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- **VILERMO, Miikka**  
**37200 Siuro (FI)**
- **LEHTINIEMI, Arto**  
**33880 Lempäälä (FI)**
- **LAITINEN, Mikko-Ville**  
**00210 Helsinki (FI)**

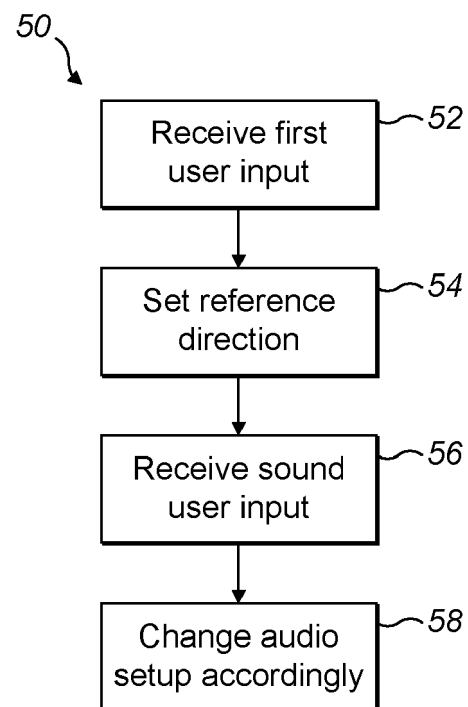
(71) Applicant: **Nokia Technologies Oy**  
**02610 Espoo (FI)**

(74) Representative: **Whiting, Gary**  
**Venner Shipley LLP**  
**5 Stirling House**  
**Stirling Road**  
**The Surrey Research Park**  
**Guildford GU2 7RF (GB)**

(72) Inventors:  
• **MATE, Sujeet Shyamsundar**  
**33720 Tampere (FI)**

(54) **AUDIO OUTPUT DEVICE**

(57) The specification describes an apparatus, method and computing program for controlling a plurality of audio outputs of a multi-directional audio output device, receiving a first user input for indicating a first direction, wherein based, at least in part, on the first user input, a first one of the plurality of audio outputs is configured to be output in the first direction and is defined as a first audio output and receiving a second user input for indicating a change in an audio setup of the multi-directional audio output device.



**FIG. 5**

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## Description

### Field

**[0001]** The present specification relates to audio output devices; for example, to the control of multi-directional audio output devices.

### Background

**[0002]** Multi-directional and omnidirectional audio output devices, such as loudspeakers, can provide a variety of output effects, such as providing different audio channels in different directions. There remains a need for alternative arrangements for interacting with and/or controlling such devices.

### Summary

**[0003]** In a first aspect, there is provided an apparatus comprising: means for controlling a plurality of audio outputs of a multi-directional audio output device; means for receiving a first user input for indicating a first direction, wherein based, at least in part, on the first user input, a first one of the plurality of audio outputs is configured to be output in the first direction and is defined as a first audio output; and means for receiving a second user input for indicating a change in an audio setup of the multi-directional audio output device.

**[0004]** At least some of the plurality of audio outputs may be configured to be output in different directions.

**[0005]** The first audio output may have the highest volume setting or audio gain setting of the plurality of audio outputs.

**[0006]** Controlling the plurality of audio outputs of a multi-directional audio output device may comprise routing at least some of a plurality of audio channels to different ones of the plurality of audio outputs. In some example embodiments, in the event of a change in the first direction from a previous first direction to an updated first direction, the means for routing the audio channels may route the audio channels such that the audio channel that was previously being output in the direction of the updated first direction becomes the first audio output (such that the first audio output is changed). In other example embodiments, in the event of a change in the first direction from a previous first direction to an updated first direction, the means for routing the audio channels routes the audio channels such that the audio channel that was previously being output in the direction of the previous first direction is output in the updated first direction (such that the first audio output remains the same, but is output in a different direction).

**[0007]** In some example embodiments, a different one of the plurality of audio channels is routed to each of the plurality of audio outputs of the audio output device. Alternatively, some audio outputs could be repeated, for example, such that there are fewer audio outputs than

audio output directions.

**[0008]** In some example embodiments, based (at least in part) on the second user input, a second one of the plurality of audio outputs is configured to be output in the first direction and is defined as the first audio output. Thus, for example, the second user input may be used to change the audio channel that is routed to the first audio output. Alternatively, or in addition, in some example embodiments, based (at least in part) on the second user input, one or more characteristics (such as, for example, a change in a bass or treble setting of an output) of at least one of the plurality of audio outputs is changed.

**[0009]** Some or all of the plurality of audio outputs may include different audio content (such as different songs, e.g. of a playlist).

**[0010]** The audio output device may comprise a loudspeaker or a plurality of loudspeakers. In forms of the invention including a plurality of loudspeakers, each of the plurality of audio outputs may be provided in the direction of one of the plurality of loudspeakers. However, this is not essential to all embodiments. For example, audio output could be provided in directions other than the directions of the plurality of loudspeakers.

**[0011]** The audio output device may an omnidirectional audio output device (such as an omnidirectional loudspeaker).

**[0012]** The means for receiving the first user input may comprise one or more touch sensors. Alternatively, or in addition, the means for receiving the second user input may comprise a motion sensor and/or a rotation input. The said motion sensor and/or rotation input may, for example, be implemented using one or more of an accelerometer, a magnetometer, a gyroscope and a compass.

**[0013]** In a second aspect, there is provided a method comprising: controlling a plurality of audio outputs of a multi-directional audio output device; receiving a first user input for indicating a first direction, wherein based, at least in part, on the first user input, a first one of the plurality of audio outputs is configured to be output in the first direction and is defined as a first audio output; and receiving a second user input for indicating a change in an audio setup of the multi-directional audio output device. At least some of the plurality of audio outputs may be configured to be output in different directions. The first audio output may have the highest volume setting or audio gain setting of the plurality of audio outputs.

**[0014]** Controlling the plurality of audio outputs of a multi-directional audio output device may comprise routing at least some of a plurality of audio channels to different ones of the plurality of audio outputs. In some example embodiments, in the event of a change in the first direction from a previous first direction to an updated first direction, the method comprises routing the audio channels such that the audio channel that was previously being output in the direction of the updated first direction becomes the first audio output (such that the first audio output is changed). In other example embodiments, in

the event of a change in the first direction from a previous first direction to an updated first direction, the method comprises routing the audio channels such that the audio channel that was previously being output in the direction of the previous first direction is output in the updated first direction (such that the first audio output remains the same, but is output in a different direction).

**[0015]** In some example embodiments, a different one of the plurality of audio channels is routed to each of the plurality of audio outputs of the audio output device. Alternatively, some audio outputs could be repeated, for example, such that there are fewer audio outputs than audio output directions.

**[0016]** In some example embodiments, based (at least in part) on the second user input, a second one of the plurality of audio outputs is configured to be output in the first direction and is defined as the first audio output. Thus, for example, the second user input may be used to change the audio channel that is routed to the first audio output. Alternatively, or in addition, in some example embodiments, based (at least in part) on the second user input, one or more characteristics (such as, for example, a change in a bass or treble setting of an output) of at least one of the plurality of audio outputs is changed.

**[0017]** Some or all of the plurality of audio outputs may include different audio content (such as different songs, e.g. of a playlist).

**[0018]** In a third aspect, this specification describes an apparatus configured to perform any method as described with reference to the second aspect.

**[0019]** In a fourth aspect, this specification describes computer readable instructions which, when executed by computing apparatus, cause the apparatus to perform a method as described with reference to the second aspect.

**[0020]** In a fifth aspect, this specification describes a computer program comprising instructions for causing an apparatus to perform at least the following: control a plurality of audio outputs of a multi-directional audio output device; receive a first user input for indicating a first direction, wherein based, at least in part, on the first user input, a first one of the plurality of audio outputs is configured to be output in the first direction and is defined as a first audio output; and receive a second user input for indicating a change in an audio setup of the multi-directional audio output device.

**[0021]** In a sixth aspect, this specification describes a computer readable medium (e.g. a non-transitory computer readable medium) comprising program instructions stored thereon for performing at least the following: controlling a plurality of audio outputs of a multi-directional audio output device; receiving a first user input for indicating a first direction, wherein based, at least in part, on the first user input, a first one of the plurality of audio outputs is configured to be output in the first direction and is defined as a first audio output; and receiving a second user input for indicating a change in an audio setup of the multi-directional audio output device.

**[0022]** In a seventh aspect, this specification describes an apparatus comprising: at least one processor; and at least one memory including computer program code which, when executed by the at least one processor, causes the apparatus to: control a plurality of audio outputs of a multi-directional audio output device; receive a first user input for indicating a first direction, wherein based, at least in part, on the first user input, a first one of the plurality of audio outputs is configured to be output in the first direction and is defined as a first audio output; and receive a second user input for indicating a change in an audio setup of the multi-directional audio output device.

## Brief description of the drawings

**[0023]** Example embodiments will now be described, by way of example only, with reference to the following schematic drawings, in which:

FIG. 1 shows a multi-directional audio output device used in example embodiments;

FIG. 2 is a plan view of the multi-directional audio output device of FIG. 1;

FIG. 3 is a plan view showing example outputs of the audio output device of FIG. 1;

FIG. 4 shows a multi-directional audio output device used in example embodiments;

FIG. 5 is a flow chart showing an algorithm in accordance with an example embodiment;

FIG. 6 shows an example user interaction with an audio output device in accordance with an example embodiment;

FIGS. 7 to 10 show example outputs of the audio output device of FIG. 6;

FIGS. 11 and 12 show example user interactions with an audio output device in accordance an example embodiment;

FIG. 13 shows example outputs of the audio output device of FIGS. 11 and 12;

FIG. 14 shows an example user interaction with an audio output device in accordance an example embodiment;

FIG. 15 is a table showing example outputs of the audio output device of FIG. 14;

FIG. 16 is a flow chart showing an algorithm in accordance with an example embodiment;

FIG. 17 shows an example user interaction with an audio output device in accordance an example embodiment;

FIG. 18 is a block diagram of a system in accordance with an example embodiment; and

FIGS. 19a and 19b show tangible media, respectively a removable memory unit and a compact disc (CD) storing computer-readable code which when run by a computer perform operations according to embodiments.

## Detailed description

**[0024]** FIG. 1 shows a multi-directional audio output device, indicated generally by the reference numeral 1, used in example embodiments. The multi-directional audio output device 1 may be a multi-directional loudspeaker having a plurality of directional loudspeakers (first to sixth directional loudspeakers 2 to 7 are shown in the example device 1). The multi-directional audio output device 1 may take many forms. For example, one or more loudspeakers forming part of an example multi-directional audio output device could be formed from a plurality of loudspeaker elements. The skilled person will be aware of many alternative arrangements.

**[0025]** FIG. 2 is a plan view, indicated generally by the reference numeral 10, of the multi-directional audio output device 1. The plan view 10 includes the first to sixth loudspeakers 2 to 7 described above. Each of the loudspeakers is orientated in a different direction such that each loudspeaker can provide an audio output in a different direction. Thus, as shown in FIG. 2, the first loudspeaker 2 is orientated in a first direction having an angle 0 degrees, with each of the other loudspeakers being orientated in a direction having an angle relative to the angle of the first loudspeaker. Specifically, the second loudspeaker 3 is orientated in a direction having an angle 45 degrees, the third loudspeaker 4 is orientated in a direction having an angle 135 degrees, the fourth loudspeaker 5 is orientated in a direction having an angle 180 degrees, the fifth loudspeaker 6 is orientated in a direction having an angle 225 degrees, and the sixth loudspeaker 7 is orientated in a direction having an angle 315. Of course, in any particular embodiment, the number of loudspeakers and the relative angles of those loudspeakers may be different to that shown in FIG. 2.

**[0026]** The loudspeakers 2 to 7 can provide audio outputs in the directions of the respective loudspeakers, but audio output can, of course, be provided in other directions. By way of example, as indicated by the dotted lines in FIG. 2, audio outputs may be provided in the directions 0 degrees (referred to below as the reference direction), 45 degrees, 90 degrees, 135 degrees, 180 degrees, 225 degrees, 270 degrees and 315 degrees. Of course, the directions shown in FIG. 2 are provided by way of example only. Any combination of directions could, in principle, be provided by the audio output device 1.

**[0027]** FIG. 3 is a plan view, indicated generally by the reference numeral 20, showing example outputs of the audio output device 1. The plan view 20 includes the first to sixth loudspeakers directional 2 to 7 described above and the various audio outputs direction described above.

**[0028]** As shown in the plan view 20, the first loudspeaker 2 provides an audio output in a reference direction. In the example of FIG. 3, the audio output in the reference direction is a first song (song N, as labelled in FIG. 3).

**[0029]** Further, as shown in FIG. 3, a second song (song N+1) is provided in the 45 degree direction, a third

song (song N+2) is provided in the 90 degree direction, a fourth song (song N+3) is provided in the 135 degree direction and a fifth song (song N+4) is provided in the 180 degree direction. Furthermore, a sixth song (song N-1) is provided in the 315 degree direction, a seventh song (song N-2) is provided in the 270 degree direction and an eighth song (song N-3) is provided in the 225 degree direction. Of course, the audio outputs shown in FIG. 3 are examples only.

**[0030]** The eight songs shown in FIG. 3 may form part of a playlist of songs, with different songs being output in different directions. In one example embodiment, the first song (song N) is played louder than the other songs. The other songs may all be played at a similar volume or may themselves be output at different volumes. For example, the volume at which a song is output may be dependent on the angle between the reference direction and the direction in which the song is output (such that, for example, the songs N+3 and N-3 are played more quietly than the songs N+2 and N-2, with the songs N+2 and N-2 being played more quietly than the songs N+1 and N-1).

**[0031]** FIG. 4 shows a multi-directional audio output device, indicated by the reference numeral 30, used in example embodiments. The multi-directional audio output device 30 may be a multi-directional loudspeaker having a plurality of directional loudspeakers (first to sixth loudspeakers 32 to 37 are shown in the example device 1). Thus, the audio output device 30 may have loudspeakers similar to the audio output device 1 described above.

**[0032]** As shown in FIG. 4, the audio output device 30 also has a first input means 38 and a second input means 40.

**[0033]** The first input means 38 may be used to enable a user to provide an input indicating a first direction (e.g. a reference direction, as described above). In one implementation, the first input means 38 is a touch sensor and/or an infra-red sensor. Of course, many alternative arrangements will be readily apparent to those skilled in the art.

**[0034]** The second input means 40 may be used to enable a user to indicate a change in the audio arrangement. The second input means 40 may be a motion sensor and/or a rotation input. In one implementation, the second input means 40 is an accelerometer, magnetometer, gyroscope or compass. Again, many alternative arrangements will be readily apparent to those skilled in the art.

**[0035]** FIG. 5 is a flow chart showing an algorithm, indicated generally by the reference numeral 50, in accordance with an example embodiment.

**[0036]** The algorithm 50 starts at operation 52, where a first user input is received. The first user input may, for example, be received by the first input means 38 of the audio output device 30 described above. As described in detail below, the first user input may define a reference direction of an audio output arrangement.

**[0037]** At operation 54, the reference direction is set, based on the first user input. The audio output in the direction of the first user input may be defined as a first audio output of the audio output device 30.

**[0038]** At operation 56, a second user input is received. The second user input may, for example, be received by the second input means 40 of the audio output device 30 described above. At operation 58, the second user input is used to change the audio setup of the audio output device 30. For example, the second user input may define a change in the audio channel that is routed to the first audio output. Examples of such changes are described in detail below.

**[0039]** FIG. 6 shows an example user interaction, indicated generally by the reference numeral 60 in accordance with an example embodiment. The user interaction 60 involves an audio output device 62, a first user 64 and a second user 66. The audio output device 62 may be similar to the audio output device 30 described above. In particular, the audio output device 62 may include a first input means 38 (not shown in FIG. 6).

**[0040]** FIG. 6 shows the first user 64 touching the audio output device (as indicated by the reference numeral 68). For example, the first user 64 may touch the first input means 38, thereby implementing the operation 52 of the algorithm 50.

**[0041]** The touching 68 of the audio output device 62 by the first user 64 results in a setting of a new reference direction (operation 54 of the algorithm 50).

**[0042]** FIG. 7 shows an example output, indicated generally by the reference numeral 70, of the audio output device 62 of FIG. 6. The output 70 is similar to the output 10 described above with reference to FIG. 2. The output 70 includes an original reference direction 72 (the reference direction before the touching 68 of the audio output device 62 by the first user 64) and a new reference direction 74 (the reference direction after the touching 68 of the audio output device 62 by the first user 64). As shown in FIG. 7, the reference direction is changed in operation 54 of the algorithm 50 to be in the direction in which the first user 64 touches the audio output device 62.

**[0043]** FIGS. 8 to 10 show exemplary uses of the audio output device 62.

**[0044]** FIG. 8 shows an initial state, indicated generally by the reference numeral 80, in which the reference direction 82 is at 0 degrees. A first song (Song N) is output in the reference direction. A second song (Song N-1) is output at 45 degrees, a third song (Song N-2) is output at 135 degrees, a fourth song (Song N+2) is output at 225 degrees, and a fifth song (Song N+1) is output at 315 degrees. As indicated in FIG. 8, the song in the reference direction (song N) is output loud and the other songs are output less loud.

**[0045]** Assume that the user 64 touches the audio output device 62 as indicated by the reference numeral 68 such that the reference direction is changed to the 315 degree position as shown in FIGS. 9 and 10. As described below, FIGS. 9 and 10 show two alternative arrange-

ments (indicated generally by the reference numerals 90 and 100 respectively) by which the initial state 80 might be changed by the user 64 touching the audio output device 62 (i.e. two different implementations of the operation 54 are shown).

**[0046]** In FIG. 9, the reference direction 94 is shown in the 315 degree position. The first to fifth songs described above with reference to FIG. 8 are still in the same positions, such that the fifth song (Song N+1) is output at 315 degrees (and is therefore in the reference direction). As indicated in FIG. 9, the fifth song (Song N+1) is output loud and the other songs are output less loud. Thus, in the example of FIG. 9, in the event of a change in the reference direction from a previous reference direction to an updated reference direction, the audio channels are routed such that the audio channel that was previously being output in the direction of the updated reference direction is still routed in the updated reference direction.

**[0047]** In FIG. 10, the reference direction 104 is also shown in the 315 degree position. The example of FIG. 10 differs from that of FIG. 9 in that the first song (Song N) is output at 315 degrees (and is therefore in the reference direction). In other words, the reference direction is changed (compared with FIG. 8), but the song being output in the reference direction (the first song, Song N) is not changed. Thus, in the example of FIG. 10, in the event of a change in the reference direction from a previous reference direction to an updated reference direction, the audio channels are routed such that the audio channel that was previously being output in the reference direction is output in the updated reference direction.

**[0048]** FIGS. 11 and 12 show example user interactions (indicated generally by the reference numerals 110a and 110b respectively) with an audio output device in accordance an example embodiment. FIGS. 11 and 12 show user interactions involving an audio output device 112, a first user 114 and a second user 116 (and are similar to the audio output device 62, first user 64 and second user 66 described above with reference to FIG. 6). The audio output device 112 may be similar to the audio output device 30 described above. In particular, the audio output device 112 may include a first input means 38 and a second input means 40 (not shown in FIGS. 11 and 12).

**[0049]** FIG. 11 shows the second user 116 touching the audio output device 112 (as indicated by the reference numeral 120). For example, the second user 116 may touch the first input means 38, thereby implementing the operation 52 of the algorithm 50.

**[0050]** The touching 120 of the audio output device 112 by the second user 116 results in a setting of a new reference direction (operation 54 of the algorithm 50).

**[0051]** FIG. 12 shows the second user 116 making a rotation motion 122 (as indicated by the reference numeral 122). For example, the second user 116 may touch and rotate the second input means 40, which rotation may, for example, be detected by motion sensors of the

second input means 40. Such motion sensors may be implemented, for example, as accelerometers or similar devices.

**[0052]** As described above, FIG. 8 shows an initial state in which the reference direction 82 is at 0 degrees. A first song (Song N) is output in the reference direction. A second song (Song N-1) is output at 45 degrees, a third song (Song N-2) is output at 135 degrees, a fourth song (Song N+2) is output at 225 degrees, and a fifth song (Song N+1) is output at 315 degrees. As indicated in FIG. 8, the song in the reference direction (song N) is output loud and the other songs are output less loud.

**[0053]** FIG. 13 shows an output arrangement, indicated generally by the reference numeral 130, by which the initial state 82 might be changed by the second user 116.

**[0054]** Assume that the second user 116 touches the audio output device 112 as indicated by the reference numeral 120 such that the reference direction is changed to the 45 degree position as shown in FIG. 13. Assume also that the second user 116 rotates the second input means such that the output songs are moved around the audio output device 112 shown in FIG. 13.

**[0055]** As shown in the output arrangement 130, the reference direction (indicated by the reference numeral 132) is in the 45 degree direction (as instructed by the touching 120 of the audio output device 112 by the second user 116).

**[0056]** Furthermore, the positions of the audio outputs have been changed as a result of rotation of the second input means by the second user 116. As shown in FIG. 13, the fifth song (song N+1) is output in the new reference direction 132, the first song (Song N) is output in the 135 degree direction and the fourth song (Song N+2) is output in the 0 degree direction. Further, as a result of the rotation of the second input means 40, a sixth song (Song N+3) is output in the 135 degree direction and a seventh song (Song N+4) is output in the 225 degree direction. Furthermore, the second song (Song N-1) and the third song (Song N-2) are no longer output.

**[0057]** As indicated in FIG. 13, the fifth song (song N+1), which is output in the new reference direction 132, is output loud and the other songs are output less loud.

**[0058]** Of course, the arrangement 130 is provided by way of example only. Many different modifications are possible with the provision of the user interactions 120 and 122.

**[0059]** FIG. 14 shows an example user interaction, indicated generally by the reference numeral 140, with an audio output device in accordance an example embodiment. The user interaction 140 includes a user 142. A first user input 144 and a second user input 145 occur between the user 142 and an interface 143. The interface 143 may, for example, be the physical device being controlled (such as a loudspeaker module), but this is not essential. For example, the interface 143 could be a control module for a loudspeaker. Moreover, the interface could be a virtual representation of such a control module.

**[0060]** In accordance with the algorithm 50 described

above, in operation 52, the user 142 provides the first input 144 defining a direction (e.g. a reference direction of an audio output arrangement). At operation 54, the reference direction is set, based on the first user input. In the example of FIG. 14, a reference direction 146 is shown at 45 degrees.

**[0061]** At operation 56, the second user input 145 is received. As indicated in FIG. 14, the second input 145 is a rotation indication.

**[0062]** FIG. 15 is a table, indicated generally by the reference numeral 150, showing example outputs of the audio output device of FIG. 14. Outputs in five different loudspeaker directions are provided (namely, 135 degrees, 90 degrees, 45 degrees, 0 degrees and 315 degrees). As a result of the first user input 144, the 45 direction is indicated as the reference direction.

**[0063]** The audio output (a song in the example of FIG. 15) that is output in each direction is dependent on the second input 145 provided by the user 142. Thus, in the event of a loudspeaker rotation of  $\theta_1$  being indicated, the songs are allocated to the loudspeakers as indicated in the first column of the table 150. In the event of a loudspeaker rotation of  $\theta_2$  being indicated, the songs are allocated to the loudspeakers as indicated in the second column of the table 150. Similarly, in the event of a loudspeaker rotation of  $\theta_3$  being indicated, the songs are allocated to the loudspeakers as indicated in the third column of the table 150.

**[0064]** In the example embodiments described above, the second user input changes the audio setup of the multi-directional audio output device by routing each of a plurality of audio channels to different ones of plurality of audio outputs. This is not essential to all embodiments.

**[0065]** FIG. 16 is a flow chart showing an algorithm, indicated generally by the reference numeral 160, in accordance with an example embodiment.

**[0066]** The algorithm 160 starts at operation 162, where a user direction is defined. The operation 162 may, for example, define a reference direction (as in the examples described above). Next, at operation 164, a setup option is selected. In the examples described above, the relevant setup options relate to routing each of a plurality of audio channels to different ones of plurality of audio outputs. This is not essential to all embodiments.

**[0067]** FIG. 17 shows an example user interaction, indicated generally by the reference numeral 170, with an audio output device in accordance an example embodiment.

**[0068]** The user interaction 170 include a user 172. A user interaction 174 occurs between the user 172 and an interface 173. The interface 173 may, for example, be the physical device being controlled (such as a loudspeaker module), but this is not essential. For example, the interface 173 could be a control module (for example, for controlling a loudspeaker). Moreover, the interface could be a virtual representation of such a control module.

**[0069]** In accordance with the algorithm 160 described above, in operation 162, the position at which the user

172 contacts the interface 173 defines a user direction (e.g. a reference direction of an audio output arrangement). At operation 164, a setup option is selected from a plurality of possible setup options. In the user interaction 174, the setup option is selected by means of a rotation input 175.

**[0070]** By way of example, the operations 162 and 164 may, for example, be implemented using the first input means 38 and second input 40 of the audio output device 30 described above. The skilled person will be aware of many alternative input arrangements, including virtual input arrangements.

**[0071]** The setup options of the operation 164 may take many different forms. For example, the circles 177, 178 and 179 may relate to different setup options that may be available for selection by means of the rotation input 175.

**[0072]** The selection options may, for example, include different audio setup arrangements optimised for different viewing locations of the same content. The selection options may enable a viewer to rotate between hearing different audio tracks of an audio content. This could, for example, provide for focusing on different instruments of a multi-instrument song, different audio setups relevant for different acoustic spaces, or could provide for audio outputs in different languages.

**[0073]** Many more potential applications for the user interaction 170 will be apparent to the skilled person. For example, one or more characteristics (such as bass and/or treble levels) of at least one of a plurality of audio outputs may be changed.

**[0074]** For completeness, FIG. 18 is a schematic diagram of components of one or more of the modules for implementing the algorithms described above, which hereafter are referred to generically as processing systems 300. A processing system 300 may have a processor 302, a memory 304 coupled to the processor and comprised of a RAM 314 and ROM 312, and, optionally, user inputs 310 and a display 318. The processing system 300 may comprise one or more network interfaces 308 for connection to a network, e.g. a modem which may be wired or wireless.

**[0075]** The processor 302 is connected to each of the other components in order to control operation thereof.

**[0076]** The memory 304 may comprise a non-volatile memory, a hard disk drive (HDD) or a solid state drive (SSD). The ROM 312 of the memory 304 stores, amongst other things, an operating system 315 and may store software applications 316. The RAM 314 of the memory 304 is used by the processor 302 for the temporary storage of data. The operating system 315 may contain code which, when executed by the processor, implements aspects of the algorithms 50 and 160.

**[0077]** The processor 302 may take any suitable form. For instance, it may be a microcontroller, plural microcontrollers, a processor, or plural processors. Processor 302 may comprise processor circuitry.

**[0078]** The processing system 300 may be a stan-

dalone computer, a server, a console, or a network thereof.

**[0079]** In some embodiments, the processing system 300 may also be associated with external software applications. These may be applications stored on a remote server device and may run partly or exclusively on the remote server device. These applications may be termed cloud-hosted applications. The processing system 300 may be in communication with the remote server device in order to utilize the software application stored there.

**[0080]** FIG. 19a and FIG. 19b show tangible media, respectively a removable memory unit 365 and a compact disc (CD) 368, storing computer-readable code which when run by a computer may perform methods according to embodiments described above. The removable memory unit 365 may be a memory stick, e.g. a USB memory stick, having internal memory 366 storing the computer-readable code. The memory 366 may be accessed by a computer system via a connector 367. The CD 368 may be a CD-ROM or a DVD or similar. Other forms of tangible storage media may be used.

**[0081]** Embodiments of the present invention may be implemented in software, hardware, application logic or a combination of software, hardware and application logic. The software, application logic and/or hardware may reside on memory, or any computer media. In an example embodiment, the application logic, software or an instruction set is maintained on any one of various conventional computer-readable media. In the context of this document, a "memory" or "computer-readable medium" may be any non-transitory media or means that can contain, store, communicate, propagate or transport the instructions for use by or in connection with an instruction execution system, apparatus, or device, such as a computer.

**[0082]** Reference to, where relevant, "computer-readable storage medium", "computer program product", "tangibly embodied computer program" etc., or a "processor" or "processing circuitry" etc. should be understood to encompass not only computers having differing architectures such as single/multi-processor architectures and sequencers/parallel architectures, but also specialised circuits such as field programmable gate arrays FPGA, application specific circuits ASIC, signal processing devices and other devices. References to computer program, instructions, code etc. should be understood to express software for a programmable processor firmware such as the programmable content of a hardware device as instructions for a processor or configured or configuration settings for a fixed function device, gate array, programmable logic device, etc.

**[0083]** As used in this application, the term "circuitry" refers to all of the following: (a) hardware-only circuit implementations (such as implementations in only analogue and/or digital circuitry) and (b) to combinations of circuits and software (and/or firmware), such as (as applicable): (i) to a combination of processor(s) or (ii) to portions of processor(s)/software (including digital signal processor(s)), software, and memory(ies) that work to-

gether to cause an apparatus, such as a server, to perform various functions) and (c) to circuits, such as a microprocessor(s) or a portion of a microprocessor(s), that require software or firmware for operation, even if the software or firmware is not physically present.

**[0084]** If desired, the different functions discussed herein may be performed in a different order and/or concurrently with each other. Furthermore, if desired, one or more of the above-described functions may be optional or may be combined. Similarly, it will also be appreciated that the flow diagram of FIGS. 5 and 16 is an example only and that various operations depicted therein may be omitted, reordered and/or combined.

**[0085]** It will be appreciated that the above described example embodiments are purely illustrative and are not limiting on the scope of the invention. Other variations and modifications will be apparent to persons skilled in the art upon reading the present specification.

**[0086]** Moreover, the disclosure of the present application should be understood to include any novel features or any novel combination of features either explicitly or implicitly disclosed herein or any generalization thereof and during the prosecution of the present application or of any application derived therefrom, new claims may be formulated to cover any such features and/or combination of such features.

**[0087]** Although various aspects of the invention are set out in the independent claims, other aspects of the invention comprise other combinations of features from the described embodiments and/or the dependent claims with the features of the independent claims, and not solely the combinations explicitly set out in the claims.

**[0088]** It is also noted herein that while the above describes various examples, these descriptions should not be viewed in a limiting sense. Rather, there are several variations and modifications which may be made without departing from the scope of the present invention as defined in the appended claims.

## Claims

### 1. An apparatus comprising:

means for controlling a plurality of audio outputs of a multi-directional audio output device;  
means for receiving a first user input for indicating a first direction, wherein based, at least in part, on the first user input, a first one of the plurality of audio outputs is configured to be output in the first direction and is defined as a first audio output; and  
means for receiving a second user input for indicating a change in an audio setup of the multi-directional audio output device.

### 2. An apparatus as claimed in claim 1, wherein at least some of the plurality of audio outputs are configured

to be output in different directions.

3. An apparatus as claimed in claim 1 or claim 2, wherein the first audio output has the highest volume setting or audio gain setting of the plurality of audio outputs.

4. An apparatus as claimed in any one of claims 1 to 3, wherein controlling the plurality of audio outputs of a multi-directional audio output device comprises routing at least some of a plurality of audio channels to different ones of the plurality of audio outputs.

5. An apparatus as claimed in claim 4, wherein, in the event of a change in the first direction from a previous first direction to an updated first direction, the means for routing the audio channels routes the audio channels such that the audio channel that was previously being output in the direction of the updated first direction becomes the first audio output.

6. An apparatus as claimed in claim 4, wherein, in the event of a change in the first direction from a previous first direction to an updated first direction, the means for routing the audio channels routes the audio channels such that the audio channel that was previously being output in the direction of the previous first direction is output in the updated first direction.

7. An apparatus as claimed in any one of the preceding claims, wherein based, at least in part, on the second user input, a second one of the plurality of audio outputs is configured to be output in the first direction and is defined as the first audio output.

8. An apparatus as claimed in any one of the preceding claims, wherein based, at least in part, on the second user input, one or more characteristics of at least one of the plurality of audio outputs is changed.

9. An apparatus as claimed in any one of the preceding claims, wherein some or all of the plurality of audio outputs include different audio content.

10. An apparatus as claimed in any one of the preceding claims, wherein the audio output device comprises a loudspeaker or a plurality of loudspeakers.

11. An apparatus as claimed in any one of the preceding claims, wherein the audio output device is an omnidirectional audio output device.

12. An apparatus as claimed in any one of the preceding claims, wherein the means for receiving the first user input comprises one or more touch sensors and /or the means for receiving the second user input comprises a motion sensor and/or a rotation input.

13. An apparatus as claimed in claim 12, wherein the motion sensor and/or rotation input is implemented using one or more of an accelerometer, a magnetometer, a gyroscope and a compass.

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14. A computer program comprising instructions for causing an apparatus to perform at least the following:

control a plurality of audio outputs of a multi-directional audio output device; 10  
receive a first user input for indicating a first direction, wherein based, at least in part, on the first user input, a first one of the plurality of audio outputs is configured to be output in the first direction and is defined as a first audio output; and 15  
receive a second user input for indicating a change in an audio setup of the multi-directional audio output device.

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15. A method comprising:

controlling a plurality of audio outputs of a multi-directional audio output device;  
receiving a first user input for indicating a first direction, wherein based, at least in part, on the first user input, a first one of the plurality of audio outputs is configured to be output in the first direction and is defined as a first audio output; and 25  
receiving a second user input for indicating a change in an audio setup of the multi-directional audio output device. 30

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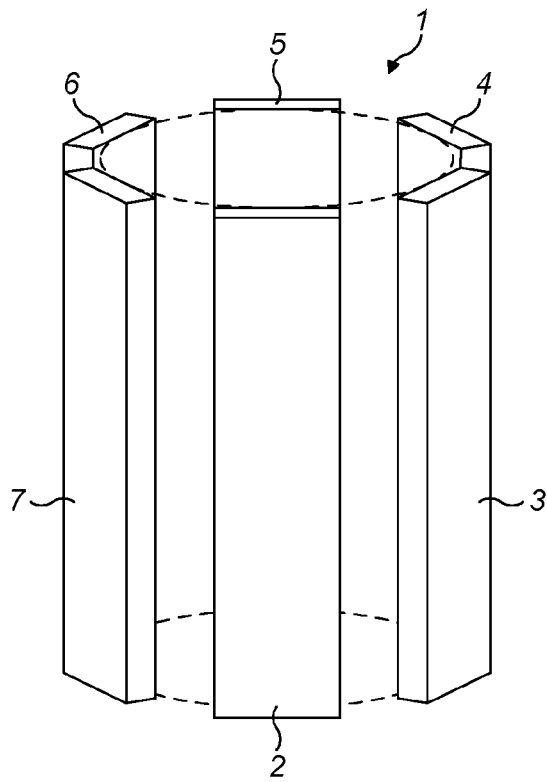


FIG. 1

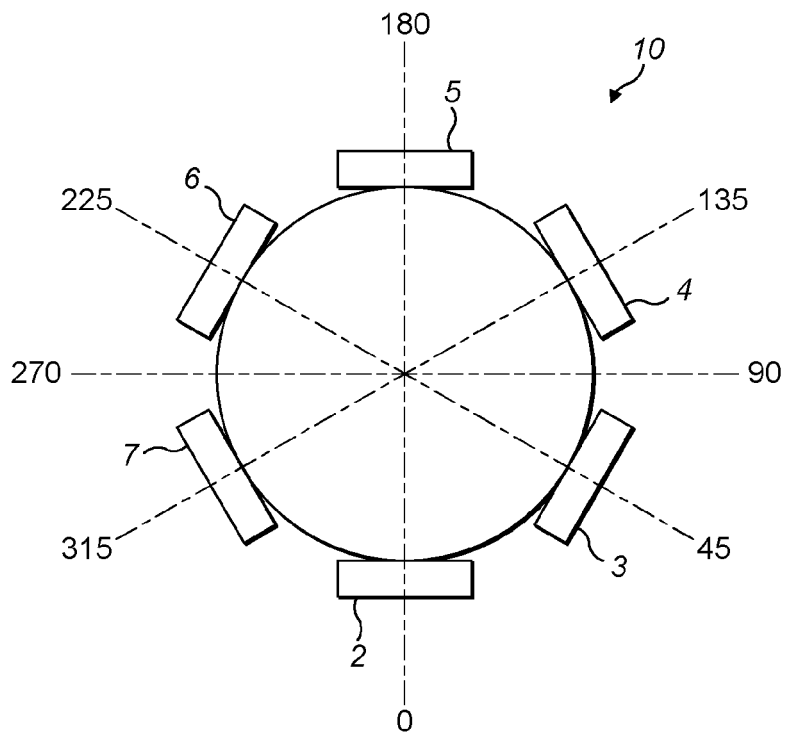


FIG. 2

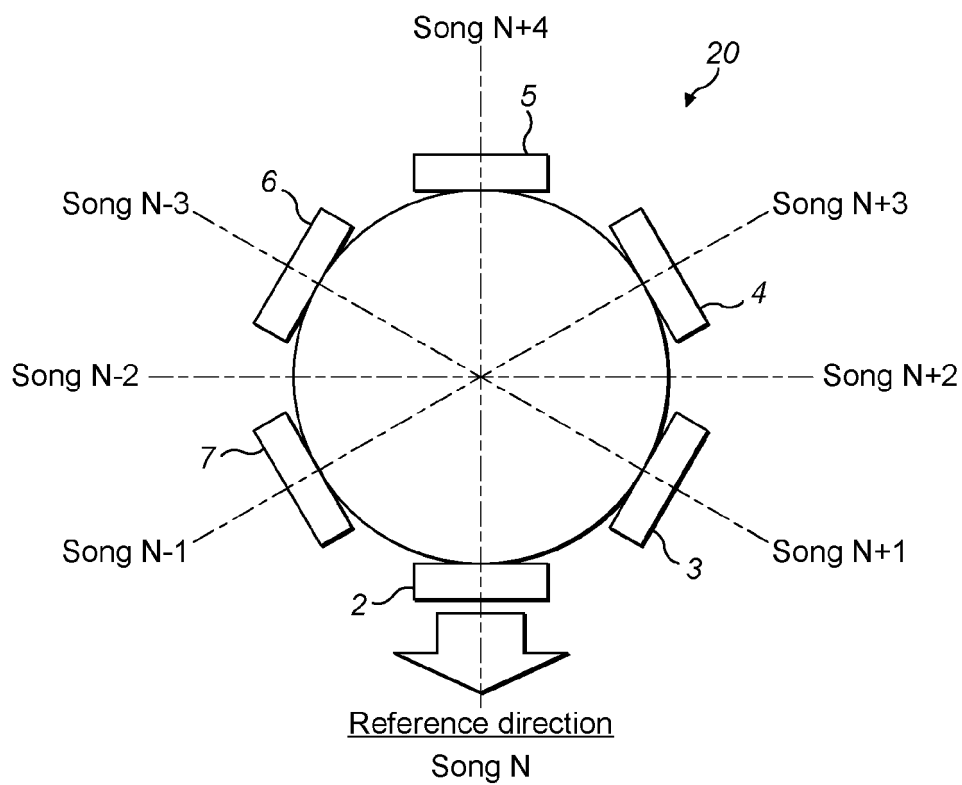


FIG. 3

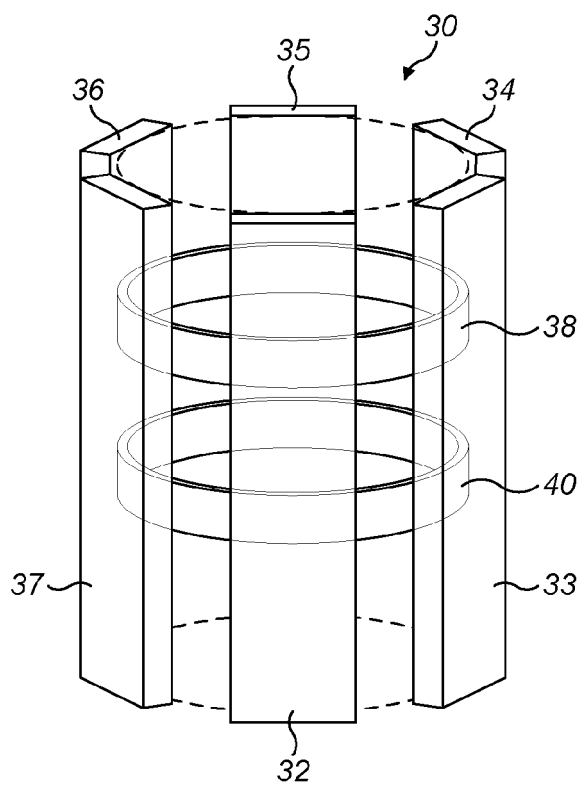
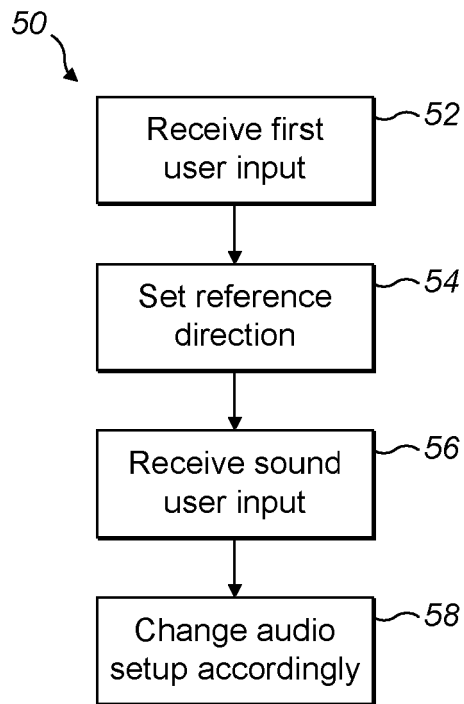
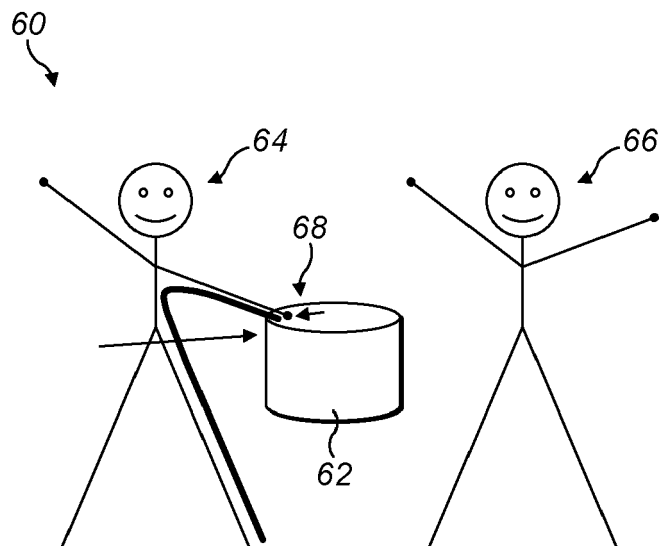


FIG. 4



**FIG. 5**



**FIG. 6**

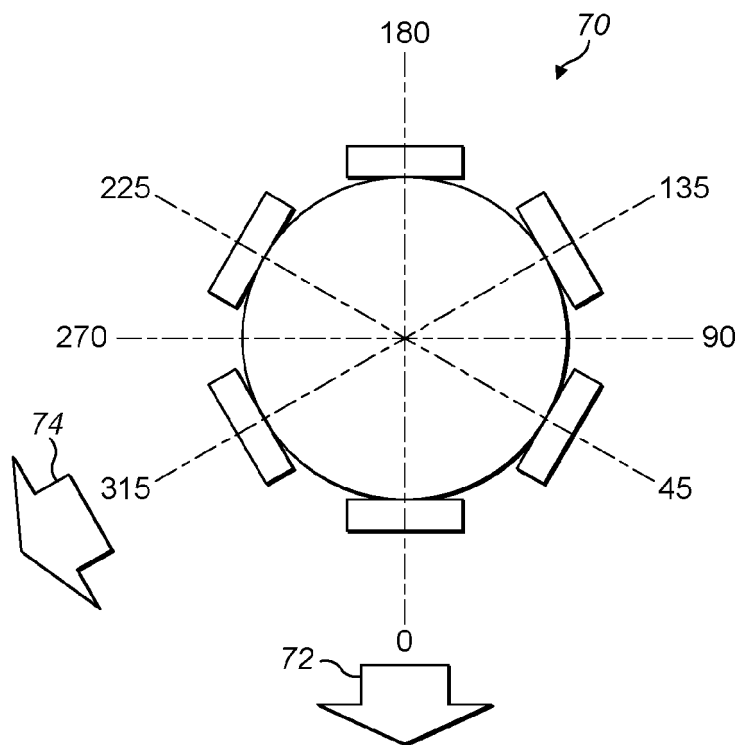


FIG. 7

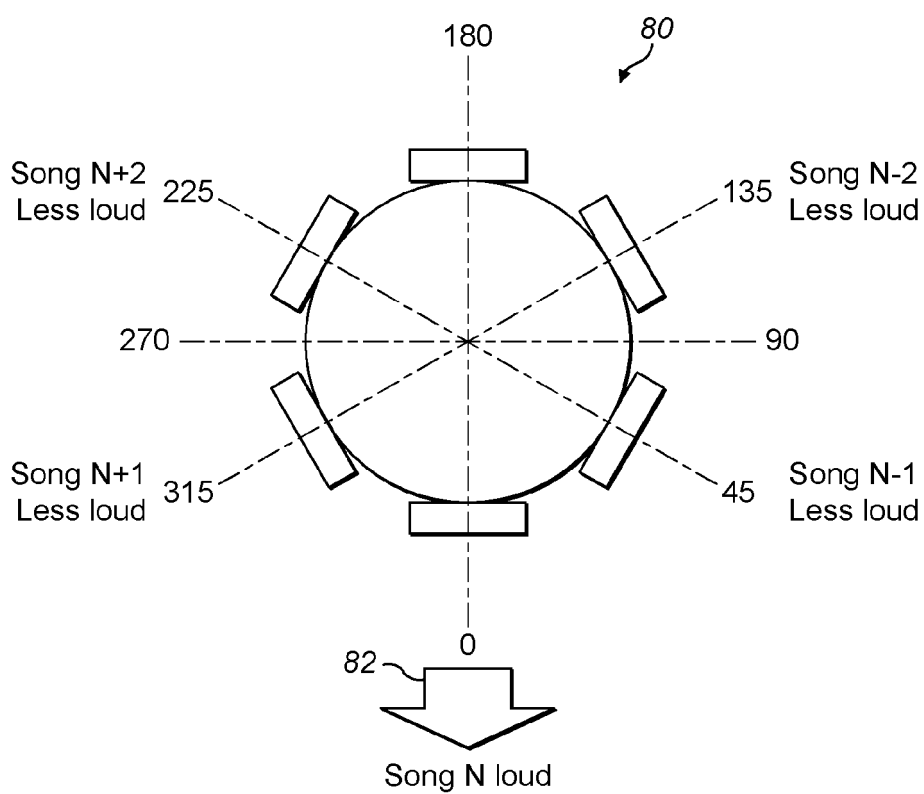
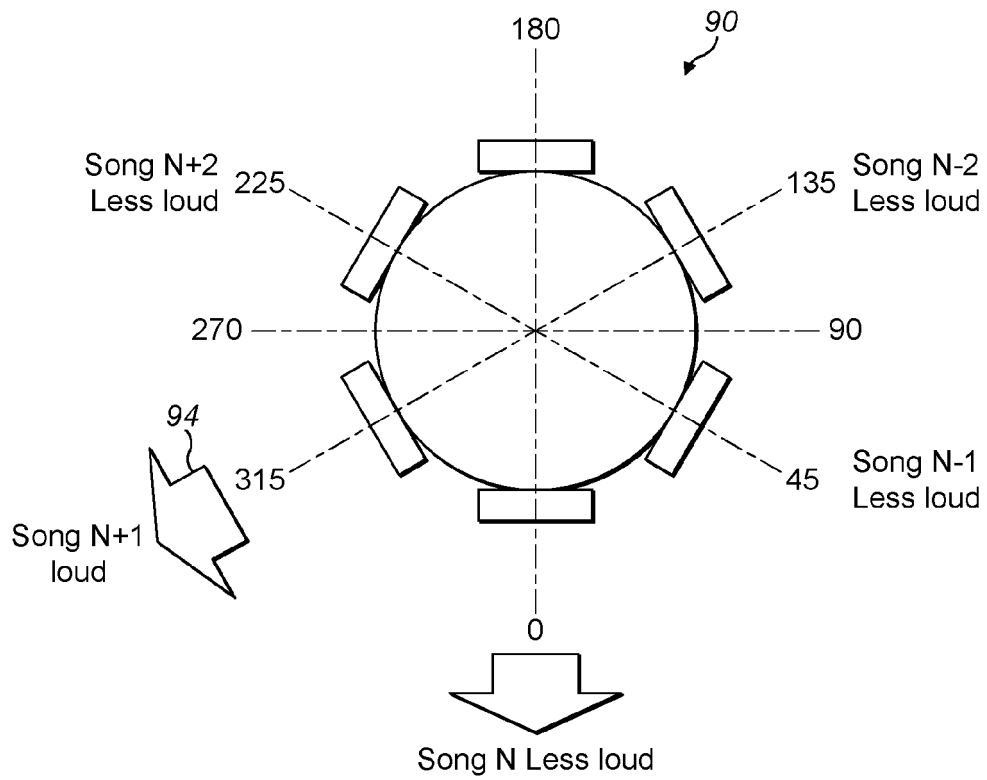
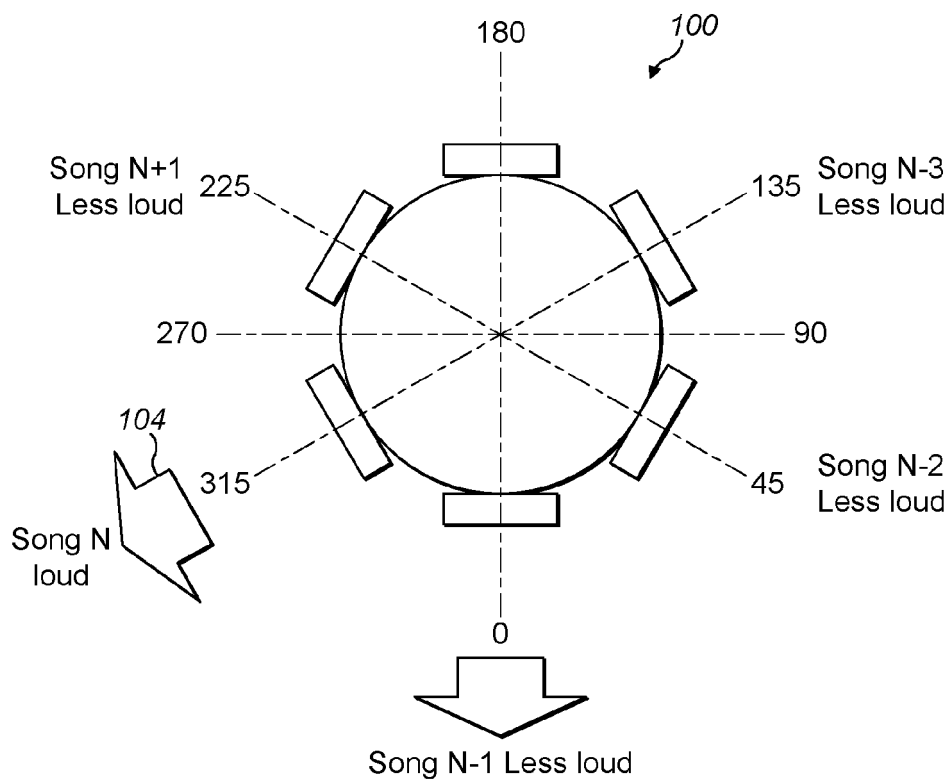


FIG. 8



**FIG. 9**



**FIG. 10**

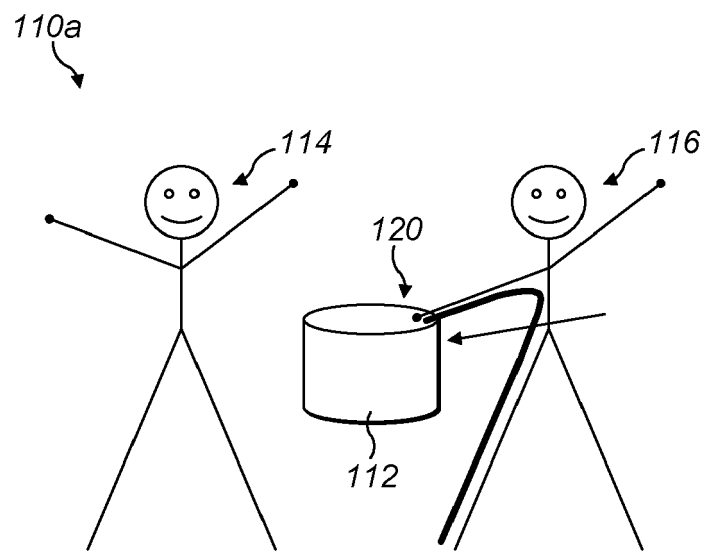


FIG. 11

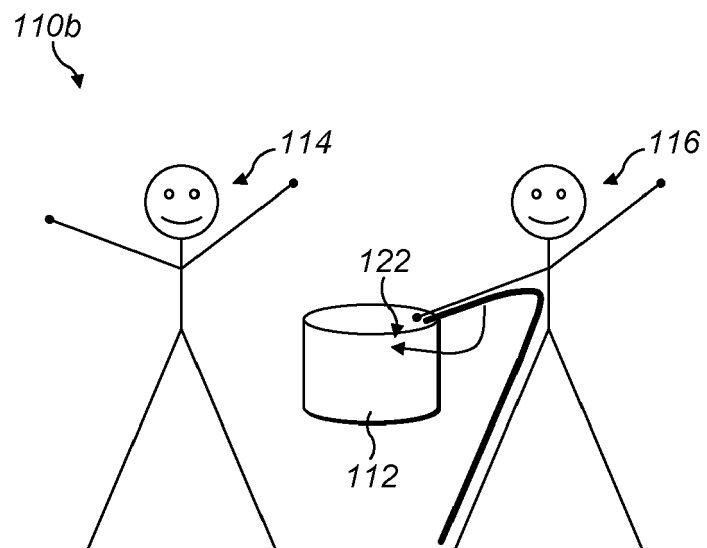


FIG. 12

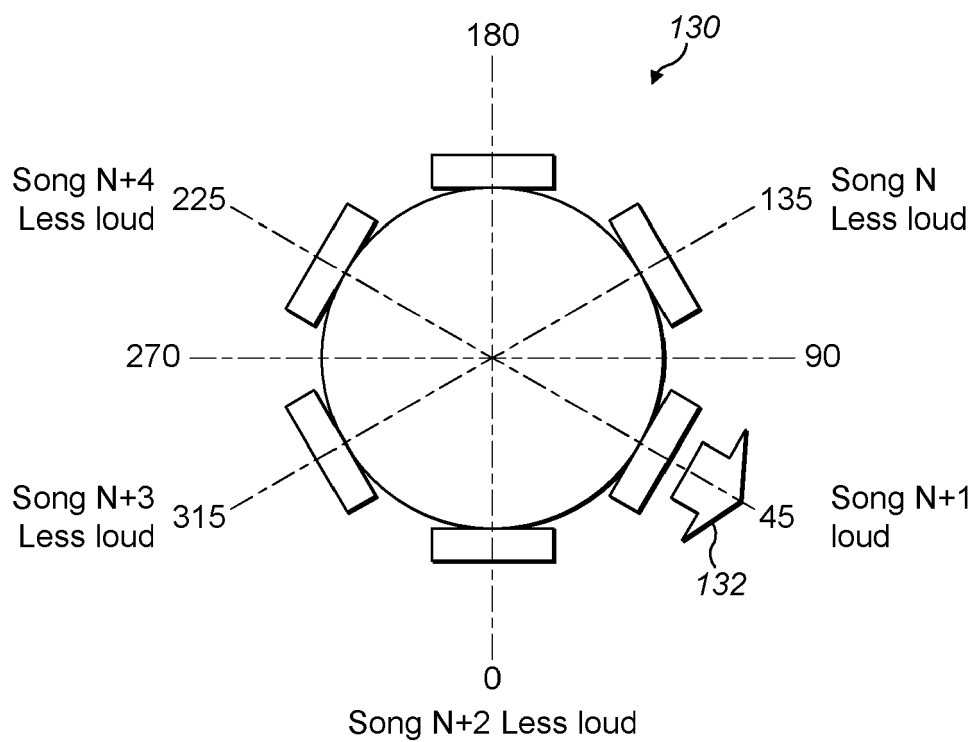


FIG. 13

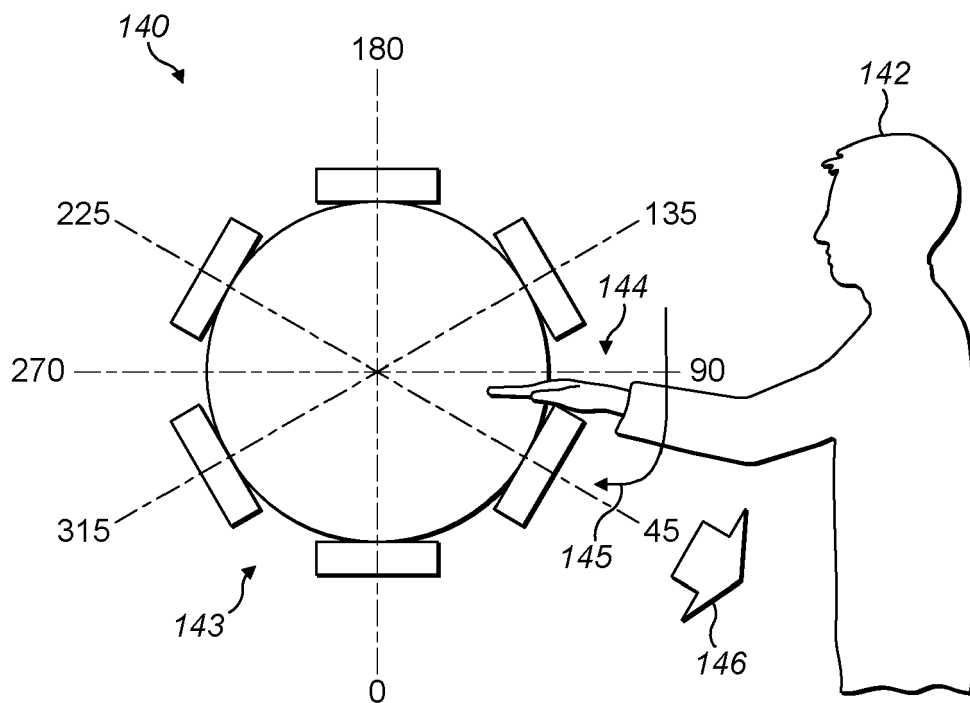
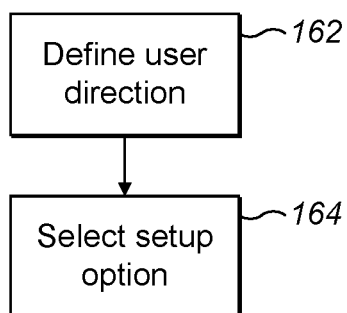


FIG. 14

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| LS rotation $\theta_1$ | LS rotation $\theta_2$ | LS rotation $\theta_3$ | Loudspeaker azimuth | Volume |
|------------------------|------------------------|------------------------|---------------------|--------|
| Song N+2               | Song N+3               | Song N+4               | 135 degrees         | Low    |
| Song N+1               | Song N+2               | Song N+3               | 90 degrees          | Low    |
| Song N                 | Song N+1               | Song N+2               | 45 degrees          | High   |
| Song N-1               | Song N                 | Song N+1               | 0 degrees           | Low    |
| Song N-2               | Song N-1               | Song N                 | 315 degrees         | Low    |

**FIG. 15**160  
**FIG. 16**

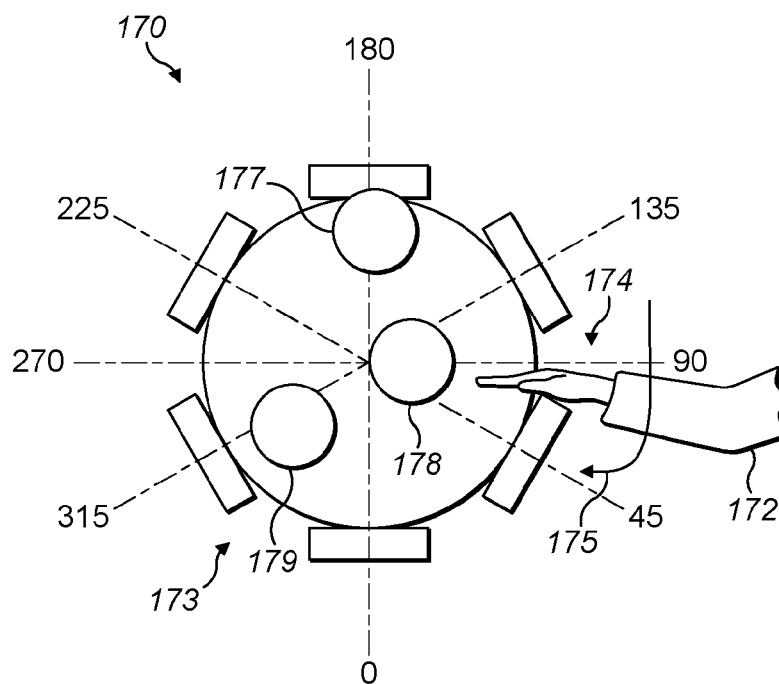


FIG. 17

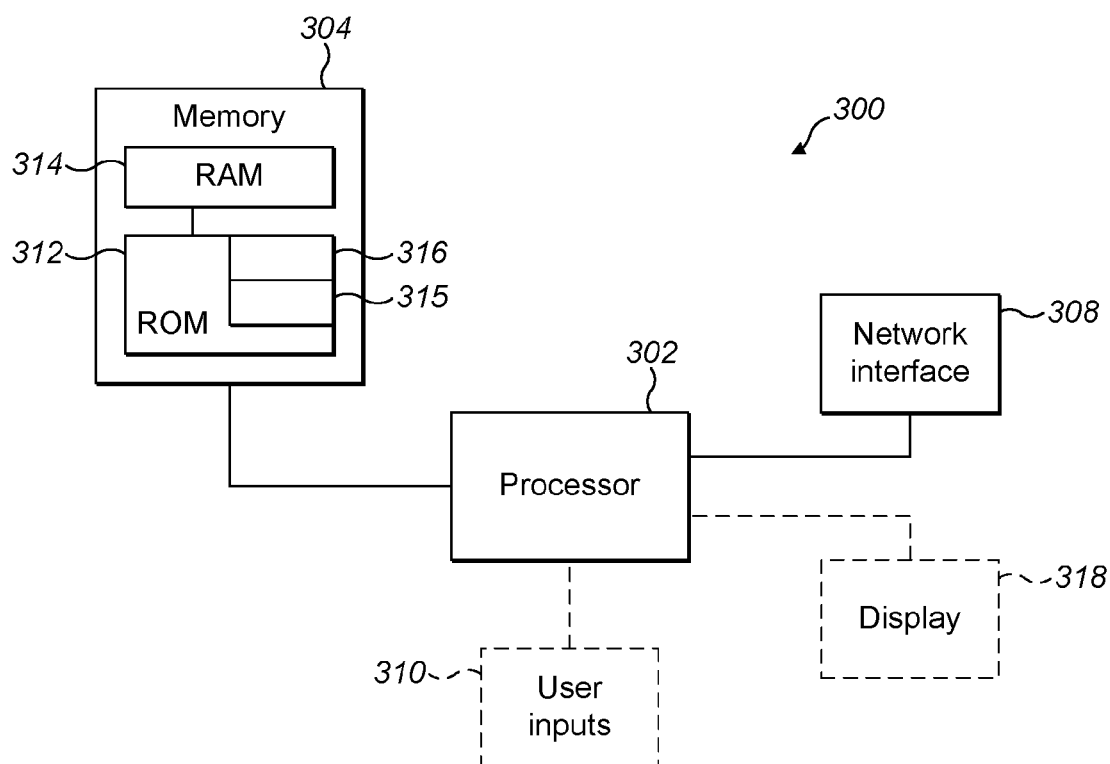
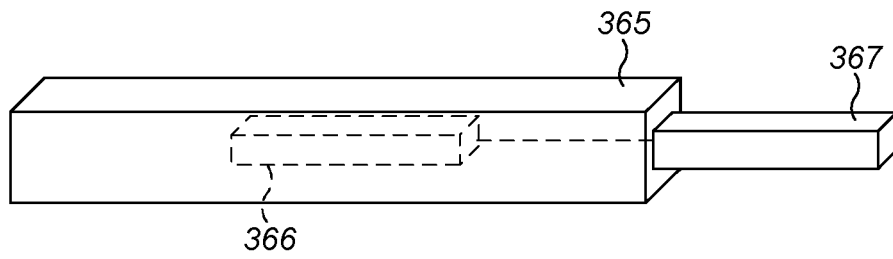
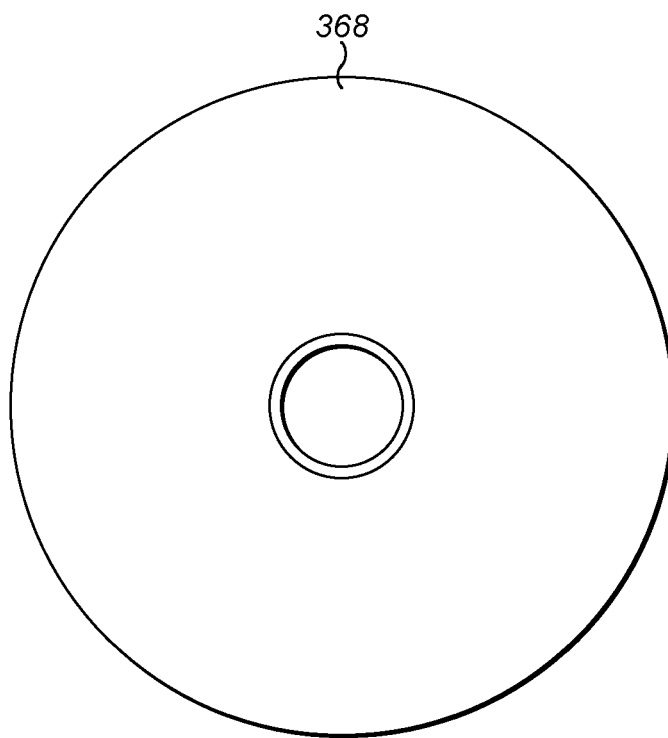


FIG. 18



*FIG. 19a*



*FIG. 19b*



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Application Number  
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| Place of search<br><b>Munich</b>                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                  | Date of completion of the search<br><b>11 January 2019</b>                                                                                                                                                                                                                   | Examiner<br><b>Fülöp, István</b>                     |
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