIG. 12.

FIG. 18 is a circuit schematic illustrating a keypad matrix and microprocessor for the embodiment according to FIG. 16.

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Detailed Description of the Drawings

A device includes keys for actuation by the user to control the operation of the device. A keypad membrane having contact areas associated with the keys of the
10 device includes a conductor layer on the bottom surface thereof. The conductor layer covers the area under the contact. The membrane conductor is connected to ground to provide a shield which blocks passage of RF signals through the key area. Because a grounded membrane conductor extends over the contact area of the keys, transmission of signals through the contact area is prevented. By providing the
15 membrane conductor on the bottom of the membrane, ease of assembling the membrane shield and an associated circuit board into an electronic device is increased.

A radiotelephone, illustrated as a portable cellular telephone, 100 (FIG. 1) includes a body 101 and a keypad cover 103. A mast antenna 104 is carried on body 101 and a cover antenna 106 (shown in phantom) is mounted inside the cover 103.
20 The mast antenna communicates with a fixed site, or base station, 102, via RF signals represented by A, and cover antenna 106 communicates with base station 102, via RF signals represented by B. The cover pivots between the extended position illustrated in FIG. 1 and a closed position covering keypad 108. The radio includes a keypad 108, a display 107, and a speaker opening 112. Although a cellular telephone is
25 illustrated, the invention will also find application in cordless telephones, two-way radios, pagers, and PDAs, and "device" as used herein shall refer to each of these and their equivalents.

The radiotelephone 100 includes a front housing 210 (FIG. 2) and a rear housing 212. The front and rear housings are integrally molded of a suitable material,
30 such as a polymer. Keys 211 (only some of which are shown) are positioned behind the front housing 210, and are manufactured of a suitable material, such as a molded polymer. A respective key 211 is associated with each opening 214 in the front housing 210.

A membrane 216 is positioned behind the keys 211. The membrane includes
35 a respective contact region, or area, 217 (only some of which are numbered) associated with each key 211. The membrane also includes holes 215 that extend

through the membrane to pass light. The contact, or key, area 217 is illustrated formed into a popple. Popple as used herein refers to a dome in the body of the membrane. However the contact area may be flat or recessed, so long as it springs back to its original shape after being flexed by actuation of the key 211. The contact area is thus deformable when pressed by key 211 and sufficiently resilient to spring back to its original position when released by key 211.

A display board assembly 218 is positioned behind the membrane 216. The display board assembly includes contacts 220 (only some of which are numbered), light emitting diodes (LEDs) 223 (only some of which are numbered), a display 107, and a speaker 222 which are mounted to the display board 219. A shield 224 is positioned between the display board assembly 218 and an RF circuit board assembly 226. RF circuitry (not shown) is mounted to the RF circuit board assembly which includes an RF transceiver (not shown in FIG. 2), a controller (not shown), and other circuitry (not specifically shown), which are mounted to an RF circuit board 227. Clips 228 and 230 are mounted to the display board to provide a ground connection for the membrane 216 as described in greater detail herein. The radiotelephone also includes a cap 234 and a connector 236.

The radiotelephone 100 (FIG. 1) includes a cover antenna 106. The cover antenna 106 is a dipole antenna provided by two electrical conductors affixed to a plastic housing 129. The conductors include respective high current sections 130 connected to the radiotelephone transceiver circuitry (not shown in FIG. 1, 1240 in FIGs. 12 and 14) via feed line and impedance transformer conductors 133, which extend through hinge 135 into body 101.

A passive radiator 310 (FIG. 3) is connected to the inside surface 312 of the front housing 210. The passive radiator is manufactured of a suitable electrically conductive material, such as a copper alloy. Passive radiator 310 includes a shoulder 314 and two arms 316. The shoulder is positioned to extend between two rows of openings 214. The arms are positioned to extend along the sides 318 and 320 of the front housing. The shoulders and arms are connected by a joinder 315. The passive radiator conductor is mounted to the interior of the front housing 210 using a suitable adhesive. The passive radiator 310 is provided to tune the cover antenna 106 (FIG. 1) when the cover 103 is closed. Tuning is provided by an electrical coupling between the high current sections 130 of cover antenna 106 and the shoulder 314 (FIG. 3) of passive radiator 310. The passive radiator and cover antenna are not coupled when the cover 103 is open.

When mounted in a fully assembled radiotelephone 100, the passive radiator 310 (FIG. 3) is not directly connected to any other electrically conductive material or any circuit elements. Because the passive radiator is not directly electrically connected to other circuitry or ground, the surface 312 around the key openings 214 can not be coated with an electrically conductive material, as has been done with prior radiotelephones.

The membrane 216 (FIG. 4) includes a respective contact area 217 for each key 211 of the keypad 108. Each illustrated contact area 217 is a popple, which is an integral dome extending upwardly from a planar web 410. The underside of each contact area 217 includes a contact 510 (FIG. 5) for connection to a respective contact 220 (FIG. 2) on the display board. When contact area 217 is deformed downwardly by the key 211, the contact 510 on the bottom of the membrane is pushed downwardly to impact on contact 220. This contact completes a circuit thereby indicating a switch closure. This provides a signal to the controller indicating that a key is actuated, and the controller identifies which key is actuated, in a conventional manner. The contact area snaps back to its original position after release of the key 211. The contact area provides a tactile feel for the user, after the key 211 is released. The planar web 410 includes holes 215 that extend through the membrane to pass light from LEDs 223 (FIG. 2) to the back of keys 211.

The inventors have found that positioning the cover antenna 106 (FIG. 1) in close proximity to the display board assembly 218 (FIG. 2) when the cover 103 is closed provides a path for RF signals from a microprocessor clock (not shown in FIG. 2, 1311 in FIG. 13) to the cover antenna 106. The microprocessor clock produces clock signals having harmonic frequencies in the frequency band of the transceiver (not shown in FIG. 2, 1240 in FIG. 13). These harmonics are detected by the cover antenna 106 when the cover 103 is closed. The area around the passive radiator 310 is not coated with a conductive material, as has been done in the past with radiotelephones that do not include a passive radiator. However, even if the interior was coated with a conductor, key openings 214 provide a path for RF signals. The inventors have found that the contacts 220, 510 (FIGs. 2 and 5 providing the key actuated switch) radiate significant amounts of noise energy. Accordingly, shielding the interior surface of the front housing or providing a ground layer that does not extend over the contact areas 217 will not provide an effective shield for the cover antenna 106, since noise from the circuit traces forming contacts 220, 510 pass through openings 214.

To overcome this problem discovered with prior shielding techniques, the membrane 216 is provided with at least two layers. The membrane includes a nonconductive membrane body 624 (FIG. 6) and a membrane conductor 626, which membrane conductor covers the entire top surface of the membrane body including the contact areas 217. The membrane body 624 is manufactured of a suitable material, such as a strong polyester web, and may for example be that commercially known as Mylar™. The body is resilient, such that it snaps between an dome position (not deformed) and a closed position (collapsed). The Mylar provides a tactile feel for users when the key 211 is pressed.

The membrane conductor 626 (FIG. 6) is a conductor layer applied using a suitable technique, such as spraying. The membrane conductor 626 is preferably a commercially available conductor such as flexible polymeric conductor composition number 5007 commercially available from DuPont™. Contacts 510 are manufactured by any suitable means, such as silver paint applied using screening techniques.

Clips 228 (FIG. 2) and 230 are provided to connect the membrane conductor 626 (not identified in FIG. 2) to ground. These clips are identical. Accordingly, only clip 228 is described in greater detail herein. Clip 228 includes parallel arms 710 (FIGs. 7-9, only some of which are numbered in each figure) extending from shoulder 712. The arms each include a fold 713 (only some of which are numbered). Upper fingers 716 project outwardly from the bottom of shoulder 712. Each of the upper fingers includes a bend 715. Middle fingers 718 project from the middle of shoulder 712. Tabs 720 extend orthogonal from the opposite ends of each shoulder 712. The clips are manufactured of suitable electrically conductive material, and may for example be manufactured of Beryllium Copper with tin over nickel plating. The clip is electrically conductive and resilient such that it can be deformed and spring back to its original position.

The cap 234 (FIG. 2) and the connector 236 are manufactured of suitable electrically conductive material, such as an aluminum alloy or a copper alloy. The cap includes fingers 1212 (FIG. 12), 1214, and 1216 which extend outwardly from body 1218. The connector 236 (FIG. 2) includes a plate 240 and springs 242.

To assemble the radiotelephone 100 (FIG. 10), membrane 216 is positioned on display board 219 such that the contacts 510 on the bottom of the contact areas 217 are aligned with respective contacts 220 on display board 219. When properly positioned, the LEDs 223 (FIG. 11) are visible through the holes 215 in membrane 216. The clip 228 (FIG. 10) is attached to the display board 219 and the membrane 216, such that the upper fingers 716 contact the membrane conductor 626. The tabs

720 are positioned against walls 1112 (FIG. 11) to locate the clip 228 at the appropriate position on the circuit board. The bend 715 (FIG. 10) contacts membrane conductor 626 and exerts a force against the layer to insure connection to the membrane conductor 626 of the membrane 216. The middle finger 718 engages the
 5 bottom surface of the display board 219. The display board is pinched between the upper finger 716 and the middle finger 718.

The clip 228 (FIG. 10) connects to conductive strips 1010. The clip 228 can be soldered to the strip 1010 to insure electrical connection therebetween. The strips run along the perimeter of display board 219 and are electrically connected to a
 10 conductor layer 1012 (FIG. 15) in display board 219 via a through conductor 1018. The conductor layer 1012 is positioned between insulator layers 1014 and 1016, and extends over substantially the entire display board 219. This electrically conductor layer 1012 is a ground conductor for display board 219. The clip 238 thus connects the membrane conductor 626 to the ground conductor, conductor layer 1012, of the
 15 display board 219.

The arms 710 of clip 238 extend outwardly from shoulder 712 to connect to shield 224. The fold 713 in arm 710 engages the shield 224. The fold 713 pushes against the shield 224 to insure electrical connection between the shield 224 and the clip. The clip thus electrically connects the membrane conductor 626 to the shield
 20 224.

The shield 224 is electrically connected to a conductor layer 1220 (FIG. 12) in the RF circuit board 227 by a through conductor 1222. The RF circuit board conductor layer 1220 is sandwiched between electrical insulators 1224 and 1226. The conductor layer 1220 extends over substantially the entire RF circuit board 227,
 25 and is the ground conductor for the RF circuit board 227. The shield 224 and the conductor layer 1220 provide a ground box around the RF circuitry. Because arms 710 of clip 228 connect to the shield 224 when the display board 219 and the RF circuit board 227 are assembled together in the radiotelephone 100, as best shown in FIG. 10, the clip 228 is connected to the RF circuit board ground conductor layer
 30 1220.

Although not specifically described herein, clip 230 is assembled into the radiotelephone 100 in an identical manner to clip 228. The description of the attachment of clip 230 is therefor omitted for brevity.

The inside surface of the front housing 210 and the rear housing 212 are
 35 sprayed with a conductive material in the area of the speaker 222. Cap 234 and connector 236 connect the conductor layer 1220 of RF circuit board 227 to the surface

of the front housing 210 and the rear housing 212 when the radiotelephone housings are assembled over the circuit boards. This layer of the telephone housing and the connection to the conductor layer 1220 provides additional grounding conductors for the radiotelephone.

5 When the housing is fully assembled, the LEDs 223 are positioned in holes 215 (FIG. 11) to provide light to the back of the keys 211. This light illuminates the keys 211 of keypad 108 during operation. The inventors have found that the LED regions (holes 215) do not pass significant amounts of RF energy of the type that interferes with the operation of RF transceiver circuit 1240 (FIG. 13)

10 The relative positioning of the components of the radiotelephone 100 when cover is closed are illustrated in FIG. 13. In this position of the cover antenna 106 is positioned substantially parallel to the membrane 216. The passive radiator 310 is positioned between the membrane 216 and the cover antenna 106. The arms 316 of the passive radiator extend along the sides of the radiotelephone circuitry. The display board 219 is positioned behind the membrane, the shield 224 is positioned under the display board, and the shield is mounted to the RF circuit board 227. The clip 230 is electrically connected to the conductor layer of membrane 216, the conductor layer of membrane 216, and the shield 224. The microprocessor 1310 for the radiotelephone is mounted to the bottom of the display board 219 and is shielded from the RF board by grounded shield 224. The high current sections 130 of the cover antenna 106, are coupled to the shoulder 314 of the passive radiator 310. Shoulder 314 is the high current section of the passive radiator. This high current section of the passive radiator extends to joiner 315, which is coupled to arms 316. The joiner 315 extends along the clips 228, 230, such that the clips provide additional shielding. Clip 228 (not shown in FIG. 13) is similarly positioned with respect to the joiner 315.

It will be recognized that the passive radiator 310 (FIG. 3) is mounted to the inside surface of the front housing 210, and is spaced from the clips 228 (FIG. 2) and 230, mounted to the display board assembly 218, such that the clips 228, 230 do not contact the passive radiator. The clips 228 and 230 are both located on the display board 219 such that they are positioned between the joiners 315 of the passive radiator and the side of the display board 219.

In operation, the microprocessor 1310 (FIG. 14) supplies RF noise signals, including harmonics of clock signals, to contacts 510. The contacts 510, 220 act as a radiator and emit these RF noise signals. The grounded membrane conductor 626 provides a shield which prevents the RF signals from reaching cover antenna 106

when the cover is closed. This prevents the RF signals from reaching RF transceiver circuit 1240. Consequently, the noise floor is lowered for the transceiver, which lowers the minimal magnitude of signals B (FIG. 1) that is necessary for the RF transceiver to receive an identifiable signal when the cover 103 is closed.

5 The invention is particular advantageous for use with a cover antenna 106 (FIG. 14). Although the cover antenna 106 is in close proximity to the display board assembly 218 when the cover 103 is closed, the shield provided by the grounded membrane conductor 626 blocks the transmission of signals between the circuit traces, which form contacts 220, 510, and the cover antenna 106. Thus, the high
10 order harmonics of the clock signals generated by microprocessor clock 1311, or any other signal source that produces signals present on the contacts 220, 510, that fall into the frequency band of the RF transceiver circuit 1240, are blocked by the grounded membrane conductor 626. Consequently, antenna 106 reception of noise signals radiated by the contacts 220, 510 is substantially reduced, and practically
15 eliminated. Additionally, the large surface area shielded by the grounded membrane conductor 626 provides improved shielding for the key area of the radiotelephone 100.

 A membrane 1600 (FIG. 16) according to an alternate embodiment of the invention, includes a generally planar membrane body 1602. Although the membrane
20 body 1602 is illustrated to be a rectangular shape, it will be recognized that the body is advantageously shaped to conform to the device in which it is used, and may be of the same shape and construction as membrane body 624 (FIG. 6). The planar body includes contact areas 1606 (FIG. 16), which contact areas can be in the form of popples as illustrated in FIGs. 16 and 17. The membrane body 1602 is constructed
25 of a suitable, deformable, resilient material, such as a polymeric material. A membrane conductor layer 1608 is mounted to a bottom surface of the membrane body 1602. The membrane conductor layer 1608 is of any suitable manufacture, such as a silver paint sprayed onto a bottom surface of the membrane body 1602. The membrane conductor layer 1608 is flexible, to not interfere with the manipulation
30 of the keys 211. The membrane conductor layer 1608 extends over, and beyond, the bottom surface of the contact areas 1606, and can advantageously extend over substantially the entire bottom surface of the membrane body 1602.

 A conductive adhesive 1700 (FIG. 17) is provided between a circuit board 1702 and the membrane conductor layer 1608. The conductive adhesive may be of
35 any suitable material, such as a fluid polymer impregnated with an electrical

conductor, a transfer tape having an electrical conductive material therein, such as Scotch brand No. 9703 transfer tape, or the like.

The circuit board 1702 (FIG. 17) has a first nonconductive outer layer 1706. Openings 1712 in this outer layer 1706 provide access to the conductor layer 1704. Thus an air pocket 1720 in the adhesive 1700 surrounds the contacts 220. The air pocket is preferably open to surrounding air, and may for example be vented, to facilitate collapse of the contact areas. This adhesive 1700 provides a reliable connection between the membrane conductor layer 1608 and the circuit board conductor layer 1704. Another nonconductor layer 1714 extends over the bottom of conductor layer 1704. The ground conductor layer is connected to a ground conductor on the inside surface of body 101 (FIG. 1) and/or to the ground conductor in circuit board assembly 226.

The keypad contacts 220 are physically organized into rows and columns. A contact 220 associated with each key in the first column is connected to conductor 1820. A contact 220 associated with each key in the second column is connected to conductor 1822. A contact 220 associated with each key in the third column is connected to conductor 1824. A contact 220 associated with each key in the first row is connected to conductor 1826. A contact 220 associated with each key in the second row is connected to conductor 1828. A contact 220 associated with each key in the third row is connected to conductor 1830. A contact 220 associated with each key in the fourth row is connected to conductor 1832. Conductors 1820, 1822, and 1824 are connected to column inputs 1802, 1804, and 1806 of microprocessor 1310 via resistors 1834, 1836, and 1838, respectively. Conductors 1826, 1828, 1830 and 1832 are connected to row inputs 1810, 1812, 1814 and 1816 of microprocessor 1310 via resistors 1840, 1842, 1844 and 1846, respectively. Each of the row inputs 1810, 1812, 1814 and 1816 is connected via a respective isolation diode 1850-1853 to interrupt input 1808 of microprocessor 1310.

To assemble the membrane 1600 to circuit board 1702, the transfer tape or the fluid adhesive is positioned between the membrane 1600 and the circuit board 1702. If transfer tape is used, the transfer tape is first applied to the conductor layer 1704 of the membrane 1600. The adhesive layer is then attached to the circuit board 1702. The transfer tape adhesive 1700 flows into the openings 1712 when the membrane is attached to the circuit board 1702. Alternately, the fluid adhesive 1700 is applied to one of the membrane 1600 and the circuit board 1702. The membrane is then attached to the circuit board 1702. The fluid must be carefully applied such that it does not connect to contacts 220. The fluid adhesive 1700 flows into the openings

1712 when the membrane is attached to the circuit board 1702. The adhesive 1700 physically and electrically connects the membrane conductor layer 1608 to the circuit board conductor layer 1704 to form an integral assembly when the fluid hardens. The adhesive 1700 is not applied in the area around contacts 220.

5 In the embodiment of FIGs. 1-15, pressing a key 211 (FIG. 10) connects contact 510 to two contacts 220, thereby shorting the two contacts 220. Those skilled in the art will recognize that this causes a hardware interrupt, resulting in a scanning of columns and rows of a matrix associated with the contact pairs, or contact sets, 220. The closed contact will cause one row and one column to have a unique voltage level, thereby identifying the key actuated.

10 In the embodiment of FIGs. 16-18, actuating the key 211 (FIG. 17) presses the grounded layer 1608 (FIG. 1) into associated contacts 220. The connected contacts 220 are pulled to ground by the grounded membrane conductor layer 1608. This ground connection causes a hardware interrupt at input 1808. The row and
15 column input having a contact pulled to ground will identify which popple is closed (i.e., which key 211 is actuated).

 The embodiment of FIGs. 16 and 17 has the advantage that the adhesive is used to connect membrane shield, provided by the membrane layer, to circuit ground. This simplifies manufacturing, as the clips 228 and 230 can require manual soldering.
20 In such circumstances, the use of the membrane on a lower surface eliminates the need for the clips to connect the ground layer to the circuit ground.

 Accordingly, it can be seen that improved key area shielding is disclosed. The shielding provides protection over the surface area of the keypad, and prevents the keypad switches from radiating RF energy through key openings to an antenna in
25 close proximity thereto.



CLAIMS

We claim:

- 5 1. A keypad membrane, comprising:
 a substantially planar resilient body constructed of an elastic pliable
 nonconductive member and including respective contact areas, the contact areas
 resiliently deformable to collapse and return to their original position; and
 a membrane conductor disposed on a bottom surface of the substantially
10 planar resilient body and covering a bottom surface of the contact areas and extending
 beyond the bottom surface of the contact areas, the membrane conductor to connect to
 ground to provide a conductor that acts as a shield in the contact areas.
2. The keypad membrane as defined in claim 1, wherein the membrane
15 conductor is flexible.
3. A device including the keypad membrane according claim 1, wherein
 the device comprises
 a plurality of keys to be actuated by a user;
20 a circuit board carrying at least one contact associated with each key; and
 the membrane positioned between said keys and said circuit board.
4. The device as defined in claim 3, wherein said circuit board includes a
 board conductor layer, and said device further including an adhesive connected to said
25 board conductor layer and said conductive membrane layer.
5. The device as defined in claim 4, wherein said circuit board further
 includes a nonconductive layer, said nonconductive layer including openings through
 which said adhesive extends to connect to said conductive membrane layer.
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6. The device as defined in claim 3, wherein said contact areas include
 respective popples.
7. The device as defined in claim 3, wherein said conductive membrane
35 layer is flexible.



8. The device as defined in claim 3, wherein the device is a radiotelephone comprising:

a housing having a body;

the circuit board positioned in the body; and

5 the keys positioned to extend through the body, the keys for actuation by a user.

9. The radiotelephone as defined in claim 8, the radiotelephone including a movable keypad cover and an antenna carried on the cover, the membrane
10 positioned between the contacts and the cover when the cover is closed.

10. The radiotelephone as defined in claim 9, further including a second circuit board having RF circuitry thereon, the first circuit board positioned between the membrane and the second circuit board.
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