(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 815 749 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
05.05.2021 Bulletin 2021/18

(51) Int Cl.:
A62B 18/02 *(2006.01)*

(21) Application number: **19206929.2**

(22) Date of filing: **04.11.2019**

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

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(54) **A FACE MASK**

(57) A face mask (10) has an outer casing (12) and a filter member (14). A fan module (10) is used, thereby defining an active face mask (10). A mask cavity is defined inside the filter member (14) when the face mask (10) is worn by a user and a chamber (15) is defined between the outer casing (12) and the filter member (14). A battery module (22) is located within the chamber (15).

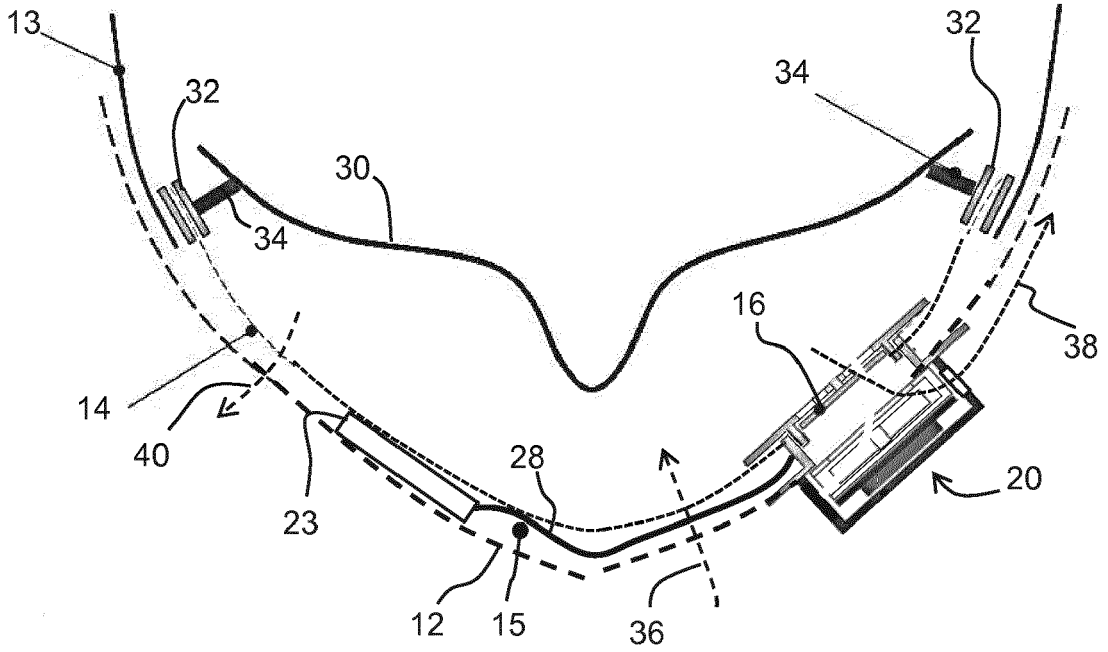

FIG. 4

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Description

FIELD OF THE INVENTION

[0001] This invention relates to face masks, for providing filtering of pollutants.

BACKGROUND OF THE INVENTION

[0002] Air pollution is a worldwide concern. The World Health Organization (WHO) estimates that 4 million people die from air pollution every year. Part of this problem is the outdoor air quality in cities. Nearly 300 smog-hit cities fail to meet national air quality standards.

[0003] Official outdoor air quality standards define particle matter concentration as mass per unit volume (e.g. $\mu g/m^3$). A particular concern is pollution with particles having a diameter less than 2.5 μm (termed "PM2.5") as they are able to penetrate into the gas exchange regions of the lung (alveoli), and very small particles (<100 nm) may pass through the lungs to affect other organs.

[0004] Since this problem will not improve significantly on a short time scale, a common way to deal with this problem is to wear a mask which provides cleaner air by filtration and the market for masks in China and elsewhere has seen a great surge in recent years.

[0005] Such masks may be made of material that acts as a filter of pollutant particles, or may have a filter for only part of the mask surface, and this filter may be replaceable when it becomes clogged.

[0006] However, during use, the temperature and relative humidity inside the mask increases and, combined with the pressure difference inside the mask relative to the outside, this makes breathing uncomfortable. This can be mitigated in part by providing an outlet valve or check valve which allows exhaled air to escape the mask with little resistance, but which requires inhaled air to be drawn through the filter. To improve comfort and effectiveness, a fan can be added to the mask, this fan drawing in air through the filter and/or providing assistance when breathing out.

[0007] One possible benefit to the wearer of using a fan-powered mask is that the lungs are relieved of the slight strain caused by inhalation against the resistance of the filters in a conventional non-powered mask. Furthermore, in a conventional non-powered mask, inhalation also causes a slight pressure drop within the mask which leads to leakage of the contaminants into the mask, which leakage could prove dangerous if these are toxic substances.

[0008] Fan-assisted masks thus may improve the breathing comfort by reducing the temperature, humidity and breathing resistance.

[0009] In one arrangement, an inlet (i.e. inhale) fan may be used to provide a continuous intake of air. In this way, the lungs are relieved of the slight strain caused by inhalation against the resistance of the filters in a conventional non-powered mask. A steady stream of air may then be provided to the face and may for example provide a slight positive pressure, to ensure that any leakage is outward rather than inward. However, this gives additional resistance to breathing when exhaling.

[0010] In another arrangement, an exhaust (i.e. exhale) fan may be used to provide a continuous release of air. This instead provides breathing assistance when exhaling. An exhale fan may be combined with a series check valve so that no flow can enter the mask through the fan.

[0011] The fan again creates a continuous flow of air through the mask. Air is drawn into the mask cavity through the filter by the flow induced by the fan or by inhaling. This improves the wearer's comfort.

[0012] Another alternative is to provide both inlet and exhaust fans, and to time the control of the fans in synchronism with the breathing cycle of the user. The breathing cycle may be measured based on pressure (or differential pressure) measurements. This provides improved control of temperature and humidity as well as reducing the resistance to breathing for both inhalation and exhalation.

[0013] Thus, several types of mask for preventing daily exposure to air pollutants are available, including passive masks, passive masks with an exhale valve, and masks with at least one active fan.

[0014] This invention relates generally to active masks. They are battery operated devices, and the battery life is of fundamental importance. In particular it is desirable to obtain the greatest battery life from a given battery mass. One issue is that the performance of batteries is temperature dependent. This is a particular issue for face masks, as they are used outdoors and are desired all year round.

SUMMARY OF THE INVENTION

[0015] The invention is defined by the claims.

[0016] According to examples in accordance with an aspect of the invention, there is provided a face mask, comprising:

an outer casing;
a filter member for mounting inside the outer casing, wherein a mask cavity is defined between the filter member and the face of a user when the face mask is worn by the user and a chamber is defined between the outer casing and the filter member;
a fan module for generating a flow between the mask cavity and the ambient surroundings; and
a battery module,
wherein the battery module is located within the chamber.

[0017] The invention thus relates to a face mask design with a two-layer structure of a filter member and an outer casing. The filter member is flexible (so that it can adapt to the contour of the face of the user).

[0018] This mask design forms a chamber between the filter member and the outer casing. Part of the exhaled breath of the wearer passes through this chamber. As a result, the chamber is maintained at an elevated temperature during cold periods, because the air content of the chamber is continuously replenished by the breathing of the user. By placing the battery module in the chamber, the battery module is exposed to higher temperatures and thus has a longer life in such conditions.

[0019] The battery module is preferably located in the path of exhaled air of the user when the mask is worn by the user. In this way, the warmth of the user's exhaled breath is directly used to heat the battery module.

[0020] The battery module is for example located at a front area of the face mask. By this is meant that it is the general area in front of the mouth and nose, rather than at the top, bottom or sides of the face mask. In this way, it is in the path of exhaled air from the nose or mouth of the user.

[0021] The battery module and the fan module are for example separate units mounted apart from each other. By separating the fan module and the battery module (which powers the fan module) it is avoided that heavy components are concentrated at individual locations of the face mask.

[0022] The mask body for example comprises opposite lateral sides which are adapted to face at least partially laterally outwardly when the mask is worn by a user, the fan assembly is mounted at one of the opposite lateral sides and the battery module is mounted at the other of the opposite lateral sides.

[0023] By providing the fan module and the battery module on opposite lateral sides, the balance is improved.

[0024] The fan module preferably comprises an exhaust fan for expelling air from the mask cavity. However, only part of the exhaled air passes through the fan; another part passes through the chamber and thereby increases the chamber temperature. Thus, the exhaled air is still able to be used for battery heating even though an exhale fan is used.

[0025] The fan module may comprise a centrifugal fan having an axial inlet communicating with the inside of the mask cavity and a radial outlet outside the mask cavity. A centrifugal fan is compact, and the radial outlet may be easily hidden from view to give a desired aesthetic appearance.

[0026] The battery module is for example part of a control unit which further comprises fan control circuitry for the fan module.

[0027] An electrical connector is preferably provided between the fan module and the battery module, located within the chamber. The electrical connection for example forms a bridge between opposite sides of the face mask. The battery module (or control unit) is for example attached to the inside surface of the outer casing or removably attached to the filter member.

[0028] The filter member may comprise a first connector part and the fan module may comprise a second connector part, for connection to the first connector part thereby to releasably fix the fan module to the filter member. Thus, the fan module may be detached from the filter member so that the filter member may be replaced or cleaned, without needing to replace the fan module.

[0029] The first and second connector parts are for example a push fit together to enable the filter member to attached to and detached from the fan module. This enables easy assembly and disassembly.

[0030] The outer casing for example has an opening and the fan module extends through the chamber and through the opening in the outer casing. This is one way to fit the and module and casing together, with the casing fitting over the fan module. This provides a simple assembly method.

[0031] The fan module may comprise a third connector part and the outer casing may comprise a fourth connector part, for connection to the third connector part thereby to fix the outer casing to the fan module, with the fan module projecting through the opening.

[0032] This further coupling between the fan module and the outer casing, for example around the inner edge of the opening in the outer casing, provides a positional fix of the position of the fan module with respect to the outer casing. The characteristics of the airflow to or from the fan module are thus maintained consistent, independent of any shape adjustment of the flexible filter member. The set of connector parts also prevents leakage and improves user comfort.

[0033] The third connector part may be a push fit to the fourth connector part.

[0034] These and other aspects of the invention will be apparent from and elucidated with reference to the embodiment(s) described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] For a better understanding of the invention, and to show more clearly how it may be carried into effect, reference will now be made, by way of example only, to the accompanying drawings, in which:

Figure 1 shows one example of a mask design to which the invention may be applied;

Figure 2 shows the design of Figure 1 in an assembled state from one front side;

Figure 3 shows the design of Figure 1 in an assembled state from an opposite front side;

Figure 4 is used to show the way the components interface with the wearer and shows an alternative design;

Figure 5 shows a battery temperature measurement for a mask design in accordance with the invention and the ambient temperature;

Figure 6 shows the outlet of the centrifugal fan;

Figure 7 shows a first cross sectional view of a design of the third and fourth connector parts;

Figure 8 shows a second cross sectional view of the design of Figure 7; and

Figure 9 shows a possible design for the first and second connector parts.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0036] The invention will be described with reference to the Figures.

[0037] It should be understood that the detailed description and specific examples, while indicating exemplary embodiments of the apparatus, systems and methods, are intended for purposes of illustration only and are not intended to limit the scope of the invention. These and other features, aspects, and advantages of the apparatus, systems and methods of the present invention will become better understood from the following description, appended claims, and accompanying drawings. It should be understood that the Figures are merely schematic and are not drawn to scale. It should also be understood that the same reference numerals are used throughout the Figures to indicate the same or similar parts.

[0038] The invention provides a face mask which has an outer casing and a filter member housed within the outer casing. A fan module is used, thereby defining an active face mask. A mask cavity is defined inside the filter member when the face mask is worn by a user (i.e. between the filter member and the face of the user) and a chamber is defined between the outer casing and the filter member. A battery module is located within the chamber.

[0039] Figure 1 shows one example of a mask design in accordance with the invention. The mask 10 is shown in exploded view and comprises an outer casing 12 which functions as a mask body and a filter member 14 mounted inside the outer casing (i.e. on the side of the outer casing facing the face of the user). The outer casing is rigid or semi-rigid with ear straps 13, whereas the filter member 14 is for example formed of a fabric and thus easily deforms such that an outer edge can match the shape of a wearer's face.

[0040] The outer casing is porous so that air can flow through the outer casing. The outer casing improves the outer appearance of the mask. The outer casing may be made from a material which itself is porous, for example it may be an air mesh, a polyurethane layer, a cotton blend, or other porous material. However, it may instead be made from a non-porous material, such as a plastics material, but with openings to allow air flow. A gap around the edge of the outer casing, between the outer casing and the filter member, may alternatively or additionally be used to enable air flow.

[0041] The invention is based on the recognition that a chamber 15 is defined between the outer casing 12 and the filter member 14, and that this chamber may be used to provide protection for the battery, in particular by increasing the temperature of the battery in the winter. The chamber 15 is an air chamber around the battery where warm air is partially trapped. Furthermore, the placement of the battery is preferably selected so that it is in the pathway of the exhaled air of the user, and thereby most effectively heated by the exhaled air.

[0042] The filter member 14 is sealed around a connector module 16. The connector module 16 is for connecting to a fan module 20, in particular to a corresponding connector part 17 of the fan module. This connection may be circular so that it allows relative rotation between the fan module 20 and the filter member 14. The fan module comprises a centrifugal fan. A centrifugal fan has a small form factor and is able to overcome the flow resistance of the check valve.

[0043] The fan module is generally for generating a flow between the mask cavity and the ambient surroundings, namely the air outside the outer casing 12.

[0044] In this particular example, the connector module 16 comprises a check valve. The connector module 16 and the fan module 20 may be considered together to comprise a fan assembly and the two modules may be connected together and disconnected manually, for example with a simple push fit. For example, a lip around one part may cooperate with a recess around the other part.

[0045] A control module 18 is coupled to the outside of the filter member 14. The control module includes the fan module 20 of the fan assembly and also a control unit 22. The control unit includes a battery module and other control circuitry. The control unit 22 is inside the outer casing (i.e. on the side facing the face of the user) and outside the filter member (i.e. on the side facing away from the face of the user), and hence located in the chamber 15 defined between the two parts.

[0046] The control unit 22, and hence the battery module, is located in the path of exhaled air of the user when the mask is worn by the user. For this purpose, it is positioned at a front area of the face mask. The design shown has the fan module offset to one lateral side and the control unit offset to the opposite lateral side. However, they are both generally positioned to be in front of the mouth and/or nose of the user. The face mask has side areas over the cheeks of the user and which connect to the ear straps 13, a top area which extends over the nose of the user, a bottom area which extends beneath the mouth (and chin) of the user, and a front area which defines the boundary of the top, bottom and side areas. The battery module is within this front area. The front area of the outer casing may for example be considered to be an area which corresponds to 50% or even 33% of the overall surface area of the outer casing. The front area is symmetric about a vertical center line and for example has a width of less than 60% or less than 50% of the overall width of the outer casing. The front area for example has a height of less than 60% or less than 50% of the overall height of the outer casing.

[0047] The control unit 22 for example include sensors. Note that the control circuitry may instead be on the fan

module side and be integrated into the fan module. Thus, the various additional circuitry elements and battery module may be divided between the fan module and the control unit in different ways.

[0048] There may be a single module which incorporates all of the components. In the more preferred example shown, the battery module is separate to and remote from the fan module. This means the weight of the components can be divided between different locations, to provide better balancing of the mask and reduced local loading.

[0049] This also means that the battery module is in an area which is not exposed directly to the fan-driven exhaust flow (i.e. the flow through the fan) but is exposed to exhaled air that has passed through the filter. The battery module is thus in a chamber which is at least partially insulated and thereby can maintain a higher temperature caused by the exhaled breath of the user. This air may for example have a lower moisture content as a result of the action of the filter member.

[0050] The battery module of the control unit is thereby protected from the ambient surroundings by the outer casing 12 and is exposed to the breath of the user downstream of the filter member. This enables the battery module to be maintained at an elevated temperature relative to the ambient surroundings.

[0051] The connector module 16 is permanently fixed to the filter member 14 so that it is discarded with the filter member 14 when there is filter replacement. The fan module 20 of the fan assembly is reusable and includes (at least) the fan drive circuitry and fan impeller.

[0052] The outer casing 12 has an opening 24 in which the fan module 20 of the fan assembly is received.

[0053] An inner surface of the outer casing may also have a receiving dock area for the control unit 22, or else there may be a receiving dock area 26 (as shown in Figure 1) on the outer surface of the filter member for locating the control unit 22. The control unit may connect to the filter member or to the outer casing by a magnetic coupling as well as, or instead of, a mechanical alignment feature.

[0054] An electrical connector 28 in the form of a bridge provides electrical connection between the control unit 22 and the fan module 20 of the fan assembly, for transfer of power and control signals.

[0055] The fan module 20 of the fan assembly and the control unit 22 are at opposite lateral sides of the mask, i.e. one on each side of the nose of the wearer. This provides a balanced weight distribution. By having two modules, the weight of each individual part is reduced, so that the loading at any one location is reduced.

[0056] In a preferred design, the fan module is an exhaust fan. In a most simple design, it operates continuously to provide a continuous supply of air to the face (using air drawn through the mask filter). This provides temperature and humidity control. However, it may be operated in synchronism with the breathing of the wearer (with suitable breath sensing), and it may be controlled bi-directionally. Alternatively, there may be separate inlet and exhaust fans, e.g. one on each lateral side.

[0057] The use of an exhaust fan is preferred. It means the fan does not need a filter just before or after the fan, reducing the airflow. Users also find air blowing on the face to be uncomfortable. The fan should be made waterproof, as the exhaled air is humid and condensation will be formed at the air outlet and fan.

[0058] All of the various known options for control of the fan may be applied, since this invention relates in particular to the location of the battery module.

[0059] Figure 2 shows the design of Figure 1 in an assembled state from one front side and Figure 3 shows the design of Figure 1 in an assembled state from an opposite front side.

[0060] The mask design shown has a V-shape when viewed from above. Thus, it has two opposite lateral sides, and a ridge between the opposite lateral sides.

[0061] Figure 4 is used to show the way the components interface with the wearer and shows an alternative design with the control circuitry at the fan module side and only a battery module 23 at the opposite side.

[0062] The face 30 of the wearer is shown in cross section from above.

[0063] The filter member 14 connects to the outer casing 12 with fixings 32. These are for example push fit poppers. An outer periphery of the filter member also carries an inwardly projecting seal 34 to form a substantially closed volume between the filter member and the face 30.

[0064] When breathing in, air is drawn through the filter member 14 as shown by arrow 36. The exhaust fan may be operating during this time, providing flow 38, or it may be turned off to save power. When breathing out, the exhaust fan is operating to create flow 38, but there is also outward flow through the filter member as shown by arrow 40.

[0065] This flow 40 heats the chamber 15 between the filter member 14 and the outer casing 12.

[0066] The flow 36 may also continue (depending on how the fan is being operated) but that flow is not breathed in at that time, but instead circulates out through the fan. Breathing comfort is improved particularly because the fan removes the exhaled air from the mask cavity and therefore prevents re-breathing (recycling) of previously exhaled and hence un-fresh air.

[0067] The fan module may for example comprise the fan, a one-way check valve, and a printed circuit board carrying control circuitry. The fan is on top of the check valve.

[0068] In the example of Figure 4, the connector module 16 and fan module 20 are again separable so that the filter member may be replaced (or washed) while reusing the module.

[0069] Figure 5 shows a battery temperature measurement for a mask design in accordance with the invention as plot 42 and the ambient temperature as plot 44, over time. The mask is used in a -10 degree environment and

is brought indoors and taken off at time t1.

[0070] In this example, the battery temperature is seen to be maintained at a temperature between 15 and 20 degrees above the ambient temperature.

[0071] In the preferred design shown, the fan module comprises a centrifugal fan having an axial inlet inside the mask cavity and a radial outlet outside the mask cavity.

[0072] Figure 6 shows a front view of the mask and shows the radial outlet 50. The positioning of the outlet is for example selected so that it is not visible from in front and above the mask body, i.e. from the likely position of the eyes of another person. For example, the radial outlet may face downwardly or backwardly (i.e. back towards the user).

[0073] In a basic design, the fan module 20 projects through the opening in the outer casing but is a loose fit in the opening. It has been found that movement of the fan module causes different flow characteristics, for example because the outlet flow may strike the outer casing, creating altered turbulence.

[0074] An additional connection is therefore preferably provided between the fan module 20 and the outer casing 12, in particular around the inner rim of the opening 24 in the outer casing 12. The use of a rim around the opening 24 in the outer casing also provides stability to the edge of the opening.

[0075] Figure 7 shows one example of a design for the design of a connection arrangement around the opening in the the outer casing. Figure 8 shows a cross section along line VII-VII to show connection between the fan module and the outer casing.

[0076] Figure 7 shows the outer casing 12 with a main structural layer 60.

[0077] The mask has four connector parts.

[0078] The filter member 14 comprises a first connector part 16 (i.e. the connector module) and the fan module 20 comprises a second connector part 17 for connection to the first connector part thereby to fix the fan module 20 to the filter member 14. These parts are shown in Figure 1 and also in Figures 7 and 8.

[0079] The fan module also has a third connector part 70, shown in Figure 8.

[0080] The outer casing 12 has a fourth connector part 72 for connection to the third connector part 70 to fix the outer casing 12 to the fan module 20, with the fan module projecting through the opening.

[0081] The fan module is thus connected to the filter in the manner already explained above, and there is a further coupling between the fan module and the outer casing. In this way, the fan module is positionally fixed with respect to the outer casing. The characteristics of the airflow to or from the fan module are thus maintained consistent, independent of any shape adjustment of the flexible filter member.

[0082] The fourth connector part 72 in the example shown comprises a ring around the inner edge of the opening 24. The fan module 20 is pushed through the opening 24 during assembly of the face mask and it then locks into a fixed position.

[0083] Note that the connection is not intended to be released by the user, since the fan module and outer casing may remain attached when the filter member is removed for cleaning. However, the connection may be reversible, for example the user may have different outer cover designs.

[0084] The fourth connector part may be a single component, but for ease of assembly, the example shown has a fourth connector part with a first ring 74 on the outside of the outer casing and a second ring 76 on the inside of the outer casing. The structural layer 60 is sandwiched between the first and second rings. The first and second rings thus provide a termination to the opening 24 in the structural layer 60. The structural layer 60 may have some flexibility, but it is more rigid than the filter member.

[0085] The first and second rings 74, 76 may be a mechanical snap fit together, or glued together or welded (e.g. ultrasonically) together. They are plastics parts. For example they may be formed of a thermoplastic material, such as acrylonitrile butadiene styrene (ABS), which is suitable for ultrasonic welding. Other plastics may be used such as polypropylene or polycarbonate.

[0086] The first and second connector parts 16, 17 are a push fit together to enable the filter member to be attached to and detached from the fan module as explained above. The third connector part 70 is also a push fit to the fourth connector part 72. This enables easy assembly of the fan module to the outer casing.

[0087] The third connector part 70 is for example a recess around an outer side wall of the fan module and the fourth connector part 72 includes a sprung tab 78, more preferably a set of sprung tabs, for engaging with the recess. This provides a snap fit connection. The recess may be all around the outer side wall, or there may be only a set of recess portions at the locations of the sprung tabs.

[0088] Figure 8 shows the tab and recess arrangement in more detail. The sprung tab 78 is biased outwardly (i.e. towards the center of the opening). It is pushed back by insertion of the fan module and then springs back into the recess 70. There may be a set of the tabs around the opening, for example three or more. However, a continuous tab is also possible.

[0089] The outer appearance of the first ring 74 (which is visible) is uniform, so that the tab design does not detract from the visual appearance. The second ring 76 has regions where the tabs are formed where the connection between the first and second rings is interrupted. In the example shown, the tabs are at the end of a folded leg, and this folded leg projects into a cavity formed in the first ring 74 as shown in Figure 8.

[0090] When the fan module is in place, projecting through the opening, the radial outlet 50 is positioned beyond the outer casing, for example extending outwardly beyond the outermost surface of the first ring 74. Thus,

the radial outlet is positioned with a minimum of obstruction to the outlet flow. However, an alternative is that the radial outlet is positioned with a desired positional relationship to a flow deflecting member 80 as is shown schematically in Figure 6.

[0091] A possible design of the third and fourth connector parts is presented above. For completeness, Figure 9 shows a possible design for the first and second connector parts. In Figure 9, the third and fourth connector parts are represented schematically only as unit 70,72.

[0092] The fan module 20 of the fan assembly comprises a main housing 86, an outer housing 82, a fan control circuit board 84, and a fan motor 88. There is also a fan impeller, not shown.

[0093] In this example, the connector module 16 comprises an annular channel 90 and the fan module comprises a spring biased engagement feature 92.

[0094] The left image of Figure 9 shows the connector module 16 and fan module 20 separated and the right image shows the connector module and fan module coupled together. When coupled together, the feature 92 engages with the annular channel 90 thereby to provide attachment of the connector module to the fan module by a push fit.

[0095] The connector module 16 is connected to the filter member 14 for example with ultrasonic welding, to create a seal around the connector module 16. In this example, the connector module 16 defines a check valve 94, such as a rubber flap valve.

[0096] The annular channel 90 results in a ring 96 of greater diameter above the channel. When pushing the connector module 16 into the fan module 20 (the arrow is only intended to show the relative movement), the feature 92 is deflected radially outwardly by the ring 96 and then snaps back into the channel 90.

[0097] Because the channel is annular, relative rotation between the two modules is possible. Thus, the connection can be made without needing accurate angular alignment. It also means that little force is applied to the filter member, for example no significant twisting force, which could damage the filter material.

[0098] In the example shown, the feature 92 comprises tabs. The tabs comprise a support arm and a head. The head is designed to fit into the channel and the support arm provides the radially inward spring bias. The main housing 86 is designed to provide space for the tabs to deflect outwardly during the coupling as the tabs ride over the ring 96.

[0099] There may be only two diametrically opposed tabs, or more preferably a set of three, or there may be more than three. The annular channel does not need to be continuous. There is a correct orientation for the fan module 20, in particular so that the electrical connector bridge 28 is in the correct position. Thus, only some angular freedom for adjustment is needed, rather than full angular control. Thus, the annular channel may comprise a set of annular channel portions (one for each tab) but they do not need to form a continuous channel.

[0100] The channels and tabs may of course be reversed, with the channel on the fan module and the tabs on the connector module.

[0101] The feature 92 is preferably metal, to provide increased elasticity and durability compared to plastic features.

[0102] The use of a spring biased connection instead of an interference fit allows regular filter replacement (or separation for cleaning).

[0103] The filter member 14 may connect to the outer casing in any suitable way and the poppers shown are only by way of example. Preferably, a push fit connection is used as this allows easy connection and disconnection of the filter member from the outer casing.

[0104] The description above relates to one design of face mask, in particular with a fan module which projects from the filter member through an opening in the outer casing. However, other configurations are possible, for example with the fan module mounted on the outside of the outer casing.

[0105] Variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. If the term "adapted to" is used in the claims or description, it is noted the term "adapted to" is intended to be equivalent to the term "configured to". Any reference signs in the claims should not be construed as limiting the scope.

Claims

1. A face mask (10), comprising:

   an outer casing (12);
   a filter member (14) for mounting inside the outer casing, wherein a mask cavity is defined between the filter member and the face of a user, when the face mask is worn by the user and a chamber (15) is defined between the outer casing and the filter member;
   a fan module (20) for generating a flow between the mask cavity and the ambient surroundings; and
   a battery module (23),
   wherein the battery module is located within the chamber (15).

2. A face mask as claimed in claim 1, wherein the battery module is located in the path of exhaled air of the user when the mask is worn by the user.

3. A face mask as claimed in claim 1 or 2, wherein the battery module is located at a front area of the face mask.

4. A face mask as claimed in any one of claims 1 to 3, wherein the battery module and the fan module are separate units mounted apart from each other.

5. A face mask as claimed in claim 4, wherein the mask body comprises opposite lateral sides which are adapted to face at least partially laterally outwardly when the mask is worn by a user, the fan assembly (20) is mounted at one of the opposite lateral sides and the battery module (23) is mounted at the other of the opposite lateral sides.

6. A face mask as claimed in any one of claims 1 to 5, wherein the fan module (20) comprises an exhaust fan for expelling air from the mask cavity.

7. A face mask as claimed in claim 6, wherein the fan module (20) comprises a centrifugal fan having an axial inlet communicating with the inside of the mask cavity and a radial outlet (50) outside the mask cavity.

8. A face mask as claimed in any one of claims 1 to 7, wherein the battery module (23) is part of a control unit (22), wherein the control unit (22) further comprises control circuitry for the fan module (20).

9. A face mask as claimed in any one of claims 1 to 8, comprising an electrical connector (28) between the fan module (20) and the battery module (23), located within the chamber (15).

10. A face mask as claimed in claim 8 or 9, wherein the battery module (22) is:

attached to the inside of the outer casing (12); or
removably attached to the filter member (14).

11. A face mask as claimed in any one of claims 1 to 10, wherein the filter member (14) comprises a first connector part (16) and the fan module comprises a second connector part (17), for connection to the first connector part (16) thereby to releasably fix the fan module (20) to the filter member (14).

12. A face mask as claimed in claim 11, wherein first and second connector parts (16,17) are a push fit together to enable the filter member (14) to attached to and detached from the fan module (20).

13. A face mask as claimed in any one of claims 1 to 12, wherein the outer casing (12) has an opening (24) and wherein the fan module (20) extends through the chamber (15) and through the opening (24) in the outer casing (12).

14. A face mask as claimed in claim 13, wherein the fan module comprises a third connector part (70) and the outer casing comprises a fourth connector part (72), for connection to the third connector part thereby to fix the outer casing to the fan module, with the fan module projecting through the opening.

15. A face mask as claimed in claim 14, wherein the third connector part (70) is a push fit to the fourth connector part (72).

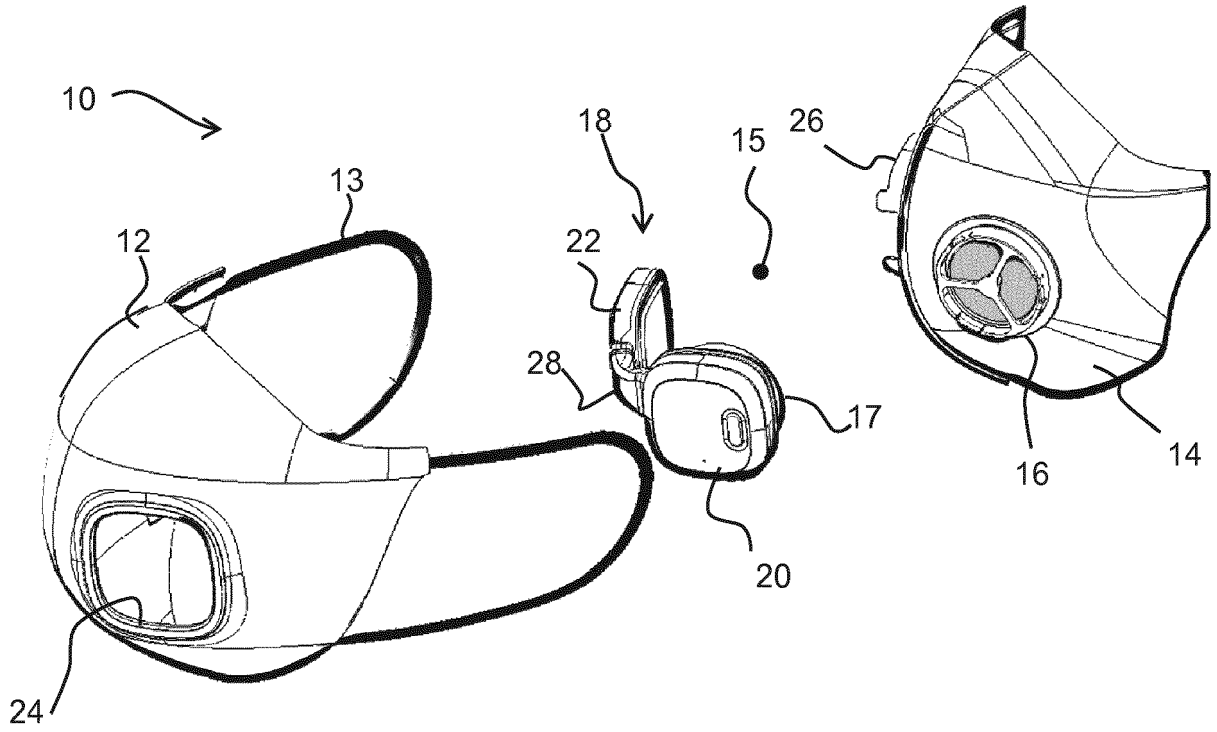

FIG. 1

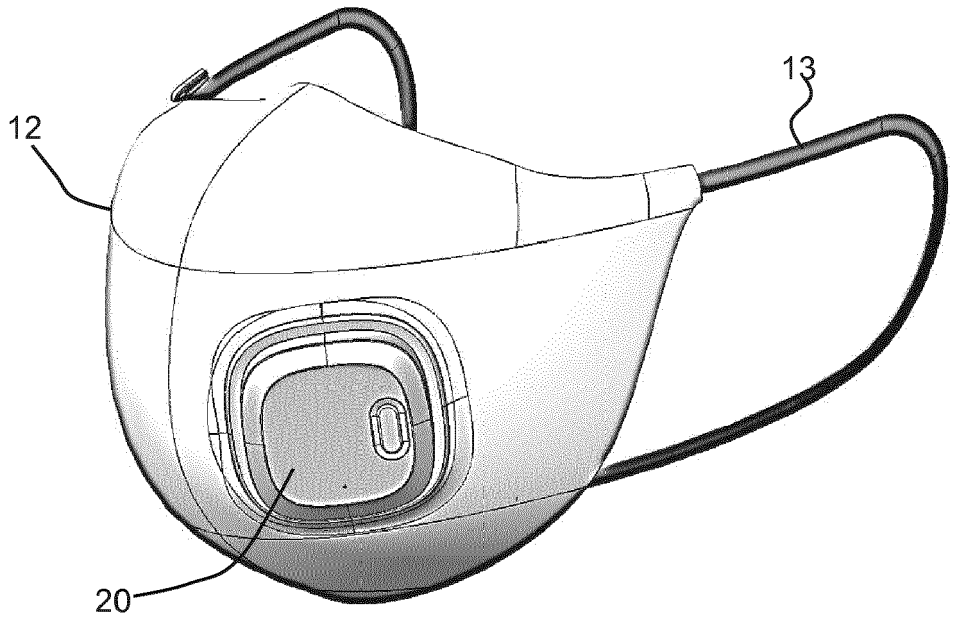

FIG. 2

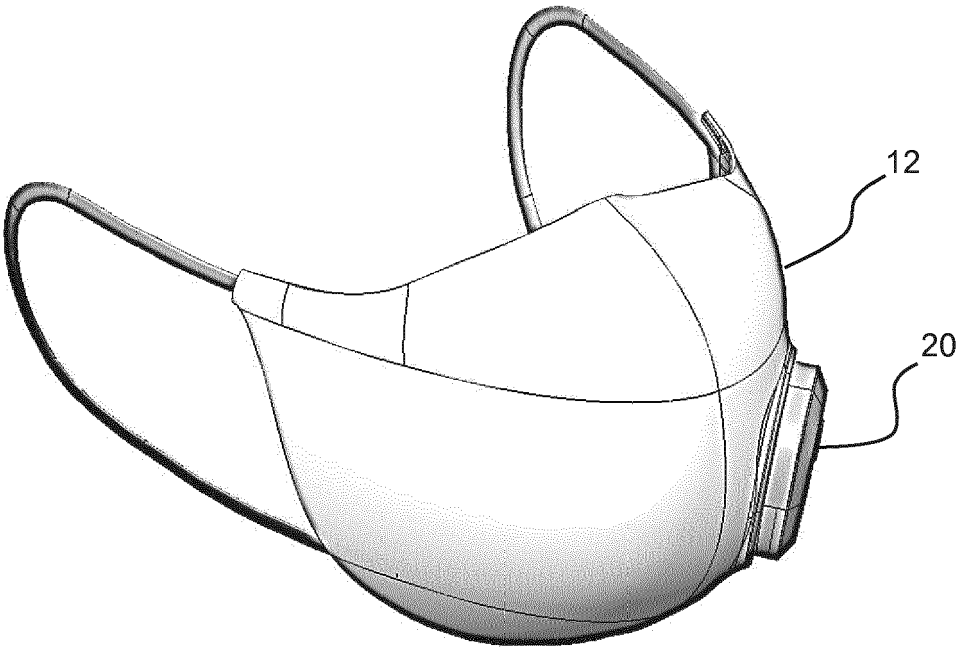

FIG. 3

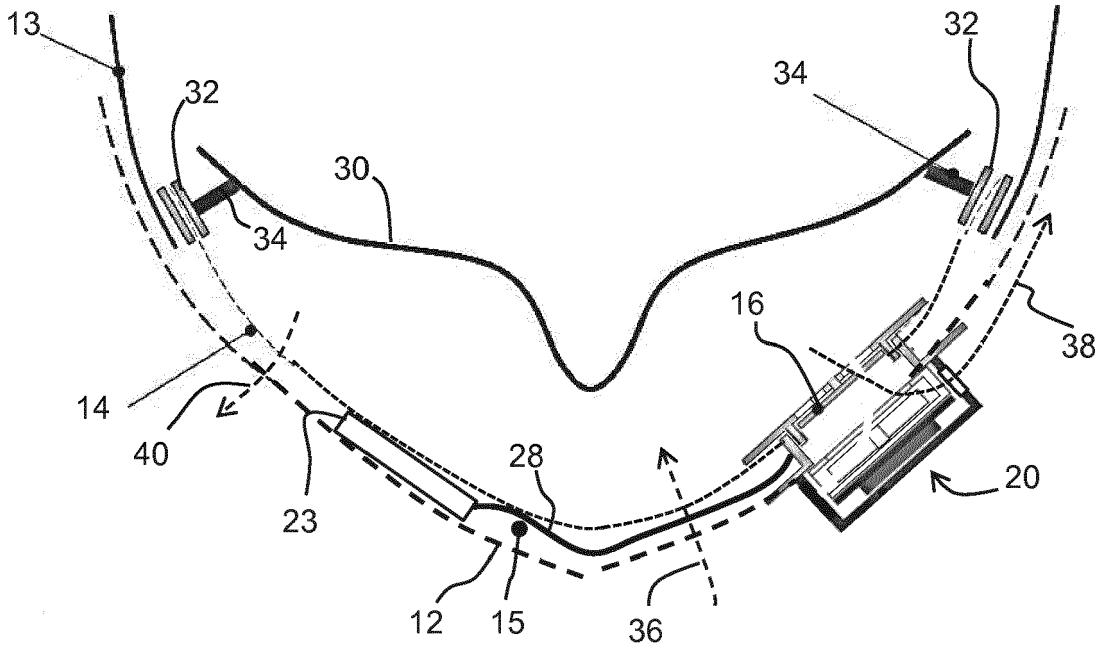

FIG. 4

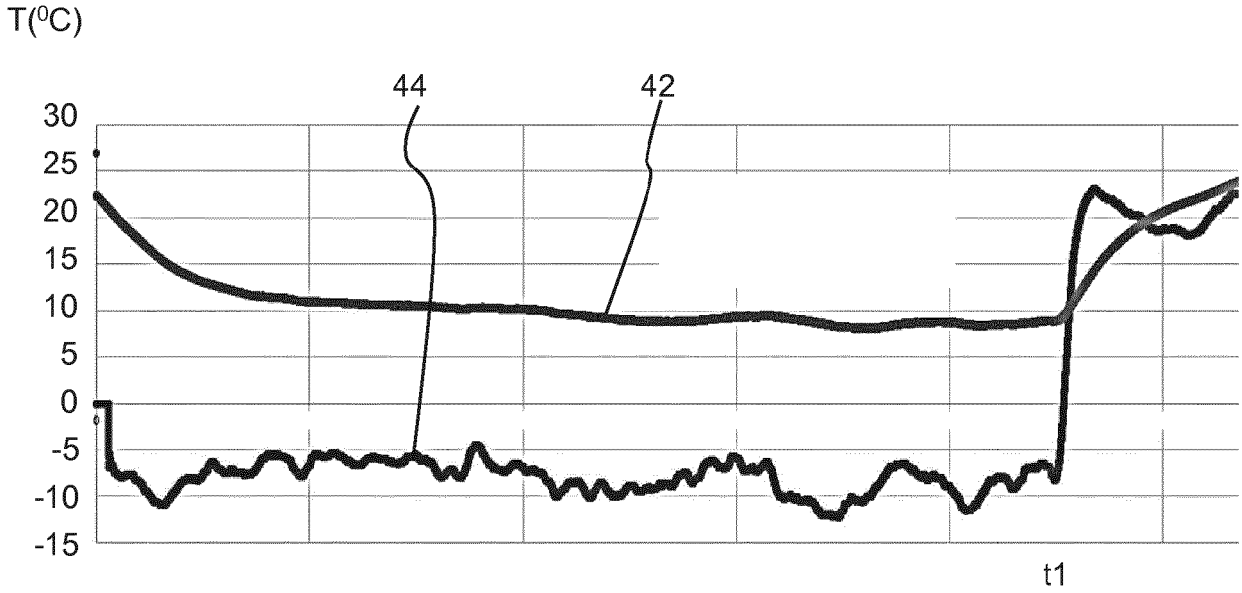

FIG. 5

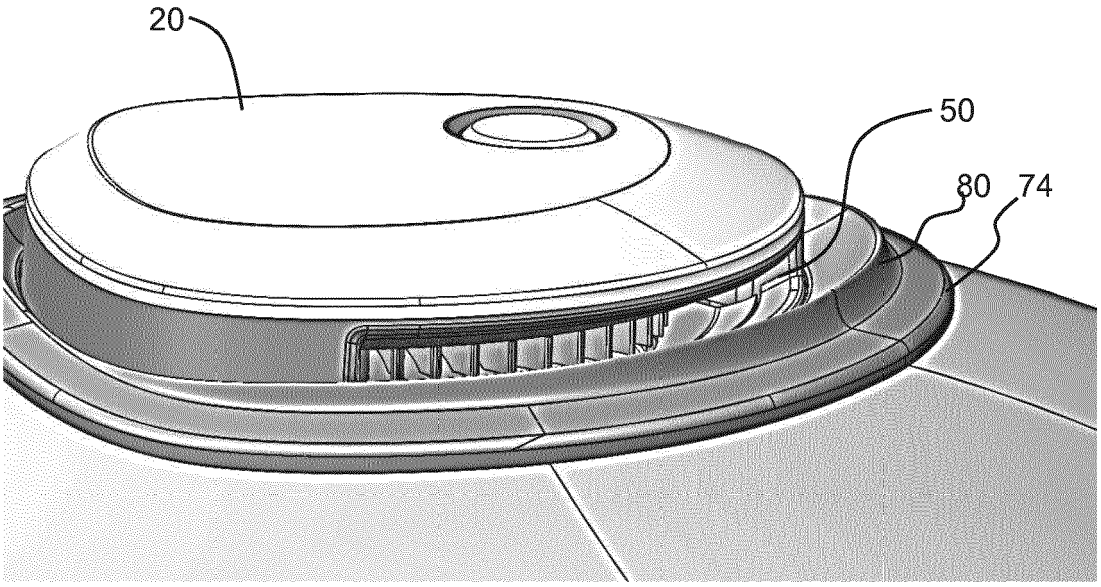

FIG. 6

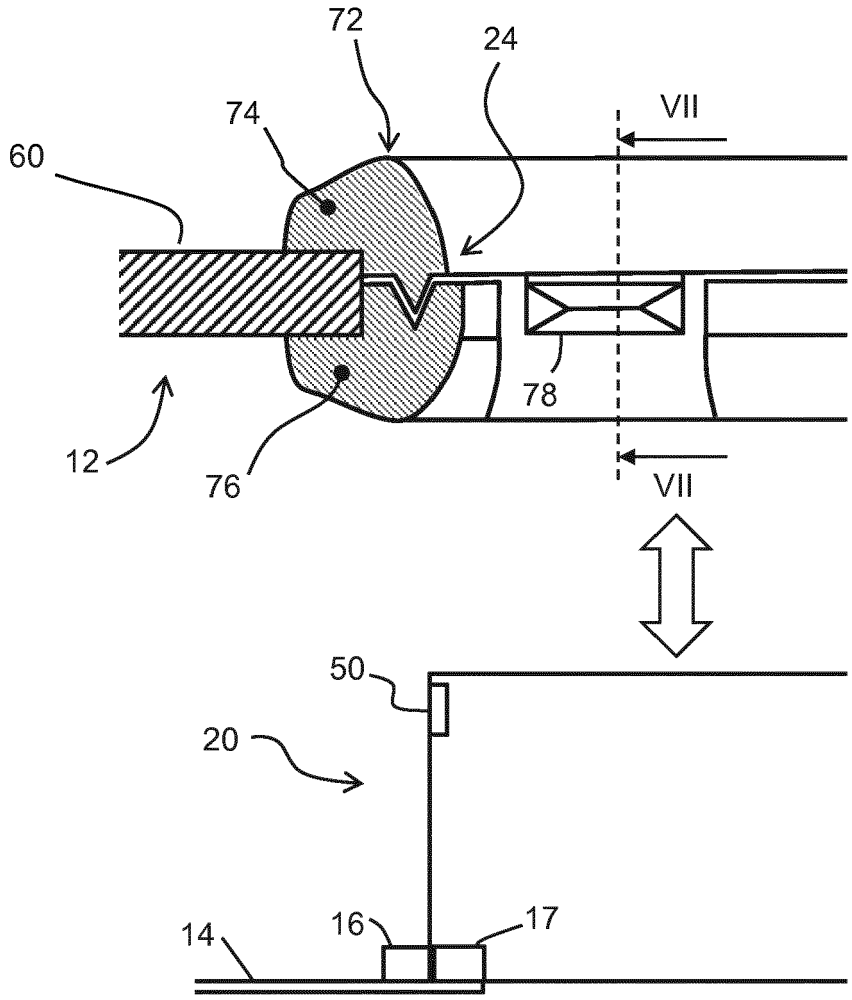

FIG. 7

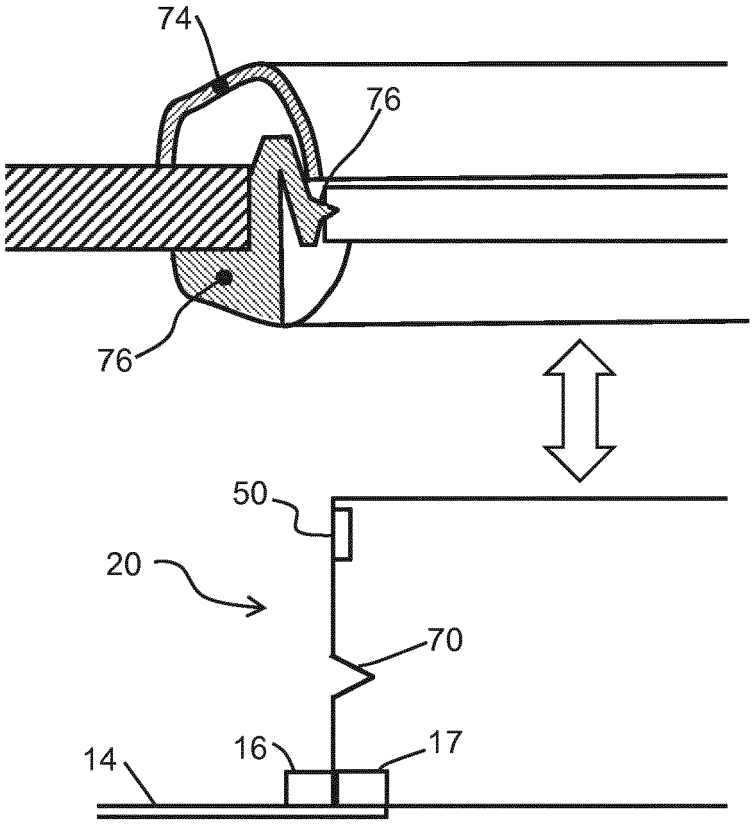
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FIG. 8

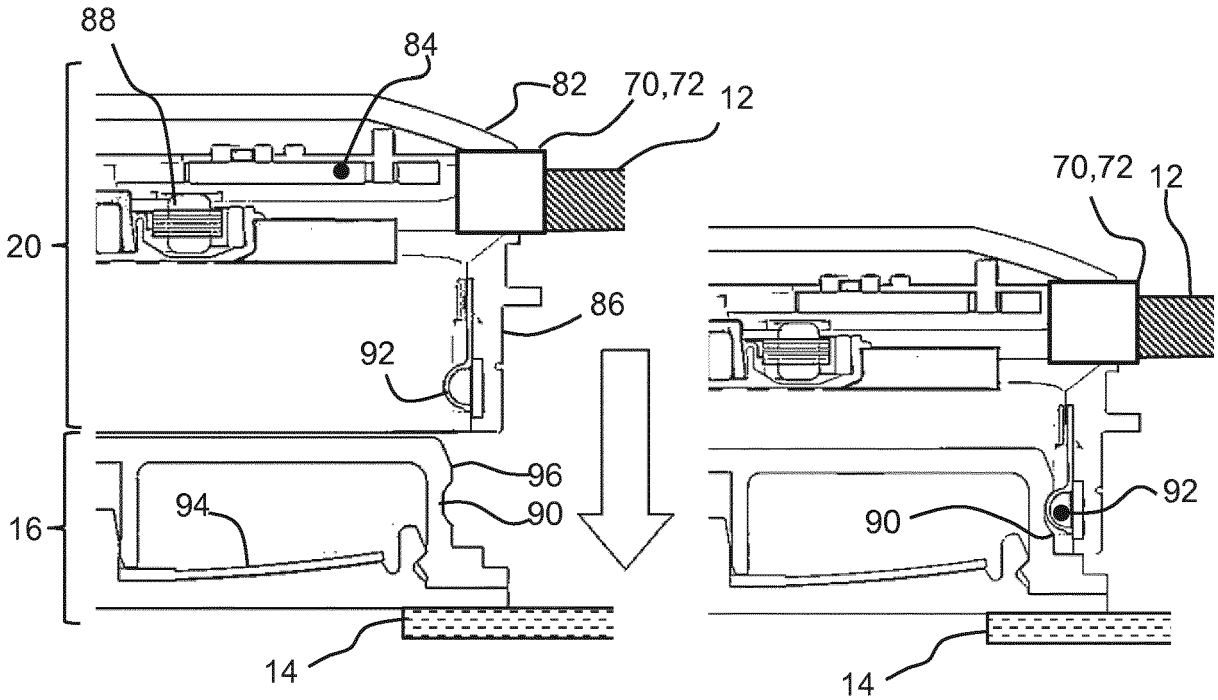
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FIG. 9

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EUROPEAN SEARCH REPORT

Application Number
EP 19 20 6929

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	WO 2019/119135 A1 (EMPOWERED STARTUPS LTD [CA]) 27 June 2019 (2019-06-27) * paragraph [0035] - paragraph [0037] * * figures 8-11 * -----	1,3,4, 8-12 2,5-7, 13-15	INV. A62B18/02
X A	EP 3 542 867 A1 (KONINKLIJKE PHILIPS NV [NL]) 25 September 2019 (2019-09-25) * paragraph [0034] - paragraph [0063] * * figures 1,2,7 * -----	1,3-15 2	

TECHNICAL FIELDS SEARCHED (IPC)

A62B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	20 April 2020	Nehrdich, Martin

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20-04-2020

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EP 3542867 A1	25-09-2019	NONE	

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