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(54) AUDIO OUTPUT DEVICE AND METHOD OF CONTROLLING THE SOUND OUTPUT OF AN ELECTRONIC DEVICE

(57) An audio output device (100) has a plurality of sound outlets (102) for outputting sound. The audio output device (100) has a proximity sensor (104) for determining the position of a user's ear (106) in relation to at least one of the sound outlets (102). The audio output device (100) is configured to adjust the relative volume of sound output by one or more of the sound outlets (102) based on the determined position of the user's ear (106).

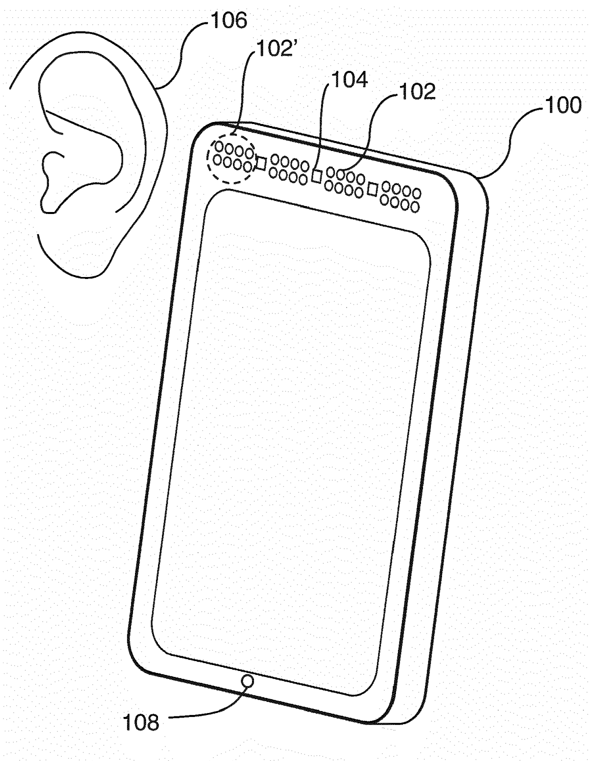

Fig. 1

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Description

Technical Field

[0001] The present disclosure relates to an audio output device and a method of controlling an audio output of an electronic device.

Background

[0002] Audio output devices allow audio to be played out to a user. Generally, these devices include one or more loudspeakers for converting electrical audio signals into corresponding sound waves, and outputting the sound waves to the user. Known devices that employ loudspeakers include smartphones, as well as tablet computers and some smartwatches, etc. However, in such devices that have plural loudspeakers or other sound outlets, the sound is usually output by each sound outlet at the same volume. This leads to an inefficient output of audio, where for example only some of the sound outlets are located close enough to the user's ear for the user to hear the output audio. This problem is further worsened if ambient noise is not taken into account, when outputting the audio. These problems all result in a sub-optimal experience for the user. Moreover, sound that is being output by a speaker that is not close to the user can be annoying for others in the vicinity of the device.

Summary

[0003] According to a first aspect disclosed herein, there is provided an audio output device comprising: a plurality of sound outlets for outputting sound; and a proximity sensor for determining the position of a user's ear in relation to at least one of the sound outlets; wherein the audio output device is configured to adjust the relative volume of sound output by one or more of the sound outlets based on the determined position of the user's ear.

[0004] In examples, the proximity sensor is configured to determine a position of the user's earhole in relation to at least one of the sound outlets, and the audio output device is configured to adjust the relative volumes output by the sound outlets based on the determined position of the user's earhole.

[0005] In examples, the audio output device comprises a microphone for receiving ambient noise, the audio output assembly being configured to adjust the volume of the sound output by one or more of the sound outlets based on the determined level of the ambient noise received by the microphone.

[0006] In examples, the audio output device comprises plural loudspeakers, each of the plural loudspeakers being arranged to provide sound to a respective one of the sound outlets.

[0007] In examples, the audio output device comprises a loudspeaker arranged to provide sound to plural of the sound outlets, each sound outlet having a selectively controllable sound output.

[0008] In examples, the loudspeaker is in communication with the sound outlets via a plurality of respective air channels, wherein each air channel includes a valve operable to adjust the volume of sound output by the respective sound outlet by selectively restricting air flow to the sound outlet.

[0009] In examples, the audio output device includes at least two loudspeakers, wherein a first loudspeaker is arranged to provide sound to a respective sound outlet and a second loudspeaker is arranged to provide sound to plural of the sound outlets, each sound outlet having a selectively controllable sound output.

[0010] In examples, the audio output device comprises a processor, the processor being arranged to receive an input signal from the proximity sensor and to adjust the relative volumes of sound output by the respective sound outlets based on the received input signal. In examples, the processor is in communication with at least one of a loudspeaker and a valve operable to control the volume of sound output by the respective loudspeaker.

[0011] In examples, a mobile device comprises the audio output device. In examples, the mobile device comprises a smartphone or a tablet.

[0012] According to a second aspect disclosed herein, there is provided a method of controlling the sound output of an electronic device, the device comprising a plurality of sound outlets for outputting sound, the method comprising: determining, using a proximity sensor, a position of a user's ear in relation to at least one of the sound outlets; and adjusting relative volumes of sound output by one or more of the sound outlets based on the determined position of the user's ear.

[0013] In examples, the adjusting comprises varying the relative volumes output by one or more of the sound outlets such that a sound outlet that is determined as being nearer to the user's ear outputs sound at a louder volume than another sound outlet that is determined as being further from the user's ear.

[0014] In examples, the method comprises detecting a noise level; and adjusting the volumes output by one or more of the sound outlets based on the detected noise level.

[0015] In examples, determining the position of the user's ear comprises determining the position of the user's earhole in relation to at least one of the sound outlets.

[0016] In examples, the electronic device is a telecommunications device, and wherein the determining of the position of the user's ear is initiated in response to connecting an audio call at the telecommunications device.

Brief Description of the Drawings

[0017] To assist understanding of the present disclosure and to show how embodiments may be put into effect, reference is made by way of example to the accompanying drawings in which:

Figure 1 shows schematically an example of an audio output device in accordance with the present disclosure;

Figure 2A shows schematically a plurality of loudspeakers, each loudspeaker being arranged to provide sound to a respective sound outlet;

Figure 2B shows schematically a loudspeaker arranged to provide sound to a plurality of sound outlets; and

Figure 3 shows schematically an example of a system for controlling the sound output of a plurality of sound outlets.

Detailed Description

[0018] Many devices and apparatus provide an audio output to a user. Examples include headphones, HiFi bars, speakers, etc. Some portable electronic devices, such as smartphones, tablets, smartwatches, etc. also provide a user with audio output.

[0019] An audio output device includes a loudspeaker for generating and outputting sound (i.e. audio). The loudspeaker receives electrical audio signals and converts them into corresponding sound waves by controlling the vibration of a driver. The vibration of the driver causes sound waves to be transmitted out of the loudspeaker, via a sound outlet. The sound outlet may include an air channel through which the sound waves are transmitted out of the device. The term 'audio output device' is used herein to refer to a device that is capable of receiving electrical audio signals and outputting corresponding sounds.

[0020] In portable electronic devices, such as smartphones and tablets and the like, the loudspeaker is typically embedded within a portion of the device, for example, a portion above the screen of the device, or a portion within one of the sides of the device. In some smartphones, the loudspeaker is located at the bottom edge of the device, next to the charging port, for example. The location of the speaker within the device can usually be identified from the corresponding speaker grille. The speaker grille appears as a plurality of small holes embedded within a portion of the device's housing. Some devices, include two loudspeakers, which may be used as stereo output speakers. Moreover, some portable electronic devices, such as smartphones, allow a user to conduct a voice-call with another user and to output audio of the voice-call via their device. However, such devices having plural sound outlets often suffer from an inefficient output of audio. This is because each sound outlet of the device typically outputs sound at the same volume, despite the sound outlets being located at different respective locations on the device (and therefore being located at different distances from the user's ear). As a result of this, a user will hear the sound output of each sound outlet with a different audibility (i.e. volume). This problem tends to remain, even if the user tilts the loudspeaker(s) of the device towards his or her ear hole. Moreover, others in the vicinity of the device may hear the sound being output by speakers that are not close to the user's ear, which can be annoying for the others and can result in a loss of privacy for the user of the device.

[0021] In examples described herein, an audio output device is provided that includes a plurality of sound outlets for outputting sound. The audio output device includes a proximity sensor for determining the position of a user's ear in relation to at least one of the sound outlets. The audio output device is configured to adjust the relative volume of the sound output by one or more of the sound outlets, based on the determined position of the user's ear. In this way, the audio output of each sound outlet can be selectively controlled so that only sound outlets that are close to or at least most likely to be within earshot of the user's ear output audio.

[0022] Figure 1 schematically shows an example of an audio output device 100, in this case an electronic device 100, for outputting audio in accordance with the present disclosure. In the example of Figure 1, the electronic device 100 is a smartphone.

[0023] As can be seen in Figure 1, the electronic device 100 includes a plurality of sound outlets 102 for outputting sound. In Figure 1, these are located on the front surface of the device 100, above the screen. It will be appreciated that the sound outlets 102 may be located elsewhere on the device 100. The sound outlets 102 are arranged to receive, and output, the sound generated by one or more loudspeakers or other driver(s). A loudspeaker will generally be located behind one or more of the sound outlets, within the housing of the device (and therefore is not shown in Figure 1).

[0024] In some examples the electronic device 100 comprises four or more sound outlets 102. In the example of Figure 1, each sound outlet 102 is formed of plural small outlet holes arranged in a regular array, but these are regarded as a single sound outlet 102 for present purposes as they all receive and output the same sound at any instant in time. A sound outlet 102 may for example be formed as a single outlet hole. In the example of Figure 1, each sound outlet 102 is formed as four by two array of sound outlet holes.

[0025] The sound outlets 102 may be distributed uniformly across the top of the device 100, for example. This is shown in Figure 1. It will be appreciated that Figure 1 is just one example of an embodiment and that other arrangements of sound outlets 102, containing greater or fewer sound outlets 102, may be employed by the device 100.

[0026] The electronic device 100 also comprises a proximity sensor 104 for determining the position of a user's ear 106 in relation to at least one of the sound outlets 102. In some examples, the proximity sensor 104 is configured to specifically determine the position of a user's ear hole, in relation to at least one of the sound outlets 102. The proximity sensor 104 may be, for example, an infra-red sensor 104 that is arranged to emit infrared radiation and to receive reflections of the emitted radiation. The time interval between emitting the infra-red signal and receiving a reflection of it can be used to determine a relative distance of the object from which the signal was reflected. In this way, the position of the user's ear 106, relative to the proximity sensor can be determined. For example, it may be expected that, when the user is taking a call, the device 100 will be oriented such that a proximity sensor 104 is level with and substantially facing the user's ear 106. Thus, any infra-red signals that are reflected back to the sensor 104 can be used to estimate the relative distance of the user's ear 106 from the proximity sensor 104.

[0027] It will be appreciated that in other examples, other types of proximity sensor 104 may be used, including for example capacitive sensors. It will be further appreciated that in some examples, the proximity sensor 104 may simply provide an input signal, including e.g. a measured time interval or a measured signal strength, to another component, such as processor. The processor may then determine, from this, the position of the user's ear 106 relative to the proximity sensor 104.

[0028] In some examples, the electronic device 100 comprises a plurality of proximity sensors 104. For example, the proximity sensors 104 may be located at locations on the device 100 that alternate with the sound outlets 102. An example of this is shown in Figure 1, where the device 100 includes three proximity sensors 104, each sensor 104 being located between a pair of sound outlets 102. In Figure 1, the proximity sensors 104 are shown as being distributed uniformly across the top of the device 100.

[0029] In some examples, detecting the relative position of the user's ear 106 may involve comparing the signals detected at two or more proximity sensors 104. For example, the position of the user's ear 106 detected at a first and a second proximity sensor 104 may be used to determine whether the user's ear 106 is closer to a first or second sound outlet 102. In such a case the relative volume output by the first sound outlet 102 may be increased. This may involve reducing the volume of sound output by the or each other sound outlet 102 and / or increasing the volume of sound output by the first sound outlet. The effect of this may be that the user can hear more of the audio that is output by the device 100, with the sound preferentially or only being output by the sound outlet 102 that is closest to the user's ear and no audio or audio at a reduced volume being output by the or each other sound outlet 102.

[0030] In some examples, the user's ear 106 may not be within a detectable range of one of the proximity sensors 104. In such a case, this may indicate that the sound outlets 102 within the vicinity of that proximity sensor 104 are located further from the user's ear 106 than the other proximity sensors 104. As a result, the sound output of those sound outlets 102 may be determined as being less audible to the user. This may result in the volume of sound output by those sound outlets 102 being reduced.

[0031] In Figure 1, a sound outlet 102 that has been identified as being closest to the user's ear is indicated as sound outlet 102'. It will be appreciated that a different sound outlet 102 may be identified as being closest to the user's ear 106 at any particular time, depending on how the user is holding the device 100 to their ear.

[0032] In some examples, the electronic device 100 comprises a microphone 108 for receiving sound. The microphone 108 may be located at the bottom of the front face of the device 100 as shown or elsewhere. In some examples, the device 100 may comprise a plurality of microphones 108. The one or more microphones 108 may be used herein to detect ambient noise in an environment in which the device 100 is being used, as will be described further.

[0033] Figure 2A schematically shows a first example of an arrangement 200 of loudspeakers in accordance with the present disclosure. The arrangement 200 shown in Figure 2A may be a component of the portable electronic device 100 shown in Figure 1, for example.

[0034] In Figure 2A, the arrangement 200 is shown as comprising a plurality of loudspeakers 202. Each loudspeaker 202 is arranged to provide sound to a respective sound outlet 102. In the example shown, each loudspeaker 202 is in communication with a respective sound outlet 102 via an air channel 204. The air channels 204 allow the sound generated by each loudspeaker 202 to be output from the respective sound outlet 102.

[0035] In the example shown in Figure 2A, each loudspeaker 202 has an individually controllable volume. That is, the volume of sound output by one loudspeaker 202 can be controlled independently of the volume of sound output by another loudspeaker 202. Each loudspeaker 202 may be connected to a controller (not shown) that controls the volume of sound output by the individual loudspeakers 202. By controlling the sound output by the loudspeakers 202, the relative volume of sound output by one or more of the sound outlets 102 can be controlled.

[0036] Figure 2B schematically shows another example of an arrangement 200 of loudspeakers in accordance with the present disclosure. In Figure 2B, a loudspeaker 202 provides a sound output to a plurality of air channels 204. Each air channel 204 leads to a different respective sound outlet 102 (i.e. located at the end of the air channel 204).

[0037] In the example shown in Figure 2B, each air channel 204 is fitted with a respective valve 206. The position of the valve 206 within the air channel 204 can be used to restrict air flow to the respective sound outlet 102 and therefore control the volume of the sound that is output by the sound outlet 102. The valve 206 can be moved from an open position to a closed position (and vice versa). Movement of the valve 206 may be controlled using a microscopic or nanoscopic electromechanical device (a so-called "MEMs" or "NEMs" device), for example. The closed position may correspond to the sound outlet 102 being substantially sealed off from the loudspeaker 202. In some examples, the valve 206 can be moved to a plurality of different positions between the open and closed positions. The volume of the sound output by the sound outlet 102 may increase in volume as the valve 206 is moved from the closed position to the open position, for example.

[0038] In Figure 2B, three valves 206 are shown as being in the closed position, with one of the valves 206' being shown in the open position. In Figure 2B, the rightmost air channel is shown with the respective valve 206' in the open position. Hence, in Figure 2B only the rightmost sound outlet 102 is shown as outputting sound. This may correspond, for example, to the rightmost sound outlet 102 being determined as the sound outlet that is located closest to the user's ear 106, relative to the other sound outlets 102. In some examples, the first three valves 206 may not be completely closed but may have their relative positions adjusted such that the volume of sound output by each sound outlet 102 gradually increases from leftmost sound outlet 102 to the rightmost sound outlet 102. More generally, the position of each valve 206 within the respective air channels 204 may have an individually controllable position. In this way, the volume of sound output by each sound outlet 102 can be controlled individually (i.e. selectively).

[0039] In another example (not shown), the loudspeakers 202 may be arranged using a combination of the arrangements shown in Figures 2A and 2B. For example, the arrangement may include at least two loudspeakers 202. One of the loudspeakers may be arranged to provide sound to a plurality of sound outlets 102, whilst the other loudspeaker 202 may be arranged to provide sound to a respective (i.e. dedicated) sound outlet 102. This arrangement may be used, for example, where one of the loudspeakers 202 is able to output sound with a louder volume than the other. In such a case, it may be desirable to distribute the sound output of the louder loudspeaker 202 to a greater number of sound outlets 102. In additional or alternative cases, one of the loudspeakers 202 may have a finer granularity of volume control than the other. In such a case, it may be desirable to allocate this loudspeaker 202 a dedicated sound outlet 102. The volume of the sound output by the other loudspeaker 202 can then be controlled by selectively restricting the air flow out of its associated air channels 204.

[0040] Figure 3 schematically shows a plurality of components for controlling the volume of sound output by one or more sound outlets 102, in accordance with the present disclosure. The components include a processor 302, a controller 304, a proximity sensor 104 and a loudspeaker 202. These components may be included in an audio output device 100, such as a smartphone or tablet, for example. In some examples, at least some of the components may be provided as a device that can be inserted into (and removed from) the audio output device 100. For example, the processor, controller and loudspeaker may form the so-called "loudspeaker assembly" of a smartphone or tablet.

[0041] Whilst not shown in Figure 3, it will be appreciated that the loudspeaker 202 will be associated with one or more sound outlets 102, as described previously. It will also be appreciated that the proximity sensor 104 and loudspeaker 202 correspond to the proximity sensors 104 and loudspeakers 202 described previously, and that there may be more than one of either of these.

[0042] As can be seen in Figure 3, the processor 302 is communication with the controller 304, which in turn is communication with a proximity sensor 104 and a loudspeaker 202. In some examples, the processor 302 is also in communication with a microphone 108 (not shown). The loudspeaker 202 and sensor 104 may also be in communication with one another. As shown in Figure 3, the sensor 104 and loudspeaker 202 provide respective inputs to processor 302 via respective communication links.

[0043] As described previously, the proximity sensor 104 allows the position of a user's ear 106 in relation to at least one of the sound outlets 102 to be determined. For example, a proximity sensor 104 may be arranged to emit and receive an infra-red signal or to determine proximity using capacitive sensing, and to provide this as a respective input signal to the processor 302. The processor 302 can then determine the relative position of the user's ear 106, based on the input signal received from the sensor 104.

[0044] In some examples, plural proximity sensors 104 may be used, with each proximity sensor 104 providing a respective input signal to the processor 302. The input signals received at the processor 302 can then be compared so as to determine whether a given proximity sensor 104 is located closer to or further away from the user's ear 106, relative to the other sensors 104.

[0045] In some examples, the processor 302 is configured to associate each proximity sensor 104 with one or more sound outlets 102. In this way, the processor 302 can determine which of the sound outlets 102 are to output sound with a louder or quieter or no volume. For example, the processor 302 can identify a sound outlet 102 that is associated with the proximity sensor 104 to which the user's ear is detected as being closest. The processor 302 can then determine how the volume output by that sound outlet 102 is to be increased and / or how the volume output of the other sound outlets 102 is to be decreased.

[0046] In examples the proximity sensor 104 may be configured to detect the position of the user's ear 106 in response to e.g. a detected movement of the audio output device 100, for example in response to the audio output device 100 having been detected as being moved to a user's ear 106. In further examples, detection of the position of the user's ear 106 may be triggered in response to the user having established a call with another user, i.e. via the audio output device 100. In any of these examples, the proximity sensor 104 may be configured to detect the user's ear 106 periodically (e.g. every e.g. 0.5s), and to provide corresponding input signals to the processor 302.

[0047] The controller 304 is configured to receive an input from the processor 302 and, based on this, control the volumes of sound output by at least some of the sound outlets 102. The input may indicate, for example, one or more sound outlets 102, and how the volume of sound output by those sound outlets 102 is to be varied.

[0048] In some examples, the controller 304 does this by individually controlling the volume of sound output by one or more loudspeakers 202. For example, the controller 304 causes the volume of sound output by the loudspeaker(s) 202 located closest to the user's ear 106 to be increased, relative to other loudspeakers 202, and causes the volume of sound output by the or each other loudspeaker 202 to be reduced (optionally to zero). In additional or alternative examples, the controller 304 may be in communication with one or more valves 206, and may be configured to control the position of one more valves 206, as was described previously in relation to Figure 2. Again, the valves 206 may be controlled so that the volume of sound output by the sound outlets located closer to the user's ear 106 is increased relative to the volume of sound output by the other, further away sound outlets 102. In this way, a user is likely to be better able to hear the sound being output from the sound outlets 102 and usage of the device 100 is less likely to be annoying to others.

[0049] Although not shown in Figure 3, in some examples a microphone 108 is used to detect ambient noise in the environment in which the audio output device 100 is outputting sound. The microphone 108 may be included as part of the audio output device 100, as described previously in relation to Figure 1. The microphone 108 is arranged to detect ambient noise and to provide an indication of this to the processor 302. The processor 302 then determines how the volume output by the one or more sound outlets 102 is to be further adjusted.

[0050] For example, if it is determined that the device 100 is in a noisy environment, the processor 302 may determine that volume of sound that is output by the sound outlet(s) 102 located closest to the user's ear 106 is to be increased further. This means, for example, that a user will be even more likely to hear the output audio, despite the output audio having to compete with other loud sources of audio present in the environment.

[0051] Conversely, if it is determined that the device 100 is in a quiet environment, the processor 302 may determine that the volume of sound that is output by the sound outlet(s) 102 located closest to the user's ear 106 is to be reduced slightly. This ensures that the output sound provides a minimal disturbance to others present in the environment. It is noted that, in some examples, the volume of sound output by the sound outlets 102 located further from the user's ear 106 will have already been decreased. Therefore disturbance to others will have already been reduced in part, by the relative increase in volume being localized to the sound outlet(s) 102 located closest to the user's ear 106. In general, the microphone 108 can be used to ensure that any relative changes in the volume are adapted to the environment in which the user is using the audio output device 100. This is particularly useful where, for example, the user is conducting a call with the audio output device 100.

[0052] The components shown in Figure 3 are represented as a schematic block diagram for the purposes of explaining the functionality of the components only. Hence, it is understood that each component is a functional block for performing the functionality ascribed to it herein. Each component may be implemented in hardware, software, firmware, or a combination thereof. Additionally, although described as separate components, some or all of the functionality may be performed by a single piece of hardware, software, or firmware.

[0053] It will be understood that the processor referred to herein may in practice be provided by a single chip or integrated circuit or plural chips or integrated circuits, optionally provided as a chipset, an application-specific integrated circuit (ASIC), field-programmable gate array (FPGA), digital signal processor (DSP), graphics processing units (GPUs), etc. The chip or chips may comprise circuitry (as well as possibly firmware) for embodying at least one or more of a data processor or processors, a digital signal processor or processors, baseband circuitry and radio frequency circuitry, which are configurable so as to operate in accordance with the exemplary embodiments. In this regard, the exemplary embodiments may be implemented at least in part by computer software stored in (non-transitory) memory and executable by the processor, or by hardware, or by a combination of tangibly stored software and hardware (and tangibly stored firmware).

[0054] Although at least some aspects of the embodiments described herein with reference to the drawings comprise computer processes performed in processing systems or processors, the invention also extends to computer programs, particularly computer programs on or in a carrier, adapted for putting the invention into practice. The program may be in the form of non-transitory source code, object code, a code intermediate source and object code such as in partially compiled form, or in any other non-transitory form suitable for use in the implementation of processes according to the invention. The carrier may be any entity or device capable of carrying the program. For example, the carrier may comprise a storage medium, such as a solid-state drive (SSD) or other semiconductor-based RAM; a ROM, for example a CD ROM or a semiconductor ROM; a magnetic recording medium, for example a floppy disk or hard disk; optical memory device s in general; etc.

[0055] The examples described herein are to be understood as illustrative examples of embodiments of the invention. Further embodiments and examples are envisaged. Any feature described in relation to any one example or embodiment may be used alone or in combination with other features. In addition, any feature described in relation to any one example or embodiment may also be used in combination with one or more features of any other of the examples or embodiments, or any combination of any other of the examples or embodiments. Furthermore, equivalents and modifications not described herein may also be employed within the scope of the invention, which is defined in the claims.

Claims

1. An audio output device comprising:

   a plurality of sound outlets for outputting sound; and
   a proximity sensor for determining the position of a user's ear in relation to at least one of the sound outlets;
   wherein the audio output device is configured to adjust the relative volume of sound output by one or more of the sound outlets based on the determined position of the user's ear.

2. An audio output device according to claim 1, wherein the proximity sensor is configured to determine a position of the user's earhole in relation to at least one of the sound outlets, and the audio output device is configured to adjust the relative volumes output by the sound outlets based on the determined position of the user's earhole.

3. An audio output device according to claim 1 or claim 2, comprising a microphone for receiving ambient noise, the audio output assembly being configured to adjust the volume of the sound output by one or more of the sound outlets based on the determined level of the ambient noise received by the microphone.

4. An audio output device according to any of claims 1 to 3, comprising plural loudspeakers, each of the plural loudspeakers being arranged to provide sound to a respective one of the sound outlets.

5. An audio output device according to any of claims 1 to 4, comprising a loudspeaker arranged to provide sound to plural of the sound outlets, each sound outlet having a selectively controllable sound output.

6. An audio output device according to claim 5, wherein the loudspeaker is in communication with the sound outlets via a plurality of respective air channels, wherein each air channel includes a valve operable to adjust the volume of sound output by the respective sound outlet by selectively restricting air flow to the sound outlet.

7. An audio output device according to any of claims 1 to 3, including at least two loudspeakers, wherein a first loudspeaker is arranged to provide sound to a respective sound outlet and a second loudspeaker is arranged to provide sound to plural of the sound outlets, each sound outlet having a selectively controllable sound output.

8. An audio output device according to any of claims 1 to 7, comprising a plurality of proximity sensors, the sound outlets and the proximity sensors alternating in location across the audio output device.

9. An audio output device according to any of claims 1 to 8, comprising a processor, the processor being arranged to receive an input signal from the proximity sensor and to adjust the relative volumes of sound output by the respective sound outlets based on the received input signal.

10. A mobile device comprising an audio output device according to any of claims 1 to 9.

11. A method of controlling the sound output of an electronic device, the device comprising a plurality of sound outlets for outputting sound, the method comprising:

    determining, using a proximity sensor, a position of a user's ear in relation to at least one of the sound outlets; and
    adjusting relative volumes of sound output by one or more of the sound outlets based on the determined position of the user's ear.

12. A method according to claim 11, wherein the adjusting comprises varying the relative volumes output by one or more of the sound outlets such that a sound outlet that is determined as being nearer to the user's ear outputs sound at a louder volume than another sound outlet that is determined as being further from the user's ear.

13. A method according to claim 11 or claim 12, comprising:

    detecting a noise level; and
    adjusting the volumes output by one or more of the sound outlets based on the detected noise level.

14. A method according to any of claims 11 to 13, wherein determining the position of the user's ear comprises determining the position of the user's earhole in relation to at least one of the sound outlets.

15. A method according to any of claims 11 to 14, wherein the electronic device is a telecommunications de-

vice, and wherein the determining of the position of the user's ear is initiated in response to connecting an audio call at the telecommunications device.

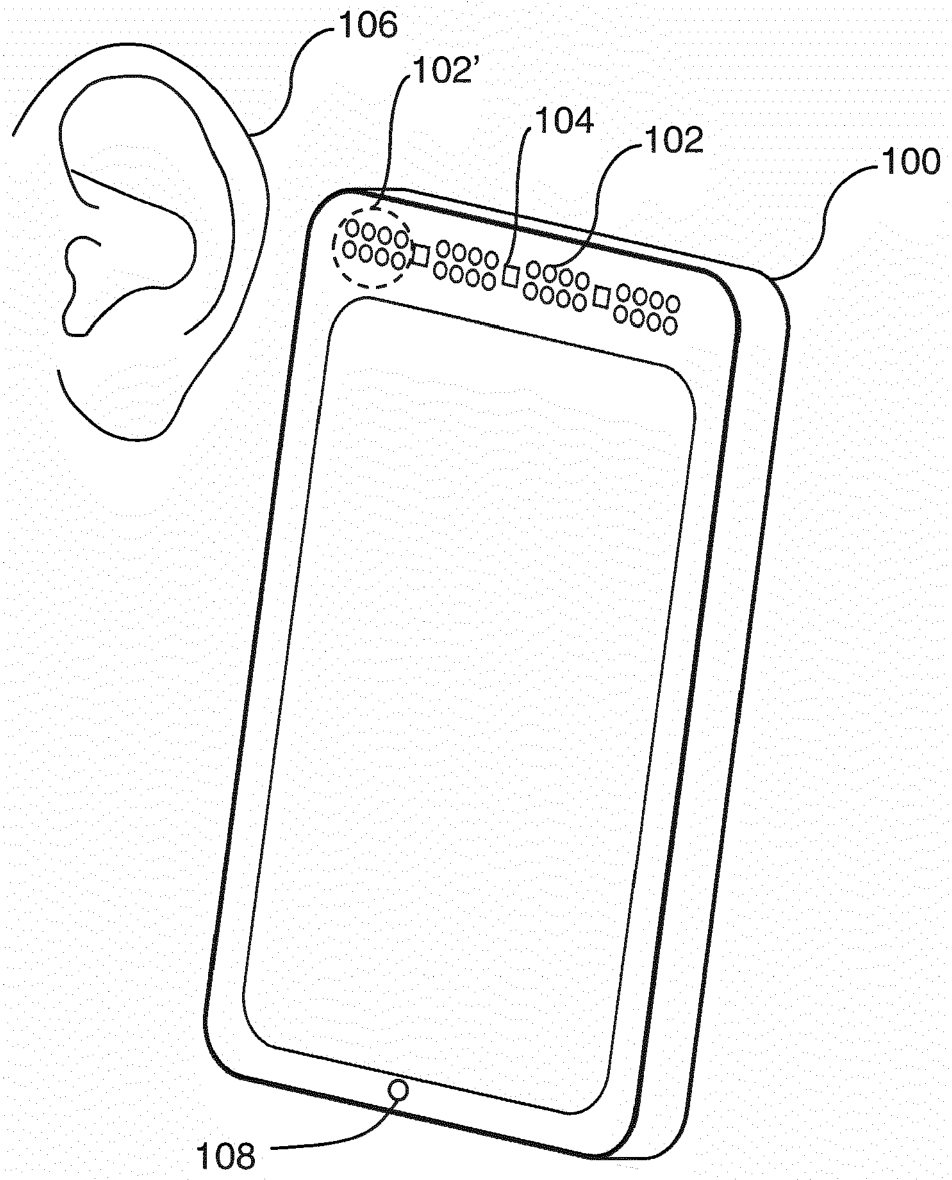

Fig. 1

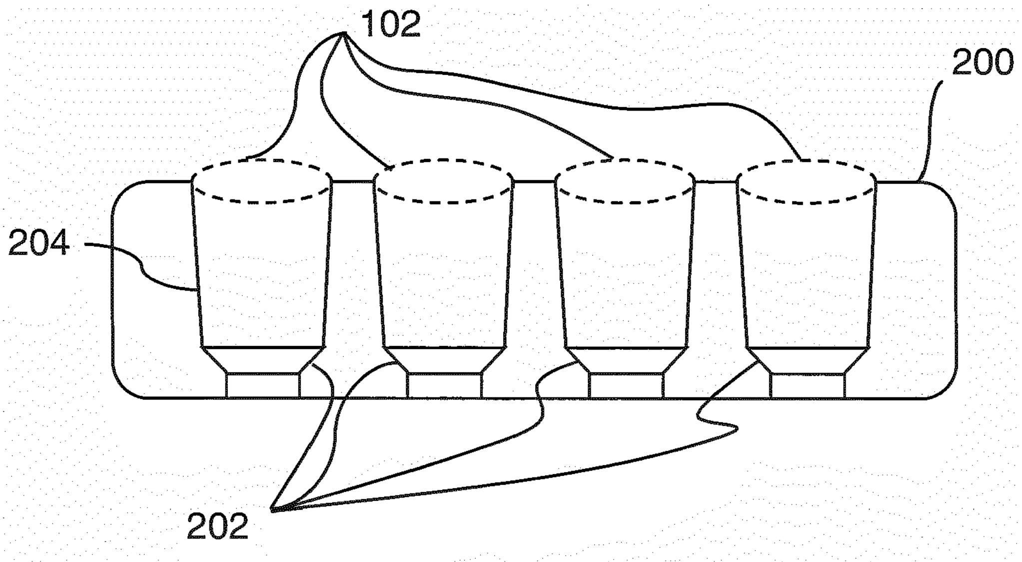

Fig. 2A

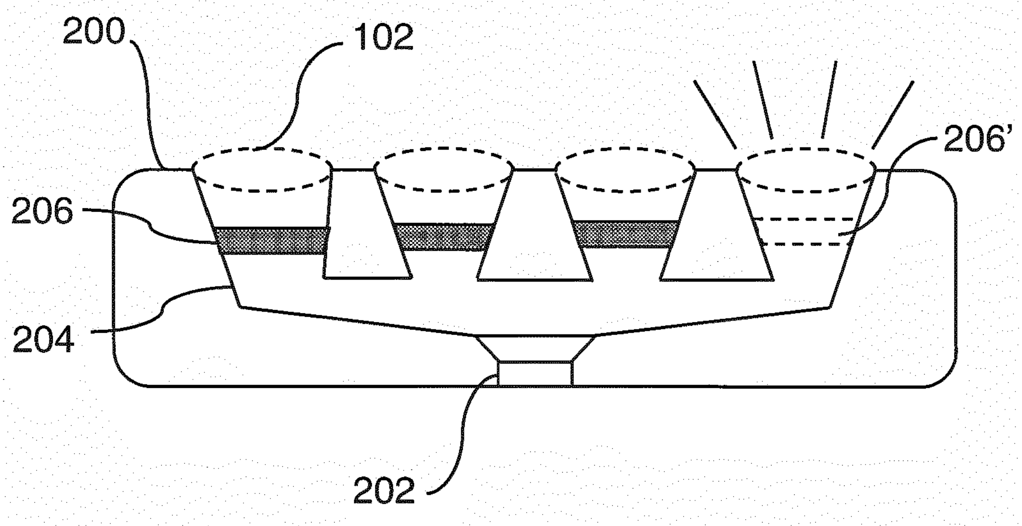

Fig. 2B

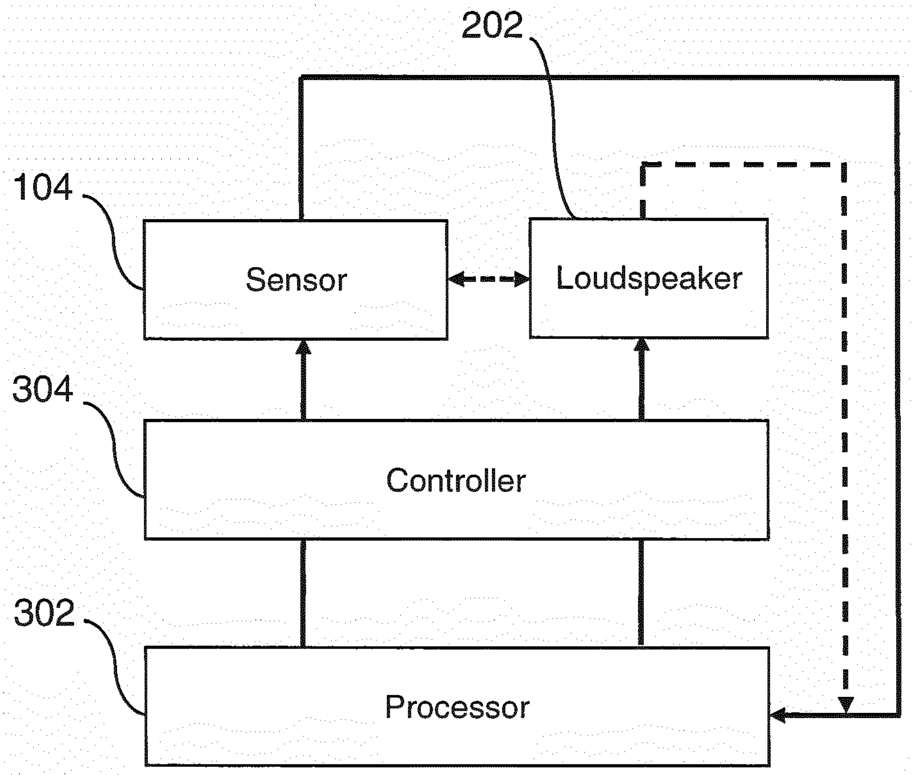

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 17 20 7465

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2009/226013 A1 (BURGE BENJAMIN D [US]) 10 September 2009 (2009-09-10) * paragraphs [0021], [0032], [0035], [0036], [0054]; figures 2,4 *	1-4,8-14	INV. H04R1/34
X	US 2016/191097 A1 (HUH JAE-YOUNG [KR] ET AL) 30 June 2016 (2016-06-30) * paragraphs [0105] - [0107], [0212] - [0128]; figures 1,8D-8G,11,12 *	1-4,7-15	
X	US 2010/046766 A1 (GREGG JUSTIN [US] ET AL) 25 February 2010 (2010-02-25) * paragraphs [0001] - [0004], [0017], [0019], [0031]; figures 1,5 *	1-4,8-15	
X	WO 2011/001012 A1 (NOKIA CORP [FI]; SUVANTO MIKKO [FI]; OZCAN KORAY [GB]) 6 January 2011 (2011-01-06) * page 1, line 6 * * page 11, line 36 - page 12, line 33; figures 6,7 *	1-3,5-15	

TECHNICAL FIELDS SEARCHED (IPC)

H04R

The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
The Hague	25 May 2018	Fobel, Oliver

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 17 20 7465

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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25-05-2018

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