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(54) Sound ducting arrangement

(57) The solution comprises a sound ducting arrangement for a portable electronic device, comprising a first end (112) serving as an audio inlet and disposed at a location of an audio speaker; a second end (106) serving as an audio outlet; a sound channel (102) connecting the first and the second end; at least one cavity (114) at a predetermined distance from the first end, the cavity comprising a neck (116) and a chamber (118), the neck of the cavity protruding from the sound channel, the cross-sectional area of the neck being smaller than the cross-sectional area of the chamber.

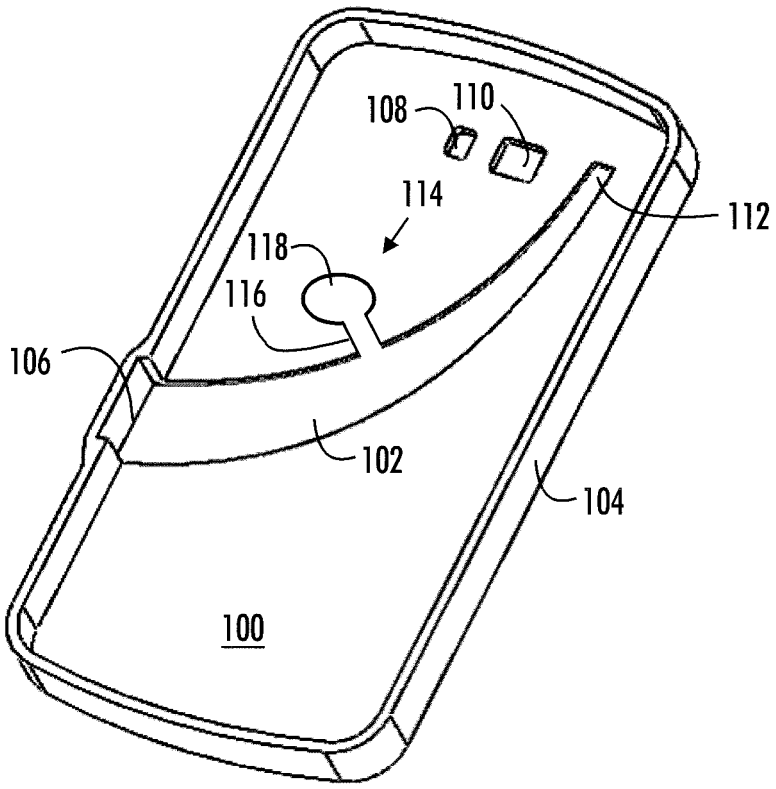

FIG. 1A

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Description

Field

[0001] The present invention relates to a sound ducting arrangement in portable electronic devices such as mobile phones and tablet computers comprising at least one audio speaker.

Background

[0002] Many portable electronic devices are used for playing audio such as music. As the size of the devices is typically small, the speaker or speakers used to play audio are likewise small and it is difficult to obtain quality audio output.

Brief description

[0003] An object of the present invention is to provide an improved audio output in portable electronic devices.

[0004] According to an aspect of the present invention, there is provided a sound ducting arrangement for a portable electronic device, comprising a first end serving as an audio inlet and disposed at a location of an audio speaker; a second end serving as an audio outlet; a sound channel connecting the first and the second end; at least one cavity at a predetermined distance from the first end, the cavity comprising a neck and a chamber, the neck of the cavity protruding from the sound channel, the cross-sectional area of the neck being smaller than the cross-sectional area of the chamber.

List of drawings

[0005] Embodiments of the present invention are described below, by way of example only, with reference to the accompanying drawings, in which

Figure 1A illustrates an embodiment of a cover for an electronic device, wherein the cover comprises an audio channel with a cavity;
Figures 1B and 1C illustrate other embodiments of the cover for the electronic device;
Figure 2 illustrates an example of a frequency response of the speaker and the audio channel of a portable electronic device;
Figures 3A and 3B illustrate other embodiments of a cover;
Figure 4 illustrates an example where the audio channel is disposed within the body of a portable electronic device, and
Figures 5A and 5B illustrate an example of a desk stand or a docking station of an electronic device.

Description of embodiments

[0006] The following embodiments are exemplary. Although the specification may refer to "an", "one", or "some" embodiment(s) in several locations, this does not necessarily mean that each such reference is to the same embodiment(s), or that the feature only applies to a single embodiment. Single features of different embodiments may also be combined to provide other embodiments. Furthermore, words "comprising" and "including" should be understood as not limiting the described embodiments to consist of only those features that have been mentioned and such embodiments may contain also features/structures that have not been specifically mentioned.

[0007] Portable electronic devices usually comprise one or more built-in loudspeakers. In addition to usage during calls, the built-in loudspeaker or loudspeakers may be used to play music files or streaming audio and they may be used in calls when the user wants to use a phone hands free. A balanced frequency response is important both in music listening and in speech reproduction.

[0008] Figure 1A illustrates a cover for a portable electronic device according to an embodiment. The material of the cover may be any material suitable for protecting the electronic device, such as plastic, silicon, or wood. The cover comprises a body 100 designed to comply with outer forms and dimensions of the electronic device. Different electronic devices typically have different dimensions and different covers may be provided for different electronic devices. The portable electronic devices for which the covers according to the embodiments of the invention are designed may comprise cell phones, portable music or video players, and tablet computers. In general, the cover is suitable for any portable electronic device that comprises a loudspeaker.

[0009] An embodiment of the present invention provides a cover that comprises a sound channel that passively amplifies the sound. In some embodiments, this may be achieved even without increasing the dimensions of the cover beyond the dimensions of conventional covers. The cover may be an accessory to the portable electronic device. The cover may be attached to a casing of the portable electronic device on top of a default back cover of the device, or it may replace the default back cover of the device. Referring to Figure 1A, the body 100 of the cover may be formed to accommodate the personal electronic device. The body 100 may comprise an inner surface that contacts with a back surface of the electronic device and edges 104 that enclose the electronic device at least partially from its sides. In some embodiments, the edges 104 may extend at least partially to a front surface of the electronic device to ensure proper fastening between the cover and the electronic device. In some embodiments, the body 100 may comprise one or more through holes 108, 110 for a camera lens and a flashlight, for example.

[0010] The cover further comprises a groove 102 provided in the inner surface of the body 100. The groove provides an audio channel that directs the sound from

the loudspeaker of the electronic device along the surface of the cover. A first end 112 of the groove serving as an audio inlet is disposed at a location of an audio speaker in the electronic device. As mentioned above, different electronic devices have different designs and, accordingly, the location of the first end may depend on the electronic device for which the cover has been designed. A second end 106 of the groove serving as an audio outlet is disposed at an edge 104 of the body 100. The audio channel is thus formed throughout the groove from the first end 112 to the second end 106. A cross-sectional area of the groove enlarges from the first end 112 towards the second end 106 to provide a sound-amplifying audio channel. The area may enlarge continuously such that the sound-amplification is realized in a similar manner as in horns. The enlargement may thus be designed such that the audio channel forms an impedance matching between a vibrating element of the loudspeaker of the electronic device and air, thus maximizing the efficiency of mechanical acoustic coupling between a speaker membrane and air such that amplification is realized. When the electronic device is not attached to the cover, the groove is open from the first end to the second end. When the electronic device is attached to the cover a back surface of the electronic device encloses the groove along the inner surface of the cover. Accordingly, the sound channel is realized by the groove together with the back surface of the electronic device. As shown in Figure 1A, the sound channel is realized by the groove together with the back surface of the electronic device even at the outlet (the second end 106) where the sound waves exit the cover.

[0011] In an embodiment, the groove is elongated to enable the horn-like sound amplification. Its central axis may be curved as shown in Figure 1A or straight. A cross-sectional view of the groove may be rectangular with sharp or rounded edges. The enlargement of the cross-sectional area may be realized by increasing the width of the groove while maintaining the depth substantially constant. In this manner, the thickness of the cover may be maintained small.

[0012] As shown in Figure 1A, the groove 102 guides the sound along the back surface of the electronic device from the location of the speaker towards an edge of the cover. The dimensions of the groove may be designed according to desired characteristics of the sound amplification. Desired amplification characteristics may be created by tuning properties of the horn, e.g. the length and expansion rate of the cross-sectional area of the groove. The expansion of the groove may be realized by enlarging the width and/or the depth of the groove. In an embodiment, the groove extends across the surface of the cover that faces the back surface of the electronic device. For example, the groove may start at a first half or quarter of the surface and extend to an edge of the opposite half or quarter of the cover.

[0013] At the edge 104 of the cover the groove may continue in a direction perpendicular to the plane of the back surface of the electronic device, i.e. along a side surface of the electronic device. For that purpose, the second end 106 of the groove may be formed into an inner surface of the edge 104 of the cover. In this manner, the sound is guided along the side surface and towards the user. The cross-sectional area may enlarge in the edge area of the groove. In other embodiments, the groove provided along the inner side surface of the cover has a constant cross-sectional area.

[0014] In an embodiment, an outer side surface on the side where the audio outlet is disposed may comprise a protrusion to accommodate the audio outlet. In another embodiment, the outer side surface may have a constant thickness from the location of the audio outlet (including the audio outlet) to at least one end of the outer side surface such that there is no distinct protrusion. For example, the depth of the groove may decrease and the width of the groove may increase in the sound outlet (the second end 106). The depth of the groove may be less than two millimetres at the sound outlet and, thus, the protrusion may be omitted with the proper design of the thickness of the cover.

[0015] In an embodiment, the groove comprises at least one cavity 114 comprising a neck 116 and a chamber 118, the neck of the cavity protruding from the audio channel and the cross-sectional area of the neck 116 being smaller than the cross-sectional area of the chamber 118.

[0016] As air flows in the audio channel the cavity comprising a neck and a chamber acts as a band-stop filter to the sound carried by the air flow. The dimensions of the neck and the chamber of the cavity 114 may be selected to attenuate a given frequency band of the frequency response of the sound channel. The dimensions of the neck and the chamber of the cavity 114 may also be selected such that given amount of attenuation is achieved. The dimensions may comprise the length of the neck, the cross-sectional area of the neck and the volume of the chamber. The cavity may act as a Helmholtz resonator known in the art.

[0017] Figure 1B illustrates an example where the sound channel comprises two or more cavities 120, 122.

[0018] Figure 1C illustrates an example where the wall of the groove forms at least a part of the neck and/or the chamber of the cavity. A section 130 of the groove may serve as a sound channel wall and a part of the wall forming either the neck 132 of the cavity or the chamber 134 of the cavity or both.

[0019] Figure 2 illustrates an example of the effect of the cavity to the frequency response of the audio channel of a portable electronic device. The example is a simplified illustrative example and does not correspond to a real audio channel response. The figure shows the frequency response 200 of the speaker of a portable device and the audio channel without a cavity. The response has an undesired rise 202 at a given frequency band Fbs which causes undesired effects to the sound played in the portable electronic device. By introducing to the audio

channel a cavity with suitable dimensions the undesired rise in the frequency response may be attenuated as the dotted line 204 indicates. The cavity has no noticeable effect on the frequency response outside the frequency band Fbs. The location of the cavity in the groove in relation to the first end of the groove has no effect on the frequency band Fbs but the location affects the strength of the attenuation. With two cavities with different dimensions two frequency bands may be attenuated. The number of cavities is only limited by the available space.

[0020] Figures 3A and 3B illustrate an embodiment where the audio channel 300 branches into two audio channels 302, 304. In other embodiments, the number of audio channel branches may be higher than two. Accordingly, the elongated groove may branch. The audio channel may comprise the audio inlet, as described above, and at least two audio outlets 306, 308 at different locations on the edge(s) of the cover. The audio outlets 306, 308 may be provided on opposite edges of the cover, as shown in Figure 3. The form of the audio channel may be designed such that the cross-sectional surface of the audio channel constantly enlarges even in the area of branching. In other words, the enlarging may occur constantly without a distinct step in the cross-sectional area at the branching area. This ensures that horn-like properties are maintained even in the case of splitting the audio channel. Each branch 302, 304 may then enlarge from the branching area towards the respective audio outlet. This ensures that the total cross-sectional area of different branches increases within the same specifications regardless of the number of branches of the particular cover.

[0021] Figure 3A illustrates an embodiment, where the groove branches into at least two audio channels. Each branch 302, 304 may have a separate audio outlet and the groove forms at least one cavity 310, 312 on each branch.

[0022] Figure 3B illustrates an embodiment, where the groove branches into at least two audio channels. Each branch 320, 304 may have a separate audio outlet, wherein the groove forms at least one cavity 314 before the branching.

[0023] Figure 4 illustrates an embodiment, where the sound ducting arrangement is disposed within the body of a portable electronic device and the second end of the sound channel is disposed at an edge of the portable electronic device. Figure 4 shows a partial body 400 of a portable electronic device enclosed within device cover 402. The loudspeaker 404 of the device comprises a sound radiating surface 406. The sound produced by the sound radiating surface is led to a sound channel 408 having a second end or sound outlet 410. In an embodiment, the sound channel comprises a cavity 412.

[0024] The sound ducting arrangement of Figure 4 may be within the body of the portable electronic device and the only part visible to the user is the outlet 410. The sound channel may comprise also other chambers in addition to the cavity 412, such as the chamber 414.

[0025] Figures 5A and 5B illustrate an embodiment, where the sound ducting arrangement is an accessory to the portable electronic device. Figure 5A illustrates an example where the sound ducting arrangement is a desk stand or docking station 502 where the portable electronic device 500 such as a mobile phone may be placed. The desk stand may comprise a sound channels configured to amplify the sound produced by the mobile phone. Sound channel may be shaped as a horn 504.

[0026] Figure 5B illustrates the structure of the desk stand or a docking station of an embodiment. The mobile phone 500 is placed in the desk stand 502. The sound channel or horn of the desk stand may be implemented such that the sound channel has a first end located by the speaker 506 of the mobile phone 500. The sound produced by the speaker is amplified in the sound channel and output at the outlet 508 of the sound channel. In an embodiment, the horn or sound channel 504 comprises at least one cavity 510 at a predetermined distance from the first end, the cavity comprising a neck and a chamber, the neck of the cavity protruding from the sound channel.

[0027] It will be obvious to a person skilled in the art that, as the technology advances, the inventive concept can be implemented in various ways. The invention and its embodiments are not limited to the examples described above but may vary within the scope of the claims.

Claims

1. A sound ducting arrangement for a portable electronic device, comprising
   a first end serving as an audio inlet and disposed at a location of an audio speaker;
   a second end serving as an audio outlet;
   a sound channel connecting the first and the second end;
   at least one cavity at a predetermined distance from the first end, the cavity comprising a neck and a chamber, the neck of the cavity protruding from the sound channel, the cross-sectional area of the neck being smaller than the cross-sectional area of the chamber.

2. The sound ducting arrangement of claim 1, wherein the dimensions and the cross-sectional areas of the neck and the chamber of the at least one cavity are selected to attenuate a given frequency band of the frequency response of the sound channel.

3. The sound ducting arrangement of claim 1, wherein the sound ducting arrangement is disposed within the body of the portable electronic device and the second end is disposed at an edge of the portable electronic device.

4. The sound ducting arrangement of claim 1, wherein the sound ducting arrangement is disposed on a cover of a portable electronic device, the cover comprising

a body arranged to accommodate the portable electronic device in a detachable manner and to provide a mechanical protection for the portable electronic device when the cover is attached to the portable electronic device;

a groove provided in a surface of the body that faces the portable electronic device, wherein the first end of the groove serving as an audio inlet is disposed at a location of an audio speaker and the second end of the groove serving as an audio outlet is disposed at an edge of the body, wherein a cross-sectional area of the groove enlarges from the first end towards the second end to provide a sound-amplifying audio channel, and wherein the groove is open from the first end to the second end such that a back surface of the portable electronic device attached to the cover encloses the groove from the first end to the second end and wherein the groove comprises at least one cavity comprising a neck and a chamber, the neck of the cavity protruding from the audio channel.

5. The sound ducting arrangement of claim 4, wherein the surface on which the groove is provided is a plane that faces the back surface of the portable electronic device and contacts the back surface of the electronic device so as to enclose the groove.

6. The sound ducting arrangement of any preceding claim 4 to 5, wherein the groove branches into at least two audio channels, wherein each branch has a separate audio outlet and the groove forms at least one cavity on each branch.

7. The sound ducting arrangement of any preceding claim 4 to 6, wherein the groove branches into at least two audio channels, each branch having a separate audio outlet, wherein the groove forms at least one cavity before branching.

8. The sound ducting arrangement of any preceding claim 4 to 7 wherein the wall of the groove forms at least a part of the neck and/or the chamber of the cavity.

9. The sound ducting arrangement of any preceding claim, wherein the arrangement is an accessory of a portable electronic device.

10. The sound ducting arrangement of any preceding claim, wherein the arrangement is a desk stand of a portable electronic device.

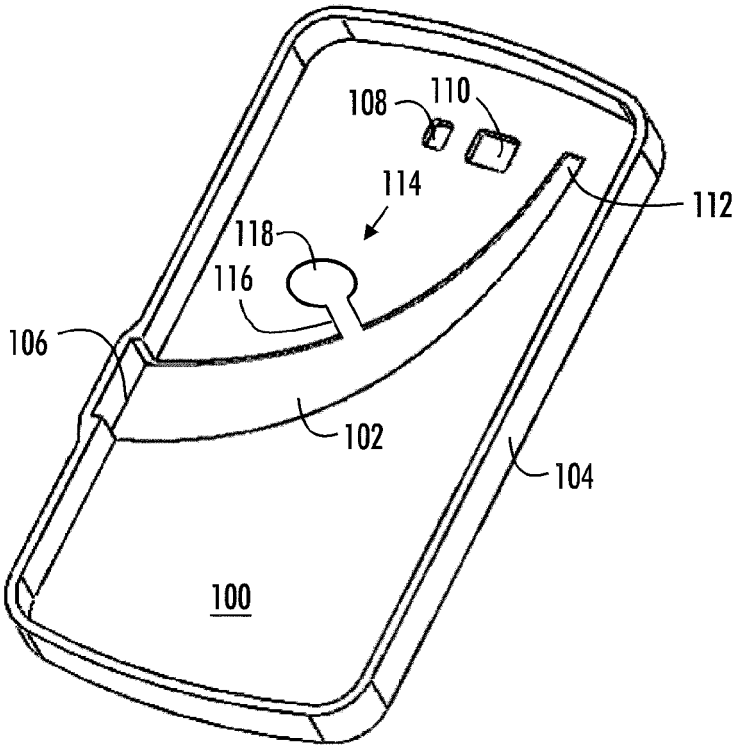

FIG. 1A

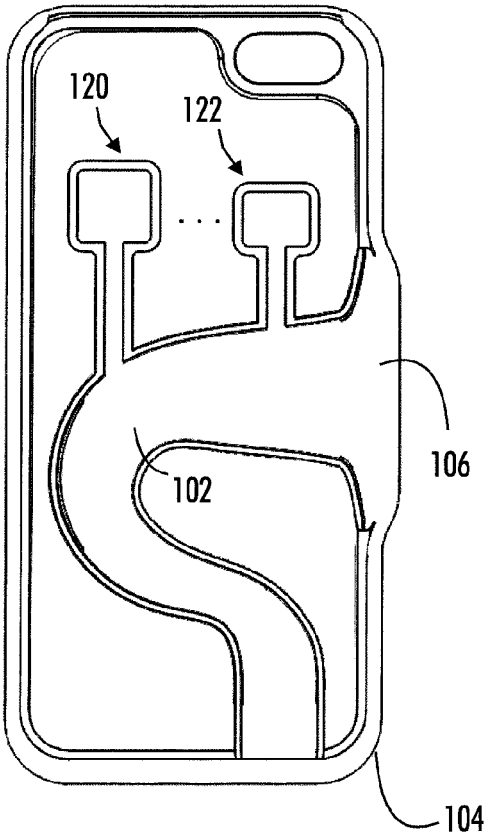

FIG. 1B

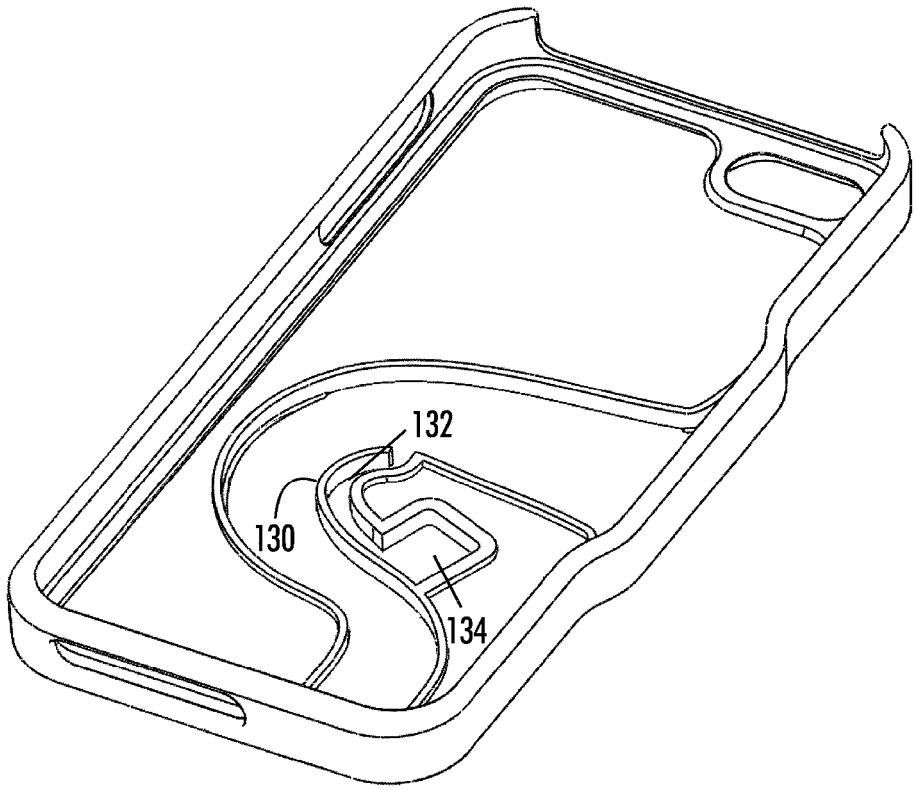

FIG. 1C

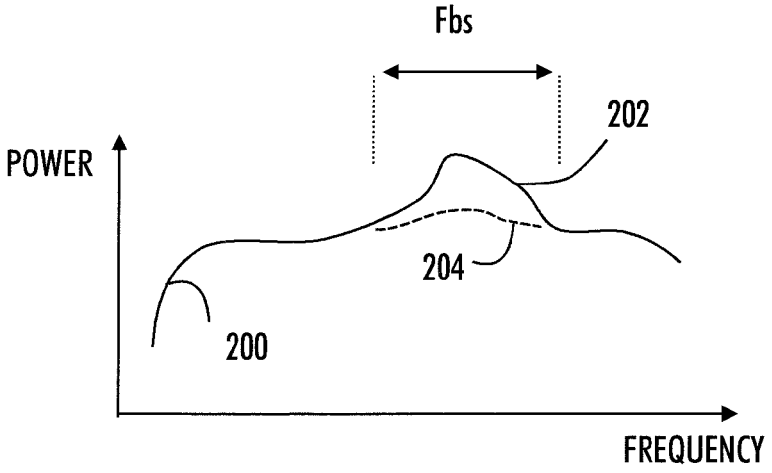

FIG. 2

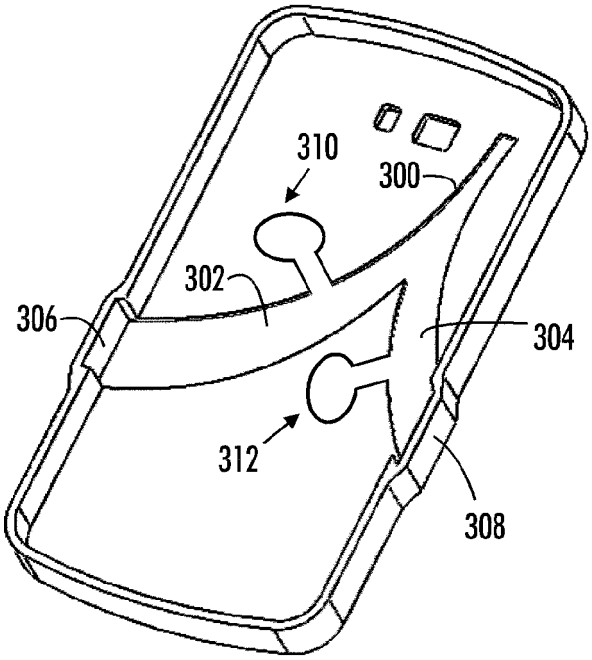

FIG. 3A

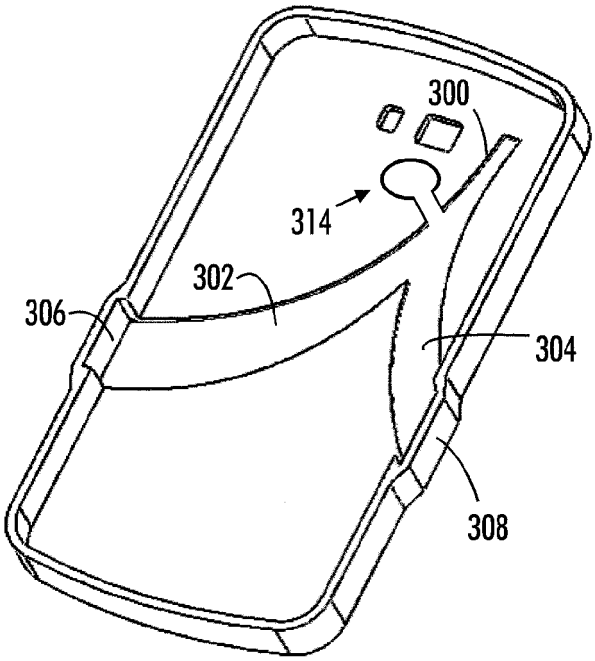

FIG. 3B

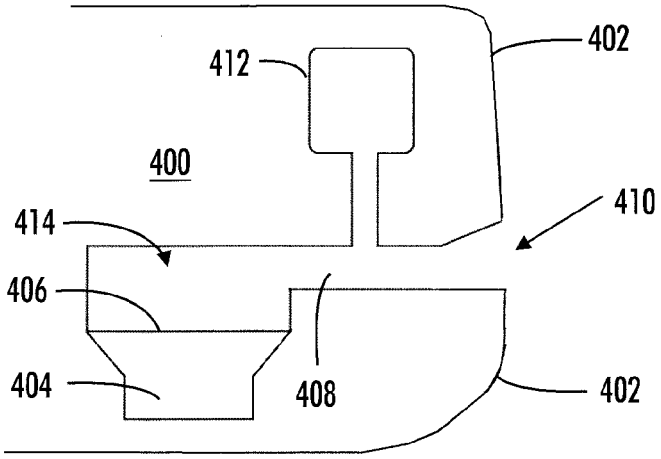

FIG. 4

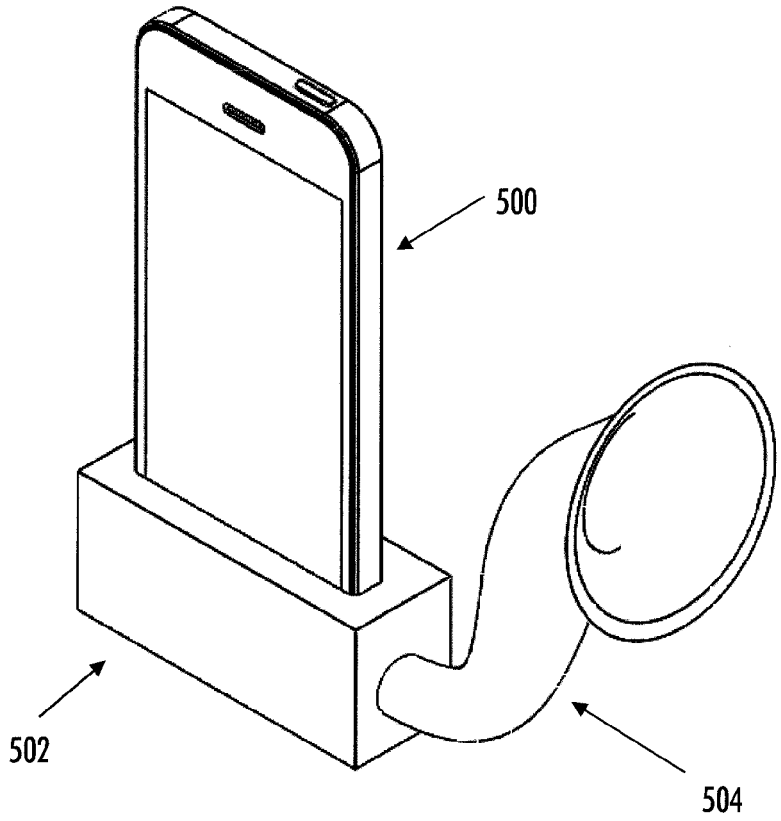

FIG. 5A

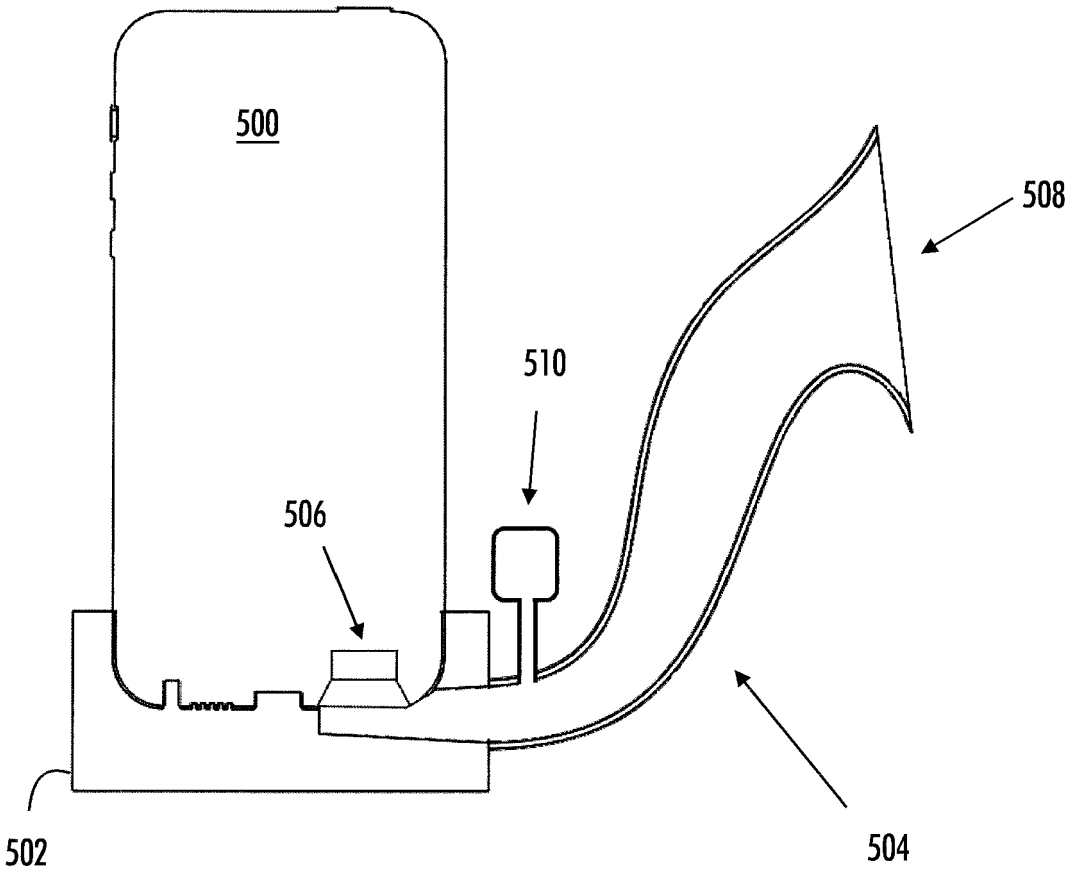

FIG. 5B

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EUROPEAN SEARCH REPORT

Application Number
EP 14 16 0849

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

H04M
B60R
A45C
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G06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	25 June 2014	Timms, Olegs

CATEGORY OF CITED DOCUMENTS

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25-06-2014

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