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(54) **Communication device and antenna thereof**

Kommunikationsvorrichtung und Antenne dafür

Dispositif de communication et antenne associée

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Description

Field of the Invention

[0001] The present invention relates to a communication device and an antenna capable of utilizing a metal frame as a common antenna for emitting and receiving radio signals of the communication device.

Background of the Invention

[0002] During product development processes of conventional communication devices, such as mobile communication products, plastic housings are mainly used by manufacturers due to cost concerns, in order to maintain basic radiation characteristics of an antenna. However, a trend of metal housing is currently brought by Apple iPhones and Macbooks. Since the metal housing has light weight, good heat dissipation, high strength, high impact resistance, good looking, anti-electromagnetic and recyclable characteristics, the metal housing is getting more and more popular. Therefore, the metal housings are mainly used in development of new generations of the mobile communication products. For example, US patent No. 8,054,231 B2 disclosed by Ahn et al. teaches a metal case having a slot, which can be used as a slot antenna of a mobile device. But the slot may obviously ruin appearance of the metal case, and the slot needs to be arranged at a position corresponding to a specific area of the metal case. The Apple iPhone cell phone from 4 series to 5 series utilizes some of metal structural components of the cell phone as a part of an antenna for radiation. Antenna design using the metal structural components can reduce size for being arranged in a limited space. The iPhone 4 has a metal loop antenna, and the iPhone 5 has a dynamic metal loop antenna. Both of them have slits formed on the metal loop antennas, as such, antenna performance can be improved, but appearance is ruined as well.

[0003] US 2014/132457 A1 discloses a communication device wherein a metal frame is used as a loop antenna for multiple transceivers.

[0004] Therefore, it is important to design a proper antenna to allow electromagnetic waves to penetrate the metal case for achieving communication purposes without obviously ruining the appearance of the metal structural components.

Summary of the Invention

[0005] This in mind, the present invention aims at providing a communication device and an antenna capable of utilizing a metal frame as a common antenna for emitting and receiving radio signals of the communication device.

[0006] This is achieved by a communication device according to claim 1. The dependent claims pertain to corresponding further developments and improvements.

Brief Description of the Drawings

[0007] In the following, the invention is further illustrated by way of example, taking reference to the accompanying drawings thereof:

FIG. 1 is a diagram showing a communication device according to an embodiment of the present invention,
FIG. 2 is an exploded view of the communication device according to the embodiment of the present invention,
FIG. 3 is a diagram showing arrangement of an antenna of the communication device according to an embodiment of the present invention,
FIG. 4 is a diagram showing arrangement of the antenna at a first position of the communication device according to an embodiment of the present invention,
FIG. 5 is a diagram showing arrangement of the antenna at the first position of the communication device (without showing a metal frame) according to the embodiment of the present,
FIG. 6 is a diagram showing relationship between a metal back cover and a ground terminal of a first circuit block of a printed circuited board according to an embodiment of the present invention,
FIG. 7 is a diagram showing arrangement of the antenna at a second position of the communication device according to an embodiment of the present invention,
FIG. 8 is a diagram showing arrangement of the antenna at the second position of the communication device (without showing the metal frame) according to the embodiment of the present, FIG. 9 is an enlarged view of an area A in FIG. 8, and
FIG. 10 is a diagram showing relationship between the metal back cover and round terminals of the printed circuited board according to an embodiment of the present invention.

Detailed Description

[0008] Fig. 1 and FIG. 2 are diagrams showing a communication device 10 according to an embodiment of the present invention. The communication device 10 comprises a metal frame 12, a display module 14, a display panel 16, a metal back cover 18, a printed circuited board 20, and a main body 22. The metal frame 12 substantially is a rectangular frame defining an opening 24, and can be utilized as a front cover of the communication device 10. The display module 14 and the display panel 16 can be separated from each other or integrated together, but the present invention is not limited to the above structure. The display panel 16 is installed between the display module 14 and the metal frame 12, and corresponding to the opening 24 of the metal frame 12. The display panel 16 is made of glass, but not limited to it. The metal

back cover 18 is substantially rectangular and located at a position corresponding to a bottom of the main body 22, for being utilized as a rear cover of the communication device 10. The printed circuit board 20 is located between the metal frame 12 and the metal back cover 18. The printed circuit board 20 comprises a first circuit block 26 and a second circuit block 28 electrically connected to the first circuit block 26. The main body 22 is located between the metal frame 12 and the metal back cover 18, for installing the display module 14, the display panel 16 and the printed circuited board 20 on the main body 22. In addition, the main body 22 is made of a non-conductive material, such as a plastic material, but not limited to it.

[0009] FIG. 3 is a diagram showing arrangement of an antenna of the communication device according to an embodiment of the present invention. FIG. 4 to FIG. 6 are diagrams showing antenna arrangement of the communication device 10 supporting a first communication function, such as a global positioning system (GPS) function. The arrangement in FIG. 4 to FIG. 6 comprises the metal frame 12, the first circuit block 26 of the printed circuit board 20, a first conductor 30, a second conductor 32 and the metal back cover 18. The metal frame 12 has a first part 34 and a second part 36 located at a position different from a position of the first part 34. In a preferred embodiment, the first part 34 and the second part 36 of the metal frame 12 are located close to an upper right position of the display panel 16. The first circuit block 26 of the printed circuit board 20 comprises a signal terminal 38 and a ground terminal 40. The first conductor 30 is connected between the first part 34 of the metal frame 12 and the signal terminal 38 of the first circuit block 26 of the print circuit board 20. The second conductor 32 is connected between the second part 36 of the metal frame 12 and the ground terminal 40 of the first circuit block 26 of the print circuit board 20. When assembling the antenna, the metal back cover 18 contacts the ground terminal 40 of the first circuit block 26 of the printed circuit board 20.

[0010] FIG. 7 to FIG. 10 are diagrams showing antenna arrangement of the communication device 10 supporting a second communication function, such as a global system for mobile communication (GSM) function. The arrangement in FIG. 7 to FIG. 10 utilizes the metal frame 12 as a common antenna, wherein the arrangement comprises the second circuit block 28 of the printed circuit board 20, a third conductor 42, a fourth conductor 44 and a signal line 46. The second circuit block 28 of the printed circuit board 20 comprises a signal terminal 48 and a ground terminal 50. The metal frame 12 further has a third part 52 and a fourth part 54 located at a position different from a position of the third part 52. In a preferred embodiment, the third part 52 and the fourth part 54 of the metal frame 12 are located close to a lower right position of the display panel 16. The third conductor 42 is connected to the third part 52 of the metal frame 12, and extended in length to be close to the second circuit block 28 of the printed circuit board 20. The fourth conductor 44 is connected to a ground surface of the second circuit block 28 of the print circuit board 20 for conducting to the ground terminal 50, and at least one coupling gap 56 is defined between the third conductor 42 and the fourth conductor 44. The signal terminal 48 of the second circuit block 28 of the printed circuit board 20 is electrically connected to the fourth part 54 of the metal frame 12. In an embodiment, the signal terminal 48 of the second circuit block 28 of the printed circuit board 20 can be electrically connected to the fourth part 54 of the metal frame 12 through the signal line 46 connecting or contacting the fourth part 54 of the metal frame 12; or, in another embodiment, the signal terminal 48 of the second circuit block 28 of the printed circuit board 20 can directly connect or contact the fourth part 54 of the metal frame 12, the present invention is not limited to the above. When assembling the antenna, the metal back cover 18 contacts the ground terminal 50 of the second circuit block 28 of the printed circuit board 20.

[0011] According to the above arrangement, when the communication device 10 is powered by an external power source, such as a battery, the metal frame 12 can work as a common antenna for the first communication function (GPS) and the second communication function (GSM). The antenna forms an approximate large loop antenna to cooperate with the first conductor 30 and the second conductor 32 forming a small loop antenna smaller than the metal frame 12, in order to provide required communication capability to the communication device 10 through calculation processing of the printed circuit board 20. On the other hand, the third conductor 42 and the fourth conductor 44 are pre-arranged to form an open circuit state through the at least one coupling gap 56, so as to adjust required antenna matching, such as impedance matching, according to requirement. The signal terminal 48 of the second circuit block 28 of the printed circuit board 20 is coupled to the ground surface and the ground terminal 50 of the second circuit block 28 of the printed circuit board 20 for grounding through the at least one coupling gap 56, and the ground terminal 50 contacts the metal back cover after assembling.

[0012] According to the above illustration, the advantages of the present invention is that appearances of the metal back cover and the metal frame are not ruined by design of the antenna, and the present invention can have better appearance in contrast to the prior art, so as to allow the communication device to have great diversity of design.

Claims

1. A communication device (10), comprising:

a metal frame (12) defining an opening (24), the metal frame (12) having a first part (34), a second part (36) bent relative to the first part (34),

a third part (52) adjacent to the second part (36), and a fourth part (54) bent relative to the third part (52) and different from the first part;
a display module (14);
a display panel (16) installed between the display module (14) and the metal frame (12), and corresponding to the opening (24) of the metal frame (12);
a metal back cover (18);
a printed circuit board (20), comprising a first circuit block (26) and a second circuit block (28) electrically connected to the first circuit block (26), each of the first and second circuit blocks (26, 28) comprising a signal terminal (38, 48) and a ground terminal (40, 50), wherein the ground terminals (40, 50) contact the metal back cover (18);
a main body (22) located between the metal frame (12) and the metal back cover (18), the main body (22) being made of a non-conductive material;
characterized by:

a first conductor (30) connected between the first part (34) of the metal frame (12) and the signal terminal (38) of the first circuit block (26) of the printed circuit board (20);
a second conductor (32) connected between the second part (36) of the metal frame (12) and the ground terminal (40) of the first circuit block (26) of the printed circuit board (20);
a third conductor (42) having a first portion arranged along the third part (52) and connected to the third part (52) of the metal frame (12), and a second portion extended from the first portion along a longitudinal direction of the second circuit block (28), the longitudinal direction being defined along the direction of the fourth part (54); and
a fourth conductor (44) arranged along the longitudinal direction of the second circuit block (28), and connected to the ground terminal (50) of the second circuit block (28) of the printed circuit board (20), at least one coupling gap (56) being defined between the second portion of the third conductor (42) and the fourth conductor (44);

wherein the signal terminal (48) of the second circuit block (28) of the printed circuit board (20) is electrically connected to the fourth part (54) of the metal frame (12).

2. The communication device of claim 1, **characterized in that** the first part (34) and the second part (36) of the metal frame (12) correspond to a first corner of the display panel (16).

3. The communication device of claim 2, **characterized in that** the third part (52) and the fourth part (54) of the metal frame (12) correspond to a second corner of the display panel (16) different from the first corner.

4. The communication device of any of claims 1-3, **characterized in that** the first conductor (30) is arranged along the first part (34) and the second part (36), the second conductor (32) is arranged along the second part (36), wherein the first conductor (30), the second conductor (32), the first part (34) and the second part (36) form a loop antenna.

Patentansprüche

1. Kommunikationsgerät (10), welches umfasst:

einen Metallrahmen (12), der eine Öffnung (24) definiert, worin der Metallrahmen (12) aufweist, ein erstes Teil (34), ein zweites Teil (36), das in Bezug zu dem ersten Teil (34) gebogen ist, ein drittes Teil (52) neben dem zweiten Teil (36), und ein viertes Teil (54), das in Bezug zu dem dritten Teil (52) gebogen und verschieden von dem ersten Teil ist;
ein Anzeigemodul (14);
ein Anzeigepaneel (16), das zwischen dem Anzeigemodul (14) und dem Metallrahmen (12) installiert ist und der Öffnung (24) des Metallrahmens (12) entspricht;
eine metallene Rückseitenabdeckung (18);
eine Leiterplatte (20), die einen ersten Schaltkreisblock (26) und einen zweiten Schaltkreisblock (28), der elektrisch mit dem ersten Schaltkreisblock (26) gekoppelt ist, umfasst, worin der erste und der zweite Schaltkreisblock (26, 28) einen Signal-Anschluss (38, 48) und einen Erdungs-Anschluss (40, 50) umfasst, worin der Erdungs-Anschluss (40, 50) mit der metallenen Rückseitenabdeckung (18) in Kontakt steht;
einen Hauptkörper (22), der zwischen dem Metallrahmen (12) und der metallenen Rückseitenabdeckung (18) angeordnet ist, worin der Hauptkörper (22) aus einem nicht-leitendem Material besteht;
dadurch gekennzeichnet, dass:

ein erster Leiter (30) zwischen dem ersten Teil (34) des Metallrahmens (12) und dem Signalanschluss (38) des ersten Schaltkreisblock (26) der Leiterplatte (20) verbunden ist;
ein zweiter Leiter (32) zwischen dem zweiten Teil (36) des Metallrahmens (12) und den Erdungsanschluss (40) des ersten Schaltkreisblock (26) der Leiterplatte (20)

verbunden ist;
ein dritter Leiter (42) aufweist, einen ersten Bereich, der entlang des dritten Teils (52) angeordnet und mit dem dritten Teil (52) des Metallrahmens (12) verbunden ist, und einen zweiten Bereich, der sich von dem ersten Bereich entlang einer Längsrichtung des zweite Schaltkreisblock (28) erstreckt, worin die Längsrichtung entlang de Richtung des vierten Teils (54) definiert wird; und ein vierter Leiter (44) entlang einer Längsrichtung des zweiten Schaltkreisblock (28) angeordnet und mit dem Erdungsanschluss (50) des zweiten Schaltkreisblock (28) der Leiterplatte (20) verbunden ist, worin mindestens ein Kupplungs-Spalt (56) zwischen dem zweiten Bereich des dritten Leiters (42) und dem vierten Leiter (44) definiert ist;

worin der Signal-Anschluss (48) des zweiten Schaltkreisblock (28) der Leiterplatte (20) elektrisch mit dem vierten Teil (54) des Metallrahmens (12) verbunden ist.

2. Kommunikationsgerät nach Anspruch 1, **dadurch gekennzeichnet, dass** das erste Teil (34) und das zweite Teil (36) des Metallrahmens (12) einer ersten Ecke des Anzeigepaneels (16) entspricht.

3. Kommunikationsgerät nach Anspruch 2, **dadurch gekennzeichnet, dass** das dritte Teil (52) und das vierte Teil (54) des Metallrahmens (12) einer zweiten Ecke des Anzeigepaneels (16), die verschieden ist von der ersten Ecke entspricht.

4. Kommunikationsgerät nach einem der Ansprüche 1-3, **dadurch gekennzeichnet, dass** der erste Leiter (30) entlang des ersten Teils (34) und des zweiten Teil (36) angeordnet ist, dass der zweite Leiter (32) entlang des zweiten Teils (36) angeordnet ist, worin the erste Leiter (30), der zweite Leiter (32), das erste Teil (34) und das zweite Teil (36) eine Schleifenantenne ausbilden.

Revendications

1. Dispositif de communication (10), comprenant :

un cadre métallique (12) définissant une ouverture (24), le cadre métallique (12) ayant une première partie (34), une deuxième partie (36) pliée par rapport à la première partie (34), une troisième partie (52) adjacente à la deuxième partie (36), et une quatrième partie (54) pliée par rapport à la troisième partie (52) et différente de la première partie ;
un module d'affichage (14) ;
un panneau d'affichage (16) installé entre le module d'affichage (14) et le cadre métallique (12), et correspondant à l'ouverture (24) du cadre métallique (12) ;
un couvercle arrière métallique (18) ;
une carte de circuit imprimé (20), comprenant un premier bloc de circuit (26) et un deuxième bloc de circuit (28) connecté électriquement au premier bloc de circuit (26), a chacun des premier et deuxième blocs de circuit (26, 28) comprenant un terminal de signal (38, 48) et un terminal de masse (40, 50), où les terminaux de masse (40, 50) sont en contact avec le couvercle arrière métallique (18) ;
un corps principal (22) situé entre le cadre métallique (12) et le couvercle arrière métallique (18), le corps principal (22) étant constitué d'un matériau non conducteur ;
caractérisé par :

un premier conducteur (30) connecté entre la première partie (34) du cadre métallique (12) et le terminal de signal (38) du premier bloc de circuit (26) de la carte de circuit imprimé (20) ;
un deuxième conducteur (32) connecté entre la deuxième partie (36) du cadre métallique (12) et le terminal de masse (40) du premier bloc de circuit (26) de la carte de circuit imprimé (20) ;
un troisième conducteur (42) ayant une première partie disposée le long de la troisième partie (52) et connecté à la troisième partie (52) du cadre métallique (12), et une deuxième partie s'étendant à partir de la première partie le long d'une direction longitudinale du deuxième bloc de circuit (28), la direction longitudinale étant définie le long de la direction de la quatrième partie (54) ; et
un quatrième conducteur (44) disposé le long de la direction longitudinale du deuxième bloc de circuit (28), et connecté au terminal de masse (50) du deuxième bloc de circuit (28) de la carte de circuit imprimé (20), au moins un espace de couplage (56) étant défini entre la deuxième partie du troisième conducteur (42) et le quatrième conducteur (44) ;

où le terminal de signal (48) du deuxième bloc de circuit (28) de la carte de circuit imprimé (20) est connecté électriquement à la quatrième partie (54) du cadre métallique (12).

2. Dispositif de communication selon la revendication 1, **caractérisé en ce que** la première partie (34) et la deuxième partie (36) du cadre métallique (12) correspondent à un premier coin du panneau d'afficha-

ge (16).

3. Dispositif de communication selon la revendication 2, **caractérisé en ce que** la troisième partie (52) et la quatrième partie (54) du cadre métallique (12) correspondent à un deuxième coin du panneau d'affichage (16) différent du premier coin.

4. Dispositif de communication selon l'une quelconque des revendications 1 à 3, **caractérisé en ce que** le premier conducteur (30) est disposé le long de la première partie (34) et de la deuxième partie (36), le deuxième conducteur (32) est disposé le long de la deuxième partie (36), où le premier conducteur (30), le deuxième conducteur (32), la première partie (34) et la deuxième partie (36) forment une antenne-cadre.

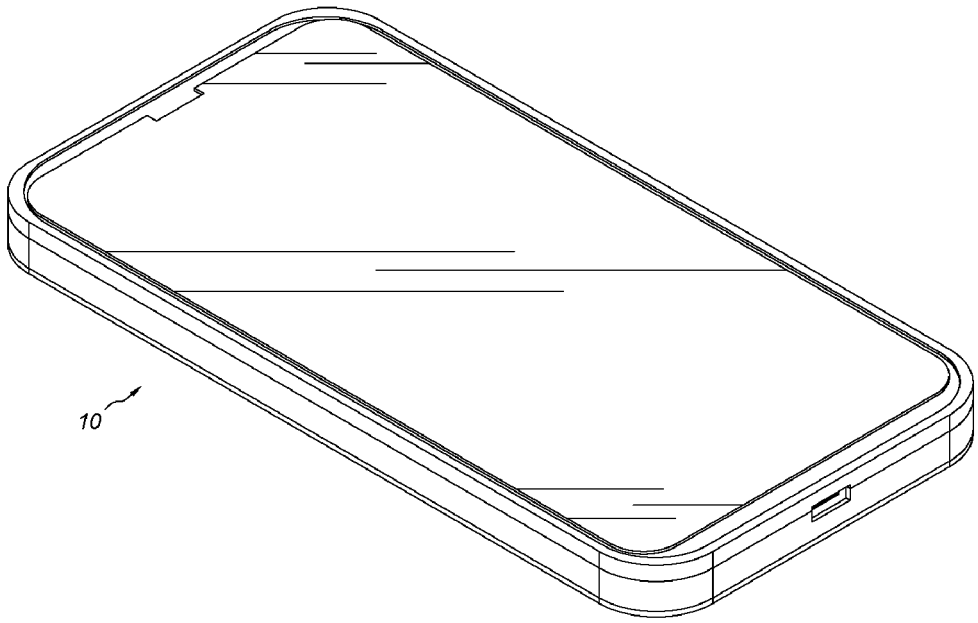

FIG. 1

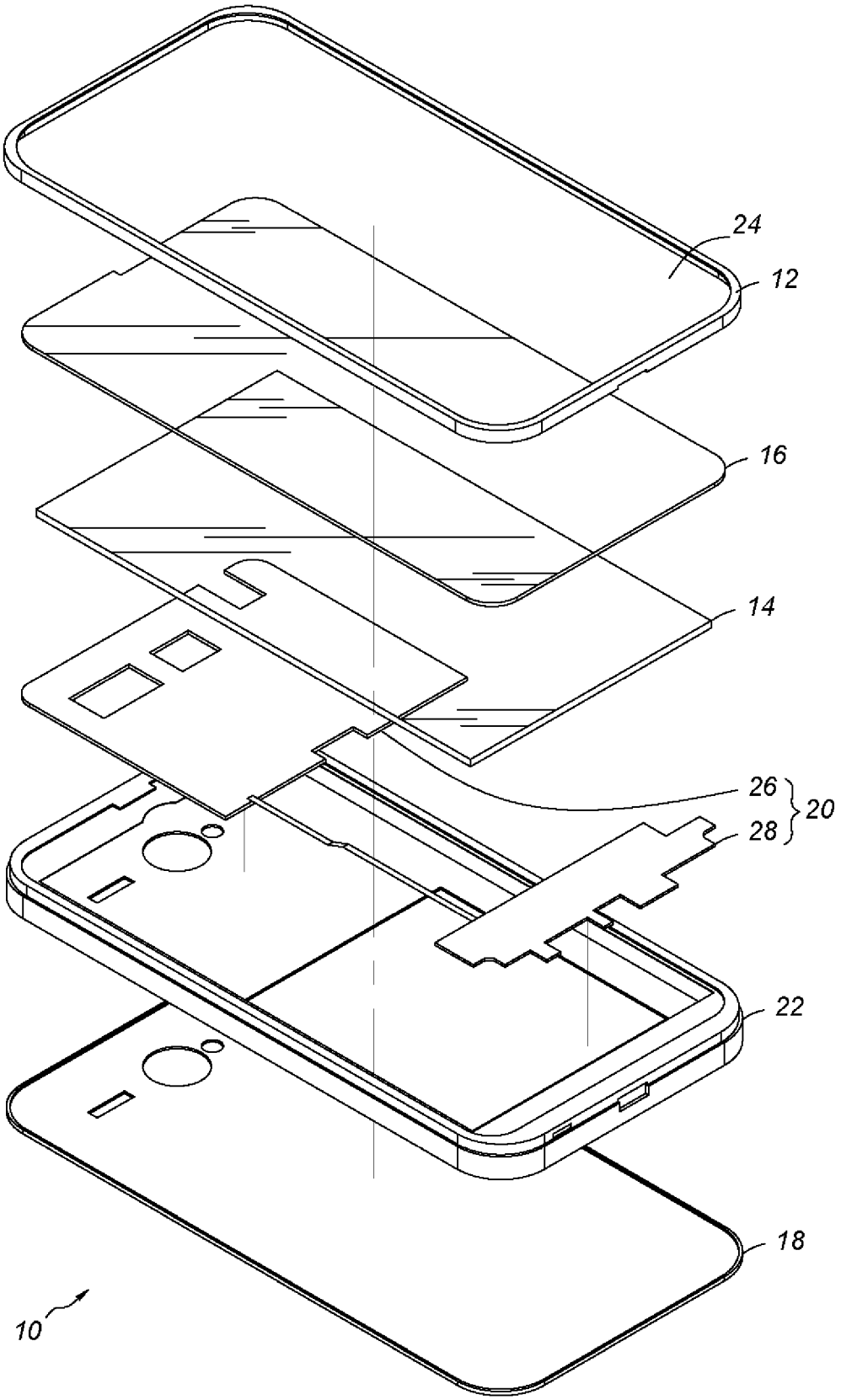

FIG. 2

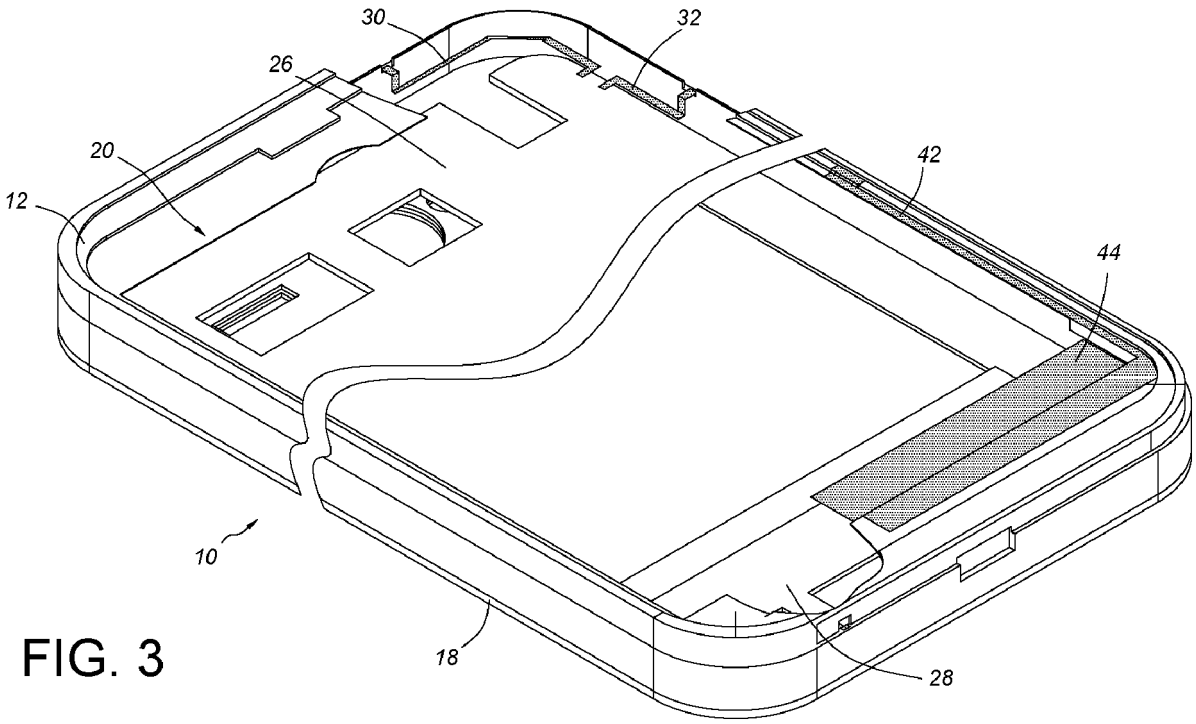

FIG. 3

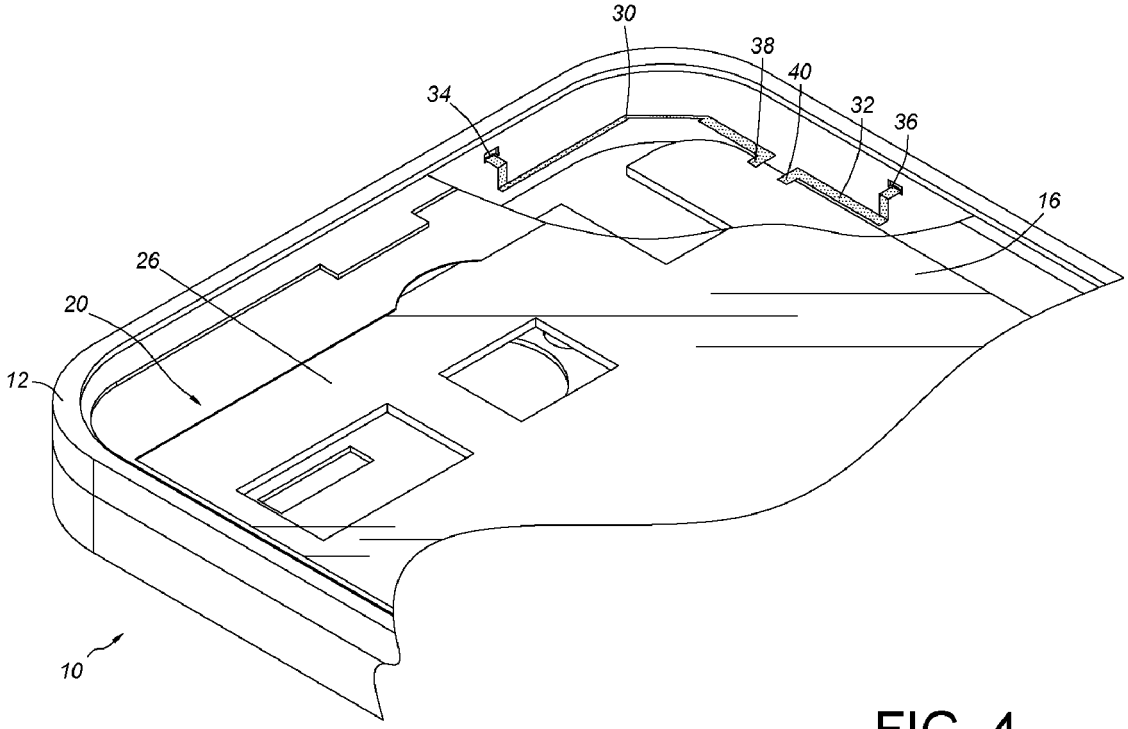

FIG. 4

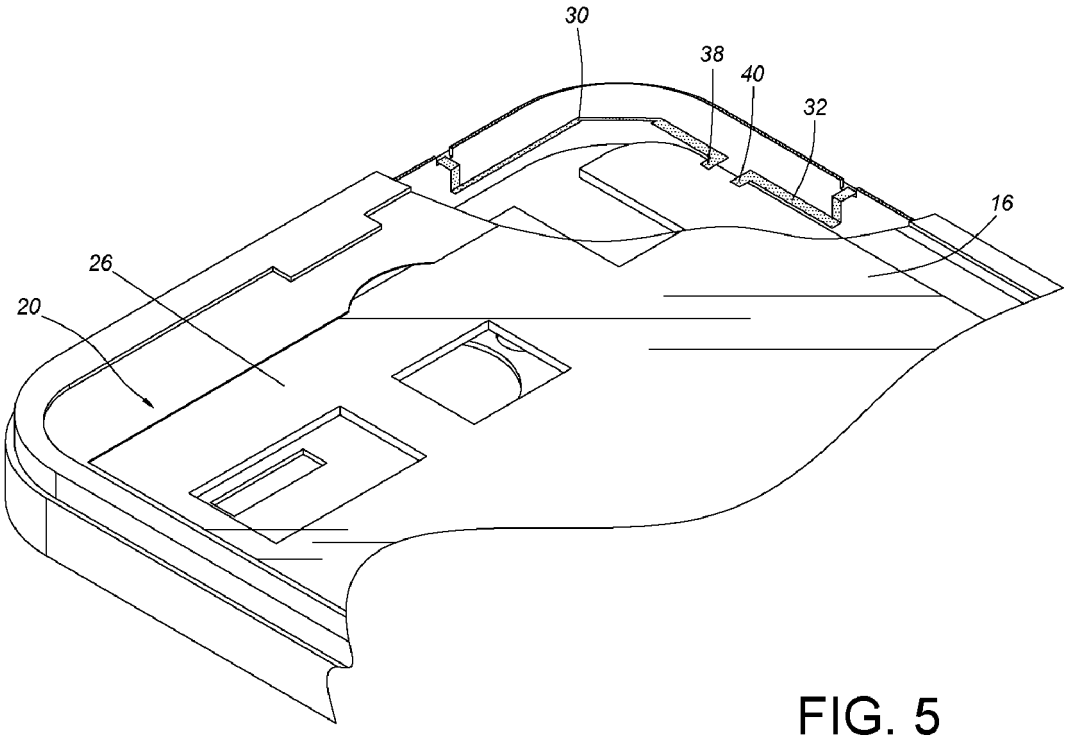

FIG. 5

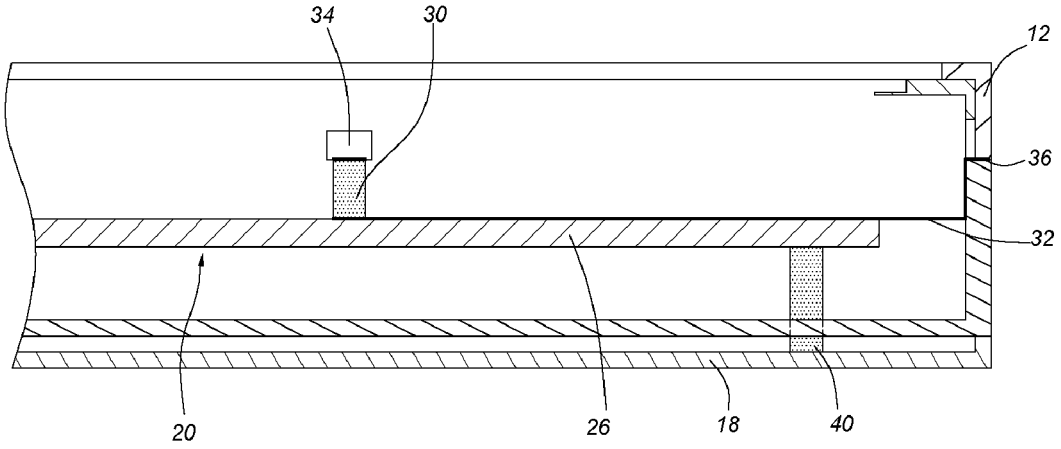

FIG. 6

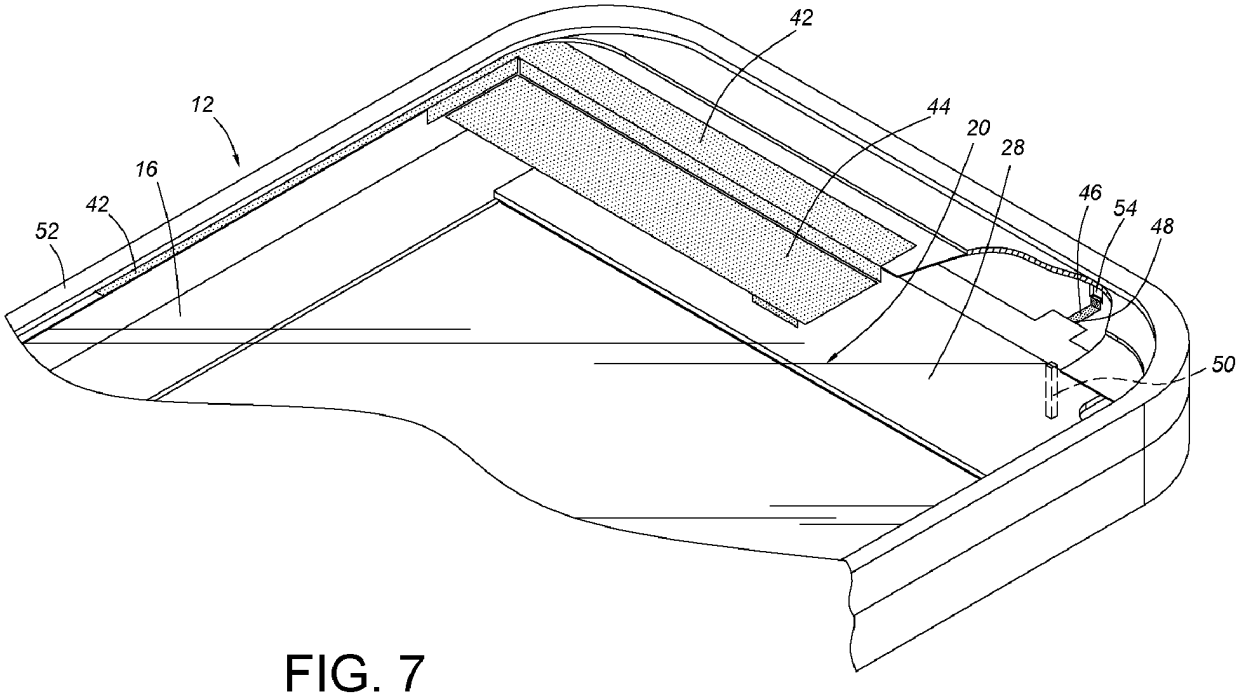

FIG. 7

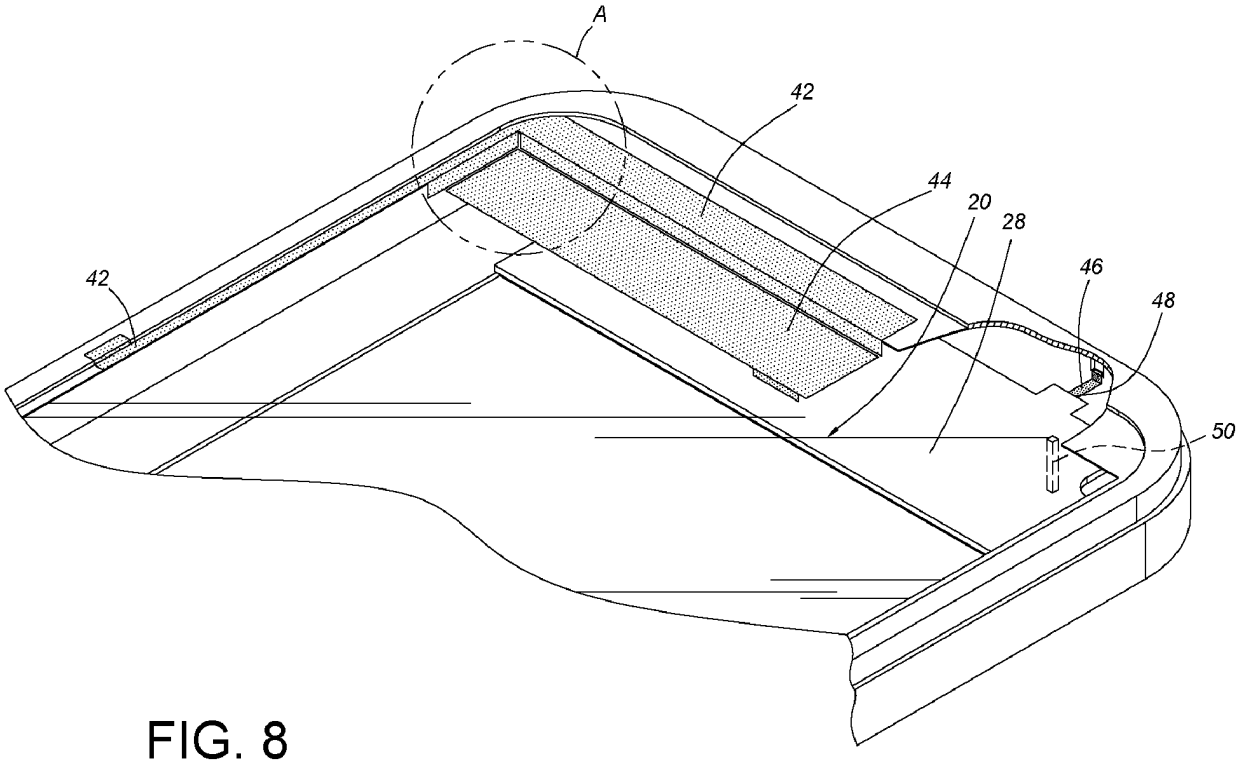

FIG. 8

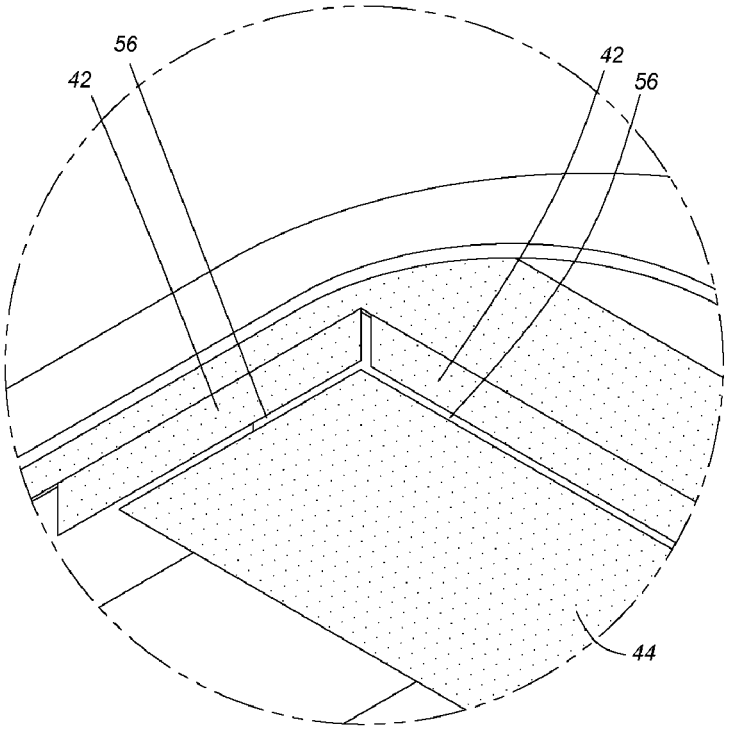

FIG. 9

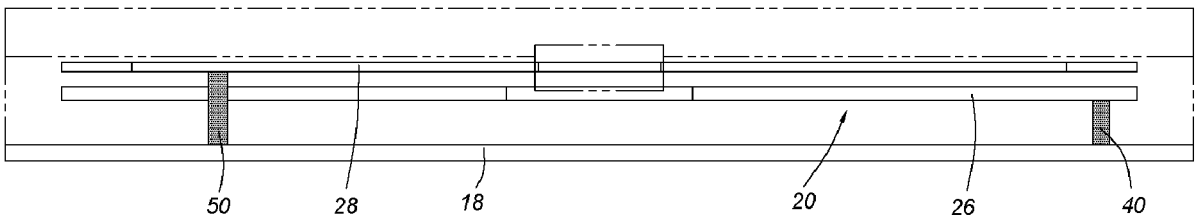

FIG. 10

REFERENCES CITED IN THE DESCRIPTION

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- US 2014132457 A1 **[0003]**