(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
30 June 2022 (30.06.2022)

WIPO | PCT

(10) International Publication Number
WO 2022/139678 A1

(51) International Patent Classification:
A62B 18/08 (2006.01) *G06F 3/01* (2006.01)
A62B 18/02 (2006.01) *G06F 3/16* (2006.01)
A62B 9/00 (2006.01) *G10L 15/22* (2006.01)
H04R 1/08 (2006.01)

(21) International Application Number:
PCT/SG2021/050420

(22) International Filing Date:
16 July 2021 (16.07.2021)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PCT/SG2020/050781
24 December 2020 (24.12.2020) SG

(71) Applicant: **RAZER (ASIA-PACIFIC) PTE. LTD.** [SG/SG]; Razer SEA HQ, 1 one-north Crescent, #02-01, Singapore 138538 (SG).

(72) Inventors: **LIM, Lionel**; c/o Razer (Asia-Pacific) Pte. Ltd., Razer SEA HQ, 1 one-north Crescent, #02-01, Singapore 138538 (SG). **GUERRERO, Gil, Palma, Jr.**; c/o Razer (Asia-Pacific) Pte. Ltd., Razer SEA HQ, 1 one-north Crescent, #02-01, Singapore 138538 (SG). **SIM, Alvin**; c/o Razer (Asia-Pacific) Pte. Ltd., Razer SEA HQ, 1 one-north Crescent, #02-01, Singapore 138538 (SG). **LEE, Kah Yong**; c/o Razer (Asia-Pacific) Pte. Ltd., Razer SEA HQ, 1 one-north Crescent, #02-01, Singapore 138538 (SG).

(74) Agent: **VIERING, JENTSCHURA & PARTNER LLP**; P.O. Box 1088, Rochor Post Office, Rochor Road, Singapore 911833 (SG).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, IT, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,

(54) Title: FACE MASKS

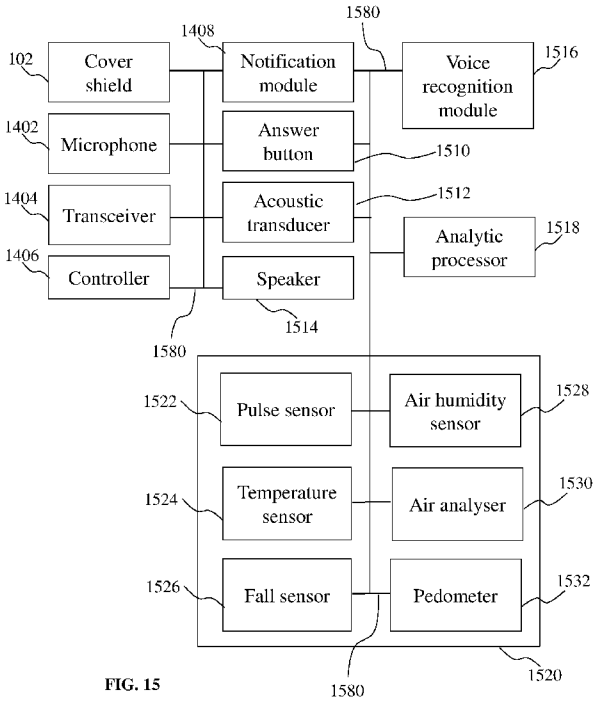

FIG. 15

(57) Abstract: According to various embodiments, a face mask includes a cover shield, a microphone, a transceiver and a controller. The cover shield is shaped to cover nose and mouth of a wearer. The cover shield has an inner surface that faces the wearer when the cover shield covers the nose and the mouth of the wearer. The microphone is coupled to the inner surface of the cover shield. The microphone is configured to receive sound waves and further configured to generate audio data based on the received sound waves. The transceiver is configured to communicate bidirectionally with a mobile device. The controller is configured to control the transceiver to transmit the generated audio data to the mobile device.

WO 2022/139678 A1

[Continued on next page]

MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

— *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

FACE MASKS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of PCT Patent Application number PCT/SG2020/050781 filed on 24 December 2020, the entire contents of which are incorporated herein by reference for all purposes.

TECHNICAL FIELD

[0002] Various embodiments relate to face masks.

BACKGROUND

[0003] Face masks are useful for providing protection against air pollution, as well as infectious diseases. Examples of face masks include disposable medical masks like the N95 mask and surgical masks, and reusable cloth masks. However, face masks can only be effective in protecting the wearers, if the wearers would keep them on their faces. Some wearers prefer to remove their face masks to speak to others, or on the phone, as their face masks muffles their voices. As such, there is a need for a face mask that may allow its wearer to still effectively communicate with others while keeping the face masks on.

SUMMARY

[0004] According to various embodiments, there may be provided a face mask. The face mask may include a cover shield, a microphone, a transceiver and a controller. The cover shield may be shaped to cover nose and mouth of a wearer. The cover shield may have an inner surface that faces the wearer when the cover shield covers the nose and the mouth of the wearer. The microphone may be coupled to the inner surface of the cover shield. The microphone may be configured to receive sound waves and further configured to generate audio data based on the received sound waves. The transceiver may be configured to communicate bidirectionally with a mobile device. The controller may be configured to control the transceiver to transmit the generated audio data to the mobile device.

[0005] Additional features for advantageous embodiments are provided in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] In the drawings, like reference characters generally refer to the same parts throughout the different views. The drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the invention. In the following description, various embodiments are described with reference to the following drawings, in which:

[0007] FIGS. 1A and 1B show external views of a face mask according to various embodiments.

[0008] FIG. 2 shows a cross-sectional view of the face mask of FIGS. 1A and 1B.

[0009] FIGS. 3A and 3B show external views of a face mask according to various embodiments.

[0010] FIGS. 4A to 4C show various disassembled views of an input fan according to various embodiments.

[0011] FIGS. 5A to 5C show various disassembled views of an output fan according to various embodiments.

[0012] FIGS. 6A to 6C show various views of a fan cover according to various embodiments.

[0013] FIGS. 7A and 7B show a top perspective view and a bottom perspective view of a light signaling member, respectively, according to various embodiments.

[0014] FIG. 8 shows a side perspective view of a face mask according to various embodiments.

[0015] FIGS. 9A and 9B show a front perspective view and a rear perspective view of a face mask, respectively, according to various embodiments.

[0016] FIGS. 10A and 10B show an eye shield according to various embodiments.

[0017] FIG. 11A and 11B shows a mounting member on a cover shield and a hole on the eye shield, respectively, according to various embodiments.

[0018] FIGS. 12A and 12B show views of cavities in the skin cushion of the face mask according to various embodiments.

[0019] FIG. 13 is a flow diagram showing a method of fabricating a face mask according to various embodiments.

[0020] FIG. 14 shows a rear perspective view of a face mask according to various embodiments.

[0021] FIG. 15 shows a conceptual diagram of the face mask according to various embodiments.

[0022] FIG. 16 is a sequence diagram that shows the interaction between the face mask and a mobile device, in a scenario where there is an incoming call on the mobile device, according to various embodiments.

[0023] FIG. 17 is a sequence diagram that shows the interaction between the face mask and a mobile device, in a scenario where there is an incoming call on the mobile device, according to various embodiments.

[0024] FIG. 18 is a flow chart of an operation process of the face mask in the face-to-face mode, according to various embodiments.

[0025] FIG. 19 is a flow chart of an operation process of the face mask in the face-to-face mode, according to various embodiments.

[0026] FIG. 20 is a flow chart of an operation process of the face mask in the face-to-face mode, according to various embodiments.

[0027] FIG. 21 shows the face mask and preferred positions of components of its sensing devices, according to various embodiments.

[0028] FIG. 22 shows a front perspective view of a face mask according to various embodiments.

[0029] FIG. 23 shows a schematic diagram of data transfer between the face mask and a health server, according to various embodiments.

[0030] FIG. 24 shows an example of the graphical user interface of the health-monitoring software, according to various embodiments.

[0031] FIG. 25 is a sequence diagram that shows the interactions between the face mask and the health server, via the health-monitoring software, according to various embodiments.

[0032] FIG. 26 is a sequence diagram that shows the interactions between the face mask and the health-monitoring software according to various embodiments.

[0033] FIG. 27 shows a flow chart of the operations of the sensing device according to various embodiments.

[0034] FIG. 28 shows a flow chart of the process of checking mask conditions according to various embodiments.

[0035] FIG. 29 shows a flow chart of the process of checking the wearer's body conditions according to various embodiments.

[0036] FIG. 30 shows a flow chart of the process of fall detection, according to various embodiments.

DESCRIPTION

[0037] Embodiments described below in context of the face masks are analogously valid for the respective methods, and vice versa. Furthermore, it will be understood that the embodiments described below may be combined, for example, a part of one embodiment may be combined with a part of another embodiment.

[0038] It will be understood that any property described herein for a specific device may also hold for any device described herein. It will be understood that any property described herein for a specific method may also hold for any method described herein. Furthermore, it will be understood that for any device or method described herein, not necessarily all the components or steps described must be enclosed in the device or method, but only some (but not all) components or steps may be enclosed.

[0039] It should be understood that the terms "on", "over", "top", "bottom", "down", "side", "back", "left", "right", "front", "lateral", "side", "up", "down" etc., when used in the following description are used for convenience and to aid understanding of relative positions or directions, and not intended to limit the orientation of any device, or structure or any part of any device or structure. In addition, the singular terms "a", "an", and "the" include plural references unless context clearly indicates otherwise. Similarly, the word "or" is intended to include "and" unless the context clearly indicates otherwise.

[0040] The term "coupled" (or "connected") herein may be understood as electrically coupled or as mechanically coupled, for example attached or fixed, or just in contact without any fixation, and it will be understood that both direct coupling or indirect coupling (in other words: coupling without direct contact) may be provided.

[0041] In order that the invention may be readily understood and put into practical effect, various embodiments will now be described by way of examples and not limitations, and with reference to the figures.

[0042] According to various embodiments, a face mask may be provided. The face mask may include a substantially transparent cover shield that is to be worn over a person's nose and

mouth, so that the face of the wearer may be visible to other people. This may facilitate social interactions as the wearer can be easily recognized by others, and his or her facial expressions are also visible to others. The face mask may include an internal light, also referred herein as a light emitter arrangement, that may be switched on to shine on the wearer's face, so that the wearer may be recognizable even in dim lighting conditions. The face mask may also include at least one external light, also referred herein as a light signaling member, that may be switched on to display lighting sequences. The lighting sequences may be synchronized with a computer application, such as a computer game. The lighting sequences may be representative of events in the computer application, and may convey information relating to the computer application, to others who are looking at the wearer. The face mask may also be integrated with an eye shield, to provide more comprehensive protection to the wearer.

[0043] FIGS. 1A and 1B show external views of a face mask 100 according to various embodiments. The face mask 100 may be worn on the face of a wearer. The face mask 100 may include a cover shield 102. The cover shield 102 may be shaped to cover the nose and mouth of the wearer, thereby defining an inner space between the cover shield 102 and the skin of the wearer. The cover shield 102 may serve to physically segregate the inner space from the ambient space. The cover shield 102 may serve to at least partially inhibit transmission of fluids between the wearer and an ambient space that is external to the cover shield 102. The cover shield 102 may be substantially transparent, so that the wearer's face may be visible through the cover shield 102. The cover shield 102 may be curved in shape, so that its opposing edges may bend around the wearer's cheeks. The cover shield 102 may be formed from a polymer, for example, plastic. The cover shield 102 may have an inner surface 105 that faces the wearer when the cover shield 102 covers the nose and mouth of the wearer.

[0044] While it is preferable for the cover shield 102 to be transparent, in alternative embodiments, the cover shield 102 may be opaque.

[0045] The face mask 100 may also include an input fan 104 and an output fan 106 coupled to the cover shield 102. The input fan 104 may be configured to draw air from outside, i.e. the ambient space, into the inner space, while the output fan 106 may be configured to expel air out of the inner space, into the ambient space. While FIG. 1A shows the input fan 104 being on disposed on a left side (from the point of view of the wearer) of the face mask 100 and the output fan 106 being disposed on a right side of the face mask 100, the positions of the input fan 104 and the output fan 106 may be interchanged.

[0046] Referring to FIG. 1A which shows a front view of the face mask 100, the input fan 104 and the output fan 106 may be arranged equidistant from a vertical center line 120 of the cover shield 102. The vertical center line 120 is merely an imaginary line helpful for describing the face mask 100. The center line 120 of the cover shield 102 may be aligned with a vertical center line of the wearer's face, and may rest on the wearer's nose. The input fan 104 and the output fan 106 may also be symmetrically arranged about the vertical center line 120.

[0047] Referring to FIG. 1B, the face mask 100 may further include a skin cushion 108 arranged along a periphery of the cover shield 102. The skin cushion 108 may be adapted to abut against the skin of the wearer for sealing the inner space from outside. The skin cushion 108 may abut against the skin of the wearer for a substantially airtight seal. The skin cushion 108 may include a compressible or resilient material that may conform to the shape of the face of the wearer. The skin cushion 108 may form a sealing engagement with the skin of the wearer. For example, the skin cushion 108 may include silicone, or a sponge material. The skin cushion 108 may include an integrated nose pad 128.The nose pad 128 may be shaped to rest on the wearer's nose bridge.

[0048] The face mask 100 may also include an attachment means configured to attach the face mask 100 to the wearer. The attachment means may be a pair of ear loops 112 attached to respective opposite edges of the cover shield 102. In alternative embodiments, the attachment means may be a head band having opposite ends attached to the respective opposite edges of the cover shield 102.

[0049] FIG. 2 shows a cross-sectional view of the face mask 100 cut along line A—A' of FIG. 1A. The cover shield 102 may have two apertures (not shown in the figures) formed in it. The first aperture may be referred to as an inlet aperture. The input fan 104 may draw in air through the inlet aperture, as indicated by the arrow 304. The input fan 104 may be fitted to the inlet aperture, for example, the input fan 104 may fit snugly in the inlet aperture. A major part of the input fan 104 may be arranged on the outer side of the face mask 100. The second aperture may be referred to as an outlet aperture. The output fan 106 may expel air through the outlet aperture, as indicated by the arrow 306. The output fan may be fitted to the outlet aperture, for example, the output fan 106 may fit snugly in the outlet aperture. A major part of the output fan 106 may be arranged on the outer side of the face mask 100. The input fan 104 may be positioned to the cover shield 102 such that the air drawn into the inner space is directed towards the nose and/or the mouth of the wearer. The output fan 106 may be

positioned to the cover shield 102 such that the output fan draws away air exhaled from the nose and/or the mouth of the wearer. As a result of the actions of the input fan 104 and the output fan 106, air flow is generated within the inner space so that the wearer is able to breathe in fresh air instead of exhaled air.

[0050] At least one of the input fan 104 and the output fan 106 may include a filter holder configured to hold a filter element. The filter holder may be positioned on the respective input fan 104 or output fan 106. The filter holder will be described in further details with respect to FIG. 4B. The filter element may include a non-woven filter sheet. For example, the filter sheet may be similar in composition, to N95 masks, or surgical masks. The filter element received in the filter holder of the input fan 104 (also referred herein as the "input filter") may filter air that is drawn into the inner space. The input filter may protect the wearer from inhaling undesirable particles that are present in the ambient space. The input filter may prevent undesirable particles, such as air pollutants, dust particles, pollens or other allergens, from entering the inner space. The input filter may block the undesirable particles outside of the filter or may trap them within the filter. Consequently, clean air is drawn into the inner space for the wearer to inhale. The filter element received in the filter holder of the output fan 106 (also referred herein as the "output filter") may filter air exhaled from at least one of the nose and the mouth of the wearer. The output filter may prevent respiratory droplets or microdroplets from being released out into the ambient space. For example, exhalation from the wearer may include droplets carrying germs such as viruses or bacteria. The output filter may block or trap these droplets so that the germs are not passed on to other people who are in the vicinity of the wearer.

[0051] Still referring to FIG. 2, the face mask 100 may further include an input air guiding member 134 and an output air guiding member 136. The input air guiding member 134 may be coupled to the input fan 104, and may extend into the inner space. The input air guiding member 134 may be adapted to direct air flow from the input fan 104 to at least one of the nose and mouth of the wearer. The input air guiding member 134 may be coupled to a base of the input fan 104. Similarly, the output air guiding member 136 may be coupled to the output fan 106, and may extend into the inner space. The output air guiding member 136 may be adapted to direct air flow from at least one of the nose and mouth of the wearer, to the output fan 106. The output air guiding member 136 may be coupled to a base of the output fan 106. The respective bases of the input fan 104 and the output fan 106 may face the wearer. The input air guiding member 134 and the output air guiding member 136 may collectively

provide a ventilation duct that guides air to flow from the input fan 104 to the output fan 106. When the face mask is in use, the wearer's nose and mouth may lie approximately midway of the ventilation duct.

[0052] According to various embodiments, the cover shield 102 may form a waterproof barrier between the inner space and the ambient space. The cover shield 102 may be impermeable to fluids. The input and output fans 104, 106 may be sealingly fitted into the inlet and outlets, respectively. The skin cushion 108 may also form a sealing engagement with the wearer's face. Consequently, gaseous exchange between the ambient space and the inner space may substantially be provided through the input and output fans 104, 106.

[0053] While it is preferable for the cover shield 102 to be impermeable to fluids, in alternative embodiments, the cover shield 102 may be partially permeable to fluids, for example, it may be formed from a fabric.

[0054] FIGS. 3A and 3B show external views of a face mask 300 according to various embodiments. Similar to the face mask 100, the face mask 300 may also include a cover shield 102, an input fan 104 and an output fan 106. In addition, the face mask 300 may include a light signaling member (not shown in FIGS. 3A and 3B) coupled to at least one of the input fan 104 and the output fan 106, at the outside of the face mask 300.

[0055] Referring to FIG. 3A, the light signaling member may be arranged to emit light in a direction away from the face of the wearer. The light signaling member may emit light out of a light transmissive window 130 on a fan cover 320, of the at least one of the input fan 104 and the output fan 106. The light transmissive window 130 may be substantially transparent. While the light transmissive window 130 is shown as a circle in the figures, it may be provided in other shapes. Light emitted by the light signaling member may be visible to other people looking at the wearer. The light signaling member may include at least one light strip, such as a light emitting diode (LED) strip, disposed on a cover of the input fan 104 or the output fan 106. The light signaling member may be configured to display lighting effects, such as different colors and lighting sequences. The light signaling member may include a plurality of light emitters which may be individually controlled. These lighting effects may be controlled by a software run on a processor that may be external to the face mask 300. The light signaling member will be described in further details with respect to FIGS. 7A and 7B.

[0056] The input fan 104 and/or the output fan 106 may include a switch 132. The switch 132 may be operable to selectively turn on and off the light signaling member. In addition,

the switch 132 may be operable to select a wind speed of the respective input fan 104 or output fan 106.

[0057] Still referring to FIG. 3A, the face mask 300 may also include an electrical connector 310. The electrical connector 310 may be disposed on the fan cover 320 of at least one of the input fan 104 and the output fan 106. The electrical connector 310 may be electrically coupled to the light signaling member. The electrical connector 310 may be configured to receive data that includes operating instructions for the light signaling member. The light signaling member may be configured to operate according to the operating instructions. For example, the operating instructions may include the color to be displayed and the timing for the display, for each light emitter in the light signaling member. The electrical connector 310 may include, for example pogo pins, USB female connector or micro USB female connector. The electrical connector 310 may be configured to receive electrical power for charging a battery in the face mask 300. In alternative embodiments, the electrical connector 310 may supply power directly to at least one of the light signaling member, the input fan 104 and the output fan 106.

[0058] The face mask 300 may further include a wireless transceiver equipment (not shown in the figures). The wireless transceiver equipment may be coupled to the light signaling member, and may be configured to receive data that includes the operating instructions. The wireless transceiver equipment may include a transceiver 1404 described with respect to FIG. 14.

[0059] Referring to FIG. 3B, the electrical connector 310 may be connectable to a connector cable 340. The connector cable 340 may include at least one output connection plug 342. The output connection plug 342 may be complementary to the electrical connector 310 and may be connectable with the electrical connector 310. The connector cable 340 may include an input connection plug 344 such a USB male connector.

[0060] The face mask 300 may further include a battery configured to supply electrical power to at least one of the input fan 104, the output fan 106, and the light signaling member. The battery may be rechargeable, via the electrical connector 310.

[0061] The face mask 300 may optionally include an eye shield 902. The eye shield 902 will be described further with respect to FIGS. 9A and 9B.

[0062] FIGS. 4A to 4C show various disassembled views of the input fan 104 according to various embodiments. The input fan 104 may include a fan cover 320. The fan cover 320 may

include at least one opening 402 so that air can flow through the fan cover 320. The fan cover 320 may be detachably coupled to the rest of the input fan 104 via a coupling means.

[0063] Referring to FIG. 4A, a filter element 404 may be visible when the fan cover 320 is removed. The fan cover 320 may be removable from the rest of the input fan 104, for easy access to the filter element 404. The filter element 404 may include a filter frame 426 structured to hold a filter sheet 424. The filter sheet 424 may include a filtration material, such as non-woven polymer fibers, for example polypropylene fibers. The filter frame 426 may be shaped to fit onto an intermediate base 432 of the input fan 104. As such, the intermediate base 432 may also be referred to as a filter holder. The filter frame 426 may include openings for accommodating internal electrical connections 422. The filter element 404 may be a consumable item that may be replaced on a periodic basis, or whenever it has become too dirty to perform its filtering function.

[0064] FIG. 4B shows an exploded view of the input fan 104. The input fan 104 may include the fan cover 320, the intermediate base 432, and a bottom base 454. The input fan 104 may further include the filter element 404, a switch cover 438 and a switch housing 442, arranged between the fan cover 320 and the intermediate base 432. The switch cover 438 may include a bracket for holding the switch button 442. The switch button 442 may be displaceable, for example, by sliding or depressing, to activate the switch 132. The intermediate base 432 may have a cavity that is shaped to hold the filter element 404. The input fan 104 may further include a plurality of fasteners 434 for attaching the intermediate base 432 to the bottom base 454. The input fan 104 may further include magnets 444, a fan rubber gasket 446, a main circuit board 448, a battery cover 450, a battery 452, and a blower 456, arranged between the intermediate base 432 and the bottom base 454. The magnets 444 may be arranged between the intermediate base 432 and the bottom base 454. The magnets 444 may be the coupling means for detachably coupling the fan cover 320 to the rest of the input fan 104. The fan cover 320 may include a ferromagnetic element, or magnets, so that the fan cover 320 may be magnetically attracted to the magnets 444 to cover the filter element 404. The fan rubber gasket 446 may seal off non-filtered openings in the input fan 104, to prevent air from passing through the non-filtered openings. The main circuit board 448 may house electrical circuits for the input fan 104. The battery cover 450 may serve to isolate the battery 452 from the rest of the face mask 300, in the event that the battery 452 catches fire. The battery cover 450 may have a flammability rating of V-0.

[0065] The electrical connections 422 shown in FIG. 4A may connect the main circuit board 448 to the light signaling member. A magnified view of the components 410 including the battery 452, the blower 456 and the bottom base 454, are shown in FIG. 4C. The blower 456 may have an input end 470 and an opposite output end (not shown in FIG. 4C). The blower 456 may include fan blades and a motor. The fan blades may be driven by the motor to rotate, thereby generating an air current. The fan blades may be configured to generate an air current that flows from the input end 470 to the output end. In the input fan 104, the blower 456 may be oriented such that the input end 470 faces the fan cover 320.

[0066] FIGS. 5A to 5C show various disassembled views of the output fan 106 according to various embodiments. Like the input fan 104, the output fan 106 may also include a fan cover 320 that includes at least one opening 402 to allow air flow.

[0067] Referring to FIG. 5A, a filter element 504 may be visible when the fan cover 320 is removed. The filter element 504 may include a filter frame 526 structured to hold a filter sheet 424. The filter element 504 may be similar to the filter element 404, but its filter frame 526 may be shaped to have an opening that is the same size or larger, than a valve 550. The valve 550 may be visible through the opening. The valve 550 may be configured to open when the output fan 106 is blowing air out of the face mask 300, and further configured to close when the output fan 106 is turned off. The valve 550 may include a thin rubber membrane and a resilient deformable protrusion. The protrusion may be insertable into an aperture in the intermediate base 432, for attaching the valve 550 to the intermediate base 432. The filter frame 526 may be shaped to fit onto an intermediate base 432 of the output fan 106. As such, the intermediate base 432 may also be referred to as a filter holder. The filter frame 526 may include openings for accommodating internal electrical connections 422.

[0068] FIG. 5B shows an exploded view of the output fan 106. The output fan 106 may include similar components as the input fan 104, which are not described in this paragraph for brevity. In addition, the output fan 106 may include the valve 550 that is adapted to fit in an opening 564 of the filter element 504. The valve 550 may be about 0.1mm in thickness, and may be made from rubber. The valve 550 may restrict air flow to substantially one direction, in the direction of exiting the inner space. In contrast, the input fan 104 may not include a valve 550 and as such, air flow is possible in both directions of into and out of, the inner space at the inlet opening. A magnified view of the components 510 including the battery 452, the blower 456 and the bottom base 454, are shown in FIG. 5C. Comparing with FIG. 4C, the blower 456 of the output fan 106 is arranged to have its blowing direction facing the

inner space, i.e. towards the cover shield 102, whereas the blower 456 of the input fan 104 is arranged to have its blowing direction facing away from the inner space, i.e. away from the cover shield 102. The blower 456 may have an input end 470 (not shown in FIG. 5C) and an opposite output end 570. The blower 456 may include fan blades configured to generate an air current that flows from the input end 470 to the output end 570. In the output fan 106, the blower 456 may be oriented such that the output end 570 faces the fan cover 320.

[0069] FIGS. 6A to 6C show various views of the fan cover 320 according to various embodiments. The fan cover 320 may include the light signaling member 650.

[0070] FIG. 6A show a top perspective view of the fan cover 320. The fan cover 320 may include a top cap 602, a front cap housing 604 fitted around the top cap 602 and a back cap housing 662 (not shown in FIG. 6A). The light transmissive window 130 may be provided on at least one of the top cap 602 and the front cap housing 604.

[0071] FIG. 6B shows a bottom perspective view of the fan cover 320. The light signaling member 650 may be arranged between the front cap housing 604 and the back cap housing 662. The light signaling member 650 may be adapted to matingly fit into a cavity in the fan cover 320. The light signaling member 650 may include electrical contact pads 612. The light signaling member 650 may receive electrical power from the battery 452, through the electrical contact pads 612.

[0072] FIG. 6C shows an exploded view of the fan cover 320. The top cap 602 may include a plurality of perforations, or openings 402. The front cap housing 604 may surround the top cap 602 circumferentially. The front cap housing 604 may be adapted to hold the light signaling member 650. For example, the front cap housing 604 may include a circumferential groove that may receive the light signaling member 650 in it. For example, the light signaling member 605 may be fastened onto the front cap housing 604 by screws. The light signaling member 650 may include a first light emitting circuit 606 and a second light emitting circuit 608. The first light emitting circuit 606 and the second light emitting circuit 608 will be described with respect to FIGS. 7A and 7B. The fan cover 320 may further include a plurality of magnets 660 between the front cap housing 604 and the back cap housing 662. The magnets 660 may be arranged to have their N-S orientation in opposite directions from the magnets 444, so that the fan cover 320 may be attracted to the magnets 444. The magnets 444 and the magnets 660 may work together to hold the fan cover 320 to the intermediate base 432 or the bottom base 454, to cover the filter element 404.

[0073] FIGS. 7A and 7B show the top perspective view and the bottom perspective view of the light signaling member 650, respectively, according to various embodiments.

[0074] The first light emitting circuit 606 may include at least one processor 720. The processor 720 may be a micro-controller unit configured to control the operating behavior of light emitter(s) 750 provided on the second light emitting circuit 608.

[0075] Referring to FIG. 7A, the first light emitting circuit 606 may further include a light guide 730. The light guide 730 may be arranged circumferentially on the first light emitting circuit 606. The light guide 730 may be arranged to be in register with the light transmission window 130. The light guide 730 may include a translucent polymer, for example polycarbonate with added diffuser powder.

[0076] Referring to FIG. 7B, the light emitter 750 may be a light emitting diode (LED) array that includes a plurality of LEDs. The light emitter 750 may be configured to selectively emit light of various colors, including red, green, and blue. The light guide 730 may serve to diffuse the light emitted by the light emitter 750, to provide an aesthetically pleasing glow.

[0077] FIG. 8 shows a side perspective view of a face mask 800 according to various embodiments. The face mask 800 may be similar to the face mask 100 or 300, and may further include a light emitter arrangement 850 coupled to the cover shield 102, for example, via the input fan 104 and/or the output fan 106. The light emitter arrangement 850 may be provided on the bottom base 454 of at least one of the input fan 104 and the output fan 106. The light emitter arrangement 850 may be configured to emit light, preferably white light, for illuminating the face of the wearer. The light emitter arrangement 850 may be positioned on an inner surface 105 of the cover shield 102 that faces the wearer. The light emitter arrangement 850 may also be coupled to the switch 132, so that it may be selectively operated via the switch 132.

[0078] FIGS. 9A and 9B show a front perspective view and a rear perspective view of a face mask 900, respectively, according to various embodiments. The face mask 900 may be similar to the face mask 100, 300, or 800, and may further include at least one mounting member 920 in a vicinity to an upper edge of the cover shield 102. The at least one mounting member 920 may be configured to removably affix an eye shield 902 above the cover shield 102 for covering the eyes of the wearer. The face mask 900 may further include the eye shield 902. The eye shield 902 may include a front fastener 922 shaped to clip onto the cover shield 102.

[0079] FIGS. 10A and 10B show the eye shield 902 according to various embodiments. The eye shield 902 may be substantially transparent. The eye shield 902 may be formed from a clear polymer, such as polycarbonate.

[0080] Referring to FIG. 10A, the eye shield 902 may be cut out from a flat, planar material. For example, it may be formed by die-cut on a flat piece of polymer. The eye shield 902 may be shaped to include the front fastener 922. The front fastener 922 may include at least two extending members 1026, separated by a center groove 1020. Each of the extending members 1026 may have a side groove 1022 adjacent to it. The front fastener 922 may fasten onto the cover shield 102 using the extending members 1026. The front fastener 922 may hook onto the skin cushion 108. The skin cushion 108 may include complementary cavities (not shown in FIG. 10A) shaped to receive the extending members 1026 of the front fastener 922. The cavities will be described with respect to FIGS. 12A and 12B. The eye shield 902 may have at least one hole 924 in a vicinity of opposite side edges of the eye shield 902. The hole 924 may be shaped to receive the mounting member 920.

[0081] Referring to FIG. 10B, the eye shield 902 may be flexible to conform to a shape of the cover shield 102. For example, the cover shield 102 may be curved, and the eye shield 902 may be deformed to form a corresponding curvature, so that the eye shield 902 may be mounted above the cover shield 102.

[0082] FIG. 11A and 11B shows the mounting member 920 on the cover shield 102 and the hole 924 on the eye shield 902, respectively, according to various embodiments. The mounting member 920 may have a first end 1120 coupled to the cover shield 102, and a second end 1124 opposite to the first end. The mounting member 920 may include a catch member 1122 between the first end 1120 and the second end 1124. The first end 1120 and the second end 1124 may be smaller in diameter than the hole 924 on the eye shield 902, while the catch member 1122 may be larger in diameter than the hole 924. The mounting member 920 may be resilient and deformable. To mount the eye shield 902 to the cover shield 102, the mounting member 920 may be pushed into the hole 924. When the mounting member 920 is pushed into the hole 924, the mounting member may be deformed so that the catch member 1122 can pass through the hole 924.

[0083] FIGS. 12A and 12B show views of the cavities 1222 in the skin cushion 108 according to various embodiments. FIG. 12A shows a simplified view of the face mask 900 where the eye shield 902, the input fan 104 and output fan 106 are omitted for brevity. The skin cushion 108 may include a plurality of cavities 1222 arranged along an upper edge of the

cover shield 102. The cavities 1222 may be positioned to match the front fastener 922. The cavities 1222 may be shaped to receive the extending members 1026 of the front fastener 922 in them. The front fastener 922 of the eye shield 902 may hook onto the cavities 1222 to attach the eye shield 902 onto the cover shield 102. FIG. 12B shows an enlarged view of the region 1220 of FIG. 12A.

[0084] FIG. 13 is a flow diagram showing a method of fabricating a face mask according to various embodiments. The method may include providing a cover shield shaped to cover the nose and mouth of a wearer, in 1202. The cover shield may define an inner space between the cover shield and the skin of the wearer. The method may further include coupling an input fan to the cover shield, in 1204. The input fan may be configured to draw air from outside into the inner space. The method may further include coupling an output fan to the cover shield, in 1206. The output fan may be configured to expel air out of the inner space.

[0085] FIG. 14 shows a rear perspective view of a face mask 1400 according to various embodiments. The face mask 1400 may be similar to any one of the face masks 100, 300, 800, or 900. The face mask 1400 may include features that are present in any one of the face masks 100, 300, 800, or 900. The face mask 1400 may include a cover shield 102 that is shaped to cover the nose and the mouth of a wearer. The cover shield 102 may have an inner surface 105 and an opposite outer surface 107. The inner surface 105 may face the wearer when the cover shield 102 covers the nose and the mouth of the wearer. The face mask 1400 may also include a microphone 1402. The microphone 1402 may be configured to receive sound waves and may be further configured to generate audio data based on the received sound waves. The microphone 1402 may be coupled to the inner surface 105 of the cover shield 102. The microphone 1402 may be positioned to the cover shield 102 such that when the face mask 1400 is in use, i.e. worn by the wearer, the microphone 1402 is facing the mouth of the wearer. The microphone 1402 may pick up the wearer's voice when the wearer is speaking, and may convert the wearer's voice into audio data. The audio data may include digitized audio information. The face mask 1400 may further include a transceiver 1404, and a controller 1406. The transceiver 1404 may be configured to communicate bidirectionally with a mobile device (not shown in FIG. 14). The transceiver 1404 may be configured to receive and transmit data over a wireless connection. The controller 1406 may be configured to control operations of the transceiver 1404, in particular, to control the transceiver 1404 to transmit audio data generated by the microphone 1402, to the mobile device.

[0086] The face mask 1400 may further include a notification module 1408. The notification module 1408 may be coupled to the cover shield 102. The notification module 1408 may be configured to generate notification signals. In an embodiment, the notification module 1408 may include a speaker configured to emit sounds, and the notification signal may be a sound, such as ringing tone, or a tune. In another embodiment, the notification module 1408 may include an actuator configured to generate haptic signals, and the notification signal may be a haptic signal. The haptic signal may be a vibration, or a movement of the actuator.

[0087] The positions of the transceiver 1404, the controller 1406 and the notification module 1408 shown in FIG. 14 are merely illustrative, and are not meant to be limiting. For example, the transceiver 1404, the controller 1406 and the notification module 1408 may be coupled to any one of the inner surface 105 or the outer surface 107 of the cover shield 102, or may be coupled to other parts of the face mask 1400.

[0088] FIG. 15 shows a conceptual diagram of the face mask 1400 according to various embodiments. As described with respect to FIG. 14, the face mask 1400 may include the cover shield 102, the microphone 1402, the transceiver 1404, the controller 1406, and may optionally include the notification module 1408. In addition, the face mask 1400 may include one or more of an answer button 1510, an acoustic transducer 1512, a speaker 1514, a voice recognition module 1516, an analytic processor 1518, and a sensing device 1520, which will be described in subsequent paragraphs. These components of the face mask 1400 may be coupled, mechanically, or electrically, like indicated by the lines 1580.

[0089] The sensing device 1520 may include at least one of a pulse sensor 1522, a temperature sensor 1524, a fall sensor 1526, an air humidity sensor 1528, an air analyser 1530 and a pedometer 1532. The sensing device 1520 will be described in subsequent paragraphs, with respect to FIGS. 21 and 27 to 30.

[0090] According to various embodiments, the face mask 1400 may be configured to perform communication functions with a mobile device. The face mask 1400 may receive the wearer's voice using the microphone 1402. In a first operation mode, herein referred to as "over-the-air" mode, the transceiver 1404 of the face mask 1400 may transmit the wearer's voice, as received by the microphone 1402, to the mobile device during the phone call. As a result, the wearer's voice may be clearly heard over the phone call, without being muffled by the cover shield 102. Therefore, the wearer may carry out a phone conversation without having to take off the face mask 1400. In a second operation mode, herein referred to as "face-to-face" mode, the face mask 1400 may transmit the wearer's voice, as received by the

microphone 1402, to the mobile device, together with an instruction message to the mobile device. The instruction message may instruct the mobile device to play the wearer's voice on a speaker mode. Consequently, the wearer may speak to another person face-to-face, by having the wearer's voice played by the mobile device. In another embodiment, the face mask 1400 may play the wearer's voice using the speaker 1514 of the face mask 1400, for face-to-face communication with another person. The speaker 1514 may amplify the wearer's voice, so that the wearer's voice may be heard clearly.

[0091] The face mask 1400 may generate a mode selection input that indicates a selected operating mode, for switching between the over-the-air mode and the face-to-face mode. The transceiver 1404 may transmit the mode selection input to the mobile device, to activate the selected operating mode in the mobile device. The face mask 1400 may include a mode switch that is operable to generate the mode selection input. Alternatively, the mode selection input may be provided by a voice recognition module 1516. The voice recognition module 1516 may be configured to recognize voice commands in sound waves received in the microphone 1402, and may generate a controller signal based on the recognized voice commands. The voice recognition module 1516 may provide the controller signal to the controller 1406 as the mode selection input. In addition, the mode selection input may be provided by the mobile device directly, for example, through a mobile device application.

[0092] FIG. 16 is a sequence diagram that shows the interaction between the face mask 1400 and a mobile device 1602, in a scenario where there is an incoming call on the mobile device 1602, according to various embodiments. The face mask 1400 may be operating in an "over-the-air" mode. The mobile device 1602 may be, for example, a mobile phone, or a computer. When the mobile device 1602 receives an incoming call from, for example, a telecommunications network, the mobile device 1602 may alert the user, i.e. the wearer of the face mask 1400, of the incoming call, in 1610. The mobile device 1602 may transmit a status signal to the face mask 1400. The status signal may be indicative of the incoming phone call. The transceiver 1404 may receive the status signal from the mobile device 1602, and may relay the status signal to the controller 1406. The transceiver 1404 may transmit and receive data over a wireless connection, such as Bluetooth, WiFi, or Near-field communication. The user may press the answer button 1510 on the face mask 1400, to answer the incoming call. The face mask 1400 may then send a command signal to the mobile device 1602, in 1612. The command signal may include instructions for the mobile device 1602 to answer the incoming call. When the user operates the answer button 1510, the answer button 1510 may

generate a button signal. The controller 1406 may receive the button signal. Based on the received button signal, the controller 1406 may transmit the command signal to the mobile device 1602. After the mobile device 1602 has answered the phone call, it may send incoming voice data to the face mask 1400, in 1614. The incoming voice data may be received by the transceiver 1404. The mobile device 1602 may also transmit a call connection status signal to the transceiver 1404. The call connection status signal may be indicative of a connected phone call on the mobile device 1602. The face mask 1400 may send user voice data to the mobile device 1602 when the phone call is connected, in 1616. The transmitter 1404 may transmit the user voice data to the mobile device 1602, in response to receiving the call connection status signal. The transmission of incoming voice data to the face mask 1400, and the transmission of the user voice data to the mobile device 1602, may repeat until the phone call ends. The transmissions may occur at a predetermined frequency.

[0093] According to various embodiments, the face mask 1400 may include a notification module configured to notify the wearer about the incoming phone call. Based on the status signal, the controller 1406 may control the notification module 1408 to generate a notification signal for informing the wearer about the incoming phone call. The notification signal may be a haptic signal, such as a vibration that may be felt by the wearer, or a notification sound such as a ring tone. The notification module 1408 may include an actuator configured to generate the haptic signal. The notification module 1408 may include a speaker configured to output the notification sound, for example, the speaker 1514.

[0094] In alternative embodiments, the face mask 1400 may communicate with the mobile device 1602 using a wired connection, such as a USB cable, and bypassing the transceiver 1404.

[0095] FIG. 17 is a sequence diagram that shows the interaction between the face mask 1400 and a mobile device 1602, in a scenario where there is an incoming call on the mobile device 1602, according to various embodiments. FIG. 17 may differ from FIG. 16, only in that the phone call is answered using the mobile device 1602, instead of using the face mask 1400, and as such, no command signal is sent from the face mask 1400 to the mobile device 1602.

[0096] FIG. 18 is a flow chart of an operation process of the face mask 1400 in the face-to-face mode, according to various embodiments. In 1802, the wearer may press a mode button. Pressing the mode button may activate a mode switch. Upon activation, the mode switch may generate a mode selection input that indicates a selected operating mode. In this scenario, the selected operating mode is the face-to-face mode. In 1804, the face mask 1400 may transmit

a command to a mobile application running on the mobile device 1602. The command may include the mode selection input. In 1806, on receiving the command, the mobile device 1602 may turn on its speaker. In 1808, after the mode selection input is generated, the face mask 1400 may turn on its internal microphone, i.e. microphone 1402. The microphone 1402 may pick up the wearer's voice up in the form of sound waves, and may generate audio data based on the sound waves. In 1810, the microphone 1402 may sample the sound waves to generate audio data, also referred herein as voice data. Sampling the sound waves may include digitally encoding the sound waves. In 1812, the microphone 1402 or the controller 1406 may packetize the voice data. Packetizing the voice data may include partitioning the voice data into units for transmission in a packet-switching network. In 1814, the transceiver 1404 may transmit the packetized voice data to the mobile device 1602. The transceiver 1404 may transmit the packetized voice data over a short range wireless technology, such as Bluetooth, NFC or infrared. In 1816, the mobile device 1602 may receive the voice data transmission 1822 from the face mask 1400. In 1818, the mobile device 1602 may convert the received packetized voice data to audio signals. In 1820, the mobile device 1602 may output the audio signals as sounds waves, using its speakers.

[0097] FIG. 19 is a flow chart of an operation process of the face mask 1400 in the face-to-face mode, according to various embodiments. In 1902, the wearer may trigger generation of a mode selection input using a mobile application running on the mobile device 1602. The mode selection input may be indicative of the mode selection, which in this case is the face-to-face mode. In 1904, upon generation of the mode selection input, the mobile device 1602 may transmit a command to the face mask 1400. The command may include the mode selection input. In 1906, on receiving the mode selection input, the mobile device 1602 may turn on its speaker. In 1908, the face mask 1400 may receive the command from the mobile device 1602, through its transceiver 1404. In 1910, on receiving the command from the mobile device 1602, the face mask 1400 may turn on its internal microphone, i.e. microphone 1402. The microphone 1402 may pick up the wearer's voice up in the form of sound waves, and may generate audio data based on the sound waves. In 1912, the microphone 1402 may sample the sound waves to generate audio data, also referred herein as voice data. Sampling the sound waves may include digitally encoding the sound waves. In 1914, the microphone 1402 or the controller 1406 may packetize the voice data. In 1916, the transceiver 1404 may transmit the packetized voice data to the mobile device 1602. The transceiver 1404 may transmit the packetized voice data over a short range wireless technology, such as Bluetooth,

NFC or infrared. In 1920, the mobile device 1602 may receive the voice data transmission 1918 from the face mask 1400. In 1922, the mobile device 1602 may convert the received packetized voice data to audio signals. In 1924, the mobile device 1602 may output the audio signals as sounds waves, using its speakers.

[0098] FIG. 20 is a flow chart of an operation process of the face mask 1400 in the face-to-face mode, according to various embodiments. The microphone 1402 of the face mask 1400 may be turned on. In 2002, the wearer may speak into the microphone 1402, to give a voice command. The face mask 1400 may include a voice recognition module 1516. In 2004, the voice recognition module 1516 may recognize the voice command in the sound waves received in the microphone 1402. The voice recognition module 1516 may recognize the voice command by detecting keywords. The voice command may include the mode selection input. The mode selection input may be indicative of the mode selection, which in this case is the face-to-face mode. In 2006, the face mask 1400 may send a command to the mobile device 1602. In 2008, on receiving the command, the mobile device 1602 may turn on its speaker. In 2010, the microphone 1402 may sample the sound waves to generate audio data, also referred herein as voice data. Sampling the sound waves may include digitally encoding the sound waves. In 2012, the microphone 1402 or the controller 1406 may packetize the voice data. In 2014, the transceiver 1404 may transmit the packetized voice data to the mobile device 1602. The transceiver 1404 may transmit the packetized voice data over a short range wireless technology, such as Bluetooth, NFC or infrared. In 2018, the mobile device 1602 may receive the voice data transmission 2016 from the face mask 1400. In 2020, the mobile device 1602 may convert the received packetized voice data to audio signals. In 2022, the mobile device 1602 may output the audio signals as sounds waves, using its speakers.

[0099] During the operation processes shown in FIGS. 18, 19 and 20, the wearer may hold a face-to-face conversation with another person while wearing the face mask 1400, by speaking into the in-built microphone 1402. The face mask 1400 converts the wearer's voice into audio signals in the form of data packets, and transmits the audio signals to the mobile device 1602 which then plays the wearer's voice on its speaker. The conversation partner may thus hear the wearer's voice as output by the mobile device 1602.

[00100] In an alternative embodiment, the face mask 1400 may operate in the face-to-face mode without requiring the mobile device 1602. The face mask 1400 may include its own in-

built speaker 1514 which outputs the wearer's voice. In this alternative embodiment, the face mask 1400 need not transmit the wearer's voice to the mobile device 1602.

[00101] According to various embodiments, the face mask 1400 may be configured to monitor the wearer's well-being. The face mask 1400 may monitor the wearer's well-being by measuring the wearer's vitals, such as his heart rate, temperature, breath, and movement. The face mask 1400 may include one or more sensing device 1520 for measuring the vitals. The transceiver 1404 may be configured to transmit the measurements, also referred herein as health-related measurements, generated by the sensing device 1520, to a server, or to a mobile device, or to a computer. The server may store the measurement data, and may transmit the measurement data to the mobile device or to the computer. The server may include an associated health-monitoring software configured to analyse the measurement data to provide insights to the wearer's health condition. The mobile device or the computer may also run associated health-monitoring software applications that may perform analysis of the measurement data, or may download the analysis results from the server. The face mask 1400 may also include an analytic processor 1518 that may be configured to assess the well-being of the wearer based on the health-related measurement. The analytic processor 1518 may be configured to generate a warning signal based on the assessment. The transceiver 1406 may transmit the warning signal to the mobile device, or to a computer, or to an emergency service. The analytic processor 1518 may perform the assessment based on a combination of the health-related measurements. For example, a first health-related measurement may indicate that the wearer's pulse rate is approaching a safety pulse rate limit, and a second health-related measurement may indicate that the wearer's temperature is approaching a safety temperature limit. Based on these health-related measurements, the analytic processor 1518 may assess that the wearer is at risk of a heat stroke. Based on the assessment by the analytic processor 1518, the controller 1406 may control the speaker 1514 or the acoustic transducer 1512 to emit a sound to warn the wearer. The controller 1406 may also control the transceiver 1404 to transmit a warning signal to the mobile device.

[00102] FIG. 21 shows the face mask 1400 and preferred positions of components of its sensing device 1520, according to various embodiments. The sensing device 1520 may be coupled to the cover shield 102. The sensing device 1520 may be configured to provide a health-related measurement of the wearer.

[00103] The sensing device 1520 may include a pulse sensor 1522. The pulse sensor 1522 may be coupled to a portion of the face mask 1400 that comes into close contact with one of

the wearer's temple, so that the pulse sensor 1522 may detect pulsing of blood at the temple. The pulse sensor 1522 may measure the heart rate of the wearer based on the detection of pulsing of blood at the temple.

[00104] The sensing device 1520 may include a fall sensor 1526 configured to detect when the wearer falls down. The fall sensor 1526 may detect a sudden drop in the wearer's vertical position. Combined with other data, the analytic processor 1518, or an associated health-monitoring software, may infer a cause of the fall, for example, from sickness or fatigue. The sensing device 1520 may also include a pedometer 1532 configured to measure steps taken by the wearer. The pedometer 1532 may also determine the walking pace or running speed of the wearer. The fall sensor 1526 and the pedometer 1532 may share a common hardware including one or more accelerometers, also referred to as gravity sensor (G-sensor). Alternatively, the fall sensor 1526 and the pedometer may include their individual G-sensors. The G-sensor may be coupled to a side of the cover shield 102, away from the mouth and nose of the wearer.

[00105] The sensing device 1520 may include an air humidity sensor 1528. The air humidity sensor 1528 may be configured to monitor the inner environment of the face mask 1400. The air humidity sensor 1528 may be configured to measure a humidity level of the air in an inner space between the cover shield 102 and the skin of the wearer. The air humidity sensor 1528 may further be configured to measure a temperature of the air in the inner space between the cover shield 102 and the skin of the wearer. The air humidity sensor 1528 may be coupled to the cover shield 102 and positioned to be near to the wearer's nose and mouth, so as to receive the wearer's exhalation. The analytics processor 1518 may analyse the health status of the wearer based on changes in the water vapor concentration and temperature in the inner space.

[00106] The sensing device 1520 may include an air analyser 1530. The air analyser 1530 may be configured to measure a concentration of carbon dioxide in the inner space between the cover shield 102 and the skin of the wearer. The air analyser 1530 may also be configured to calculate a concentration of oxygen in the inner space, or a ratio of the concentration of oxygen to carbon dioxide in the inner space. The measurements relating to the concentration of carbon dioxide and/or oxygen may be indicative of lung issues of the wearer. The air analyser 1530 may be coupled to the cover shield 102 and positioned to be near to the wearer's nose and mouth, so as to receive the wearer's exhalation.

[00107] The sensing device 1520 may include a temperature sensor 1524. The temperature sensor 1524 may be coupled to the face mask 1400 at a portion that comes into contact with a temple of the wearer. The temperature sensor 1524 may be configured to measure temperature at the temple of the wearer. The temperature sensor 1524 may include a digital thermometer.

[00108] The face mask 1400 may further include a speaker 1514. The speaker 1514 may be coupled to an external surface of the cover shield 102. The external surface may be opposite to the inner surface 105 of the cover shield 102. The speaker 1514 may be configured to emit sound waves picked up by the microphone 1402, for example, to output the wearer's voice. The speaker 1514 may be configured to convert the audio data generated by the microphone 1402 into sound waves. The speaker 1514 may be also be controlled by the controller 1406, configured to emit other sounds, such as warning sounds, or music.

[00109] The face mask 1400 may further include an acoustic transducer 1512. The acoustic transducer 1512 may be coupled to a portion of the face mask 1400 that is near the wearer's ear. The acoustic transducer 1512 may be configured to receive audio data from the mobile device and may be configured to convert the received audio data to sound waves. The acoustic transducer 1512 may include a wireless earphone, or a speaker. In an alternative embodiment, the transceiver 1404 may receive the audio data from the mobile device, and the acoustic transducer 1512 may receive the audio data from the transceiver 1404 through the controller 1406.

[00110] It should be noted that the positions of the pulse sensor 1522, the fall sensor 1526, the pedometer 1532, the air humidity sensor 1528, the air analyser 1530, the speaker 1514, the acoustic transducer 1512, and the temperature sensor 1524 need not be limited to the positions shown in FIG. 21.

[00111] FIG. 22 shows a front perspective view of a face mask 1400 according to various embodiments. The face mask 1400 may include a pair of extension panels 2202 coupled to opposite ends of the cover shield 102. The pair of extension panels 2202 may extend from the opposite ends of the cover shield 102 towards the ears of the wearer. Each extension panel 2202 may at least partially cover an ear of the wearer. Each extension panel 2202 may extend towards the wearer's temples and may at least partially cover a temple of the wearer. The acoustic transducer 1512 may be coupled to one of the extension panels 2202. The face mask 1400 may also include a pair of acoustic transducers 1512. Each acoustic transducer 1512 may be coupled to a respective extension panel 2202. The pulse sensor 1522 may be coupled

to one of the extension panels 2202, such that the pulse sensor 1522 may be in proximity or may contact the wearer's temple. Similarly, the temperature sensor 1524 may be coupled to one of the extension panels 2202, such that the temperature sensor 1524 may be in proximity or may contact the wearer's temple.

[00112] FIG. 23 shows a schematic diagram of data transfer between the face mask 1400 and a health server 2302, according to various embodiments. The face mask 1400 may transmit health-related measurements to the mobile device 1602, in 2310. The mobile device 1602 may be running a health-monitoring software 2330 that may generate a health status report of the wearer based on the received health-related measurements. The health status report may include information measured or calculated by the sensing device 1520, such as pulse rate, humidity, temperature, G-position and carbon dioxide levels. The health status report may indicate any detected irregularities associated with the wearer's health. The mobile device 1602 may transmit the health status report to a health server 2302, in 2312. The health server 2302 may be a cloud server. The health server 2302 may transmit the health status report to a client server, in 2314. The client server may be, for example, a computer in a hospital. For example, a medical professional 2304 may download the health status report from the health server 2302, to evaluate the medical condition of the wearer. The medical professional 2304 may also upload a medical assessment report to the health server 2302, in 2316. The mobile device 1602 may download the medical assessment report from the health server 2302 using the health-monitoring software 2330, in 2318. The health-monitoring software 2330 may generate an alert message based on the medical assessment report, and the mobile device 1602 may send the alert message to the face mask 1400, in 2320. The notification module 1408 of the face mask 1400 may generate a notification signal based on the alert message. For example, the medical assessment report may indicate that the wearer has a heart condition, and the alert message may warn the wearer to reduce his workload. The notification signal may catch the wearer's attention, so that the wearer may check his mobile device 1602 to read the alert message.

[00113] FIG. 24 shows an example of the graphical user interface (GUI) 2400 of the health-monitoring software 2330, according to various embodiments. The health-monitoring software 2330 may be a mobile phone application, and may be installed in the mobile device 1602. The wearer may log into his or her user account on the health-monitoring software 2330. When the health-monitoring software 2330 uploads the wearer's health status report to the health server 2302, the health-monitoring software 2330 may also transmit the wearer's

user account identification, so that the health server 2320 may associate the wearer's health status report with the wearer's user profile.

[00114] The health-monitoring software 2330 may be configured to generate the health status report based on a combination of various health-related measurements. For example, the health-monitoring software 2330 may determine that the wearer's health status is poor, based on an accelerated pulse rate, increasing body temperature, and a sudden change in G-position. Upon determining a potential issue with the wearer's health status, the health-monitoring software 2330 may upload the health status report and may also send a request for the health status report to be evaluated by a medical professional 2304. The health-monitoring software 2330 2330 may also upload the health status report to the health server 2302 on a regular basis, regardless of the health condition of the wearer.

[00115] Referring to the GUI 2400, the health-monitoring software 2330 may display the health-related measurements obtained by the sensing device 1520. For example, the GUI 2400 may display the mask humidity and the mask temperature measured by the air humidity sensor 1528. The GUI 2400 may also display the oxygen rate and the carbon dioxide rate measured by the air analyser 1530. The health-monitoring software 2330 may be configured to receive user inputs to customize the oxygen and carbon levels that are defined as "high", "normal" and "low". The GUI 2400 may display the oxygen rate and the carbon rate in different colors for "high", "normal" and "low".

[00116] The GUI 2400 may also display pulse rate, i.e. heart rate, measured by the pulse sensor 1522. The health-monitoring software 2330 may be configured to receive user inputs to customize the pulse rates that are defined as "high", "normal" and "low". The GUI 2400 may display the pulse rate in different colors for "high", "normal" and "low".

[00117] The GUI 2400 may also display body temperature, measured by the temperature sensor 1524. The health-monitoring software 2330 may be configured to receive user inputs to customize the body temperatures that are defined as "high", "normal" and "low". The GUI 2400 may display the body temperature in different colors for "high", "normal" and "low".

[00118] The GUI 2400 may also include a user menu for the wearer to calibrate the G-sensor used for the fall sensor and the pedometer. The GUI 2400 may also include a user menu for the wearer to pair the mobile device 1602 with the face mask 1400, through Bluetooth. The GUI 2400 may also include a user menu for the wearer to customize the health settings, which may include setting the range of values for "high",

"normal" and "low" for each of the oxygen rate, the carbon dioxide rate, the pulse rate, and the body temperature.

[00119] In various embodiments, the user-defined health settings may be stored in the face mask 1400, for example, a memory in the face mask 1400, or in the analytic processor 1518 or in the controller 1406. The analytic processor 1518 may detect irregularities in the wearer's health status based on comparing the health-related measurements against the user-defined health limits, and may transmit an emergency signal to the mobile device 1602 in response to detecting irregularities.

[00120] In other embodiments, the user-defined health settings may be stored in the health server 2302. The health server 2302 may detect irregularities in the wearer's health status based on comparing the health-related measurements against the user-defined health limits, and may transmit an emergency signal to the mobile device 1602 in response to detecting irregularities.

[00121] FIG. 25 is a sequence diagram that shows the interactions between the face mask 1400 and the health server 2302, via the health-monitoring software 2330, according to various embodiments. The face mask 1400 may establish a wireless connection 2502 with the health-monitoring software 2330. The wireless connection 2502 may be established via a short range wireless technology such as Bluetooth. The health-monitoring software 2330 may establish connection 2504 with the health server 2302. The connection 2504 may be established via cellular network, or via the Internet. In a data collection process, the face mask 1400 may periodically report the wearer's health to the health-monitoring software 2330, in 2506. The face mask 1400 may send health-related measurements in these periodic reports. The health-monitoring software 2330 may send user health data to the health server 2302, in 2508. The user health data may include the health status report. The health server 2330 may perform analysis on the received user health data, or transmit the user health data to a client server for performing analysis. The analysis may be performed by a medical professional, or by artificial intelligence techniques, such as machine-learning.

[00122] The face mask 1400 may send alert notifications to the health-monitoring software 2330 when abnormal conditions are detected, in 2510. The face mask 1400 may detect the abnormal conditions based on comparing the health-related measurements against predefined threshold values. These threshold values may be user-defined through the health-monitoring software 2330 and stored in the face mask 1400. The health-monitoring software 2330 may

also be configured to send alert notifications to the face mask 1400, based on the periodic reports received from the face mask 1400.

[00123] The health server 2302 may receive ad-hoc queries, for example, through a client server. For example, a medical professional may request for the wearer's health data through a client server connected to the health server 2302. The health server 2302 may then transmit the query to the health-monitoring software 2330, in 2512. The health-monitoring software 2330 may forward the query to the face mask 1400, in 2514. The face mask 1400 may respond to the query, and provide the health data to the health-monitoring software 2330, in 2516. The health-monitoring software 2330 may then forward the health data to the health server 2302, in 2518.

[00124] FIG. 26 is a sequence diagram that shows the interactions between the face mask 1400 and the health-monitoring software 2330 according to various embodiments. The sequence diagram of FIG. 26 may be similar to that of FIG. 25, except that the mobile device 1602 may not be connected to the health server 2302 and therefore may store the health reports or data provided by the face mask 1400, instead of immediately transmitting them to the health server 2302. The mobile device 1602 may upload these data to the health server 2302 only upon establishing connection to the health server 2302. A user may also make queries about the wearer's health status through the health-monitoring software 2330.

[00125] FIG. 27 shows a flow chart of the operations of the sensing device 1520 according to various embodiments. The sensing device 1520 may include a plurality of sensors 2700. The plurality of sensors 2700 may include the pulse sensor 1522, the temperature sensor 1524, the fall sensor 1526, the air humidity sensor 1528, the air analyser 1530, and the pedometer 1532. In 2702, the air humidity sensor 1528 may measure the mask humidity level. In 2704, the air humidity sensor 1528 may measure the mask temperature. In 2706, the air analyser 1530 may measure the oxygen rate, or oxygen concentration level, in the face mask 1400. In 2708, the air analyser 1530 may measure the carbon dioxide rate, or carbon dioxide concentration level, in the face mask 1400. In 2710, the pulse sensor 1522 may measure the wearer's pulse rate. In 2712, the temperature sensor 1524 may measure the wearer's temperature. In 2714, the G-sensor of the fall sensor 1526 or the pedometer 1532 may measure an acceleration. In 2716, the measurements of each of these sensors 2700 may be packetized. In 2718, the packetized data may be transmitted to the mobile device 1602. In 2720, the controller 1406 may determine if local checking is enabled. Local checking is a process performed by the face mask 1400, to check for abnormal conditions based on the measurements of the sensors 2700.

The local checking process may be performed by the analytic processor 1518. If local checking is enabled, the mask conditions may be checked in 2722, the wearer's body conditions may be checked in 2724, and fall detection may be conducted in 2726. When the mask conditions are checked, the processes that follow are denoted as "A" 2730, which are described with respect to FIG. 28. When the wearer's body conditions are checked, the processes that follow are denoted as "B" 2732, which are described with respect to FIG. 29. When fall detection is conducted, the processes that follow are denoted as "C" 2734, which are described with respect to FIG. 30. If local checking is not enabled, the measurements of the sensors 2700 may be analysed by the health-monitoring software 2330 in the mobile device or the health server 2302.

[00126] FIG. 28 shows a flow chart of the process of checking mask conditions according to various embodiments. In 2802, the air humidity sensor 1528 may measure the mask humidity level. In 2804, the controller 1406 may determine if the mask humidity level is above a predefined limit. If the mask humidity level exceeds the predefined humidity limit, in 2806, the controller 1406 may provide feedback to the wearer through the notification module 1408. The feedback may be provided in the form of haptic signals or audible alerts. In 2808, the transceiver 1404 may send an alert notification to the mobile device 1602. In 2810, the controller 1404 may control operation of the input fan 104 (as described with respect to FIGS. 1A and 1B), to increase the rate of air flow into the inner space between the cover shield 102 and the skin of the wearer, as well as to increase the rate of expelling air out of the inner space. Consequently, the humidity level in the inner space may decrease.

[00127] In 2812, the air humidity sensor 1528 may measure the mask temperature. In 2814, the controller 1406 may determine if the mask temperature is above a predefined temperature limit. If the mask temperature exceeds the predefined temperature limit, in 2816, the controller 1406 may provide feedback to the wearer through the notification module 1408. The feedback may be provided in the form of haptic signals or audible alerts. In 2818, the transceiver 1404 may send an alert notification to the mobile device 1602. In 2820, the controller 1404 may control operation of the input fan 104 (as described with respect to FIGS. 1A and 1B), to increase the rate of air flow into the inner space between the cover shield 102 and the skin of the wearer, as well as to increase the rate of expelling air out of the inner space. Consequently, the temperature in the inner space may decrease.

[00128] FIG. 29 shows a flow chart of the process of checking the wearer's body conditions according to various embodiments. In 2902, the air analyser 1530 may measure the oxygen

rate in the inner space between the cover shield 102 and the skin of the wearer. In 2904, the controller 1406 may determine if the oxygen rate is above a predefined oxygen rate limit. If the oxygen rate exceeds the predefined oxygen rate limit, in 2906, the controller 1406 may provide feedback to the wearer through the notification module 1408. The feedback may be provided in the form of haptic signals or audible alerts. In 2908, the transceiver 1404 may send an alert notification to the health-monitoring software 2330 that runs on the mobile device 1602.

[00129] In 2910, the air analyser 1530 may measure the carbon dioxide rate in the inner space between the cover shield 102 and the skin of the wearer. In 2912, the controller 1406 may determine if the carbon dioxide rate is above a predefined carbon dioxide rate limit. If the carbon dioxide rate exceeds the predefined carbon dioxide rate limit, in 2914, the controller 1406 may provide feedback to the wearer through the notification module 1408. The feedback may be provided in the form of haptic signals or audible alerts. In 2916, the transceiver 1404 may send an alert notification to the health-monitoring software 2330 that runs on the mobile device 1602.

[00130] In 2920, the temperature sensor 1524 may measure the body temperature of the wearer. In 2922, the controller 1406 may determine if the body temperature is above a predefined temperature limit. If the body temperature exceeds the predefined body temperature limit, in 2924, the controller 1406 may provide feedback to the wearer through the notification module 1408. The feedback may be provided in the form of haptic signals or audible alerts. In 2926, the transceiver 1404 may send an alert notification to the health-monitoring software 2330 that runs on the mobile device 1602.

[00131] In 2930, the pulse sensor 1522 may measure the pulse rate of the wearer. In 2932, the controller 1406 may determine if the pulse rate is above a predefined pulse sensor 1522 limit. If the pulse rate exceeds the predefined pulse rate limit, in 2934, the controller 1406 may provide feedback to the wearer through the notification module 1408. The feedback may be provided in the form of haptic signals or audible alerts. In 2936, the transceiver 1404 may send an alert notification to the health-monitoring software 2330 that runs on the mobile device 1602.

[00132] FIG. 30 shows a flow chart of the process of fall detection, according to various embodiments. In 3002, the fall sensor 1526 may execute a fall detection algorithm. In 3004, the fall sensor 1526 may determine if the wearer has fallen. If the wearer is determined to

have sustained a fall, in 3006, the transceiver 1404 may send an alert notification to the health-monitoring software 2330 that runs on the mobile device 1602.

[00133] The following examples pertain to further embodiments.

[00134] Example 1 is a face mask including: a cover shield shaped to cover nose and mouth of a wearer, the cover shield having an inner surface that faces the wearer when the cover shield covers the nose and the mouth of the wearer; a microphone coupled to the inner surface of the cover shield, the microphone configured to receive sound waves and further configured to generate audio data based on the received sound waves; a transceiver configured to communicate bidirectionally with a mobile device; and a controller configured to control the transceiver to transmit the generated audio data to the mobile device.

[00135] In example 2, the subject-matter of example 1 may further include: a notification module coupled to the cover shield, wherein the transceiver is configured to receive from the mobile device, a status signal indicative of an incoming phone call on the mobile device, and wherein in response to the transceiver receiving the status signal, the controller is further configured to control the notification module to generate a notification signal for informing the wearer about the incoming phone call.

[00136] In example 3, the subject-matter of example 2 may further include that the notification module includes a speaker, and wherein the notification signal is a sound.

[00137] In example 4, the subject-matter of any one of examples 2 to 3 may further include that the notification module includes an actuator, and wherein the notification signal is a haptic signal.

[00138] In example 5, the subject-matter of any one of examples 1 to 4 may further include: an answer button operable to provide a user input, wherein in response to the answer button being operated, the controller is configured to transmit to the mobile device, a command signal including instructions for the mobile device to answer a phone call.

[00139] In example 6, the subject-matter of any one of examples 1 to 5 may further include that the transceiver is configured to receive a call connection status signal indicative of a connected phone call, and wherein the transceiver is further configured to transmit the audio data to the mobile device, in response to receiving the connection status signal.

[00140] In example 7, the subject-matter of any one of examples 1 to 6 may further include: a pair of extension panels coupled to opposite ends of the cover shield, wherein the pair of extension panels extend from the opposite ends of the cover shield towards the ears of the wearer.

[00141] In example 8, the subject-matter of example 7 may further include: an acoustic transducer coupled to one extension panel of the pair of extension panels, wherein the transceiver is further configured to receive audio data from the mobile device, and wherein the acoustic transducer is configured to convert the received audio data to sound waves.

[00142] In example 9, the subject-matter of any one of examples 7 to 8 may further include: a pulse sensor coupled to one extension panel of the pair of extension panels, wherein the extension panels cover temples of the wearer, and wherein the pulse sensor is configured to measure pulse of blood flow at the temple of the wearer.

[00143] In example 10, the subject-matter of any one of examples 7 to 9 may further include: a temperature sensor coupled to one extension panel of the pair of extension panels, wherein the extension panels cover temples of the wearer, and wherein the temperature sensor is configured to measure temperature at the temple of the wearer.

[00144] In example 11, the subject-matter of any one of examples 1 to 10 may further include that the microphone is positioned to the cover shield such that, in use, the microphone is facing the mouth of the wearer.

[00145] In example 12, the subject-matter of any one of examples 1 to 11 may further include: a speaker configured to amplify the sound waves received by the microphone.

[00146] In example 13, the subject-matter of example 12 may further include that the controller is further configured to selectively operate the face mask in one of an over-the-air mode and a face-to-face mode, based on a mode selection input provided by the user, wherein in the over-the-air mode, the transceiver is configured to transmit the sound waves received by the phone, to the mobile device, and wherein in the face-to-face mode, the speaker is configured to output the amplified sound waves.

[00147] In example 14, the subject-matter of example 13 may further include: a voice recognition module configured to recognise voice commands in sound waves received in the microphone, and further configured to generate controller signals based on the recognised voice commands, wherein the mode selection input is provided through the controller signals generated by the voice recognition module.

[00148] In example 15, the subject-matter of any one of examples 1 to 14 may further include: a sensing device coupled to the cover shield, the sensing device configured to provide a measurement, wherein the transceiver is further configured to transmit the measurement to the mobile device.

[00149] In example 16, the subject-matter of example 15 may further include: an analytic processor configured to assess well-being of the wearer based on the measurement, and further configured to generate a warning signal based on the assessment, wherein the transceiver is further configured to transmit the warning signal to the mobile device.

[00150] In example 17, the subject-matter of any one of examples 15 to 16 may further include that the sensing device includes a fall sensor configured to detect a sudden drop in the wearer's vertical position.

[00151] In example 18, the subject-matter of any one of examples 15 to 17 may further include that the sensing device includes a pedometer configured to measure steps taken by the wearer.

[00152] In example 19, the subject-matter of any one of examples 15 to 18 may further include that the sensing device includes an air humidity sensor configured to measure a humidity level of air in an inner space between the cover shield and skin of the wearer.

[00153] In example 20, the subject-matter of any one of examples 15 to 19 may further include that the sensing device includes an air analyser configured to measure a concentration of carbon dioxide in an inner space between the cover shield and skin of the wearer.

[00154] While embodiments of the invention have been particularly shown and described with reference to specific embodiments, it should be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention as defined by the appended claims. The scope of the invention is thus indicated by the appended claims and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced. It will be appreciated that common numerals, used in the relevant drawings, refer to components that serve a similar or the same purpose. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. Unless specifically stated otherwise, the term "some" refers to one or more. Combinations such as "at least one of A, B, or C," "one or more of A, B, or C," "at least one of A, B, and C," "one or more of A, B, and C," and "A, B, C, or any combination thereof" include any combination of A, B, and/or C, and may include multiples of A, multiples of B, or multiples of C.

Specifically, combinations such as “at least one of A, B, or C,” “one or more of A, B, or C,” “at least one of A, B, and C,” “one or more of A, B, and C,” and “A, B, C, or any combination thereof” may be A only, B only, C only, A and B, A and C, B and C, or A and B and C, where any such combinations may contain one or more member or members of A, B, or C. All structural and functional equivalents to the elements of the various aspects described throughout this disclosure that are known or later come to be known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the claims. Moreover, nothing disclosed herein is intended to be dedicated to the public regardless of whether such disclosure is explicitly recited in the claims. The words “module,” “mechanism,” “element,” “device,” and the like may not be a substitute for the word “means.” As such, no claim element is to be construed as a means plus function unless the element is expressly recited using the phrase “means for.”

CLAIMS

1. A face mask comprising:

a cover shield shaped to cover nose and mouth of a wearer, the cover shield having an inner surface that faces the wearer when the cover shield covers the nose and the mouth of the wearer;

a microphone coupled to the inner surface of the cover shield, the microphone configured to receive sound waves and further configured to generate audio data based on the received sound waves;

a transceiver configured to communicate bidirectionally with a mobile device; and

a controller configured to control the transceiver to transmit the generated audio data to the mobile device.

2. The face mask of claim 1, further comprising:

a notification module coupled to the cover shield,

wherein the transceiver is configured to receive from the mobile device, a status signal indicative of an incoming phone call on the mobile device, and

wherein in response to the transceiver receiving the status signal, the controller is further configured to control the notification module to generate a notification signal for informing the wearer about the incoming phone call.

3. The face mask of claim 2, wherein the notification module comprises a speaker, and wherein the notification signal is a sound.

4. The face mask of claim 2, wherein the notification module comprises an actuator, and wherein the notification signal is a haptic signal.

5. The face mask of claim 1, further comprising:

an answer button operable to provide a user input,

wherein in response to the answer button being operated, the controller is configured to transmit to the mobile device, a command signal comprising instructions for the mobile device to answer a phone call.

6. The face mask of claim 1, wherein the transceiver is configured to receive a call connection status signal indicative of a connected phone call, and wherein the transceiver is further configured to transmit the audio data to the mobile device, in response to receiving the connection status signal.

7. The face mask of claim 1, further comprising:

a pair of extension panels coupled to opposite ends of the cover shield, wherein the pair of extension panels extend from the opposite ends of the cover shield towards the ears of the wearer.

8. The face mask of claim 7, further comprising:

an acoustic transducer coupled to one extension panel of the pair of extension panels,

wherein the transceiver is further configured to receive audio data from the mobile device, and wherein the acoustic transducer is configured to convert the received audio data to sound waves.

9. The face mask of claim 7, further comprising:

a pulse sensor coupled to one extension panel of the pair of extension panels, wherein the extension panels cover temples of the wearer, and wherein the pulse sensor is configured to measure pulse of blood flow at the temple of the wearer.

10. The face mask of claim 7, further comprising:

a temperature sensor coupled to one extension panel of the pair of extension panels, wherein the extension panels cover temples of the wearer, and wherein the temperature sensor is configured to measure temperature at the temple of the wearer.

11. The face mask of claim 1, wherein the microphone is positioned to the cover shield such that, in use, the microphone is facing the mouth of the wearer.

12. The face mask of claim 1, further comprising:

a speaker configured to amplify the sound waves received by the microphone.

13. The face mask of claim 12, wherein the controller is further configured to selectively operate the face mask in one of an over-the-air mode and a face-to-face mode, based on a mode selection input provided by the user, wherein in the over-the-air mode, the transceiver is configured to transmit the sound waves received by the phone, to the mobile device, and wherein in the face-to-face mode, the speaker is configured to output the amplified sound waves.

14. The face mask of claim 13, further comprising:

a voice recognition module configured to recognise voice commands in sound waves received in the microphone, and further configured to generate controller signals based on the recognised voice commands, wherein the mode selection input is provided through the controller signals generated by the voice recognition module.

15. The face mask of claim 1, further comprising:

a sensing device coupled to the cover shield, the sensing device configured to provide a measurement,

wherein the transceiver is further configured to transmit the measurement to the mobile device.

16. The face mask of claim 15, further comprising:

an analytic processor configured to assess well-being of the wearer based on the measurement, and further configured to generate a warning signal based on the assessment,

wherein the transceiver is further configured to transmit the warning signal to the mobile device.

17. The face mask of claim 15, wherein the sensing device comprises a fall sensor configured to detect a sudden drop in the wearer's vertical position.

18. The face mask of claim 15, wherein the sensing device comprises a pedometer configured to measure steps taken by the wearer.

19. The face mask of claim 15, wherein the sensing device comprises an air humidity sensor configured to measure a humidity level of air in an inner space between the cover shield and skin of the wearer.

20. The face mask of claim 15, wherein the sensing device comprises an air analyser configured to measure a concentration of carbon dioxide in an inner space between the cover shield and skin of the wearer.

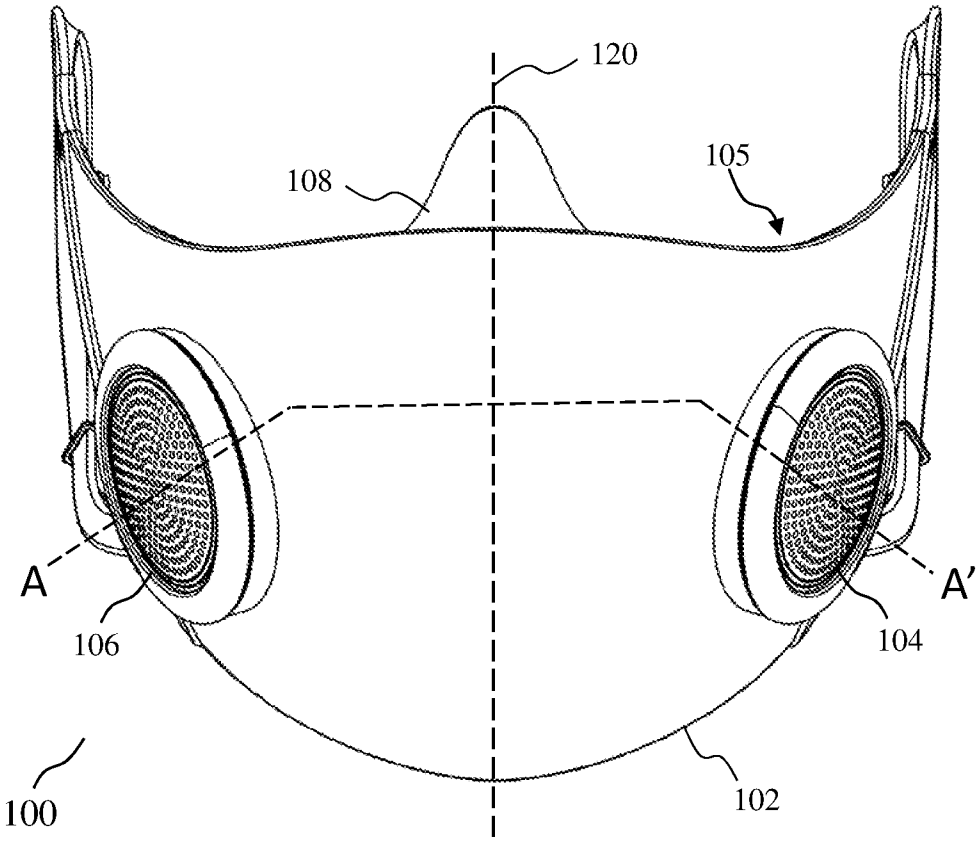

FIG. 1A

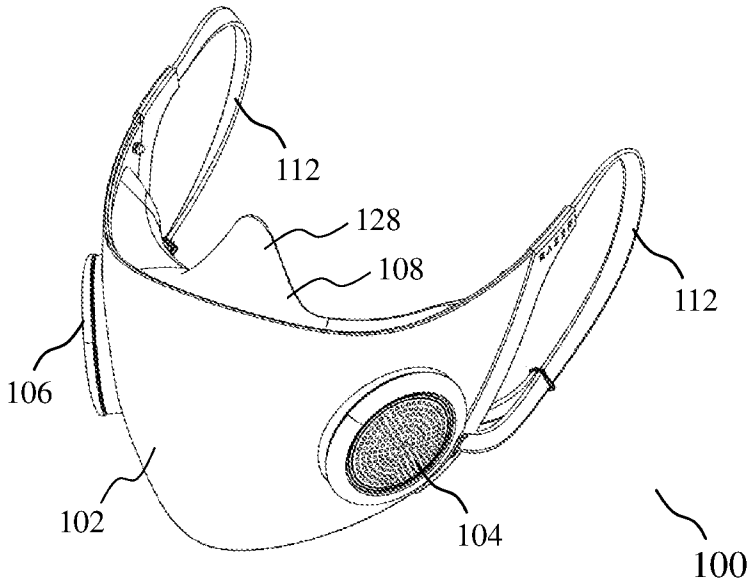

FIG. 1B

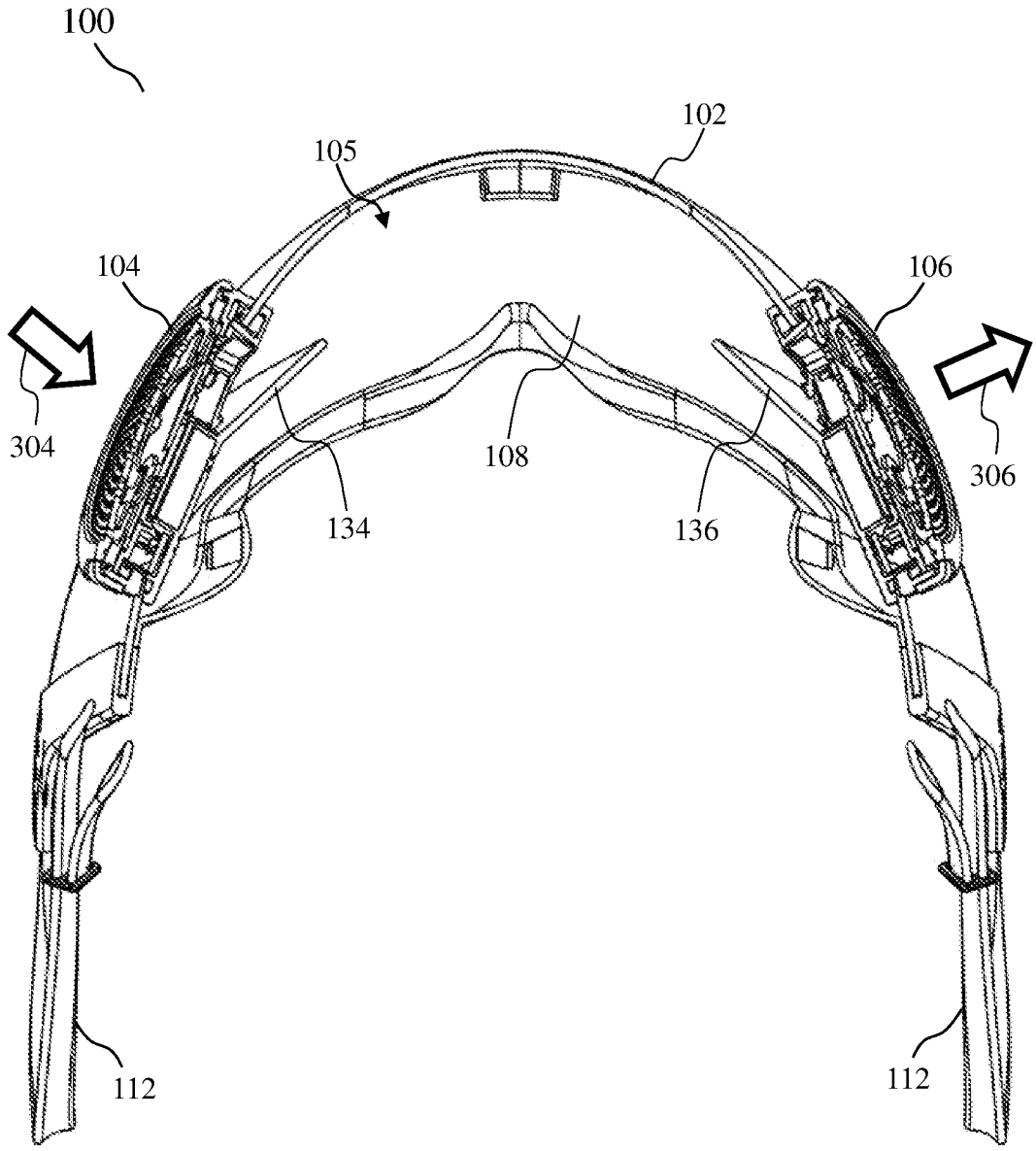

FIG. 2

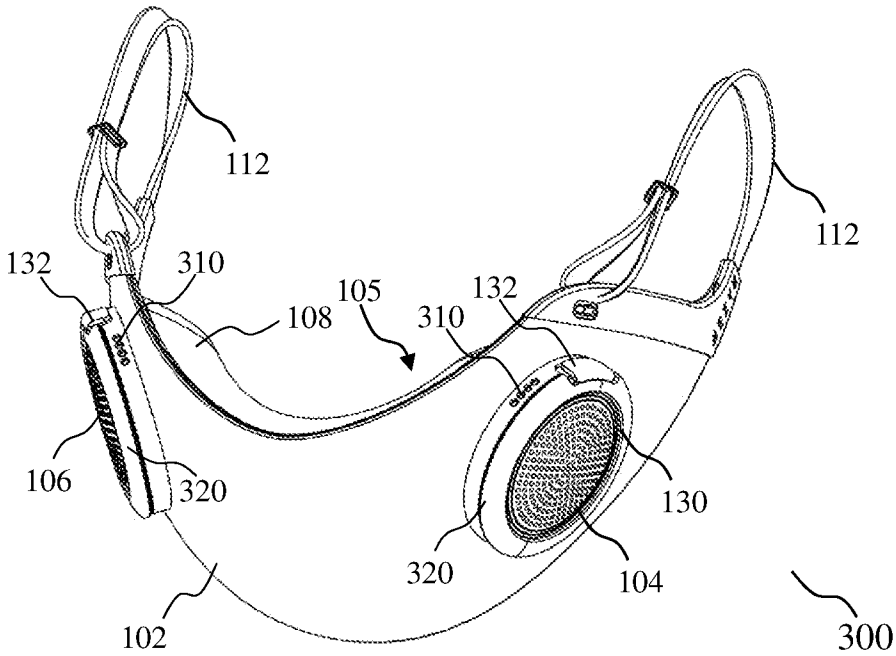
112
112
132
310
105
132
108
310
106
320
130
320
104
102
300

FIG. 3A

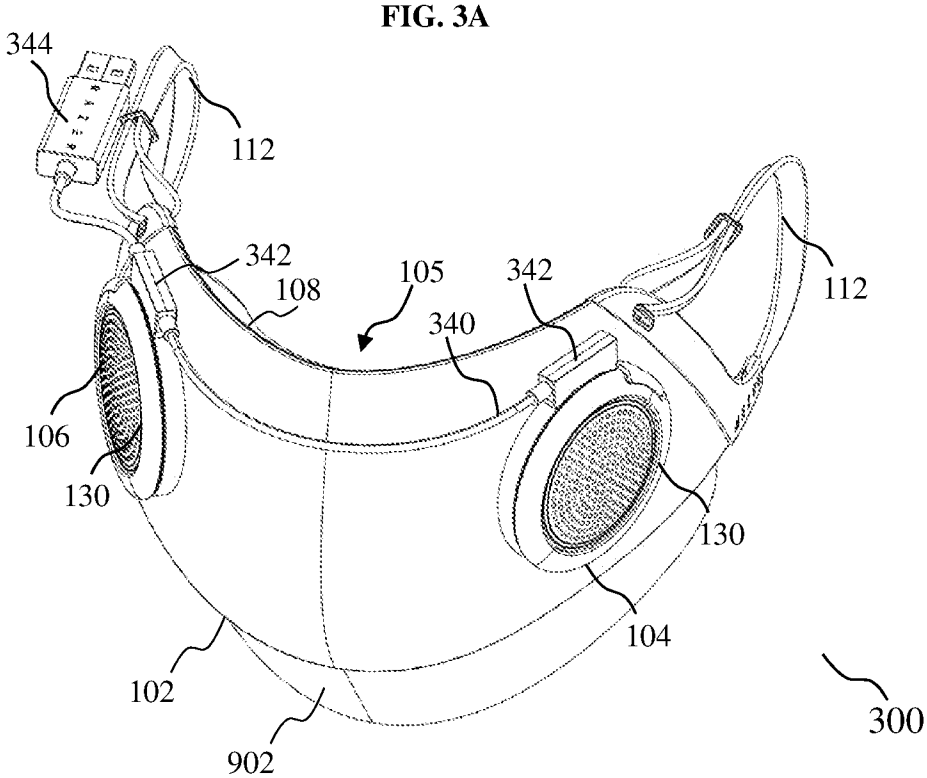
344
112
342
105
342
108
112
340
106
130
130
104
102
902
300

FIG. 3B

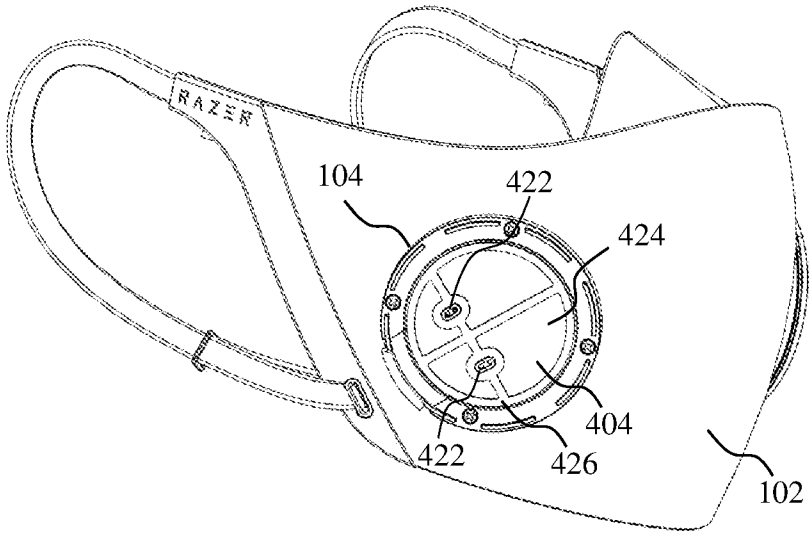
RAZER
104
422
424
404
422
426
102

FIG. 4A

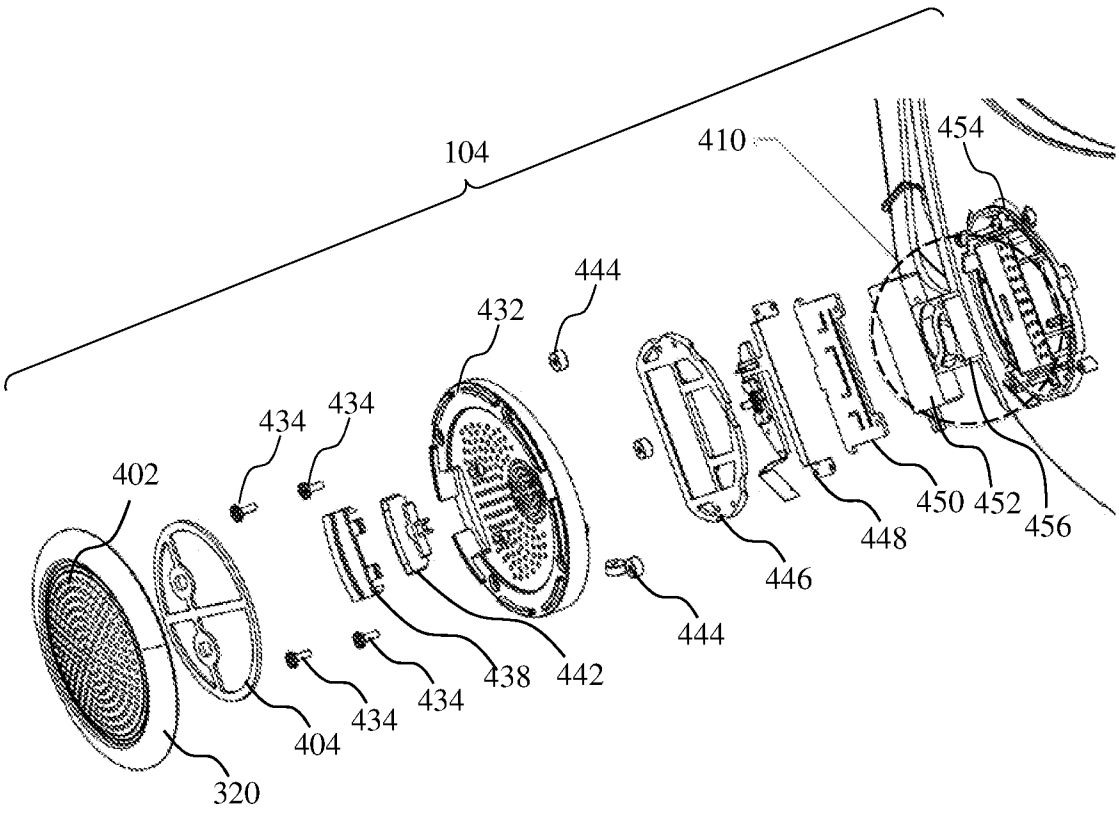
104
410
454
444
432
434
434
402
450
452
456
448
446
444
438
442
434
434
404
320

FIG. 4B

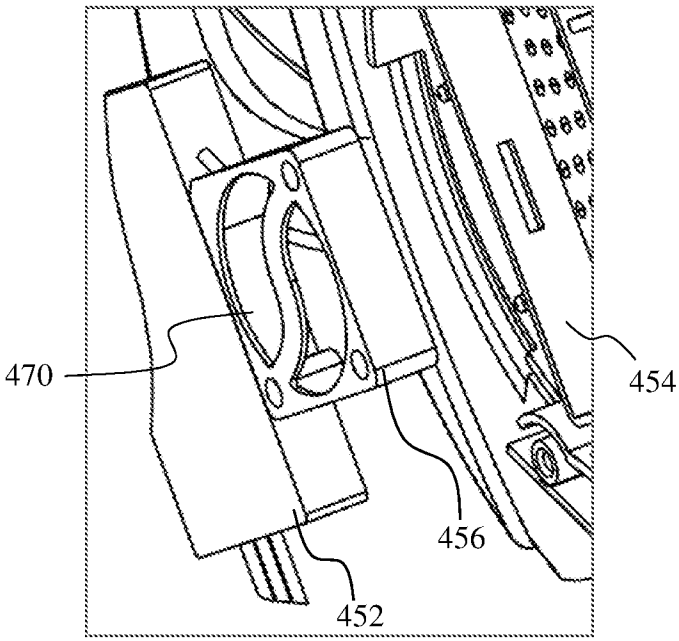

FIG. 4C

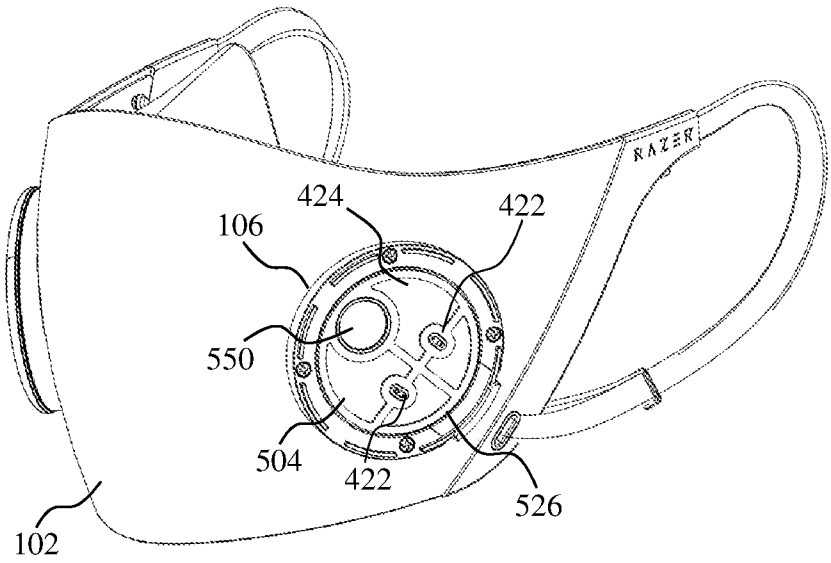

FIG. 5A

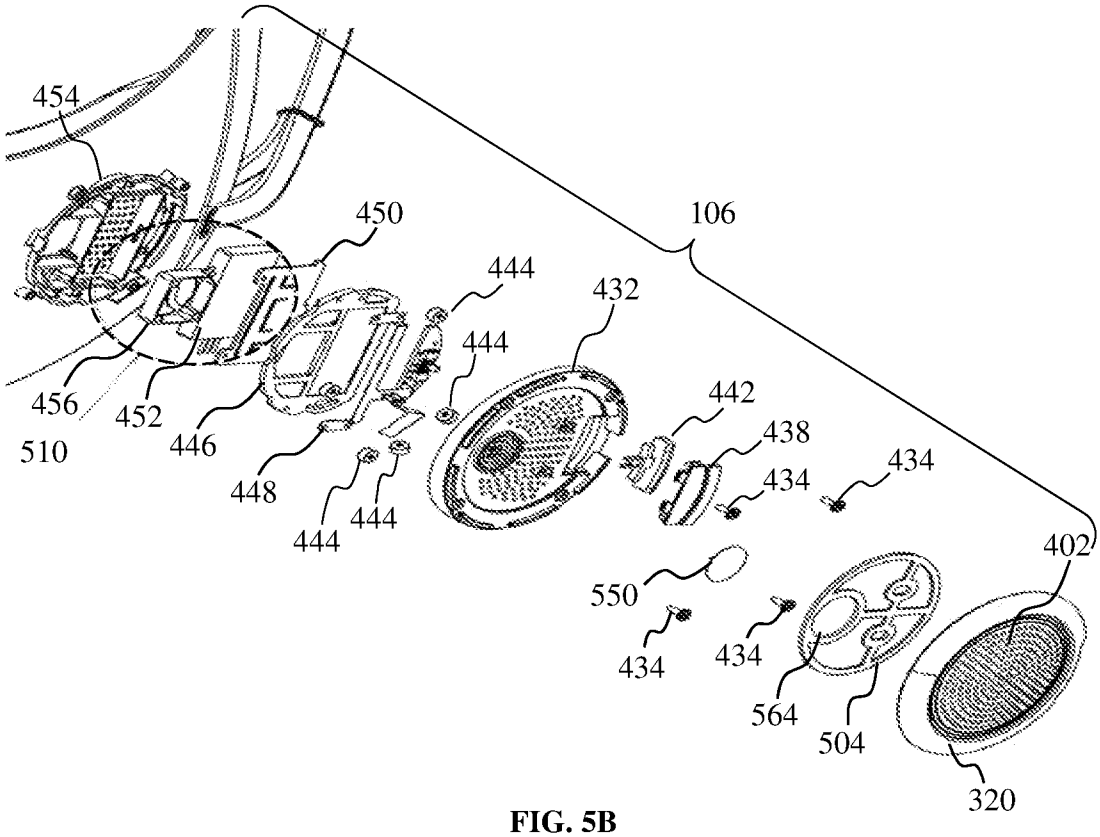
454
450
106
444
432
444
456
452
446
442
438
510
448
434
434
444
444
402
550
434
434
564
504
320

FIG. 5B

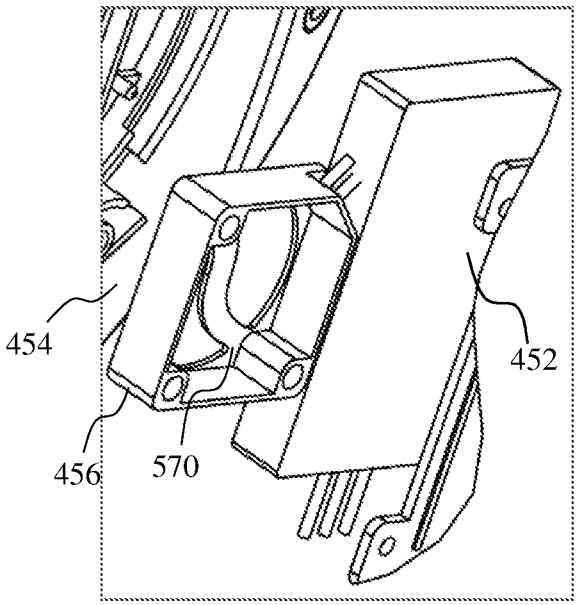
454
452
456
570

FIG. 5C

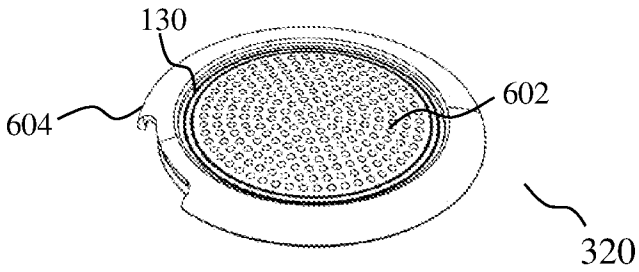

FIG. 6A

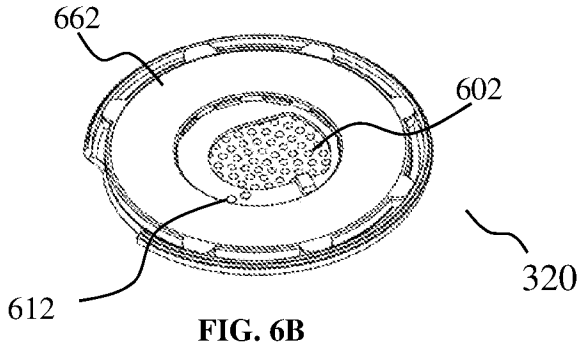

FIG. 6B

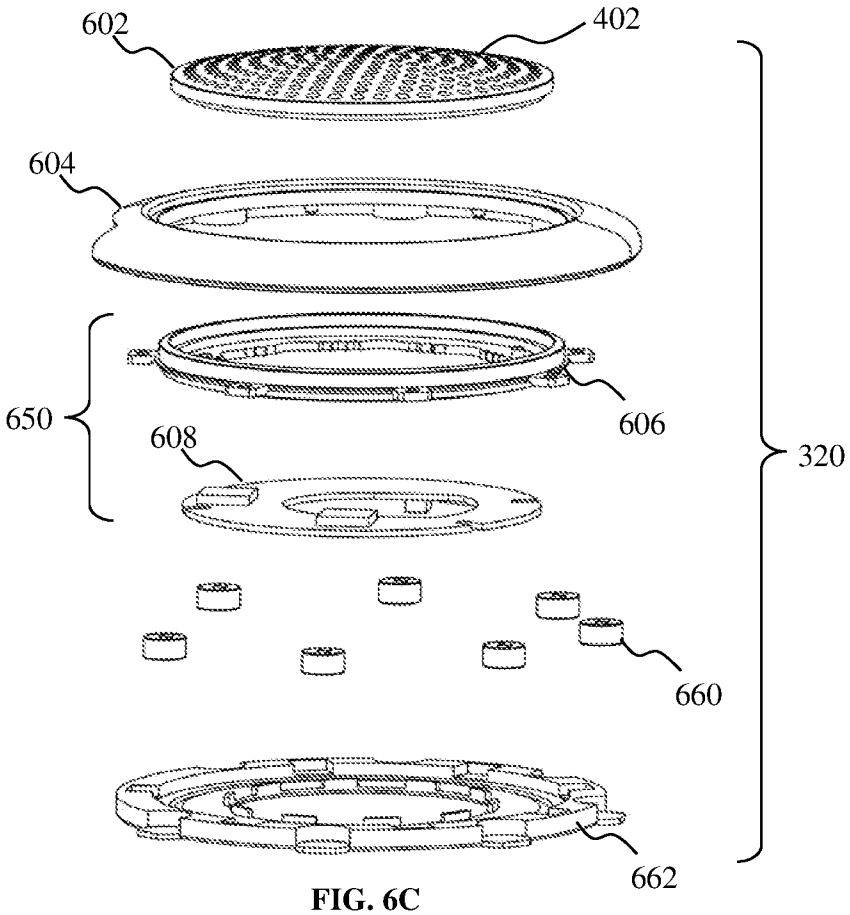

FIG. 6C

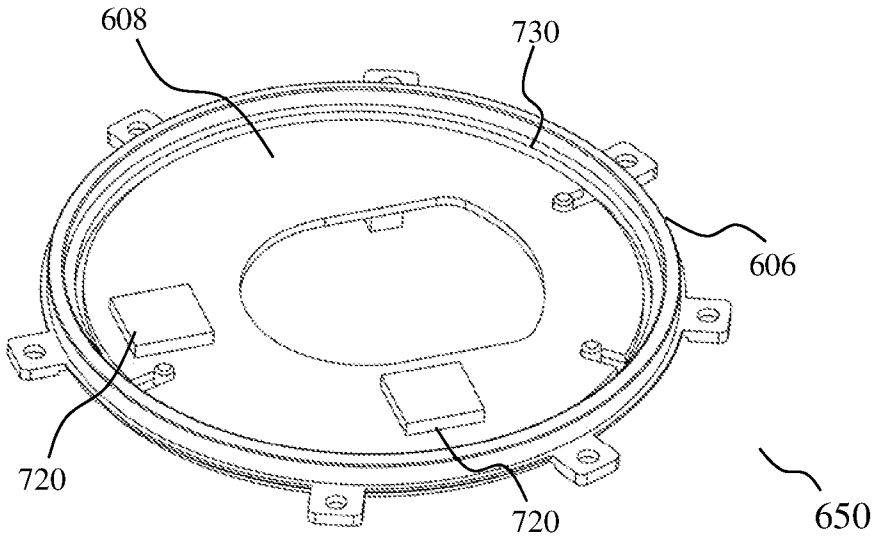
608
730
606
720
720
650

FIG. 7A

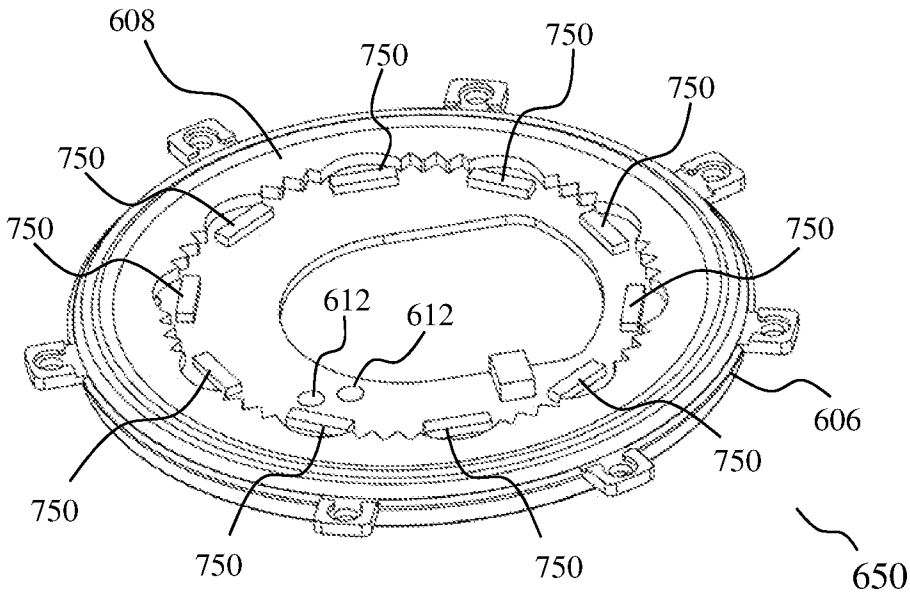
608
750
750
750
750
750
750
612
612
606
750
750
750
750
650

FIG. 7B

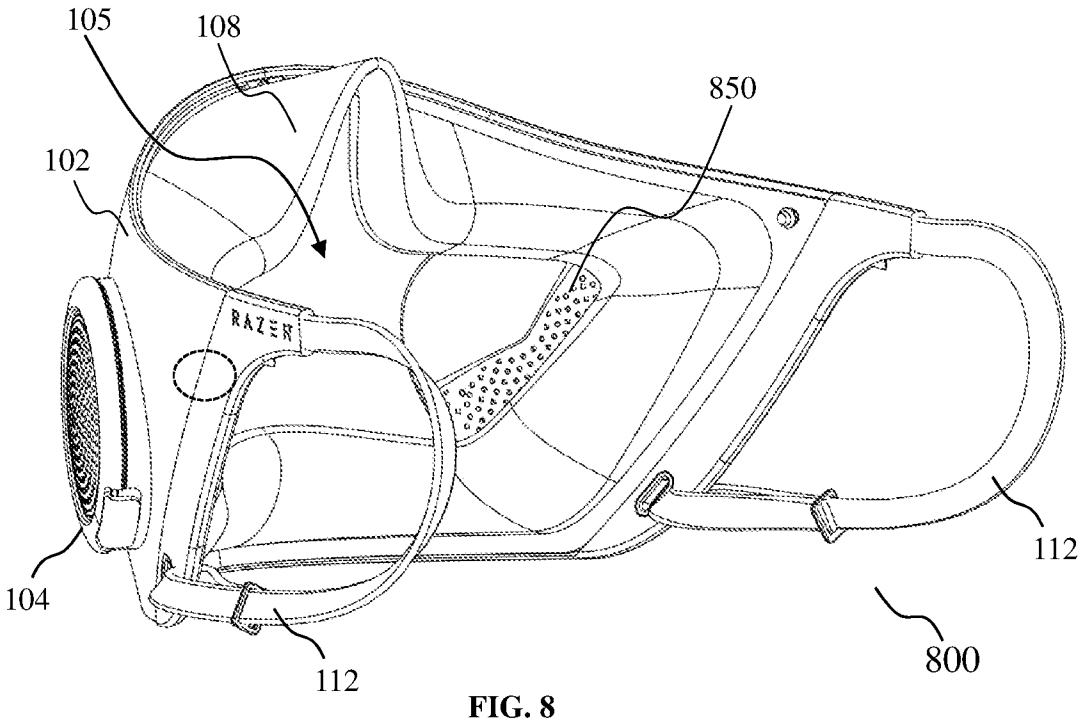

FIG. 8

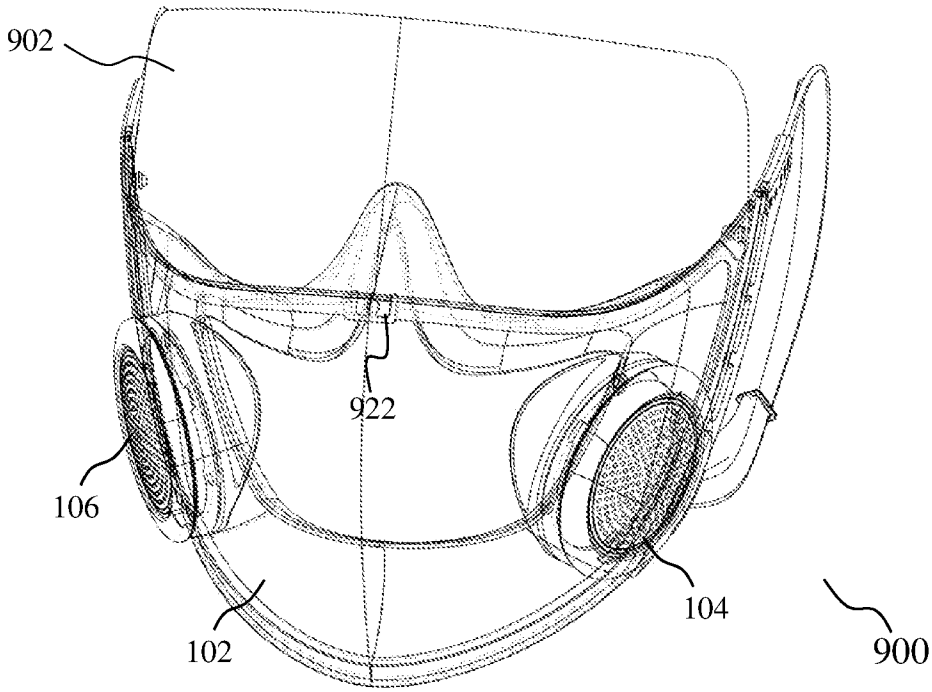

FIG. 9A

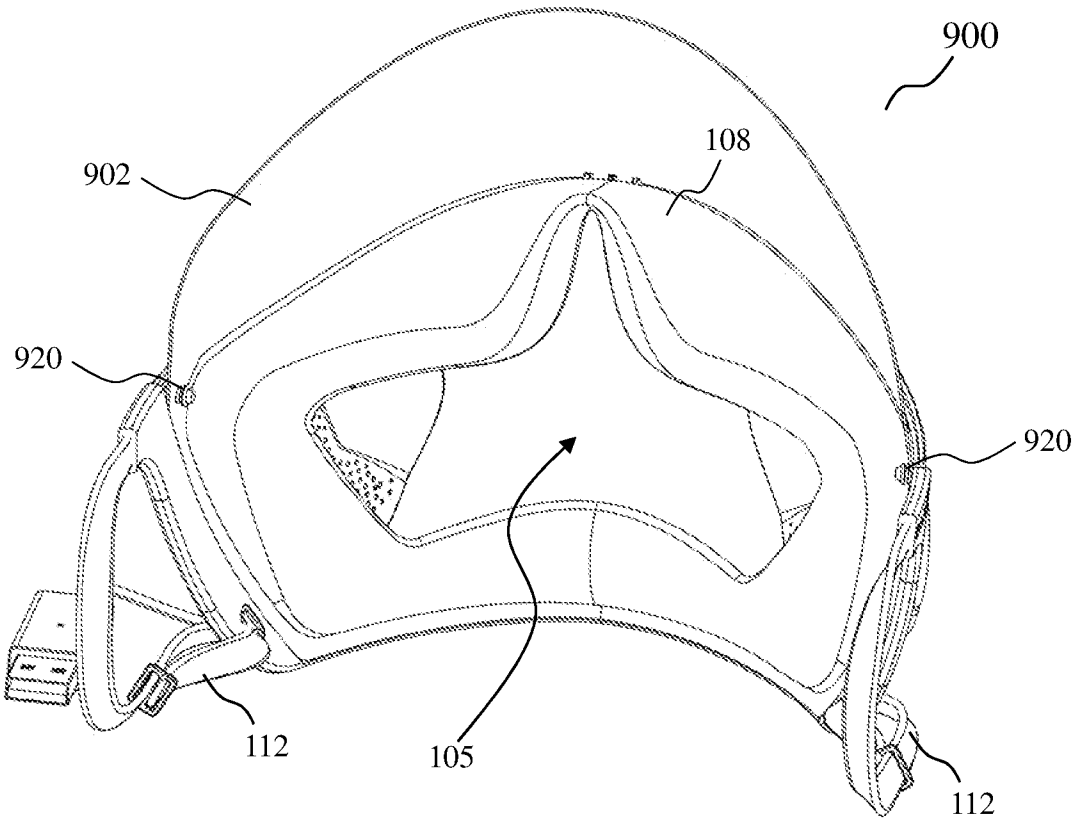

FIG. 9B

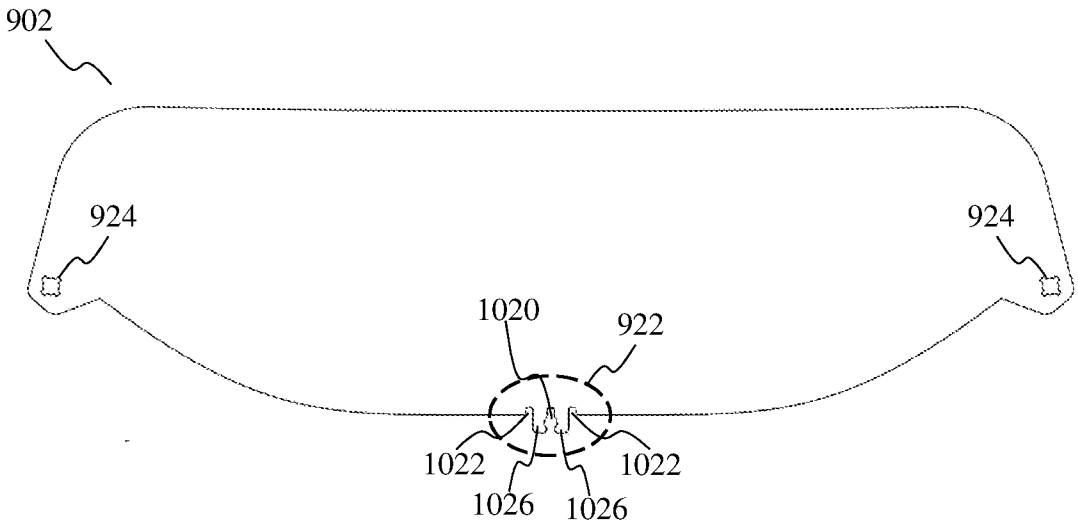

FIG. 10A

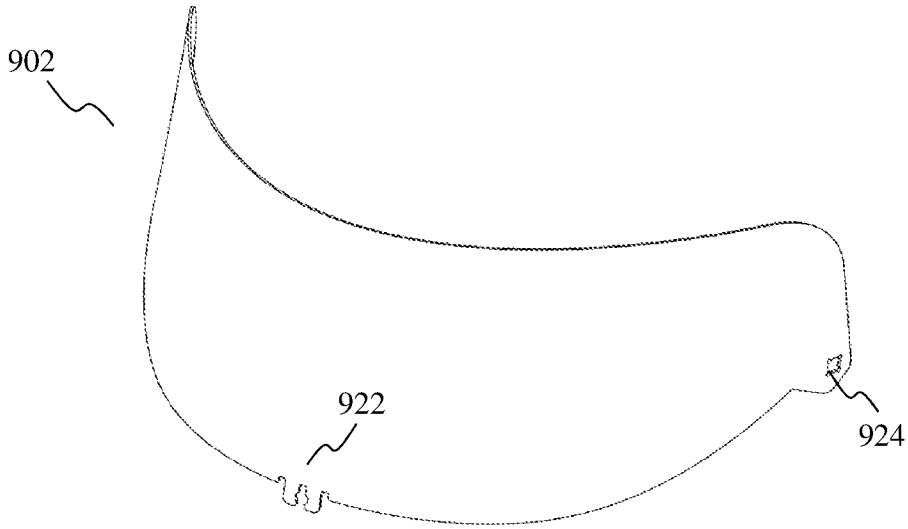

FIG. 10B

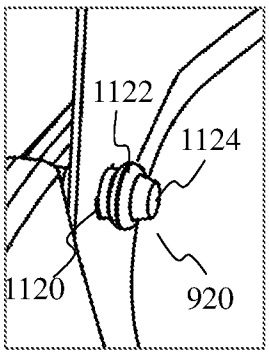

FIG. 11A

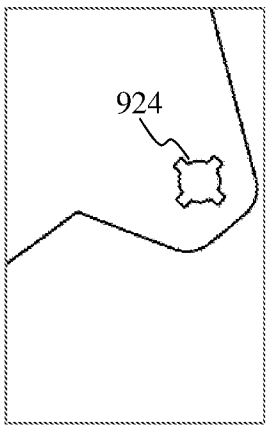

FIG. 11B

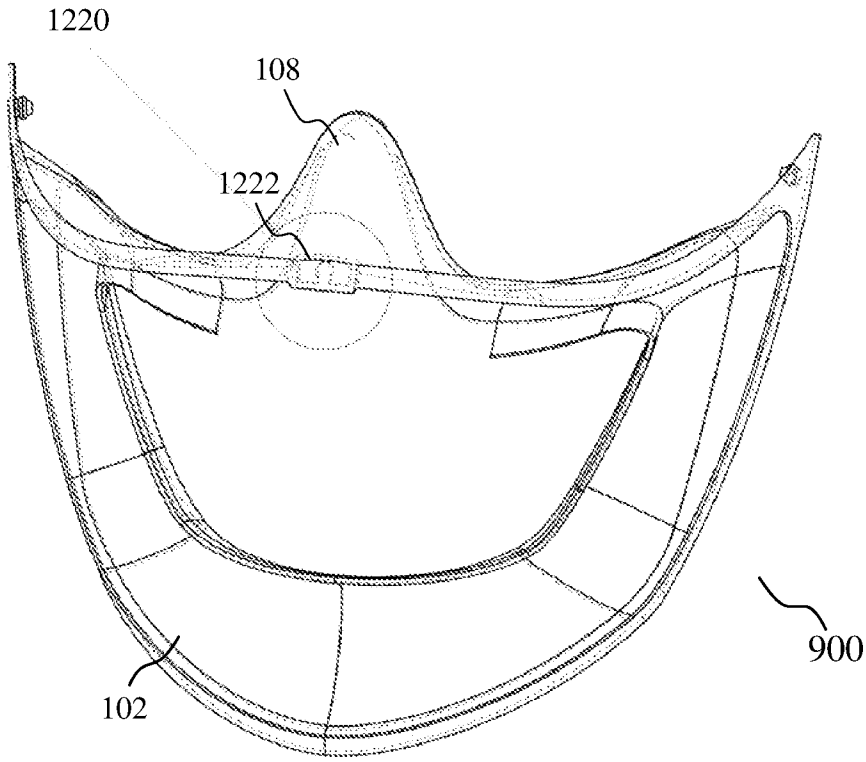

FIG. 12A

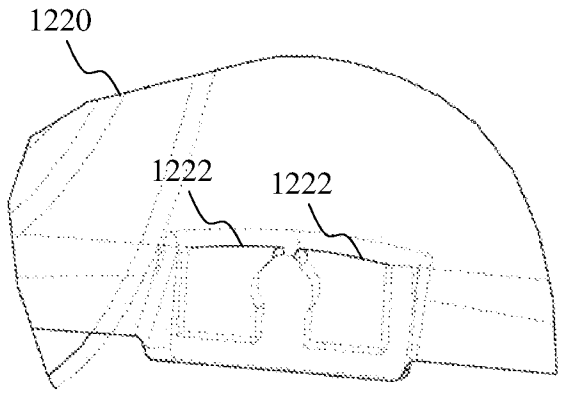

FIG. 12B

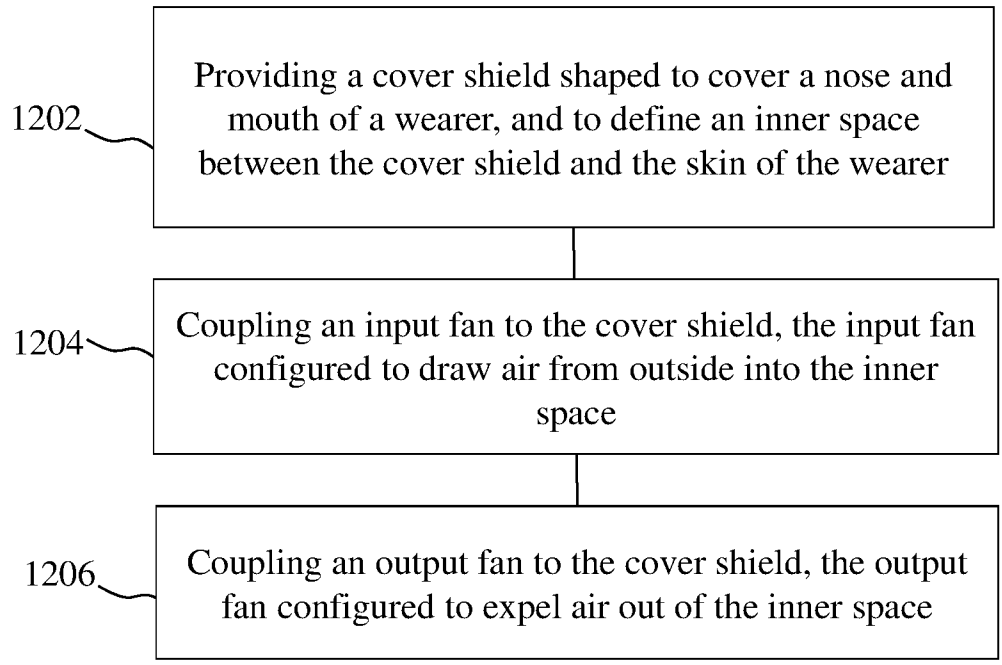
1202
Providing a cover shield shaped to cover a nose and mouth of a wearer, and to define an inner space between the cover shield and the skin of the wearer
1204
Coupling an input fan to the cover shield, the input fan configured to draw air from outside into the inner space
1206
Coupling an output fan to the cover shield, the output fan configured to expel air out of the inner space

FIG. 13

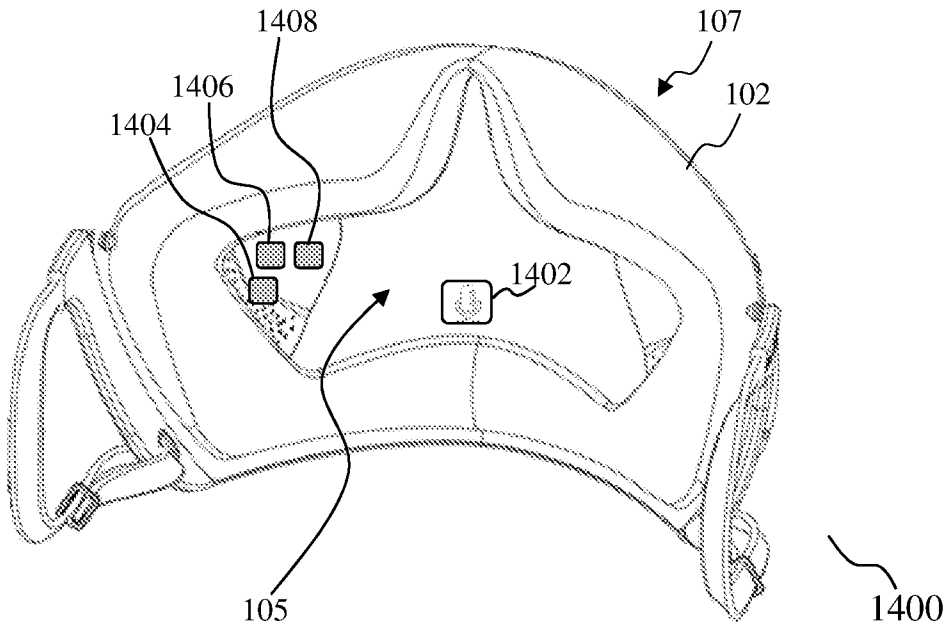
1408
107
1406
102
1404
1402
105
1400

FIG. 14

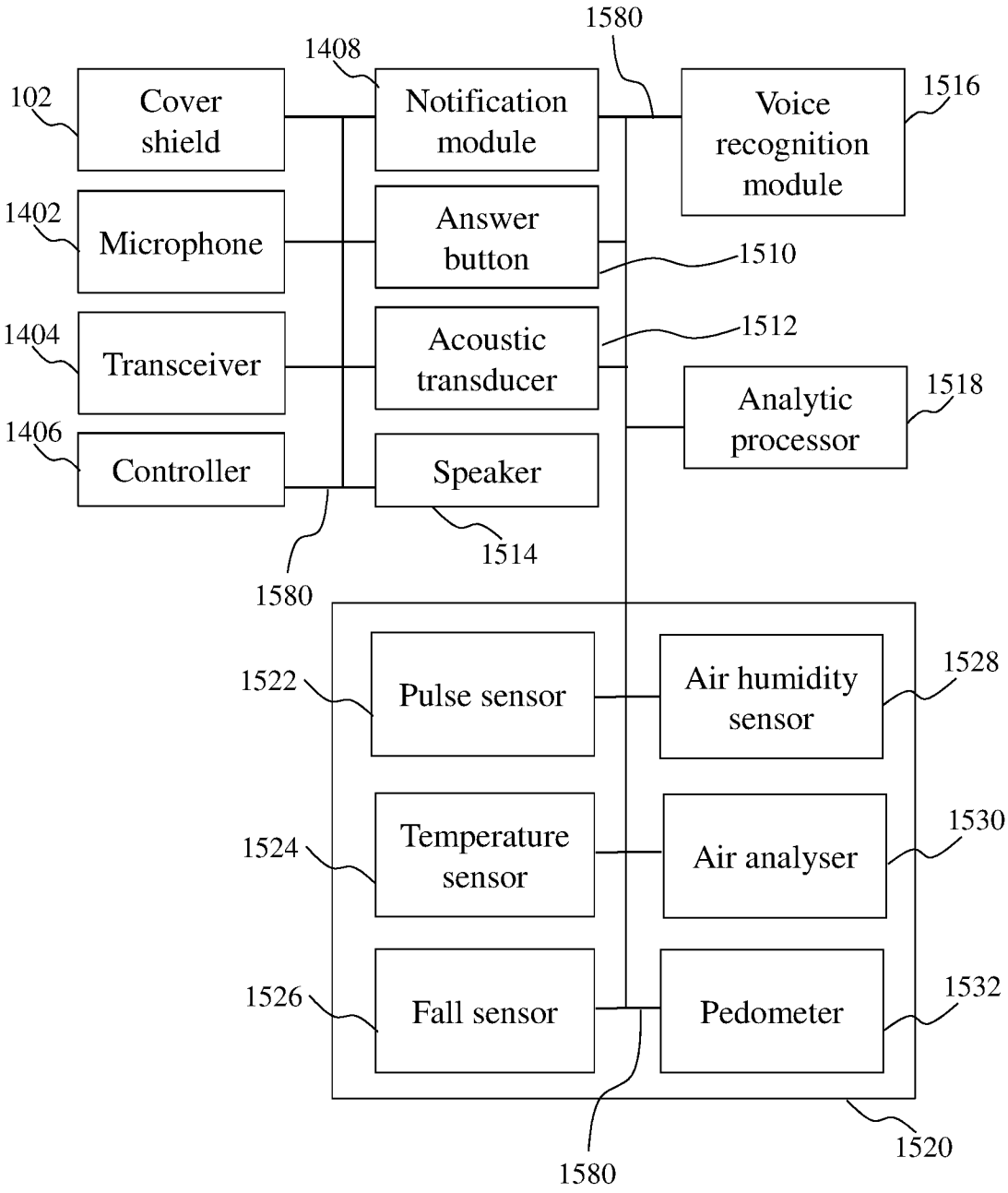
1580
1408
102
Cover shield
Notification module
Voice recognition module
1516
1402
Microphone
Answer button
1510
1404
Transceiver
Acoustic transducer
1512
Analytic processor
1518
1406
Controller
Speaker
1514
1580
1522
Pulse sensor
Air humidity sensor
1528
1524
Temperature sensor
Air analyser
1530
1526
Fall sensor
Pedometer
1532
1580
1520

FIG. 15

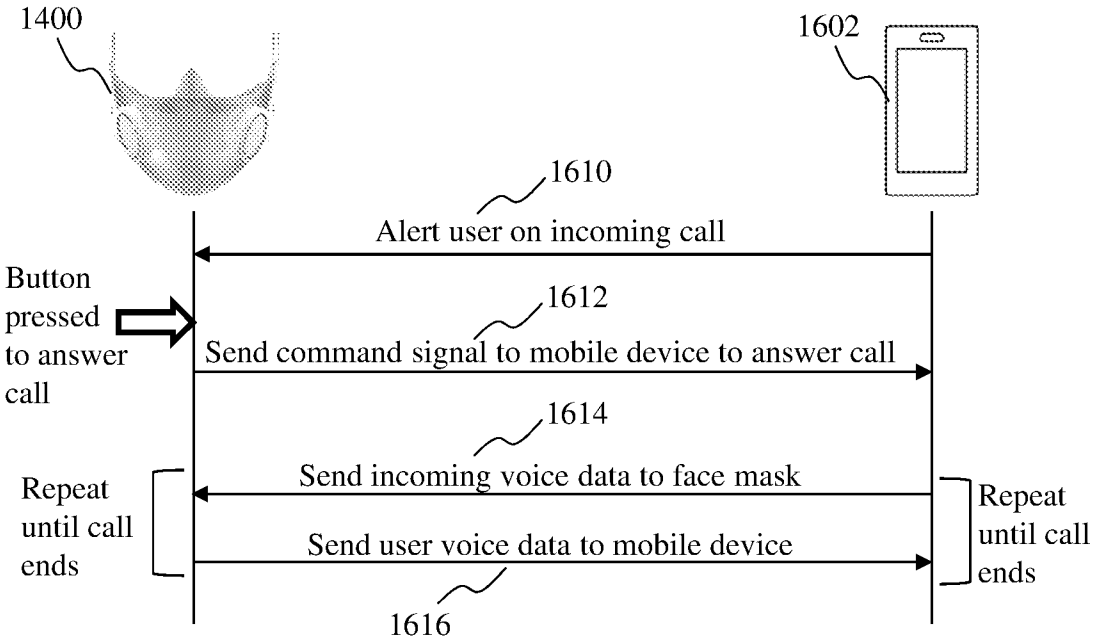
1400
1602
1610
Alert user on incoming call
Button pressed to answer call
1612
Send command signal to mobile device to answer call
1614
Send incoming voice data to face mask
Repeat until call ends
Send user voice data to mobile device
Repeat until call ends
1616

FIG. 16

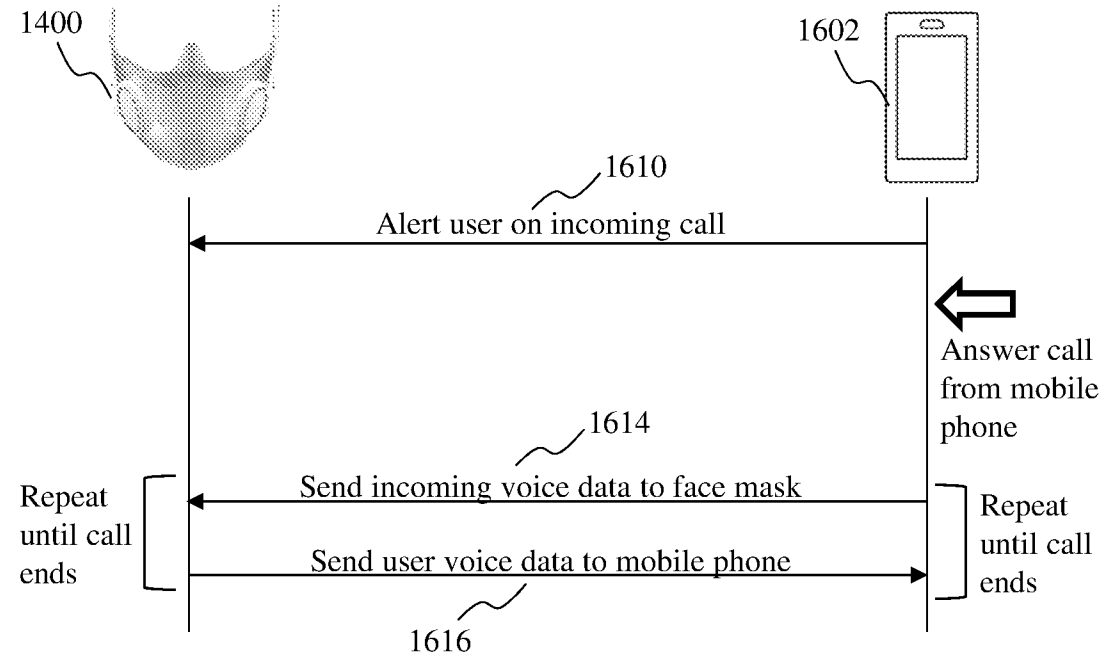
1400
1602
1610
Alert user on incoming call
Answer call from mobile phone
1614
Send incoming voice data to face mask
Repeat until call ends
Send user voice data to mobile phone
Repeat until call ends
1616

FIG. 17

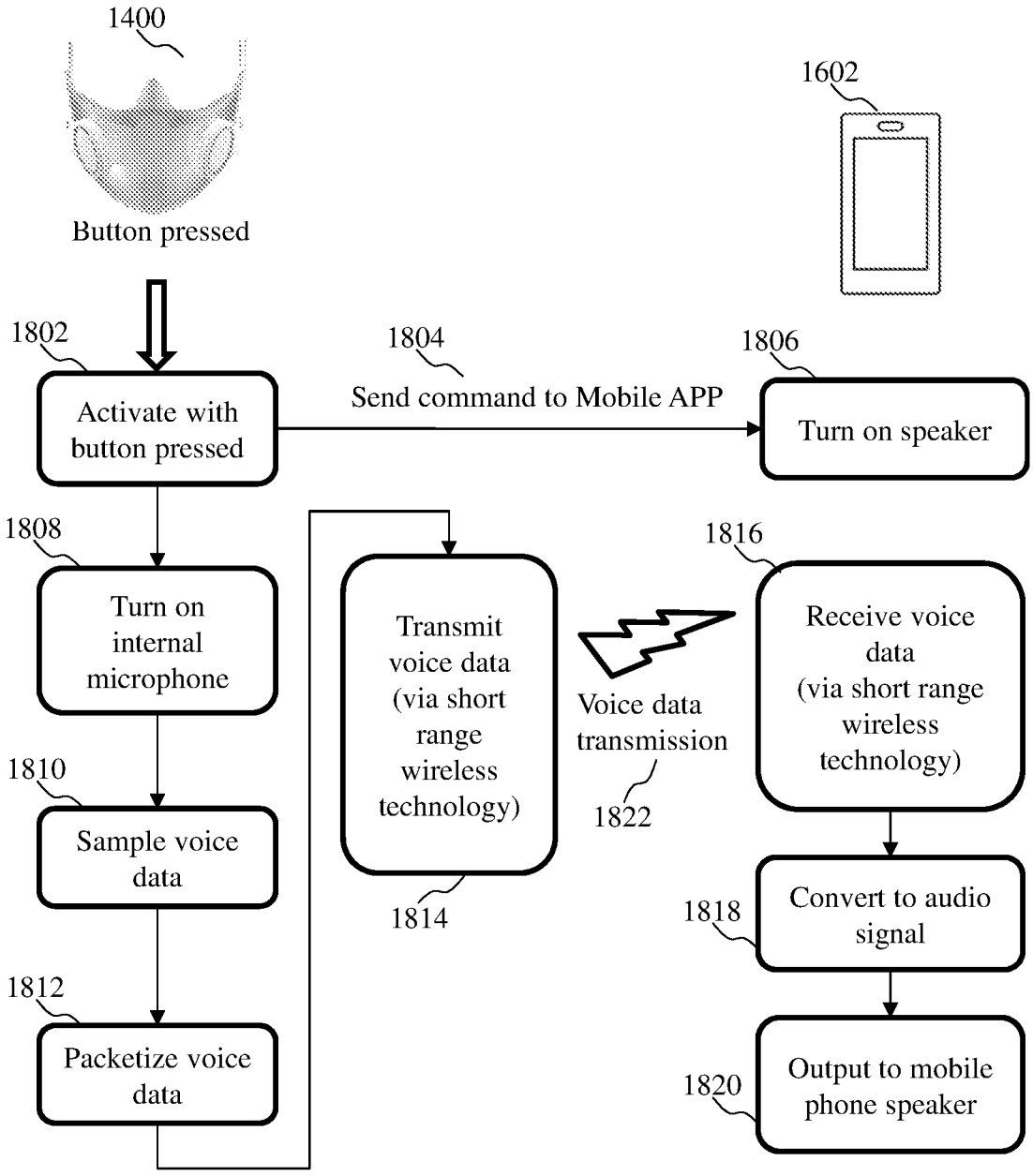
1400
Button pressed
1602
1802
Activate with button pressed
1804
Send command to Mobile APP
1806
Turn on speaker
1808
Turn on internal microphone
1810
Sample voice data
1812
Packetize voice data
Transmit voice data (via short range wireless technology)
1814
Voice data transmission
1822
1816
Receive voice data (via short range wireless technology)
1818
Convert to audio signal
1820
Output to mobile phone speaker

FIG. 18

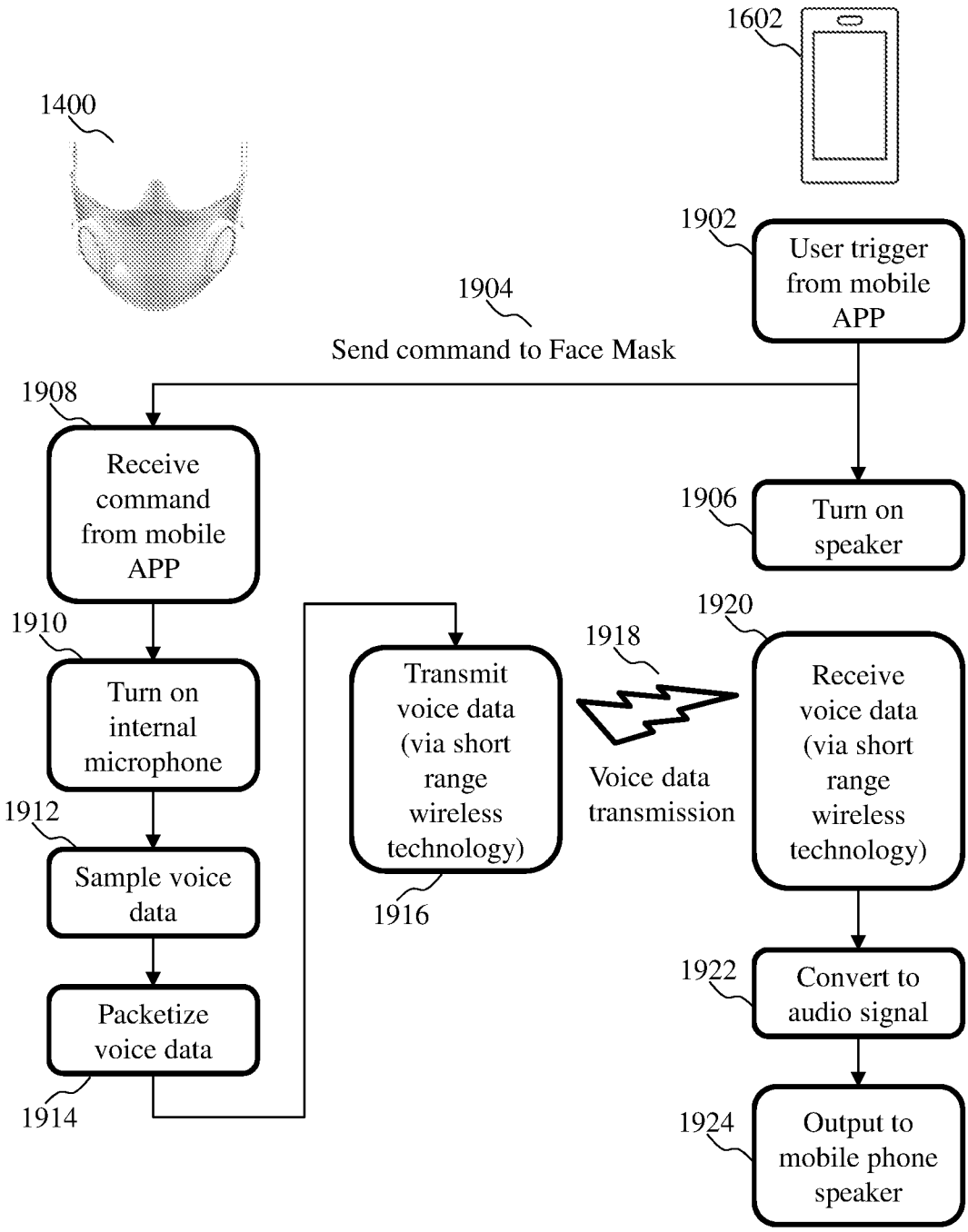
1602
1400
1902
User trigger from mobile APP
1904
Send command to Face Mask
1908
Receive command from mobile APP
1906
Turn on speaker
1910
Turn on internal microphone
1912
Sample voice data
Packetize voice data
1914
Transmit voice data (via short range wireless technology)
1916
1918
Voice data transmission
1920
Receive voice data (via short range wireless technology)
1922
Convert to audio signal
1924
Output to mobile phone speaker

FIG. 19

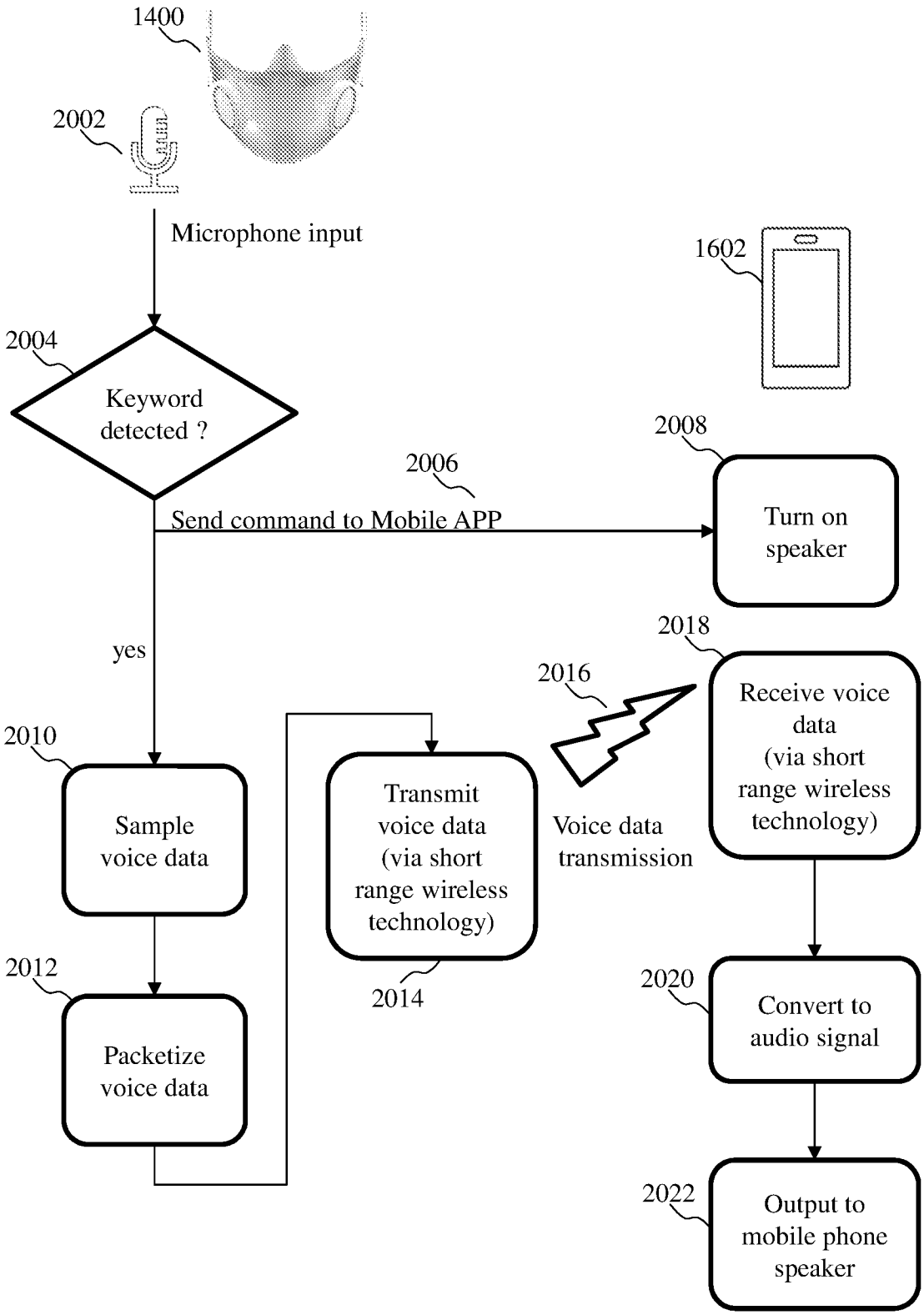
1400
2002
Microphone input
1602
2004
Keyword detected ?
2008
2006
Send command to Mobile APP
Turn on speaker
yes
2018
2016
Receive voice data (via short range wireless technology)
2010
Sample voice data
Transmit voice data (via short range wireless technology)
Voice data transmission
2012
Packetize voice data
2014
2020
Convert to audio signal
2022
Output to mobile phone speaker

FIG. 20

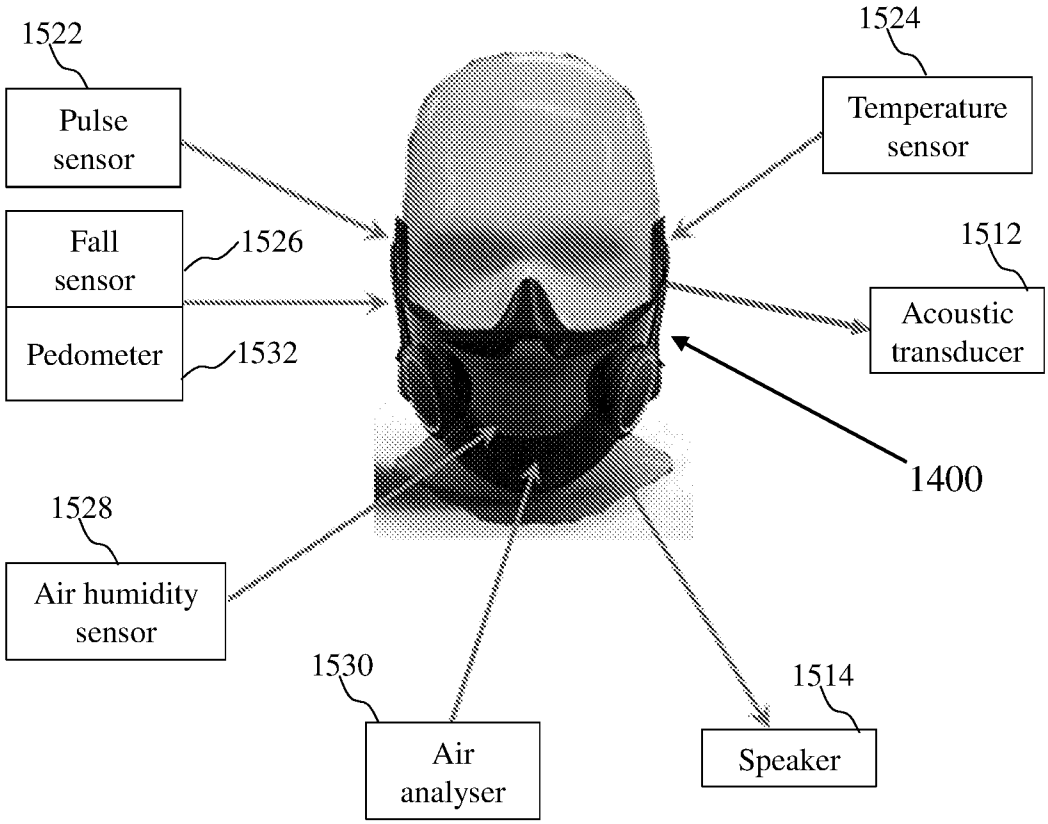
1522
Pulse sensor
Fall sensor
1526
Pedometer
1532
1528
Air humidity sensor
1530
Air analyser
1524
Temperature sensor
1512
Acoustic transducer
1400
1514
Speaker

FIG. 21

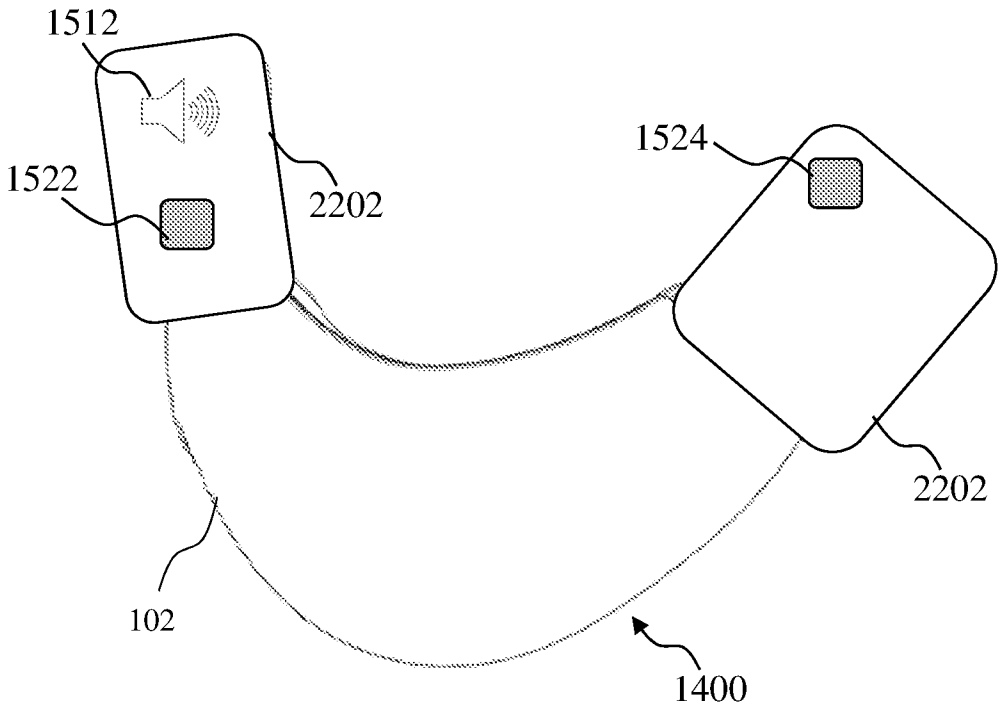
1512
1522
2202
1524
2202
102
1400

FIG. 22

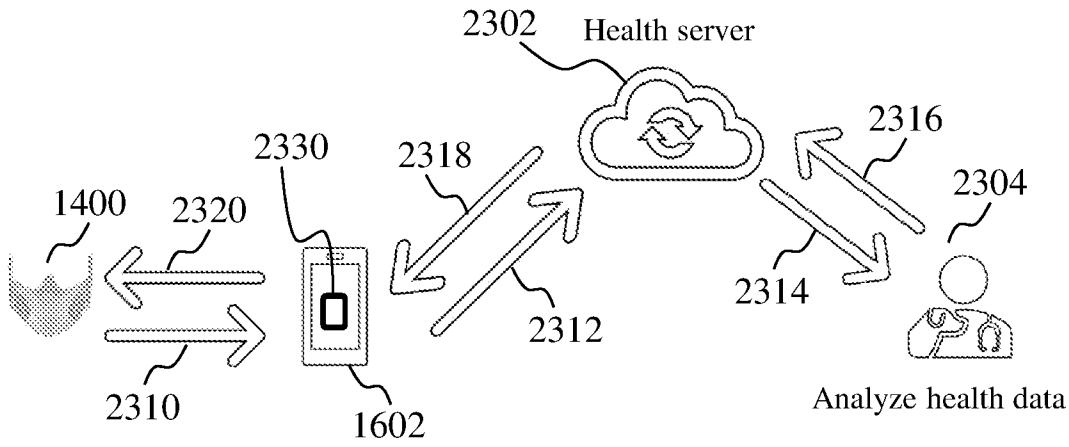
2302
Health server
2316
2330
2318
2304
1400
2320
2314
2312
2310
1602
Analyze health data

FIG. 23

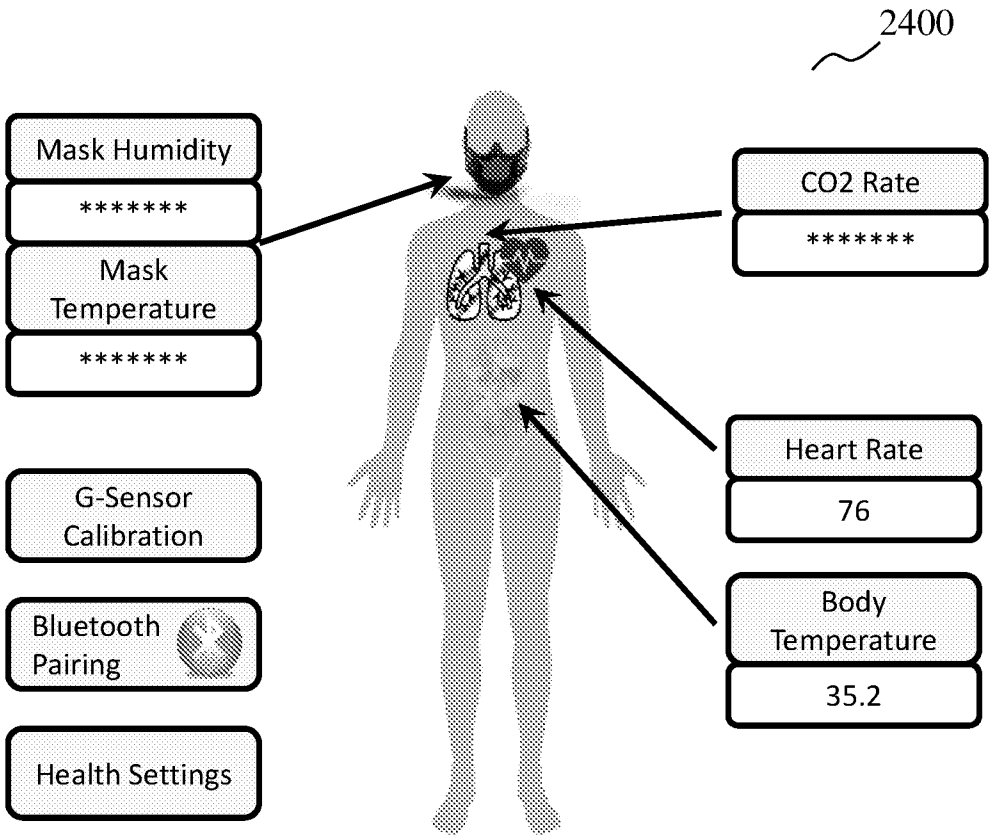
2400
Mask Humidity
****
Mask Temperature
****
G-Sensor Calibration
Bluetooth Pairing
Health Settings
CO2 Rate
****
Heart Rate
76
Body Temperature
35.2

FIG. 24

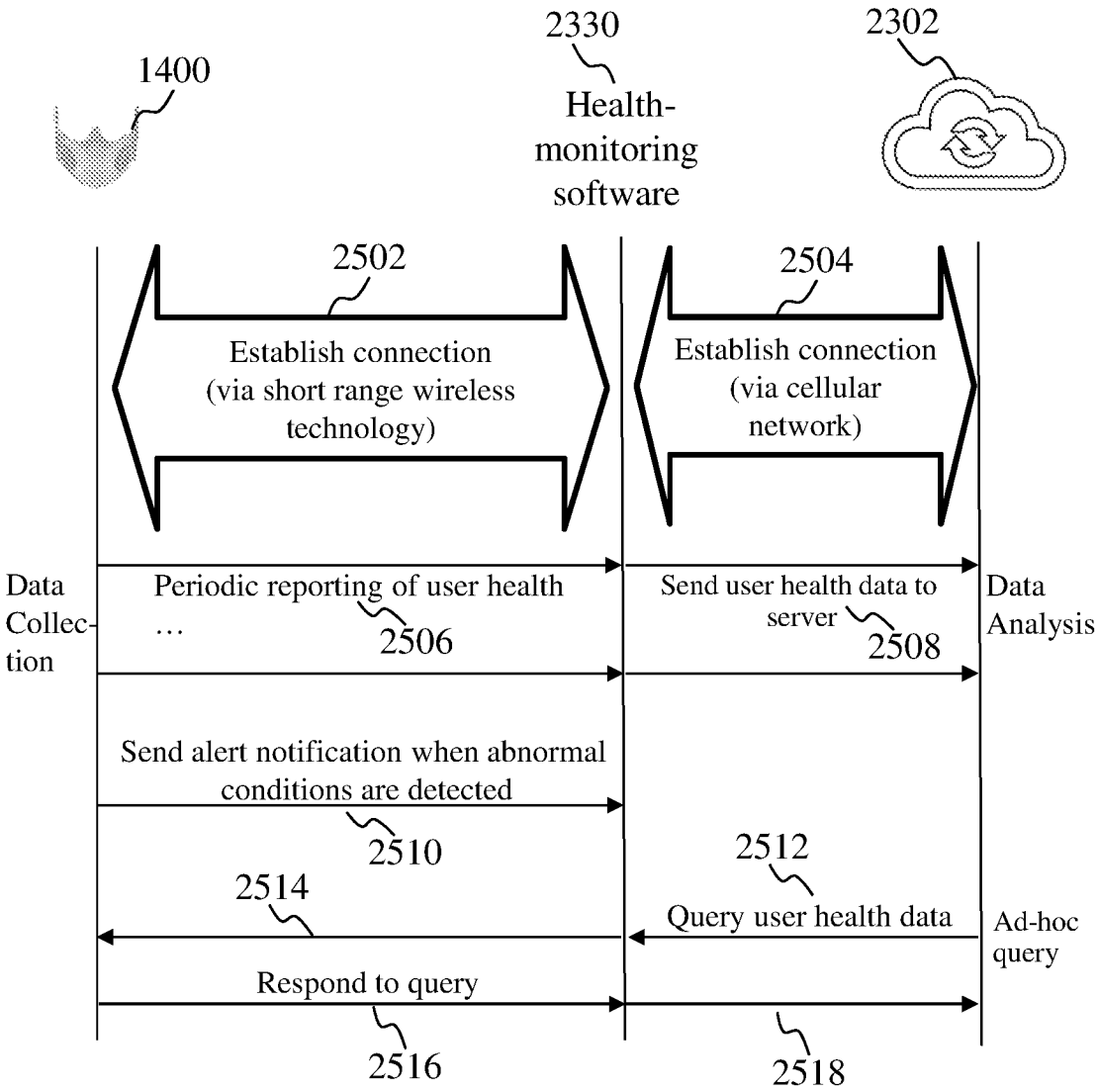
1400
2330
Health-monitoring software
2302
2502
Establish connection (via short range wireless technology)
2504
Establish connection (via cellular network)
Data Collection
Periodic reporting of user health
…
2506
Send user health data to server
2508
Data Analysis
Send alert notification when abnormal conditions are detected
2510
2512
Query user health data
2514
Ad-hoc query
Respond to query
2516
2518

FIG. 25

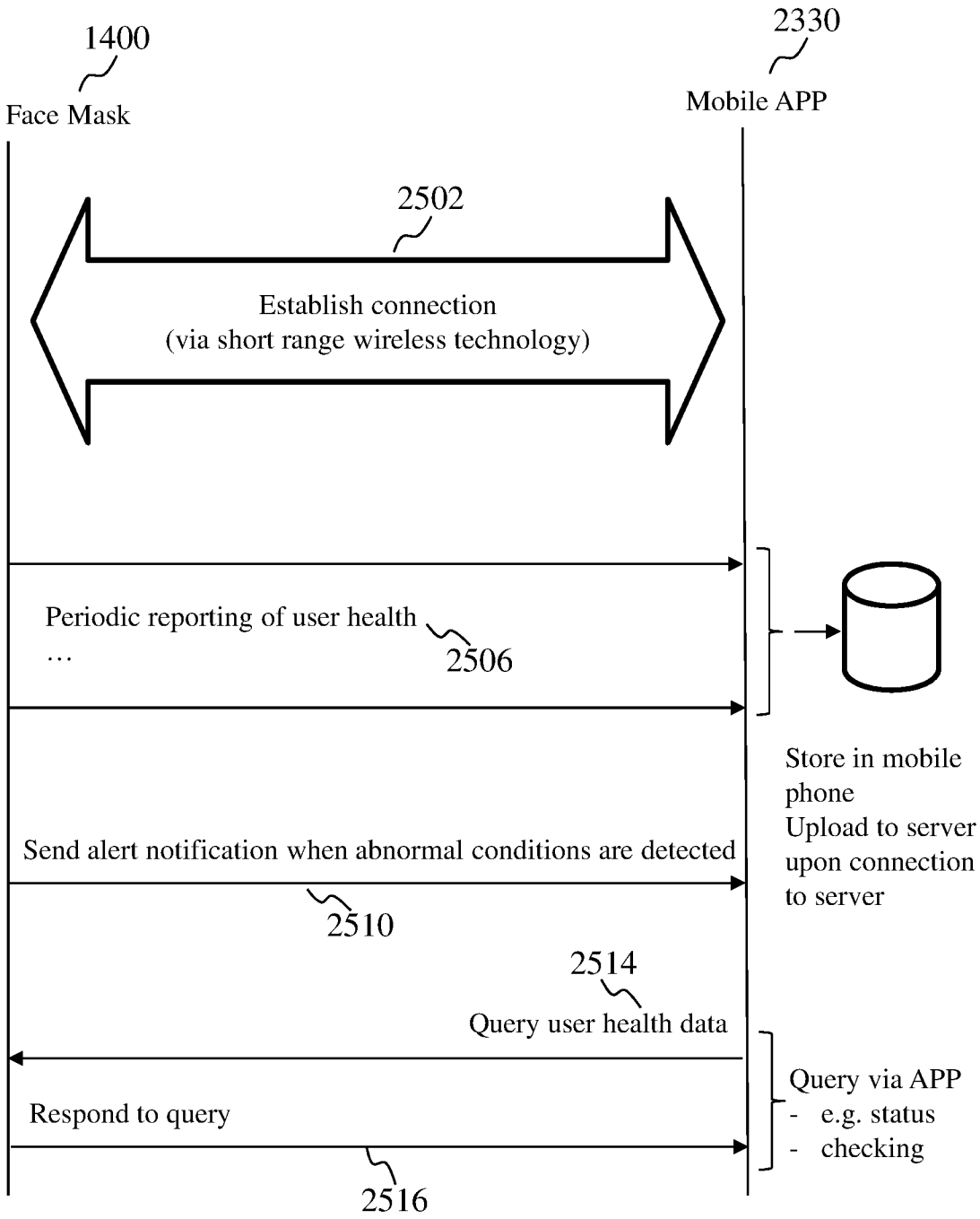
1400
Face Mask
2330
Mobile APP
2502
Establish connection
(via short range wireless technology)
Periodic reporting of user health
…
2506
Store in mobile phone
Upload to server upon connection to server
Send alert notification when abnormal conditions are detected
2510
2514
Query user health data
Query via APP
- e.g. status
- checking
Respond to query
2516

FIG. 26

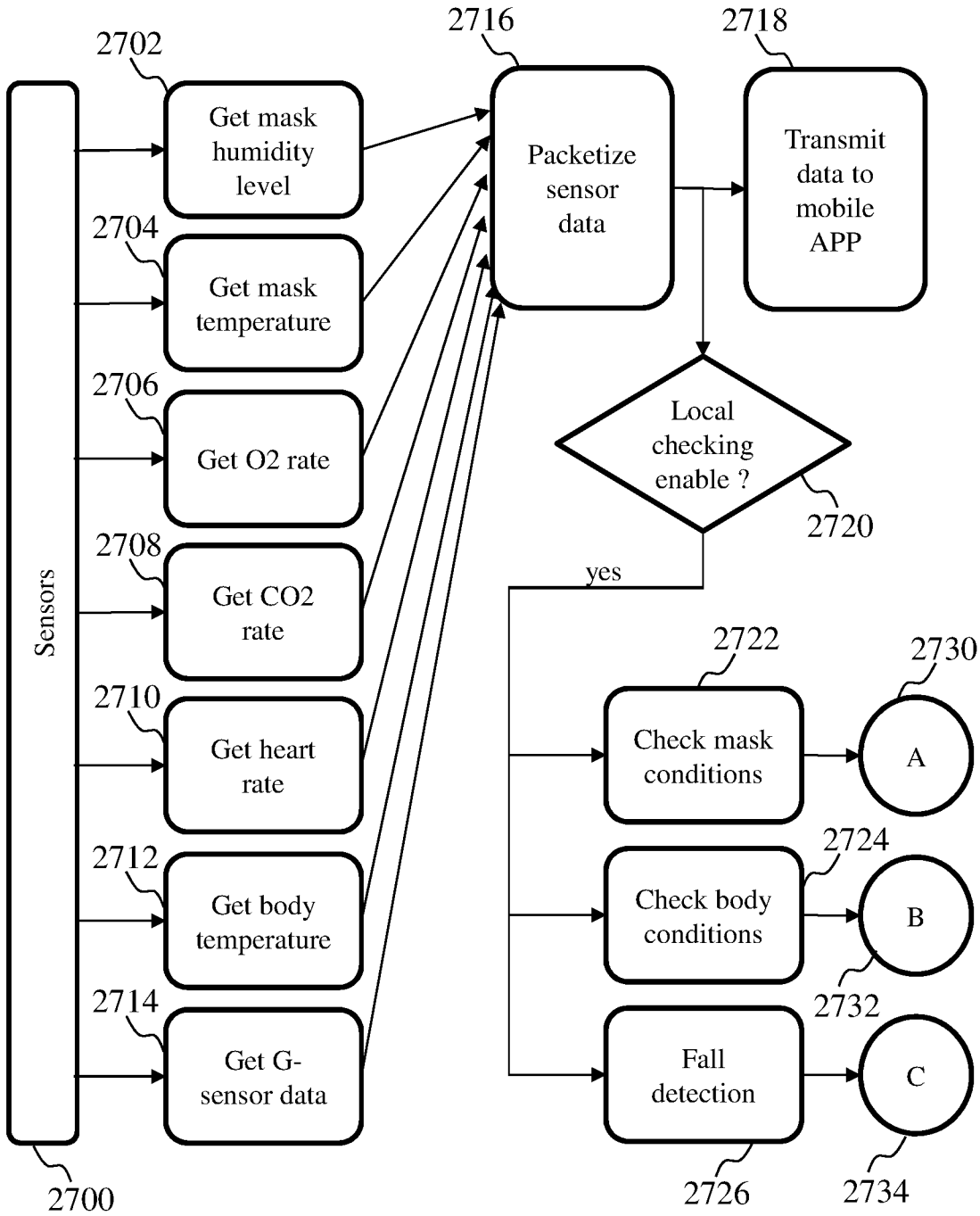
2702
2716
2718
Get mask humidity level
Packetize sensor data
Transmit data to mobile APP
2704
Get mask temperature
2706
Get O2 rate
Local checking enable ?
2720
2708
Get CO2 rate
yes
Sensors
2722
2730
Check mask conditions
A
2710
Get heart rate
2712
2724
Get body temperature
Check body conditions
B
2732
2714
Get G-sensor data
Fall detection
C
2700
2726
2734

FIG. 27

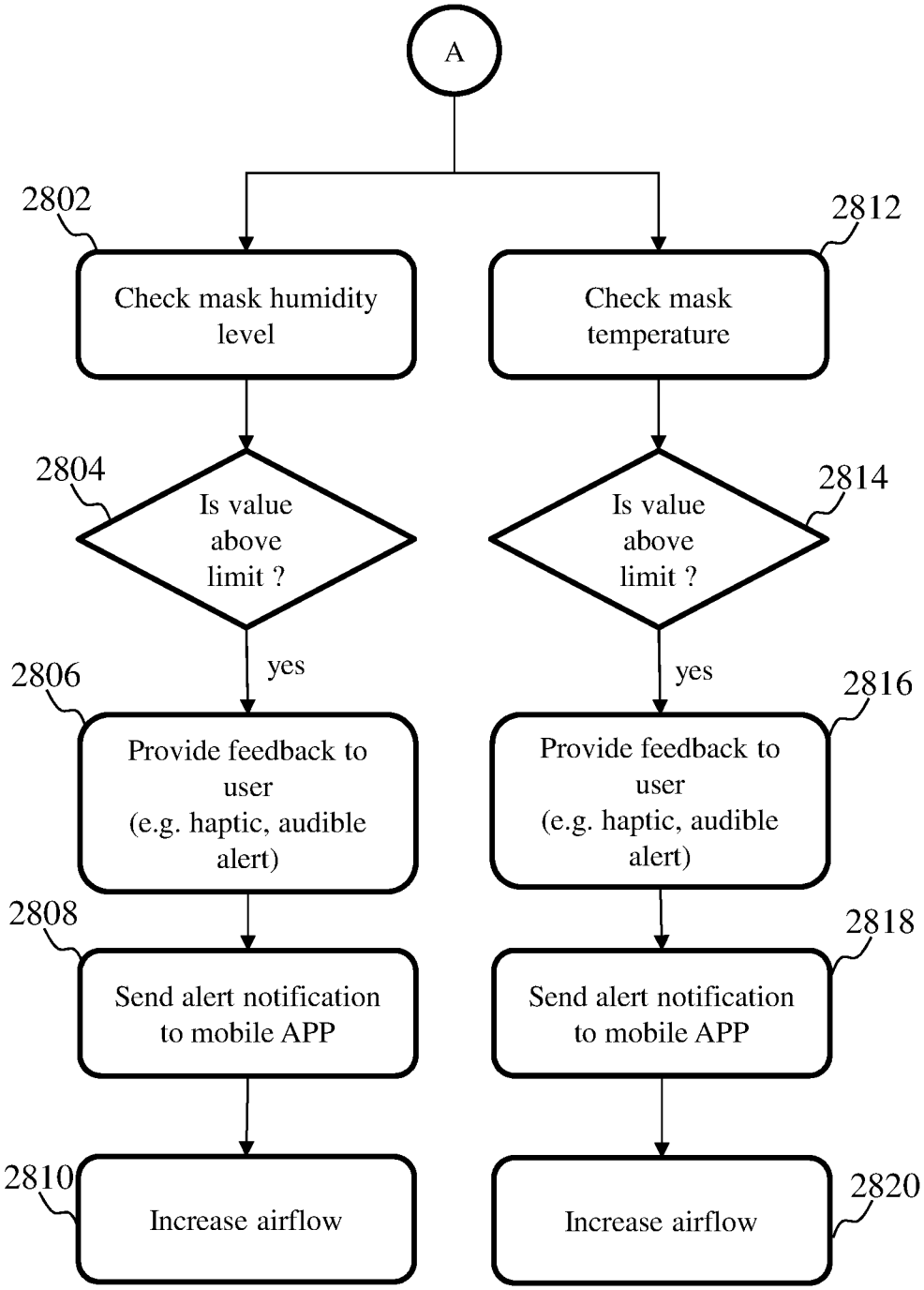
A
2802
Check mask humidity level
2804
Is value above limit ?
yes
2806
Provide feedback to user (e.g. haptic, audible alert)
2808
Send alert notification to mobile APP
2810
Increase airflow
2812
Check mask temperature
2814
Is value above limit ?
yes
2816
Provide feedback to user (e.g. haptic, audible alert)
2818
Send alert notification to mobile APP
2820
Increase airflow

FIG. 28

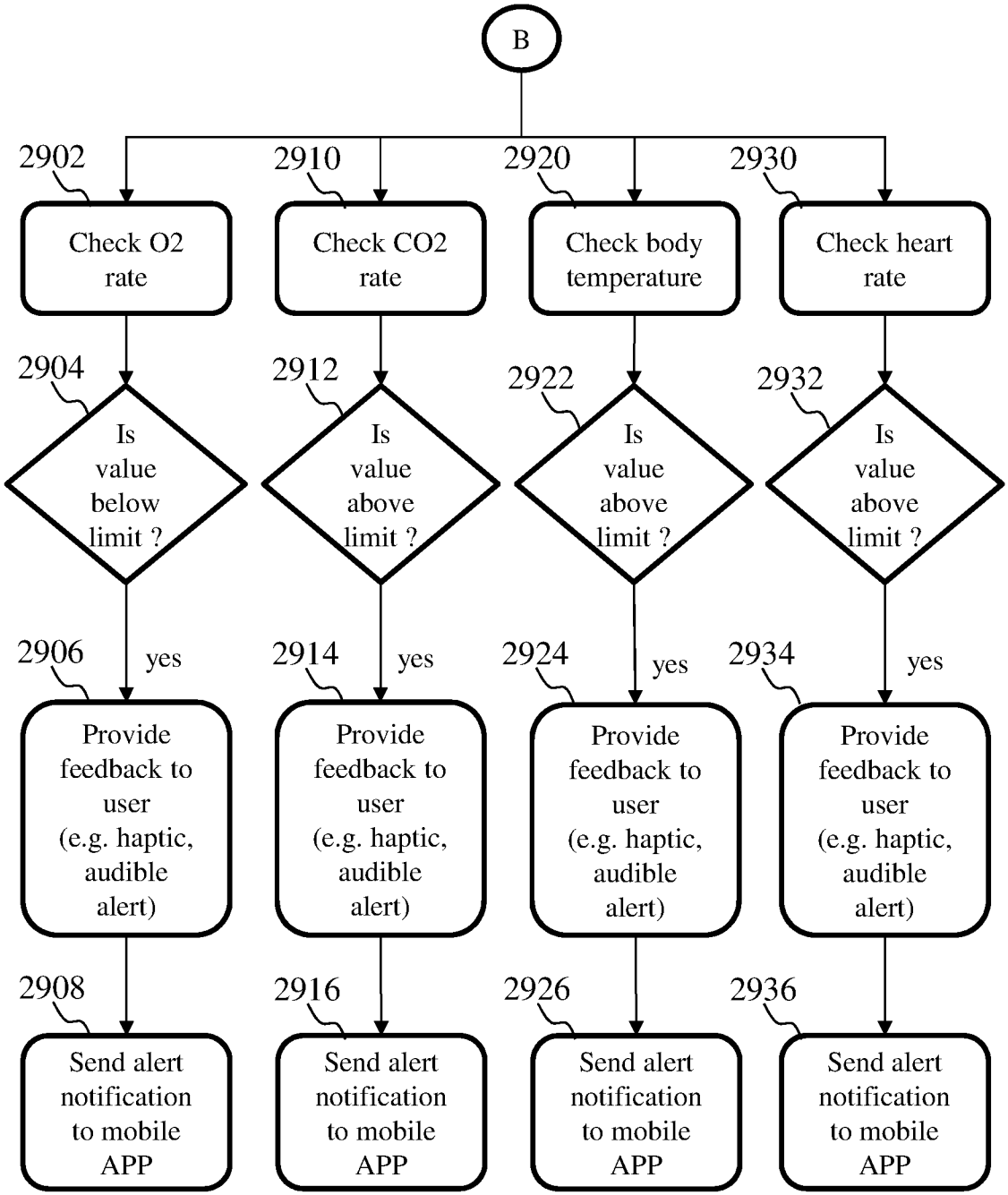
B
2902
Check O2 rate
2904
Is value below limit ?
yes
2906
Provide feedback to user (e.g. haptic, audible alert)
2908
Send alert notification to mobile APP
2910
Check CO2 rate
2912
Is value above limit ?
yes
2914
Provide feedback to user (e.g. haptic, audible alert)
2916
Send alert notification to mobile APP
2920
Check body temperature
2922
Is value above limit ?
yes
2924
Provide feedback to user (e.g. haptic, audible alert)
2926
Send alert notification to mobile APP
2930
Check heart rate
2932
Is value above limit ?
yes
2934
Provide feedback to user (e.g. haptic, audible alert)
2936
Send alert notification to mobile APP

FIG. 29

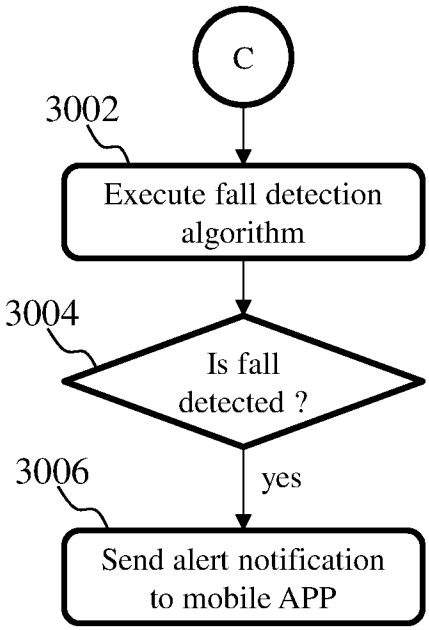
C
3002
Execute fall detection algorithm
3004
Is fall detected ?
yes
3006
Send alert notification to mobile APP

FIG. 30

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SG2021/050420

A. CLASSIFICATION OF SUBJECT MATTER

A62B 18/08(2006.01)i; **A62B 18/02**(2006.01)i; **A62B 9/00**(2006.01)i; **H04R 1/08**(2006.01)i; **G06F 3/01**(2006.01)i; **G06F 3/16**(2006.01)i; **G10L 15/22**(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A62B 18/08(2006.01); A41D 13/11(2006.01); A62B 18/04(2006.01); A62B 18/10(2006.01); A62B 7/10(2006.01); G16H 80/00(2018.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPOinternal) & Keywords: face mask, cover shield, microphone, transceiver, controller, mobile device, audio data, phone call, haptic signal, sound, user input, sensor

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2018-0078798 A1 (MICROSFERE PTE. LTD.) 22 March 2018 (2018-03-22) paragraphs [0124]-[0147] and figures 1-5	1,5-12,15-16,19-20
Y		2-4,13-14,17-18
Y	CN 106963001 A (NANJING ZHENGZE TECHNOLOGY CO., LTD.) 21 July 2017 (2017-07-21) paragraphs [0039]-[0040] and figures 2-3	2-4
Y	KR 10-2020-0126488 A (AN, HYO JAE) 09 November 2020 (2020-11-09) paragraphs [0084], [0113]-[0115] and figures 2-3	13-14
Y	KR 10-2020-0140684 A (CARLSON COMPANY LTD.) 16 December 2020 (2020-12-16) paragraph [0037] and figures 1-2	17-18
A	US 2005-0172959 A1 (WILLIAMS, ROBBY GORDON) 11 August 2005 (2005-08-11) claim 1 and figure 1	1-20

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 October 2021	**28 October 2021**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office **189 Cheongsa-ro, Seo-gu, Daejeon** **35208, Republic of Korea**	**LEE, Hun Gil**
Facsimile No. **+82-42-481-8578**	Telephone No. **+82-42-481-8525**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/SG2021/050420

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
US 2018-0078798 A1	22 March 2018	CN 107405508 A	28 November 2017
		EP 3277386 A1	07 February 2018
		HK 1249069 A1	26 October 2018
		JP 2018-512518 A	17 May 2018
		KR 10-2017-0132188 A	01 December 2017
		SG 11201707644 A	30 October 2017
		TW 201701915 A	16 January 2017
		WO 2016-157159 A1	06 October 2016
CN 106963001 A	21 July 2017	None	
KR 10-2020-0126488 A	09 November 2020	KR 10-2218636 B1	19 February 2021
KR 10-2020-0140684 A	16 December 2020	KR 10-2020-0140685 A	16 December 2020
		US 2021-0195387 A1	24 June 2021
US 2005-0172959 A1	11 August 2005	AU 2003-229210 A1	22 December 2003
		CA 2487434 A1	18 December 2003
		GB 2404814 A	09 February 2005
		GB 2404814 B	14 December 2005
		GB 2415316 A	21 December 2005
		WO 03-103773 A1	18 December 2003