



EUROPEAN PATENT APPLICATION

(43) Date of publication:
13.07.2022 Bulletin 2022/28

(51) International Patent Classification (IPC):
H04R 1/02 ^(2006.01) **H04R 1/28** ^(2006.01)
H04R 1/34 ^(2006.01)

(21) Application number: **21150638.1**

(52) Cooperative Patent Classification (CPC):
H04R 1/026; H04R 1/2807; H04R 1/345

(22) Date of filing: **08.01.2021**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(72) Inventors:
• **Sagoo, Kiran Pal**
82256 Fürstenfeldbruck (DE)
• **Ellwitz, Tom**
74549 Wolpertshausen (DE)
• **Etzbach, Andrea**
80634 München (DE)
• **Graus Almenar, Javier**
50002 Zaragoza (ES)

(71) Applicant: **BSH Hausgeräte GmbH**
81739 München (DE)

Remarks:
Amended claims in accordance with Rule 137(2) EPC.

(54) **ELECTRONIC DEVICE WITH ONE OR MORE SPEAKER DRIVERS**

(57) An electronic device (100) is described. The electronic device (100) comprises a main body (106) extending along a longitudinal axis which is parallel to a ground (202) that the electronic device (100) is standing on. The main body (106) comprises one or more speaker drivers (108) for rendering an audio signal, wherein the

one or more speaker drivers (108) are at least partially oriented towards the ground (202). The electronic device (100) further comprises one or more feet (105, 111) extending downwards from the main body (106) and configured to hold the main body (106) elevated at an elevation distance (203) from the ground (202).

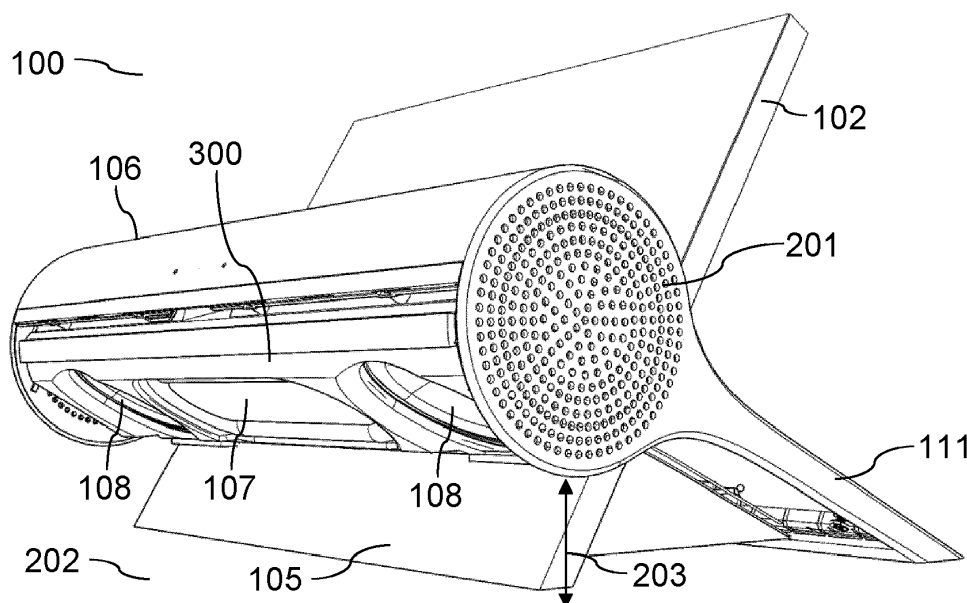


Fig. 2a

Description

[0001] The present document relates to an electronic device, notably to a (smart) docking unit or docking station, which may be used within a household, notably within a kitchen, e.g. to provide support for cooking.

[0002] An electronic device, notably a docking station, may be used within a household, notably within a kitchen, to provide support for a household task, such as cooking, to a user of the electronic device. The user may use the electronic device for playing back an audio signal (e.g., music or audio instructions for a recipe or an answer by a voice assistant). The audio signal can be streamed directly from the internet via Wifi (e.g., voice assistant answer or music streaming) or may be transmitted via Bluetooth from a smart device, notably a smartphone or a tablet PC, to the smart electronic device.

[0003] The present document addresses the technical problem of increasing the comfort of use of an electronic device such as a docking station, notably with respect to the quality and intelligibility of audio signals that are played back by the docking station. The technical problem is solved by the independent claim. Preferred examples are described in the dependent claims.

[0004] According to an aspect, an electronic device, notably a docking station for a handheld user device (e.g., for a smartphone or for a tablet PC), is described. The electronic device may be designed to be placed on a table or a worktop within a kitchen. Furthermore, the electronic device, notably the docking station, may be configured to hold a DIN A4 or DIN A5 sized user device (e.g., with a display size of up to 11 inches or 12 inches).

[0005] As a standalone device, the electronic device may act as a smart speaker. In combination with a smart user device (e.g., a smartphone or tablet PC), the electronic device may be used as a Bluetooth speaker. By placing a smart user device in the holder of the electronic device, the electronic device may act as a smart display device.

[0006] The electronic device, notably the docking station, may e.g. be configured to communicate with a user device which is placed into a holder of the electronic device, notably for rendering an audio signal provided by the user device and/or provided from an internet streaming platform. The audio signal may be rendered using one or more (loud-) speakers or speaker drivers of the electronic device.

[0007] In particular, the electronic device, notably the docking station, may comprise a control unit which is configured to determine whether or not a user device has been placed in conjunction with, notably into (the holder of), the electronic device. For this purpose, the electronic device may comprise one or more presence sensors (e.g. a weight sensor) which are configured to detect the presence of a user device, notably the presence of a user device in a holder, such as a back support, of the electronic device.

[0008] The control unit of the electronic device may be configured to automatically establish a communication link with the user device, if it is determined that the user device has been placed in conjunction with, notably into the holder of, the electronic device. By way of example, a wireless communication link, such as a Bluetooth link, may be established between the electronic device and the user device.

[0009] Furthermore, the control unit may be configured to receive an audio signal from the user device via the communication link and/or from an internet streaming platform, and to cause one or more speaker drivers of the electronic device to render the audio signal that has been received from the user device and/or from the internet streaming platform. Hence, the electronic device may be configured to enable a comfortable interaction of a user with a user device or with an internet streaming platform.

[0010] The electronic device comprises a main body, wherein the main body may exhibit a (circular) cylindrical form. The main body may exhibit a longitudinal axis which may be oriented in parallel to the ground (e.g., the worktop) onto which the electronic device is placed. The main body may e.g. have a diameter between 4cm and 8cm. Furthermore, the main body may e.g. have a length along the longitudinal axis between 10cm and 25cm.

[0011] In addition, the electronic device comprises one or more feet extending downwards from the main body and enabling the main body to be placed on a ground (e.g., a worktop). The one or more feet may extend along the longitudinal axis of the main body (e.g., from one end to the other end of the main body). The electronic device may exhibit a front foot at a front side of the electronic device (facing the user of the electronic device, when the user is using the electronic device). Alternatively, or in addition, the electronic device may exhibit a rear foot (at the rear side of the electronic device). By providing one or more feet, the electronic device may be placed on a ground in a stable manner.

[0012] The one or more feet may be configured to hold the main body elevated at an elevation distance from the ground. The elevation distance may e.g. be between 1cm and 15cm. By positioning the main body (which comprises one or more speaker drivers) at a certain elevation distance from the ground, an electronic device having a high audio quality and intelligibility may be provided.

[0013] As indicated above, the (elevated) main body comprises one or more (active or passive) speaker drivers for rendering an audio signal. The one or more speaker drivers are preferably oriented at least partially towards the ground. In particular, the one or more speaker drivers may be arranged such that a main emission direction of an audio signal that is emitted by the one or more speaker drivers is oriented towards the ground. By way of example, the main emission direction may form an angle with ground having a magnitude which is greater than 0°, notably greater than 20°.

[0014] By providing an electronic device having an elevated main body with one or more speaker drivers that are oriented towards the ground that the electronic device is standing on, the quality and the intelligibility of emitted audio signals may be increased, thereby increasing the comfort of use of the electronic device.

[0015] In addition, the electronic device typically comprises a holder, notably a back support, extending upwards from the main body and enabling a user device to be placed in conjunction with and/or into the electronic device. The holder may exhibit an angle between 45° and 75° relative to the ground that the electronic device is standing on. The holder may form a flat backplane which is at least partially in contact with the backside of a (flat) user device that is placed into the electronic device. In other words, the holder, notably the back support, may hold a user device from the back.

[0016] The electronic device may be designed such that the holder can be detached from the main body or attached to the main body by a user of the electronic device (e.g., using one or two hands). In particular, detaching and/or attaching may be performed without using a tool. As a result of this, a particularly comfortable electronic device may be provided.

[0017] The main body may comprise one or more active speaker drivers and/or one or more passive acoustic radiators, which are arranged side by side along the longitudinal axis within the main body. The one or more active speaker drivers and/or the one or more passive acoustic radiators may each be oriented towards the ground that the electronic device is standing on. In particular, the main body may comprise one or more active speaker drivers and a passive acoustic radiator, which are arranged side by side along the longitudinal axis. When providing more than one active speaker driver, stereo sound may be output. The main body may e.g. comprise a passive acoustic radiator with one active speaker driver at each side of the passive acoustic radiator. Alternatively, or in addition, a passive acoustic radiator may be played at a, notably at each, face side of the cylindrical main body. By making use of at least one passive acoustic radiator in conjunction with one or more active speaker drivers, the audio quality of the electronic device may be increased further (notably in the low frequency range).

[0018] The one or more speaker drivers of the main body may each comprise a membrane which is configured to generate an acoustic wave (for an audio signal that is being rendered). The plane of the membrane of a speaker driver may form an orientation angle with the ground that the electronic device is standing on. The magnitude of the orientation angle is preferably 45° or smaller, notably 35° or smaller. Furthermore, the magnitude of the orientation angle may be 10° or more. By arranging the one or more speaker drivers in such a manner, a particularly high audio quality and intelligibility may be achieved (notably by reflecting (higher frequency) sound waves towards the user of the electronic device).

[0019] The one or more speaker drivers of the main body may be configured to emit an acoustic wave such that the acoustic wave is reflected by the ground before reaching a user of the electronic device, who is facing the (front side of the) electronic device. In particular, the one or more speaker drivers may be oriented such that 50% or more of the acoustic waves that are (and/or 50% or more of the acoustic energy that is) emitted by the one or more speaker drivers of the main body are reflected by the ground before reaching a user of the electronic device, who is facing the (front side of the) electronic device. By rendering an audio signal in an indirect manner using reflections, the audio quality and intelligibility may be increased further.

[0020] As indicated above, the holder may form a certain angle with respect to the ground that the electronic device is standing on. In particular, the holder may form a support plane that exhibits a support angle, notably a support angle between 45° and 70°, with respect to the ground. The main emission direction of the one or more speaker drivers of the main body may be substantially parallel to the support plane, notably with a maximum deviation of $\pm 5^\circ$, wherein the main emission direction of a speaker driver may be the average direction of the acoustic waves that are emitted by the (membrane of the) speaker driver. By rendering the audio signal in an aligned manner with the back plane, the audio quality and intelligibility may be increased further.

[0021] The front foot of the electronic device, which extends downwards from the main body at the front side of the electronic device, may be aligned with the holder and/or with the support plane, which extends upwards from the main body at the rear side of the electronic device. In particular, the front foot may form the same angle with ground as the support angle of the holder. Furthermore, the front foot may form a plate having a width along the longitudinal axis, which is equal to the width of the holder. Hence, the front foot may form an extension of the holder towards the ground.

[0022] The main body and the one or more speaker drivers of the main body may be positioned between a user facing the front side of the electronic device and the front foot of the electronic device. Hence, rendering of the audio signal may be performed into a room which is blocked at the rear side by the front foot of the electronic device. By doing this, a particularly high audio quality and intelligibility may be achieved.

[0023] The main body may enclose a main acoustic chamber, notably a hollow acoustic chamber and/or an acoustic chamber having a cylindrical shape. The one or more speaker drivers may be positioned within the main acoustic chamber. By providing a cylindrical acoustic chamber within the main body, the audio quality and intelligibility of the electronic device may be further increased.

[0024] The active speaker drivers may exhibit different sizes (e.g., a tweeter with a relatively small size and a midrange speaker with a relatively large size). The main body may comprise a (dedicated) acoustic volume for each active speaker driver, wherein the size of the acoustic volume may be adapted to the size of the active speaker driver. The passive

radiator of the electronic device may be placed within the acoustic volume of the relatively large active speaker driver.

[0025] The electronic device may exhibit an extension of the main acoustic chamber, which extends beyond the main body. In particular, the extension of the main acoustic chamber may extend into the housing of the electronic device, which may be arranged between the rear foot (notably the rear foot plate) and the front foot (notably the front foot plate) of the electronic device. By providing an extension of the main acoustic chamber, the audio quality may be improved further. In addition, the wall of the extension of the main acoustic chamber may be used for increasing the mechanical stability of the electronic device.

[0026] The main body may comprise an opening, notably a lattice or a grill of openings, at one or more end faces of the cylindrical main body, to allow acoustic waves to exit the main acoustic chamber along the longitudinal axis. Furthermore, the electronic device may comprise a passive radiator at the one or more end faces of the cylindrical main acoustic chamber. The ratio between holes and structural material may be between 20% and 80%. As a result of this, the audio quality of the electronic device may be increased.

[0027] The electronic device may comprise one or more microphones which are each configured to capture a microphone signal. The control unit may be configured to analyze the microphone signals of the one or more microphones, e.g. in order to enable a speech or voice control of the electronic device.

[0028] The one or more microphones may be located at or in the main body of the electronic device. The one or more microphones may be oriented away from the ground that the electronic device is standing on. In particular, the main capturing direction of the one or more microphones may be oriented away from the ground (and away from the main emission direction of the one or more speaker drivers of the electronic device). By way of example, the main capturing direction and the main emission direction may form an angle with a magnitude greater than 90°, notably greater than 150°.

[0029] By providing one or more microphones which are oriented away from the one or more speaker drivers of the main body, the degree of interference of an audio signal which is rendered by the one or more speaker drivers with the one or more microphones may be reduced, thereby increasing the reliability for voice control of the electronic device.

[0030] It should be noted that the methods and systems including its preferred embodiments as outlined in the present document may be used stand-alone or in combination with the other methods and systems disclosed in this document. In addition, the features outlined in the context of a system are also applicable to a corresponding method. Furthermore, all aspects of the methods and systems outlined in the present document may be arbitrarily combined. In particular, the features of the claims may be combined with one another in an arbitrary manner.

[0031] The invention is explained below in an exemplary manner with reference to the accompanying drawings, wherein

Figure 1a	shows a (smart) docking station as an example for an electronic device in a perspective view;
Figure 1b	shows an example docking station in a side view;
Figures 2a to 2e	illustrate an example docking station with a speaker chamber including two active speaker drivers in different views;
Figures 3a and 3b	show an example docking station with a speaker chamber including one active speaker; and
Figures 4a to 4c	illustrates an example acoustic chamber for two active drivers and one passive radiator for a docking station.

[0032] As outlined above, the present document is directed at increasing the comfort of use (in particular with regards to the sound quality) of an electronic device, notably of a docking station. In the following, an example docking station is described, which may be configured to be coupled to a user device, such as a smartphone or tablet PC. It should be noted that the aspects which are outlined in the present document are applicable to an electronic device in general.

[0033] Figs. 1a and 1b show an example docking station 100. The (smart) docking station 100 comprises a main body 106, which may have a cylindrical form as illustrated in Fig. 1a. The main body 106 may comprise one or more electronic components such as a control unit 120, e.g. a microcontroller, of the docking station 100. Furthermore, the main body 106 may comprise a control panel 103 with one or more control elements, notably control buttons. The control panel 103 may enable a user to interact with the docking station 100, e.g. for speaker volume control or for quick touch interaction with the voice assistant (stop listening, start listening).

[0034] Alternatively, or in addition to a control panel 103, the docking station 100 may comprise a gesture sensor 104 (located e.g. on the main body 106), which is configured to sense gesture data regarding a (hand) gesture performed by a user of the docking station 100. The docking station 100 may be controlled in dependence of the gesture data. In addition, the docking station 100 may comprise one or more light elements 110, notably light emitting diodes (LED), e.g. for providing status information regarding the status of the docking station 100 to a user of the docking station 100.

[0035] The main body 106 may further comprise one or more active speaker drivers (which are also referred to herein as loudspeakers) 108 which are configured to emit an audio signal. The one or more loudspeakers 108 may be located at a face side and/or at a shell surface of the (cylindrical) main body 106 or of the (cylindrical) acoustic chamber comprised within the main body 106. The main body 106 may act as and/or may enclose an acoustic chamber for improving the sound quality of the one or more loudspeakers 108. In addition, the docking station 100 may comprise one or more

(passive) acoustic radiators 107 on the (cylindrical) surface of the main body 106 and/or at the one or more face sides of the main body 106.

[0036] The docking station 100 may comprise one or more base feet 105, 111, notably a base foot 105 at a front side facing the user and/or a rear foot 111 at a rear side of the docking station 100. The one or more base feet 105, 111 may be attached to the main body 106, and may extend from the main body 106 towards the ground, onto which the docking station 100 is placed. The one or more base feet 105, 111 may extend along the longitudinal axis of the (cylindrical) main body 106. In particular, the feet 105, 111 may have the form of a plate. As such the feet 105, 111 may be referred to herein as foot plates.

[0037] The one or more base feet 105, 111 may each comprise an isolator element 109, e.g. comprising silicone, at the end of the respective foot 105, 111, which is in contact with the ground that the docking station 100 is placed on. The use of an isolator element 109 allows the docking station 100 to be placed in a stable manner, preventing it from sliding over the surface 202 that the docking station 100 is placed on (notably in case of touch interaction with the docking station 100 and/or when audio is played back). Furthermore, the docking station 100 may be isolated against (acoustic) vibrations.

[0038] In addition, the docking station 100 may comprise a holder, notably a back support, 102 which extends from the main body 106 upwards (i.e. away from the ground that the docking station 100 is placed on). The back support 102 may exhibit an angle with regards to the ground between 45° and 75°, when the docking station 100 is placed on the ground. The back support 102 may be designed as a support for a typical tablet PC (e.g. with a screen size between 8 inches and 13 inches), also being able to support smaller devices such as phones starting at 5 inches. The back support 102 may extend along the longitudinal axis of the main body 106 (from one face to the other face of the main body 106).

[0039] The back support 102 may exhibit one or more isolator stripes 101 which may extend horizontally across the back support 102, or may have at least two support pads. Furthermore, the back support 102 may comprise an isolator section 112 at the top end of the back support 102. The use of isolator stripes 101 and/or of an isolator section 112 allows an object, such as a tablet PC, to be placed onto the back support 102 in a stable manner. Furthermore, isolation of acoustic vibrations may be provided.

[0040] In addition, the docking station 100 may comprise a base support 124, as shown in Fig. 1b, which is located at the contact point between the main body 106 and the back support 102. The base support 124 may form a gap within which the lower edge of a user device, notably of a tablet PC, may be placed, in order to hold the user device in a stable manner on the back support 102. The base support 124 may comprise an isolating material, in order to allow vibrations of the docking station 100 (e.g. due to rendering of an audio signal via a loudspeaker 108 of the docking station 100) to be isolated. Alternatively, or in addition, the base support 124 may comprise one or more presence sensors (e.g. weight sensors) for detecting the presence of a user device on the back support 102.

[0041] Figure 1b shows a side view of the docking station 100. The docking station 100 may comprise a housing 121 for one or more electronic components (e.g. for the control unit 120). The housing 121 may be located between the front foot 105 and the rear foot 111 of the docking station 100. Furthermore, the docking station 100 may comprise a data and/or power interface 122 (e.g. a USB interface) for data communication and/or for power supply (e.g. at the housing 121). In addition, the docking station 100 may comprise a section 123 for placing a power cord for a power supply of the docking station 100.

[0042] As outlined above, the docking station 100, notably the main body 106 of the docking station 100, may comprise one or more active speaker drivers 108 and/or one or more passive radiators 107. As illustrated in a first example of the docking station 100 in Figures 2a to 2e and in a second example of the docking station 100 in Figures 3a and 3b, the docking station 100 may comprise one or more speaker drivers 108 and/or radiators 107, which are facing the ground 202 that the docking station 100 is standing on.

[0043] As shown in Fig. 2a, the main body 106 of the docking station 100 is held by the one or more feet 105, 111 of the docking station 100 at a certain elevation distance 203 from the ground 202. The elevation distance 203 between the main body 106 and the ground 202 may e.g. be 2cm or more (e.g. between 2cm and 7cm). The one or more speakers 108 and/or radiators 107 may be placed within the acoustic chamber that is located within the main body 106 such that the one or more speakers 108 and/or radiators 107, notably the membrane of the one or more speakers 108 and/or radiators 107, is at least partially facing the ground 202.

[0044] As a result of this, the one or more speakers 108 and/or radiators 107 emit acoustic waves 210 towards the ground 202 that the docking station 100 is standing on. These acoustic waves 210 are reflected by the ground 202, as illustrated in Fig. 2c, thereby increasing the quality and the intelligibility of the acoustic signals that are rendered by the docking station 100 in the direction of the user.

[0045] Furthermore, the main body 106 may comprise openings 201 (notably a grid or lattice of openings 201) at one face or at both faces of the (cylindrical) main body 106. The openings 201 may be configured to allow acoustic waves 210 to exit the acoustic chamber which is enclosed within the main body 106 (as illustrated in Fig. 2c) along the longitudinal axis of the main body 106.

[0046] Fig. 2d shows an example spread angle 220 of a speaker 108 of the docking station 100. The spread angle

220 indicates the spread of acoustic waves 210 that are emitted by the speaker 108. The spread angle 220 is preferably 100°, notably 120°, or higher.

[0047] Fig. 2e shows an example orientation of a speaker 108 and/or radiator 107, relative to (a horizontal) ground 202. In particular, Fig. 2e illustrates an example orientation angle 230 between the plane of the membrane of the speaker 108 and/or radiator 107 and the ground plane. The orientation angle 230 is preferably in the range between 20° and 45°, notably between 25° and 35°. The use of such orientation angles 230 allows rendering of audio signals with particularly high quality and intelligibility (which are directed at the user).

[0048] Figs. 2a to 2e illustrate an example docking station 100 that comprises a speaker chamber with two active speaker drivers 108 and a passive radiator 107 between them. Figs. 3a and 3b illustrate an example docking station 100 that comprises an active speaker driver 108 and a passive radiator 107.

[0049] Figures 4a to 4c show an example (main) acoustic chamber 300 of the main body 106 of the docking station 100. The main acoustic chamber 300 has a cylindrical shape with openings 307, 308 for placing one or more passive radiators 107 and/or one or more active speaker drivers 108. Furthermore, the acoustic chamber 300 may comprise one or more openings 301 at one or more faces of the chamber 300, for allowing acoustic waves 210 to exit the acoustic chamber 300 via the one or more faces of the chamber 300. The main acoustic chamber 300 may form a hollow (cylindrical) room within which acoustic waves 210 may propagate and reflect and excite the passive radiator 107 prior to exiting the acoustic chamber 300, thereby further improving the quality and intelligibility of an audio signal that is rendered by the docking station 100 (notably in the low frequency range).

[0050] The main acoustic chamber 300 may be extended using one or more extensions 310 that extend out from the cylindrical chamber 300. An extension 310 may e.g. extend into the housing 121 of the docking station 100, which is placed below the main body 106, between the front foot 105 and the rear foot 111 (as shown in Fig. 1b). The extension 310 may comprise a hollow room that is coupled with the hollow room of the main acoustic chamber 300 within the cylindrical main body 106, thereby increasing the overall volume of the acoustic chamber 300, 310 of the docking station 100. The quality and intelligibility of an audio signal that is rendered by the docking station 100 may be further improved may making use of an acoustic chamber 300, 310 that comprises one or more extension units 310. This extension may also be used to increase the internal stability of the docking station 100.

[0051] Hence, a smart docking station 100 is described. The smart docking station 100 may be configured to be operated as a standalone (smart) speaker (without the use of a docked user device). When a user places a user device onto the docking station 100, an automatic docking may be performed, thereby increasing the functionality of the docking station 100 with the additional display of the user device and/or with the audio signals stored on the user device.

[0052] The docking station 100 may be configured to render audio signals (in a standalone mode or in a docked mode (when being coupled with a user device)). The acoustic configurations which are described in the present document allow for the rendering of high quality and highly intelligible audio signals.

[0053] The docking station 100 comprises a cylindrical main body 106 and a cylindrical main speaker chamber 300, which exhibit a horizontal orientation (along the longitudinal axis). The main body 106 and the main speaker chamber 300 are raised with respect to ground 202, thereby forming a gap between the main body 106 and ground 202. This gap may be used for emitting acoustic waves 210 from the main body 106, which are reflected on the ground 202.

[0054] The docking station 100 may comprise one or more microphones (not shown), e.g. at the main body 106, which are configured to capture acoustic microphone signals, notably speech signals, e.g. in order to enable speech control of the docking station 100. The docking station 100, notably a control unit 120 of the docking station 100, may be configured to separate an audio signal that has been emitted by the docking station 100 from an acoustic microphone signal that has been captured by the one or more microphones of the docking station 100, thereby enabling a reliable speech control, even when rendering an audio signal. The one or more microphones may be oriented away from the one or more speakers 108 and/or the one or more radiators 107, for enabling a particularly reliable separation of an emitted audio signal from a captured microphone signal.

[0055] As illustrated in Figs. 2a to 2e, two active speakers 108 and a passive radiator 107 may be aligned at a certain orientation angle 230 (e.g., substantially corresponding to the 8 o'clock angle on an analog clock) to provide high quality audio rendering (notably with regards to the rendering of a boosted bass). In a second configuration (shown in Figs. 3a and 3b), the docking station 100 may comprise one relatively big active speaker 108 and one relatively big passive radiator 107, which may be aligned in a similar manner. Furthermore, the audio quality may be improved by extending the main acoustic chamber 300 using one or more extensions 310 of the cylindrical main chamber.

[0056] The docking station 100 described in the present document comprises a horizontally placed cylindrical main acoustic chamber 300, with one or more active speakers 108 and/or passive radiators 107 being placed within the main acoustic chamber 300. The cylindrical main acoustic chamber 300 comprises one or more through holes 307, 308, wherein the one or more holes 307, 308 may start from the bottom of the main acoustic chamber 300 from where the one or more speakers 108 and/or radiators 107 may be placed inside the chamber 300. The one or more through holes 307, 308 may each exhibit a specific opening ratio or aperture 220, which may depend on the output power of the speaker 108 or radiator 107 that is to be placed within the respective hole 307, 308.

[0057] The main acoustic chamber 300 and/or the main body 106 may exhibit side grills 201 on one or more both faces, thereby providing a holistic sound experience. The acoustic chamber 300 may stretch to and may be connected to the back foot 111 of the docking station 100, thereby forming an elongated tear drop shape. Furthermore, the main body 106 may exhibit one or more grills facing the one or more speaker drivers 107, 108.

[0058] Providing an orientation of the one or more speakers 108 and/or radiators 107, which is facing the ground 202, notably using an 8 o'clock position or orientation of the one or more speakers 108 and/or radiators 107, leads to acoustic waves 210 being reflected on the ground 202 (e.g., on the table that the docking station 100 is placed upon), and to an improved acoustic quality. Furthermore, it allows an improved separation of acoustic microphone signals that are captured by one or more microphones of the docking station 100 and audio signals that are rendered by the docking station 100, thereby enabling a reliable speech control of the docking station 100.

[0059] The one or more speakers 108 and the one or more radiators 107 may be aligned with respect to one another. The one or more speakers 108 and the one or more radiators 107 may emit acoustic waves 210 towards the ground 202. On the other hand, the one or more microphones may be oriented in an upward direction. The magnitude of the angle between rendering (by the one or more speakers 108 and/or radiators 107) and capturing (by the one or more microphones) may be between 90° and 180°, for enabling a reliable separation of speech commands.

[0060] The main body 106 may comprise two active speaker drivers 108 which are partially oriented outwards along the longitudinal axis, one to the first side and a second to the opposite side. By doing this, the distance between the spots where the sound is reflected may be widened, thereby increasing the impression of stereo sound.

[0061] The opening angle 220 of the one or more speakers 108 and/or radiators 107 may be 120° or more, thereby improving the diffraction and reflection of sound, while at the same time reducing negative reflection.

[0062] The overall acoustic performance of the docking station 100 may be improved by utilizing space at the back of the cylindrical main acoustic chamber 300 as additional acoustic volume, i.e. as an extension 310 of the main acoustic chamber 300.

[0063] The docking station 100 may comprise one or more passive radiator(s) 107 at a side or face of the cylindrical acoustic chamber 300. The one or more active speakers 108 of the docking station 100 may comprise a woofer and/or a tweeter (In this case the acoustic volume in the sound chamber may be divided into two or more acoustic volumes).

[0064] Hence, a docking station 100 is described which allows for an improved audio quality using a relatively small footprint. Furthermore, a suitable sound setup is described to simultaneously use one or more microphones for speech interaction and to allow a user to render audio signals from a user device being placed on the holder 102 without compromising the sound quality. The back of the sound chamber 300, which may be used as an extension 310 of the chamber 300, may also be used to provide a mechanical stabilization of the docking station 100, e.g. by providing a firm attachment of the outer housing 121 and the back support 102.

[0065] It should be noted that the description and drawings merely illustrate the principles of the proposed methods and systems. Those skilled in the art will be able to implement various arrangements that, although not explicitly described or shown herein, embody the principles of the invention and are included within its spirit and scope. Furthermore, all examples and embodiment outlined in the present document are principally intended expressly to be only for explanatory purposes to help the reader in understanding the principles of the proposed methods and systems. Furthermore, all statements herein providing principles, aspects, and embodiments of the invention, as well as specific examples thereof, are intended to encompass equivalents thereof.

Claims

1. An electronic device (100), the electronic device (100) comprising

- a main body (106) extending along a longitudinal axis which is parallel to a ground (202) that the electronic device (100) is standing on; wherein the main body (106) comprises a main acoustic chamber (300) with one or more speaker drivers (108, 107) for rendering an audio signal; wherein the one or more speaker drivers (108, 107) are at least partially oriented towards the ground (202); and
- one or more feet (105, 111) extending downwards from the main body (106) and configured to hold the main body (106) elevated at an elevation distance (203) from the ground (202).

2. The electronic device (100) of claim 1, wherein

- the main body (106) comprises one or more active speaker drivers (108) and/or one or more passive acoustic radiators (107), which are arranged side by side within the main acoustic chamber (300) along the longitudinal axis; and
- the one or more active speaker drivers (108) and/or the one or more passive acoustic radiators (107) are each

at least partially oriented towards the ground (202).

3. The electronic device (100) of any previous claim, wherein

- a speaker driver (108) of the main body (106) comprises a membrane which is configured to generate an acoustic wave (210);
- a plane of the membrane forms an orientation angle (230) with the ground (202);
- a magnitude of the orientation angle (230) is 45° or smaller, notably 35° or smaller; and
- the magnitude of the orientation angle (230) is notably 10° or more.

4. The electronic device (100) of any previous claim, wherein

- the one or more speaker drivers (108) are configured to emit an acoustic wave (210) such that the acoustic wave (210) is reflected by the ground (202) before reaching a user of the electronic device (100); and/or
- the one or more speaker drivers (108) are oriented such that 50% or more of the acoustic waves (210) that are emitted by the one or more speaker drivers (108) are reflected by the ground (202) before reaching a user of the electronic device (100).

5. The electronic device (100) of any previous claim, wherein

- the electronic device (100) comprises a holder (102), notably a back support extending upwards from the main body (106), enabling a handheld user device to be placed in conjunction with the electronic device (100);
- the holder (102) forms a support plane that exhibits a support angle, notably a support angle between 45° and 70°, with respect to the ground (202);
- an emission direction of the one or more speaker drivers (108) is substantially parallel to the support plane, notably with a maximum deviation of $\pm 5^\circ$; and
- the emission direction of a speaker driver (108) is notably an average direction of acoustic waves (210) that are emitted by the speaker driver (108).

6. The electronic device (100) of claim 5, wherein

- a front foot (105) of the electronic device (100), which extends downwards from the main body (106) at a front side of the electronic device (100), is aligned with the holder (102), which extends upwards from the main body (106) at a rear side of the electronic device (100); and/or
- the front foot (105) forms a plate having a width along the longitudinal axis, which is equal to a width of the holder (102) along the longitudinal axis.

7. The electronic device (100) of any previous claims, wherein

- the electronic device (100) comprises one or more microphones which are configured to capture a microphone signal; and
- the one or more microphones are oriented away from the ground (202) that the electronic device (100) is standing on.

8. The electronic device (100) of any previous claims, wherein

- the main body (106) encloses the main acoustic chamber (300), notably a hollow acoustic chamber (300) and/or an acoustic chamber (300) having a cylindrical shape; and
- the one or more speaker drivers (108) are positioned within the main acoustic chamber (300).

9. The electronic device (100) of claim 8, wherein the electronic device (100) exhibits an extension (310) of the main acoustic chamber (300), which extends beyond the main body (106), notably into a housing (121) of the electronic device (100), between a rear foot (111) and a front foot (105) of the electronic device (100).

10. The electronic device (100) of any of claims 8 to 9, wherein the main body (106) comprises an opening (201, 301), notably a lattice of openings (201, 301), at one or more end faces of the cylindrical main body (106), to allow acoustic waves (210) to exit the main acoustic chamber (300).

11. The electronic device (100) of any previous claims, wherein the electronic device (100) comprises a control unit (120) configured to

- determine whether or not a user device has been placed in conjunction with the electronic device (100); and
- automatically establish a communication link with the user device, if it is determined that the user device has been placed into the electronic device (100).

12. The electronic device (100) of claim 12, wherein the control unit (120) is configured to,

- receive an audio signal from the user device via the communication link and/or from an internet streaming platform; and
- cause the one or more speaker drivers (108) to render the audio signal that has been received from the user device and/or from the internet streaming platform.

13. The electronic device (100) of any previous claims, wherein

- the main body (106) comprises one or more active speaker drivers (108) and a passive acoustic radiator (107), which are arranged side by side along the longitudinal axis; and/or
- the main body (106) comprises a passive acoustic radiator (107) with one active speaker driver (108) at each side.

14. The electronic device (100) of any previous claims, wherein

- the main body (106) forms a cylinder, notably a circular cylinder, around the longitudinal axis; and/or
- the main body (106) extends between 10cm and 25cm along the longitudinal axis; and/or
- the main body (106) exhibits a diameter between 4cm and 8cm; and/or
- the elevation distance (203) is between 1cm and 7cm.

Amended claims in accordance with Rule 137(2) EPC.

1. An electronic device (100), the electronic device (100) comprising

- a main body (106) extending along a longitudinal axis which is parallel to a ground (202), when the electronic device (100) is standing on said ground; wherein the main body (106) comprises a main acoustic chamber (300) with one or more active speaker drivers (108, 107) for rendering an audio signal; wherein the one or more active speaker drivers (108, 107) are arranged such that a main emission direction of an audio signal that is emitted by the one or more active speaker drivers is at least partially oriented towards the ground (202); and
- one or more feet (105, 111) extending downwards from the main body (106) and configured to hold the main body (106) elevated at an elevation distance (203) from the ground (202);
- wherein the electronic device (100) comprises a holder (102) enabling a handheld user device to be placed in conjunction with the electronic device (100);

characterized in that

- the holder (102) forms a support plane that exhibits a support angle between 45° and 70° with respect to the ground (202); and
- the emission direction of the one or more speaker drivers (108) is substantially parallel to the support plane.

2. The electronic device (100) of claim 1, wherein

- the main body (106) comprises in addition to the one or more active speaker drivers (108) one or more passive acoustic radiators (107), which are arranged side by side within the main acoustic chamber (300) along the longitudinal axis; and
- the one or more passive acoustic radiators (107) are each arranged such that a main emission direction of an audio signal that is emitted by the one or more passive acoustic radiators (107) is at least partially oriented towards the ground (202).

3. The electronic device (100) of any previous claim, wherein

- a speaker driver (108) of the main body (106) comprises a membrane which is configured to generate an acoustic wave (210);
- a plane of the membrane forms an orientation angle (230) with the ground (202);
- a magnitude of the orientation angle (230) is 45° or smaller, notably 35° or smaller; and
- the magnitude of the orientation angle (230) is notably 10° or more.

4. The electronic device (100) of any previous claim, wherein

- the one or more speaker drivers (108) are configured to emit an acoustic wave (210) and
- the one or more speaker drivers (108) are oriented such that 50% or more of the acoustic waves (210) that are emitted by the one or more speaker drivers (108) are reflected by the ground (202) before reaching a user of the electronic device (100).

5. The electronic device (100) of any previous claim, wherein

- the holder (102) is a back support extending upwards from the main body (106);
- the emission direction of the one or more speaker drivers (108) is parallel to the support plane with a maximum deviation of $\pm 5^\circ$; and
- the emission direction of a speaker driver (108) is notably an average direction of acoustic waves (210) that are emitted by the speaker driver (108).

6. The electronic device (100) of claim 5, wherein

- a front foot (105) of the electronic device (100), which extends downwards from the main body (106) at a front side of the electronic device (100), is aligned with the holder (102), which extends upwards from the main body (106) at a rear side of the electronic device (100); and/or
- the front foot (105) forms a plate having a width along the longitudinal axis, which is equal to a width of the holder (102) along the longitudinal axis.

7. The electronic device (100) of any previous claims, wherein

- the electronic device (100) comprises one or more microphones which are configured to capture a microphone signal; and
- the one or more microphones are oriented away from the ground (202) that the electronic device (100) is standing on.

8. The electronic device (100) of any previous claims, wherein

- the main body (106) encloses the main acoustic chamber (300), notably a hollow acoustic chamber (300) and/or an acoustic chamber (300) having a cylindrical shape; and
- the one or more speaker drivers (108) are positioned within the main acoustic chamber (300).

9. The electronic device (100) of claim 8, wherein the electronic device (100) exhibits an extension (310) of the main acoustic chamber (300), which extends beyond the main body (106), notably into a housing (121) of the electronic device (100), between a rear foot (111) and a front foot (105) of the electronic device (100).

10. The electronic device (100) of any of claims 8 to 9, wherein the main body (106) comprises an opening (201, 301), notably a lattice of openings (201, 301), at one or more end faces of the cylindrical main body (106), to allow acoustic waves (210) to exit the main acoustic chamber (300).

11. The electronic device (100) of any previous claims, wherein the electronic device (100) comprises a control unit (120) configured to

- determine whether or not a user device has been placed in conjunction with the electronic device (100); and
- automatically establish a wireless communication link with the user device, if it is determined that the user device has been placed into the electronic device (100).

12. The electronic device (100) of claim 11, wherein the control unit (120) is configured to,

- receive an audio signal from the user device via the communication link and/or from an internet streaming platform; and
- cause the one or more speaker drivers (108) to render the audio signal that has been received from the user device and/or from the internet streaming platform.

5

13. The electronic device (100) of any previous claims, wherein

- the main body (106) comprises a passive acoustic radiator (107) with one active speaker driver (108) at each side.

10

14. The electronic device (100) of any previous claims, wherein

- the main body (106) forms a cylinder, notably a circular cylinder, around the longitudinal axis; and/or
- the main body (106) extends between 10cm and 25cm along the longitudinal axis; and/or
- the main body (106) exhibits a diameter between 4cm and 8cm; and/or
- the elevation distance (203) is between 1cm and 7cm.

15

20

25

30

35

40

45

50

55

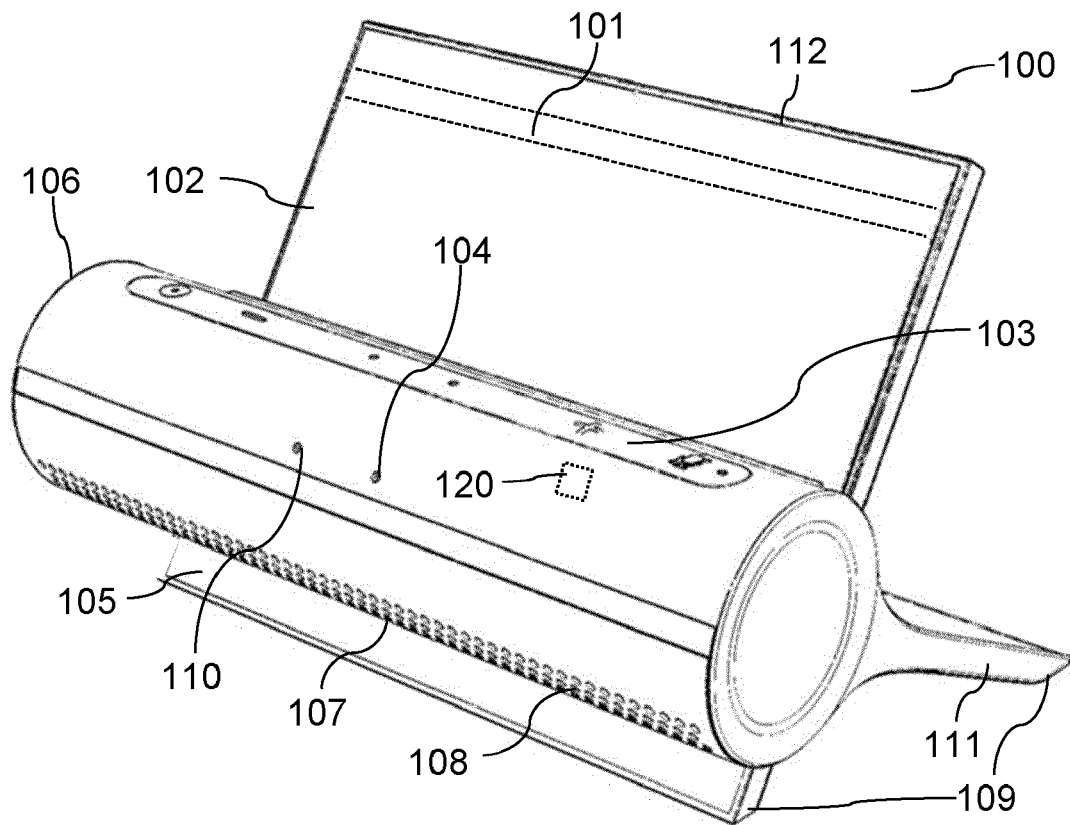


Fig. 1a

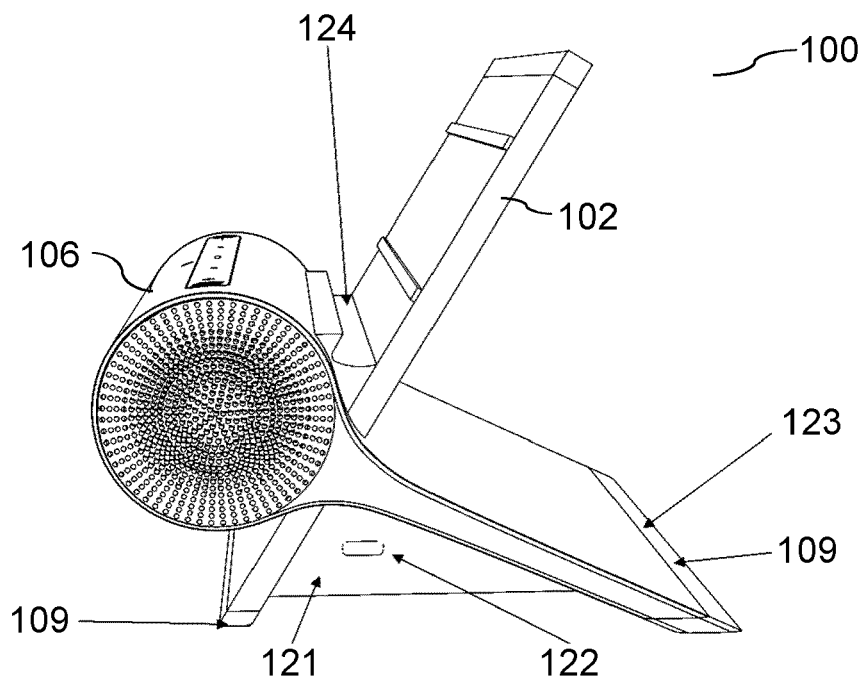


Fig. 1b

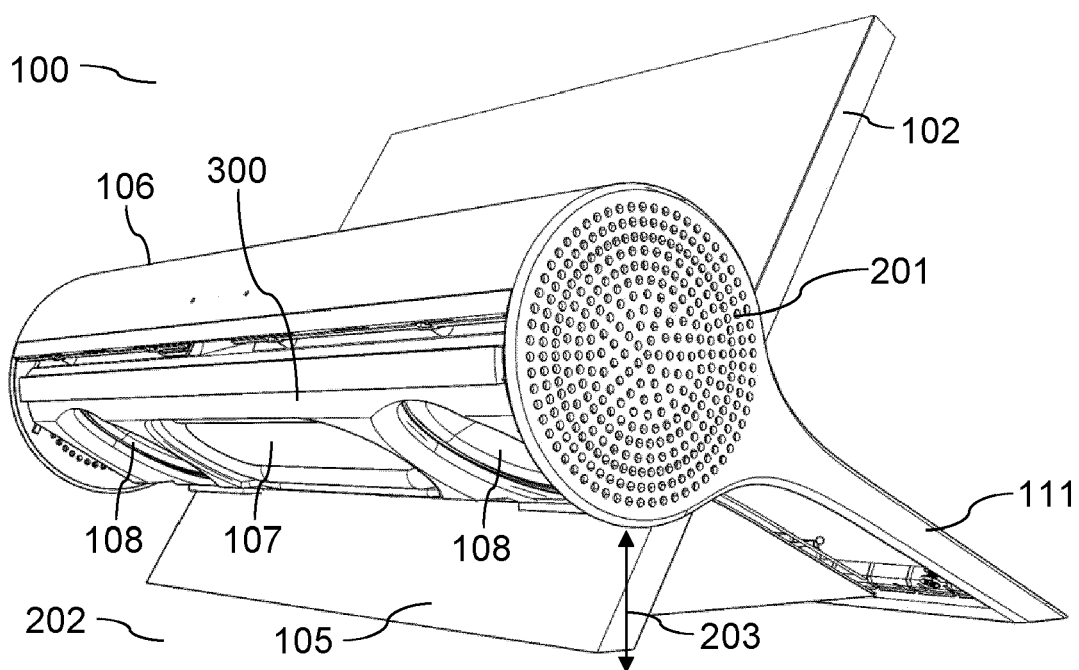


Fig. 2a

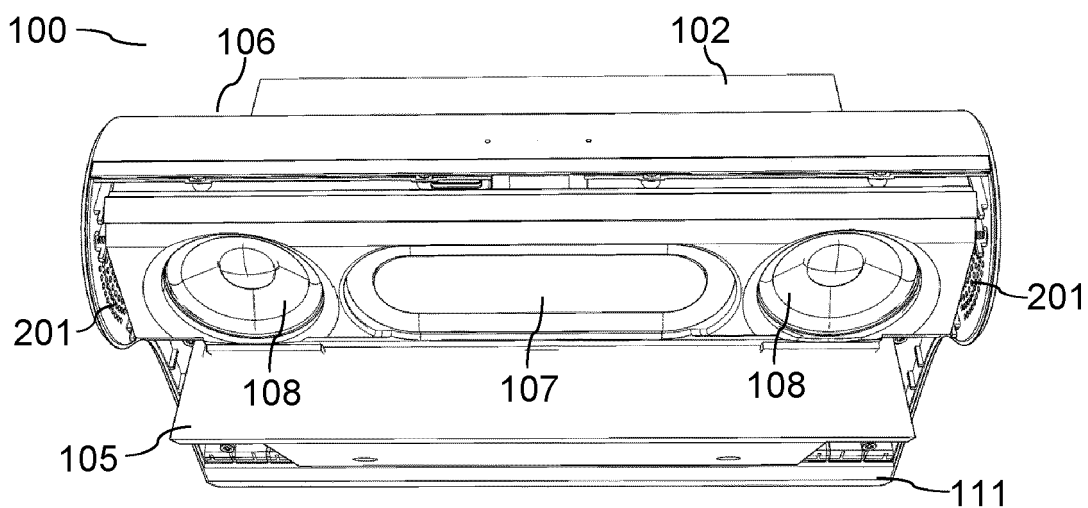


Fig. 2b

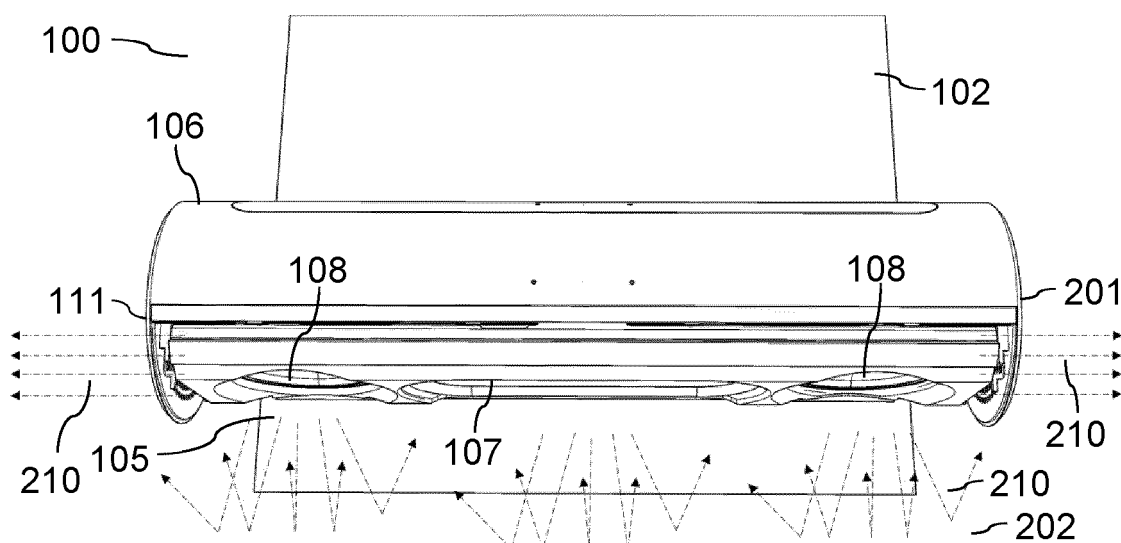


Fig. 2c

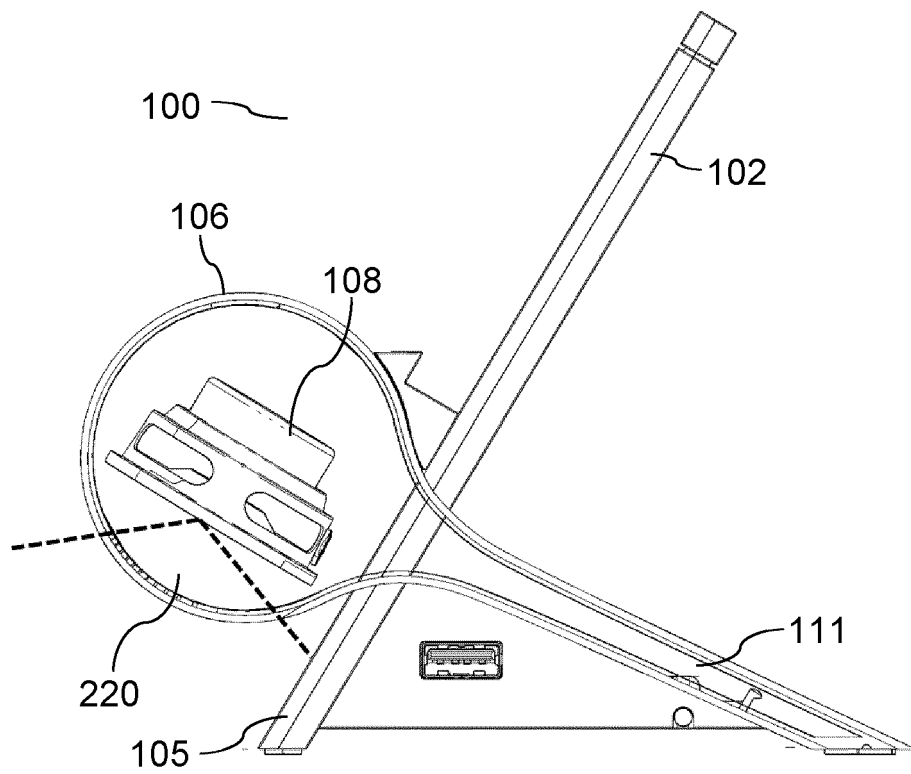


Fig. 2d

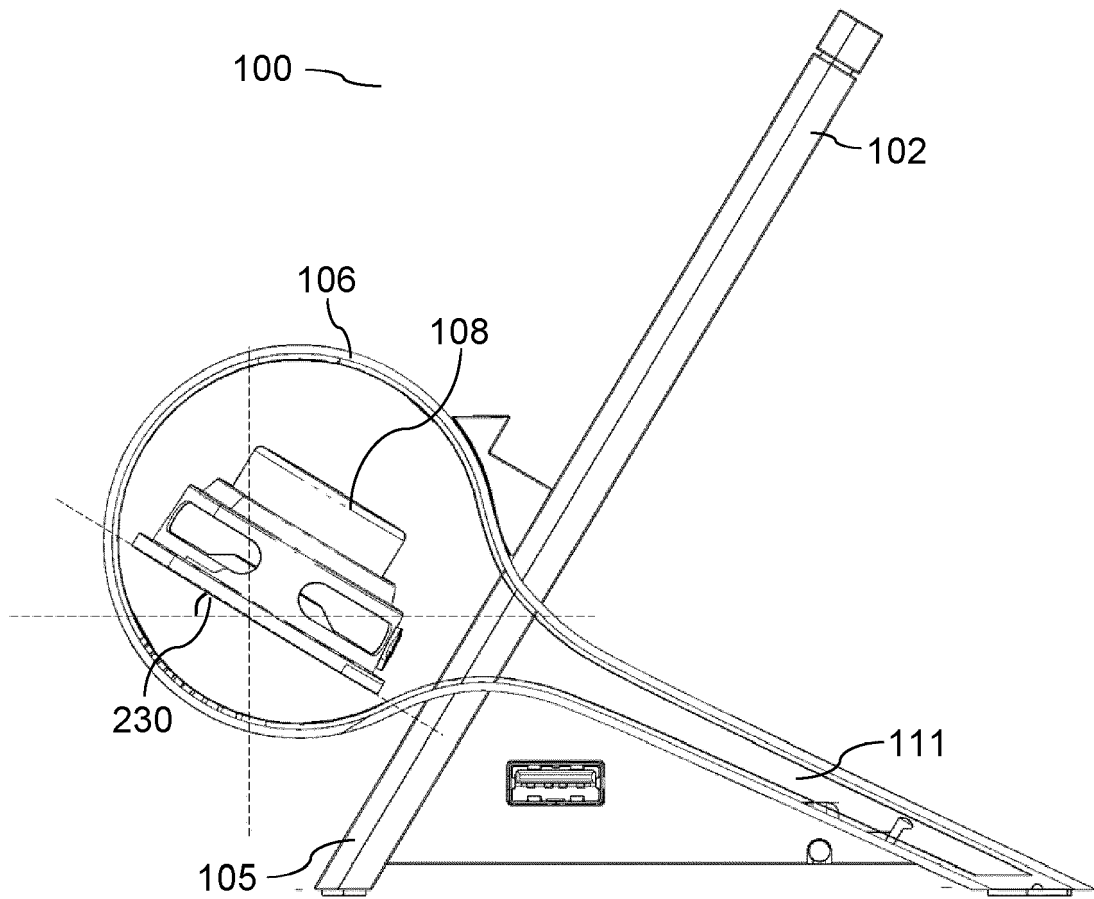


Fig. 2e

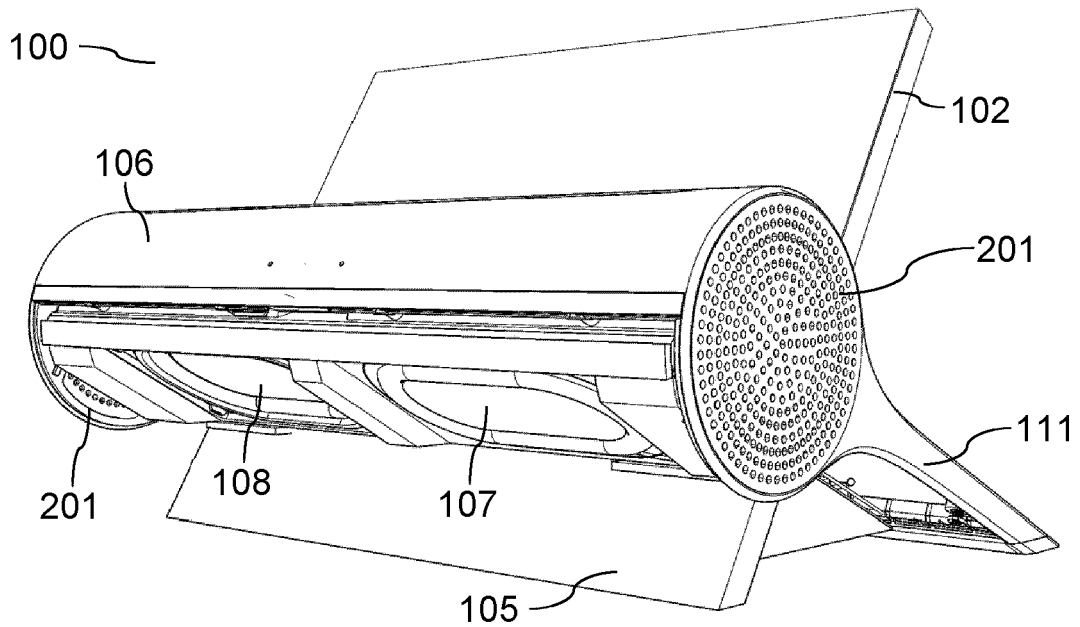


Fig. 3a

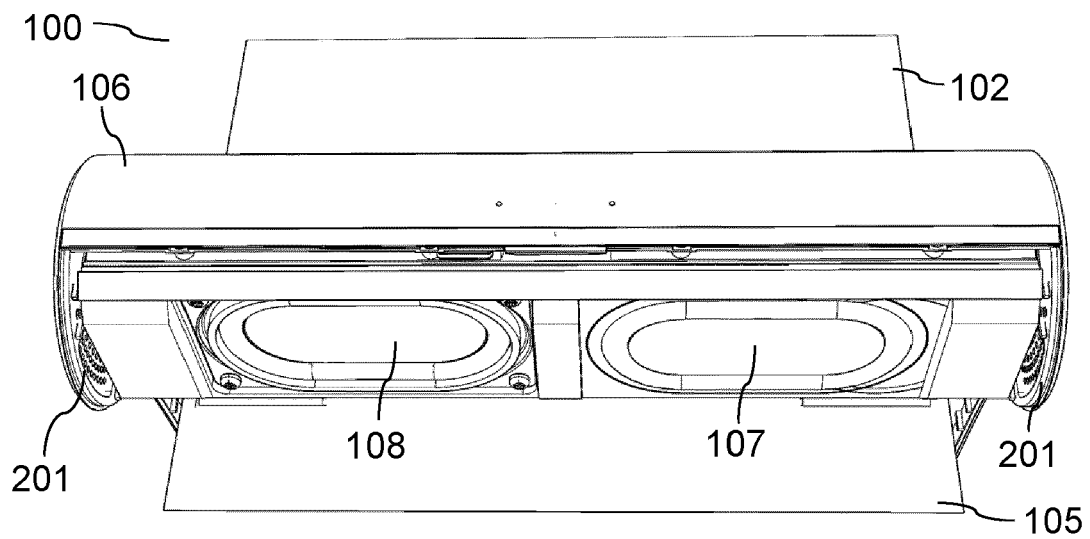


Fig. 3b

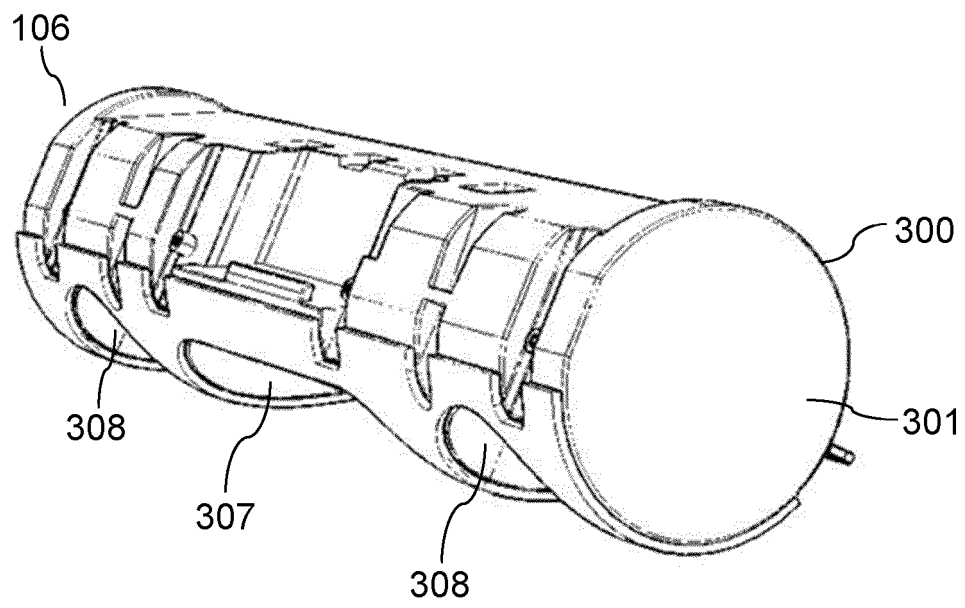


Fig. 4a

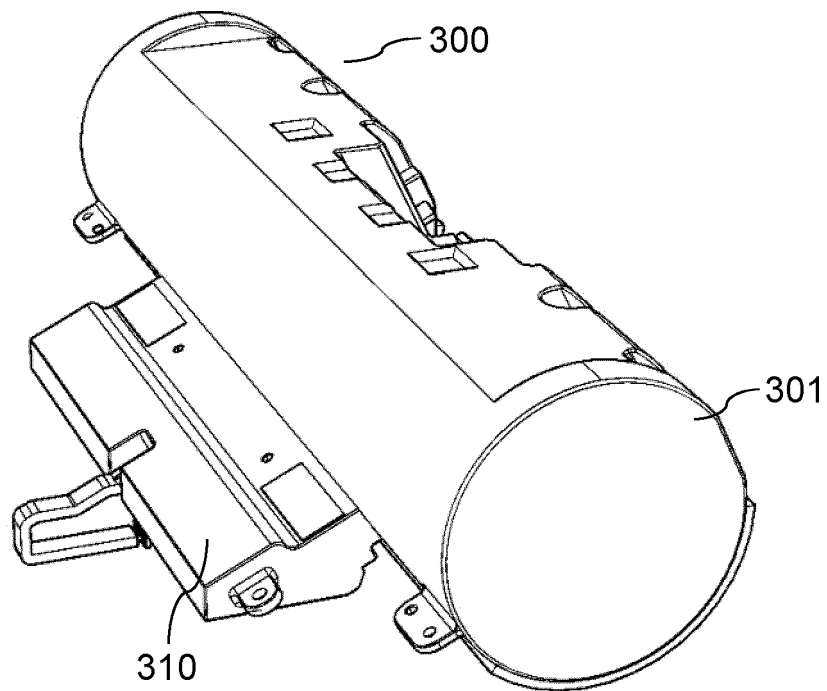


Fig. 4b

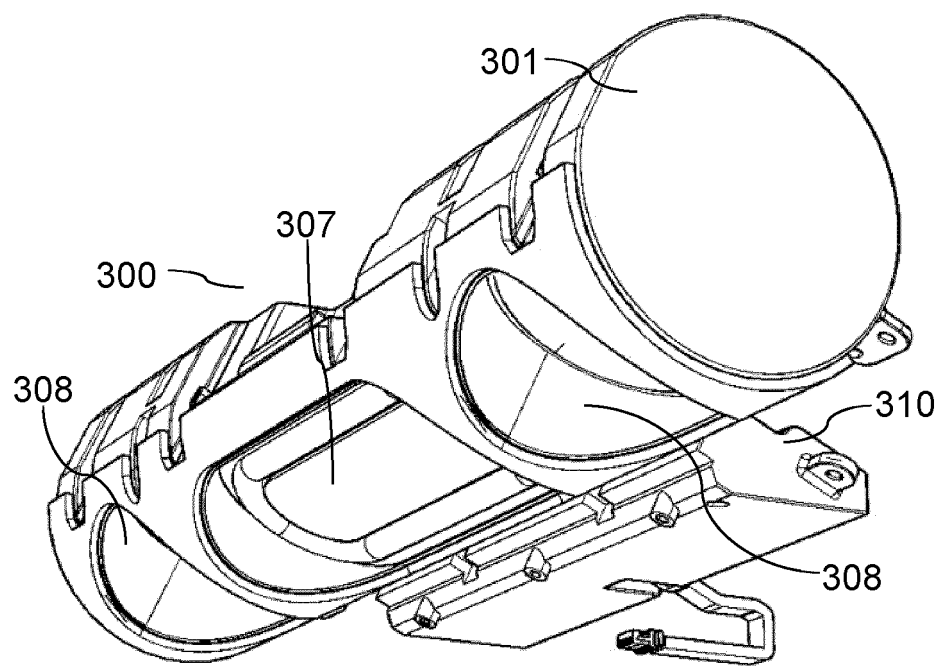


Fig. 4c



EUROPEAN SEARCH REPORT

Application Number
EP 21 15 0638

5

10

15

20

25

30

35

40

45

50

55

2

EPO FORM 1503 03.82 (P04C01)

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 4 378 468 A (BRAUN DARYL P) 29 March 1983 (1983-03-29) * column 5, lines 6-23; figures 2,4 *	1-14	INV. H04R1/02 H04R1/28 H04R1/34
X	US 2012/063630 A1 (MAEZAWA YASUYUKI [JP] ET AL) 15 March 2012 (2012-03-15) * paragraphs [0073] - [0090], [0131] - [0137]; figures 1,7,9 *	1-14	
X	US 2015/053497 A1 (HORIUCHI YASUO [JP]) 26 February 2015 (2015-02-26) * paragraphs [0043] - [0059]; figure 2 *	1	
X	US 2010/310104 A1 (HAMADA SHINGO [JP]) 9 December 2010 (2010-12-09) * paragraphs [0023] - [0027]; figures 1,2, *	1	
X	EP 3 748 988 A1 (LG ELECTRONICS INC [KR]) 9 December 2020 (2020-12-09) * paragraphs [0037] - [0050]; figure 1 *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			H04R
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 6 May 2021	Examiner Kunze, Holger
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 21 15 0638

5 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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

06-05-2021

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4378468 A	29-03-1983	NONE	
US 2012063630 A1	15-03-2012	CN 102404655 A	04-04-2012
		CN 202514035 U	31-10-2012
		JP 5640593 B2	17-12-2014
		JP 2012065039 A	29-03-2012
		US 2012063630 A1	15-03-2012
US 2015053497 A1	26-02-2015	JP 2015041814 A	02-03-2015
		US 2015053497 A1	26-02-2015
US 2010310104 A1	09-12-2010	EP 2262250 A1	15-12-2010
		JP 5263014 B2	14-08-2013
		JP 2010283636 A	16-12-2010
		US 2010310104 A1	09-12-2010
EP 3748988 A1	09-12-2020	EP 3748988 A1	09-12-2020
		KR 20190092982 A	08-08-2019
		US 2021044895 A1	11-02-2021
		WO 2019151582 A1	08-08-2019