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(54) **A FACE MASK**

(57) A face mask comprises a filter member and a fan assembly. The fan assembly has two modules, one connected to the filter member and the other carrying the reusable parts of the fan assembly. The two modules are connected together by a spring biased coupling.

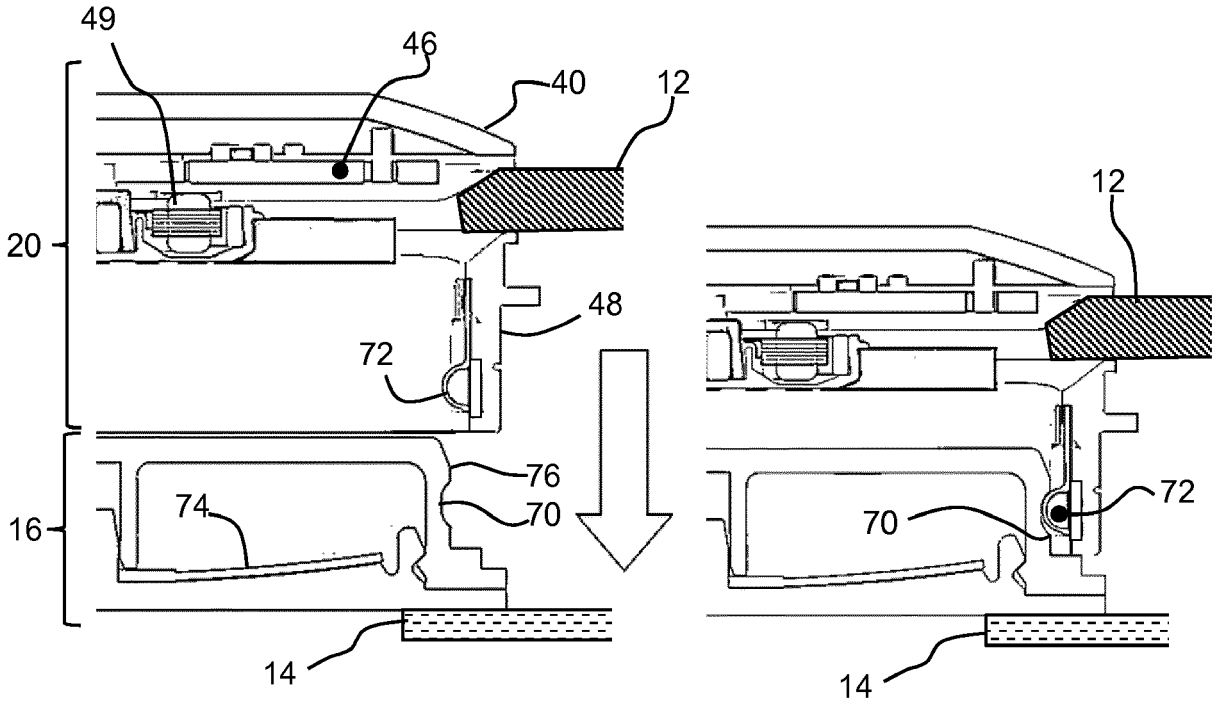

FIG. 6

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Description

FIELD OF THE INVENTION

[0001] This invention relates to face mask, 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 wearing 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 volume through the filter by the flow induced by the fan. This improves wearer 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 in particular to active masks, having a fan. One issue is that the mask filter needs regular cleaning or changing. The fan is typically formed in such a way that a seal is formed between the fan and the mask filter. This seal needs to be released in order to separate the fan from the mask filter, because the fan (in particular its associated electrical and electronic components) is not suitable for cleaning and does not need to be replaced as regularly as the filter.

[0015] There is a need for a connection system which enables the mask filter to be separated from the fan, in a low cost yet robust way, such that the release and reconnection can be performed numerous times. The connection needs to provide good alignment between the fan and the mask filter, otherwise the parts will be under tension leading to deformation of the filter, difficulty with assembling, and durability issues.

SUMMARY OF THE INVENTION

[0016] The invention is defined by the claims.

[0017] According to examples in accordance with an aspect of the invention, there is provided a face mask, comprising:

a filter member;

a fan assembly, wherein the fan assembly comprises a connector module which is fixed to the filter member and a fan module, wherein the connector module and fan module are separable to enable the filter member to be detached from the fan module,

wherein one of the connector module and fan module

comprises a receiving channel or set of receiving channel portions and the other of the connector module and fan module comprises a spring biased engagement feature adapted to engage with the receiving channel or set of receiving channel portions thereby to provide attachment of the connector module to the fan module.

[0018] This mask has a connection between two modules of the fan assembly, and hence between one module of the fan assembly and the filter member, which is achieved by a spring based system. By using a spring biased connection instead of an interference fit (for example of plastic parts), the durability is improved, to allow regular filter replacement. This design also makes assembly easy, because precise alignment is not needed, due to the use of a receiving channel design.

[0019] The receiving channel may comprise an annular channel (such as a circular channel) or the receiving channel portions may comprise annular channel portions (such as portions of a common circular channel).

[0020] This allows the two parts to be coupled within one or more continuous ranges of relative angular orientation.

[0021] The engagement of the spring biased engagement feature with the receiving channel (or set of receiving channel portions) preferably provides attachment of the connector module to the fan module by a push fit. The spring based system can thus be pressed ("clicked") together.

[0022] When the two modules are pressed together, the spring biased engagement feature is for example forced backwards, and then returns to its original position (or at least to a less deformed position) when it engages with the receiving channel (or receiving channel portions). The two modules are then held together, and in the case of a circular annular channel, with some freedom to rotate.

[0023] The spring biased engagement feature is durable, for example by ensuring that it only deforms within its elastic range. A large amount of deformation can be permitted, and this makes the alignment between the two modules less critical, which makes it easier to assemble the parts.

[0024] In examples using a circular annular channel, the coupling can rotate freely once connected, at least within a limited angular range, as only rotational friction resists the rotation.

[0025] The spring biased engagement feature for example comprises a set of spring biased tabs. Thus, a small friction is present to resist rotation of the coupling. The tabs are for example formed of a sprung metal.

[0026] The spring biased engagement feature may instead comprise a spring ring. This may expand when located radially outside the receiving channel and contract when engaging with the receiving channel.

[0027] Another possible example is a set of spring biased ball bearings, which project into the channel or channel portions.

[0028] The fan module for example comprises a fan and a fan motor. By separating the fan module and the connector module, the fan and motor are separated from the filter member, so that the filter member (with the connector module attached) can be replaced or cleaned.

[0029] In one example, the fan module may further comprise a check valve. In this case, the connector module may simply comprise a connector which forms a seal with the filter member.

[0030] In another example, the connector module may comprise a check valve. This may be a low cost component and it may also be washable, so it can be a part of the filter member.

[0031] In both cases, the fan assembly (the combined fan module and connector module) then defines a fan and check valve assembly.

[0032] The fan module for example has the spring biased engagement feature and the connector module has the receiving channel or set of receiving channel portions.

[0033] The fan assembly for example comprises an exhaust (or exhale) fan for expelling air from a volume defined by the inner filter member. This is one possible option for the fan, to provide a continuous release of air. This provides breathing assistance when exhaling and also ensures a continuous supply of air to the face. The exhaust fan is for example combined with a check valve (which may be part of the connector module or the fan module).

[0034] The mask preferably further comprises a control unit, wherein the control unit and the fan assembly are on opposite lateral sides of the face mask.

[0035] This provides balancing of the weight of the various components on opposite sides of the mask. The controller for example sends control signals to the fan. It may include a breathing sensor, temperature sensor, pressure sensor etc. The control unit for example comprise a battery unit and optionally also control circuitry for the fan assembly (some or all control circuitry may be at the fan module).

[0036] An electrical connector bridge is then preferably provided between the control unit and the fan module, located outside the filter member. Thus, when the connector module and fan module are decoupled, to allow the filter member to be replaced, the electrical connector bridge remains in place.

[0037] The filter member may define the outer surface of the mask. The decoupling of the connector module and fan module then basically disconnects the reusable (and non-washable) parts of the mask from the filter member. However, in another design, the mask further comprises an outer casing, wherein the filter member is an inner filter member for mounting inside the outer casing.

[0038] This provides a protective outer casing. The inner filter member for example is a push fit to connect to the outer casing, for example with poppers.

[0039] In one design, the control unit is attached to the

inside of the outer casing. Thus, when the first and second modules are decoupled, the control unit and the fan module of the fan assembly (and the electrical connector bridge between them) remain supported by the outer casing.

[0040] In another design, the control unit is removably attached to the inner filter member. This may simply be a location function rather than a secure connection.

[0041] A magnetic coupling may be provided to retain the control unit in place.

[0042] The outer casing for example comprises an opening, and the fan module is fixed to the outer casing aligned with (and extending into or through) the opening.

[0043] The invention also provides a fan module for use in a face mask as defined above, comprising:

a receiving channel or set of receiving channel portions adapted to engage with a spring biased engagement feature of the connector module (e.g. by a push fit); or
a spring biased engagement feature adapted to engage with a receiving channel or set of receiving channel portions of the connector module (e.g. by a push fit).

[0044] The invention also provides a filter for use in a face mask as defined above, comprising:

a filter layer; and
a connector module attached to the filter layer, wherein the connector module comprises:

a receiving channel or set of receiving channel portions adapted to engage with a spring biased engagement feature of the fan module (e.g. by a push fit); or
a spring biased engagement feature adapted to engage with a receiving channel or set of receiving channel portions of the fan module (e.g. by a push fit).

[0045] 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

[0046] 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 an exploded view of the control module of the design of Figures 1 to 3;
Figure 6 shows the coupling design used in either of the mask designs;
Figure 7 shows one possible design for the spring biased engagement feature
Figure 8 shows another possible design for the spring biased engagement feature.
Figure 9 shows another possible design for the spring biased engagement feature; and
Figure 10 shows another possible design for the spring biased engagement feature.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0047] The invention will be described with reference to the Figures.

[0048] 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.

[0049] The invention provides a face mask which comprises a filter member and a fan assembly. The fan assembly has two modules, one connected to the filter member and the other carrying the reusable parts of the fan assembly. The two modules are connected together by a spring biased coupling, preferably a push fit coupling.

[0050] Figure 1 shows one example of a mask design to which the invention may be applied. The mask 10 is shown in exploded view and comprises an outer casing 12 and an inner filter member 14. The outer casing is rigid or semi-rigid with ear straps 13, whereas the filter member 14 is formed of a fabric and thus easily deforms such that an outer edge can match the shape of a wearer's face.

[0051] The outer casing is porous so that air can flow through the outer casing.

[0052] The inner filter member 14 is sealed around a connector module 16. The connector module 16 is for connecting to a fan module 20. In this particular example, the connector module 16 comprises a passive check valve. The connector module and the fan module may be considered together to comprise a fan assembly and the two modules may be connected together and discon-

nected manually.

[0053] 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 22 for example comprises a battery and other control circuitry. This may include sensors. Note that the control circuitry may instead be on the fan module side. Thus, the various additional circuitry elements and battery may be divided between the fan module and the control unit in different ways.

[0054] 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.

[0055] The outer casing 12 has an opening 24 in which the fan module 20 of the fan assembly is received.

[0056] 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 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..

[0057] An electrical connector bridge 28 provides electrical connection between the control unit 22 and the fan module 20 of the fan assembly, for transfer of power and control signals.

[0058] 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.

[0059] In this example, the fan assembly 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.

[0060] All of the various options for control of the fan may be applied, since this invention relates in particular to the physical assembly of the fan module to the filter member, regardless of how it is controlled in use.

[0061] 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.

[0062] Figure 4 is used to show the way the components interface with the wearer and shows an alternative design with a single module. The invention may equally be applied to a single module design. The face 30 of the wearer is shown in cross section from above.

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

[0064] The single module of this example is located centrally (again so that the weight is balanced). The module comprises a connector module 16 and a fan module 20 as in the example of Figure 1. The fan module 20 then incorporates the reusable parts of both the fan assembly and the control module.

[0065] When breathing in, air is drawn through the inner 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, and there may also be outward flow through the inner filter member as shown by arrow 40. 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.

[0066] The single module may for example comprise a fan, a one-way check valve, a battery and a printed circuit board carrying control circuitry. The fan is on top of the check valve.

[0067] In the example of Figure 4, the connector module 16 and fan module 20 are again separable so that the inner filter member may be replaced (or washed) while reusing the module.

[0068] Returning to the design of Figures 1 to 3, Figure 5 shows an exploded view of the control module 18.

[0069] The fan module 20 of the fan assembly comprises an outer housing 40, a power button 42 which extends through an opening 44, a fan control circuit board 46, a main housing 48 of the fan module 20 which houses the fan motor 49, a fan impeller 50 an a pressure plate 52. The pressure plate improve the performance of the fan and protects the impeller from the user for any potential misuse, such as touching the impeller in any way.

[0070] The control unit 22 comprises an outer housing 60, a battery 62, a control unit circuit board 64 and an inner housing 66.

[0071] The control unit is not intended for separation or dismantling by the user. Instead it is retained, as a closed unit, in a receiving port on the inner surface of the outer casing, or on the outer surface of the filter member, as explained above.

[0072] This invention relates in particular to the way the two fan assembly modules are coupled together.

[0073] Figure 6 shows the coupling design.

[0074] In this example, the connector module 16 comprises a receiving channel 70, in this example an annular channel, in particular a circular annular channel, and the fan module comprises a spring biased engagement feature 72. A circular receiving channel enables connection to be made in different relative rotational positions. How-

ever, the receiving channel may have other shapes such as a polygonal shape. Again, this may allow connection in a discrete number of different orientations.

[0075] The left image of Figure 6 shows the connector module and fan module separated and the right image shows the connector module and fan module coupled together. When coupled together, the feature 72 engages with the annular channel 70 thereby to provide attachment of the connector module to the fan module. This is preferably achieved with a push fit, however a push and twist connection is also possible, wherein the final twist engages the spring biased engagement feature with the channel or channel portions. In all cases, the retention is achieved by the engagement against the spring bias, rather than by a tight interference fit such as a screw thread.

[0076] 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 74, such as a rubber flap valve. The fan module 20 is connected to the outer casing 12, for example by clamping to it during assembly. This connection is not intended to be released by the user.

[0077] The annular channel 70 results in a ring 76 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 72 is deflected radially outwardly by the ring 76 and then snaps back into the channel 70.

[0078] 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.

[0079] In the example shown, the feature 72 comprises tabs.

[0080] As shown in Figure 7, the tabs comprise a support arm 80 and a head 82. The head is designed to fit into the channel and the support arm provides the radially inward spring bias. The main housing 48 is designed to provide space for the tabs to deflect outwardly during the coupling as the tabs ride over the ring 76.

[0081] 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. Thus, more generally, the receiving channel may comprise a set of receiving channel portions, and those portions may be portions of an annulus (which is what is intended to be meant by "annular channel portions").

[0082] The channels and tabs may of course be reversed, with the channel on the fan module and the tabs on the connector module.

[0083] The feature 72 is preferably metal, to provide increased elasticity and durability compared to plastic features.

[0084] The use of a spring biased connection instead of an interference fit allows regular filter replacement (or separation for cleaning).

[0085] There are alternatives for the feature 72.

[0086] Figure 8 shows an alternative formed as a loop which may be considered to be a spring ring. This shows the loop from above. It has fixed points 90 (at a diameter greater than the channel) and sides 92 which extend between those fixed points. The ring expands when located around the ring 76 because the sides bow outwardly. The ring contracts when engaging with the annular channel when the sides straighten under the spring force.

[0087] There may be three, four or more sides.

[0088] There are other possible connector designs.

[0089] Figure 9 shows a ring of spring biased engagement features in the form of straight upstanding tabs 94. These deflect outwardly when a channel is introduced and spring back radially inwardly into the channel. These may be considered to be elongate versions of the tabs of Figure 7 to define a near continuous loop.

[0090] Figure 10 shows spring loaded recessed ball bearings 100 which function as spring biased engagement features. These are depressed into their sockets when the annular channel lip passes, and then project back out to engage with the channel. There may additionally be a locking sleeve which locks the ball bearings in the radially inner positions, so that the sleeve needs to be moved to make the connection and to break the connection. This provides additional security.

[0091] The designs of Figures 8 to 10 may each connect to a channel design as shown in Figure 6.

[0092] Thus, various spring base rotational couplings are possible, preferably to enable a push fit connection.

[0093] The main example above has an outer shell and an inner mask. However, the same connection approach may be used for a mask with only a filter layer. The fan assembly is then attached to the filter layer in the same way, namely the mask of Figure 1 does not need the outer cover. The control unit may connect to the filter in the same way as the fan module, with the same, e.g. push fit, spring biased arrangement. The control unit may instead connect in a different way, for example with interference fit plastic parts, plastic and rubber parts with an interference fit, or Velcro, a button arrangement, a magnet or any other suitable design. This is a less critical coupling as it is not involved in creating a seal. The filter will then have a strap or other connection for fitting the mask to the wearer.

[0094] In the design with an outer casing, the control unit does not need to attach firmly to the filter or the casing, it just needs to be retained in position, for example simply docking into a receiving port.

[0095] When an outer casing used, the inner filter member may connect to it in any suitable way. Preferably, a push fit connection is used as this allows easy connection and disconnection of the filter member from the outer casing.

[0096] The connection system described above may be applied to a mask with one fan and control module or with separate control and fan modules as shown in detail above.

[0097] The connection between the connector module and fan module may take various forms. The fan module may have the smaller male connecting part i.e. the projecting annular channel, or the connector module may have the smaller male connecting part.

[0098] 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, comprising:

a filter member (14);
a fan assembly, wherein the fan assembly comprises a connector module (16) which is fixed to the filter member and a fan module (20), wherein the connector module and fan module are separable to enable the filter member (14) to be detached from the fan module (20),
wherein one of the connector module (16) and fan module (20) comprises a receiving channel (70) or set of receiving channel portions and the other of the connector module and fan module comprises a spring biased engagement feature (72) adapted to engage with the receiving channel (70) or set of receiving channel portions thereby to provide attachment of the connector module (16) to the fan module (20).

2. A face mask as claimed in claim 1, wherein the receiving channel comprises an annular channel or the receiving channel portions comprise annular channel portions.

3. A face mask as claimed in claim 1 or 2, wherein the engagement of the spring biased engagement feature (72) with the receiving channel (70) or set of receiving channel portions provides attachment of the connector module (16) to the fan module (20) by a push fit.

4. A face mask as claimed in any one of claims 1 to 3, wherein the spring biased engagement feature (72) comprises:

a set of spring biased tabs (72; 94);.
a spring ring (92);
a set of ball bearings (100).

5. A face mask as claimed in any one of claims 1 to 4, wherein the fan module comprises a fan and a fan motor and wherein the face mask further comprises a check valve, wherein the check valve is either part of the connector module or part of the fan module.

6. A face mask as claimed in any one of claims 1 to 5, wherein the fan module (20) has the spring biased engagement feature and the connector module (16) has the receiving channel or set of receiving channel portions.

7. A face mask as claimed in any one of claims 1 to 6, wherein the fan assembly comprises an exhaust fan for expelling air from a volume defined by the inner filter member.

8. A face mask as claimed in any one of claims 1 to 7, further comprising a control unit (22), wherein the control unit (22) and the fan assembly (16,20) are on opposite lateral sides of the face mask.

9. A face mask as claimed in claim 8, further comprising an electrical connector bridge (28) between the control unit (22) and the fan module (20), located outside the filter member.

10. A face mask as claimed in claim 8 or 9, wherein the control unit comprises a battery unit and optionally also control circuitry for the fan assembly.

11. A face mask as claimed in any one of claims 1 to 10, further comprising an outer casing, wherein the filter member is an inner filter member for mounting inside the outer casing.

12. A face mask as claimed in claim 11, wherein the control unit is:

attached to the inside of the outer casing; or
removably attached to the inner filter member.

13. A face mask as claimed in claim 11 or 12, wherein the outer casing comprises an opening, and the fan module is fixed to the outer casing aligned with the

opening.

14. A fan module adapted for use in a face mask as claimed in any one of claims 1 to 13, comprising:

a receiving channel or set of receiving channel portions adapted to engage with a spring biased engagement feature of the connector module; or
a spring biased engagement feature adapted to engage with a receiving channel or set of receiving channel portions of the connector module.

15. A filter adapted for use in a face mask as claimed in any one of claims 1 to 13, comprising:

a filter layer; and
a connector module attached to the filter layer, wherein the connector module comprises:

a receiving channel or set of receiving channel portions adapted to engage with a spring biased engagement feature of the fan module; or
a spring biased engagement feature adapted to engage with a receiving channel or set of receiving channel portions of the fan module.

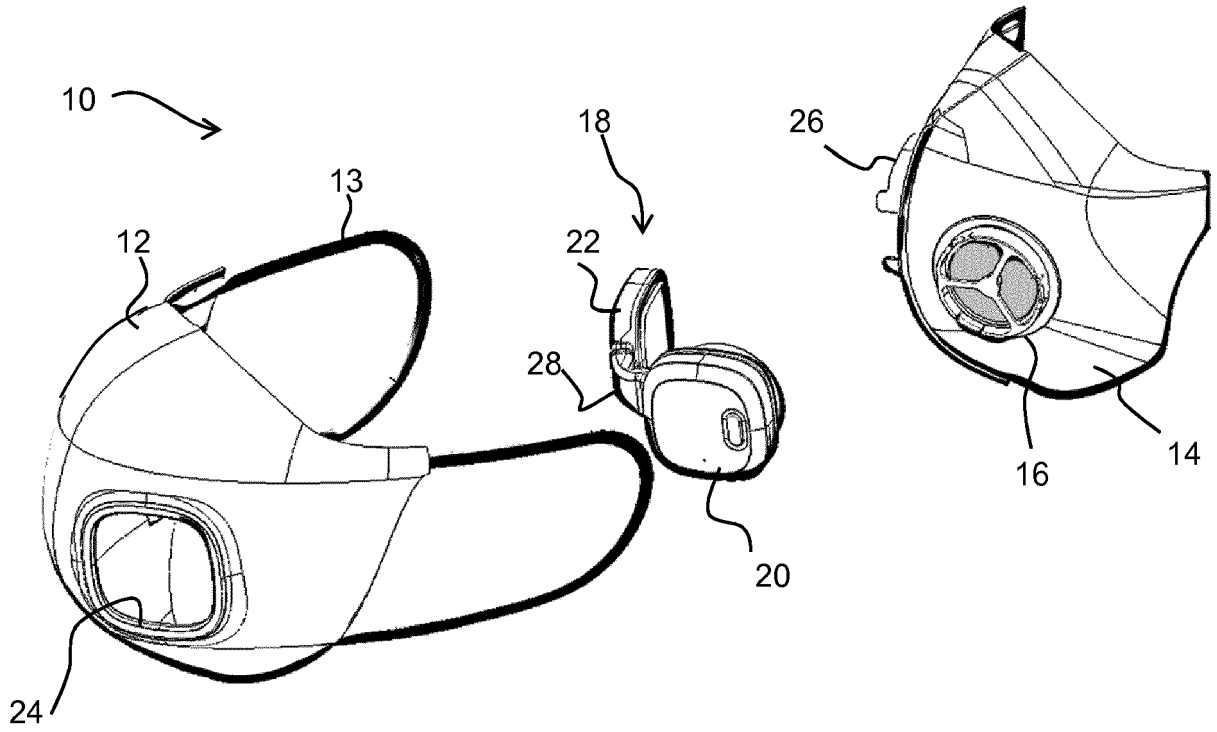

FIG. 1

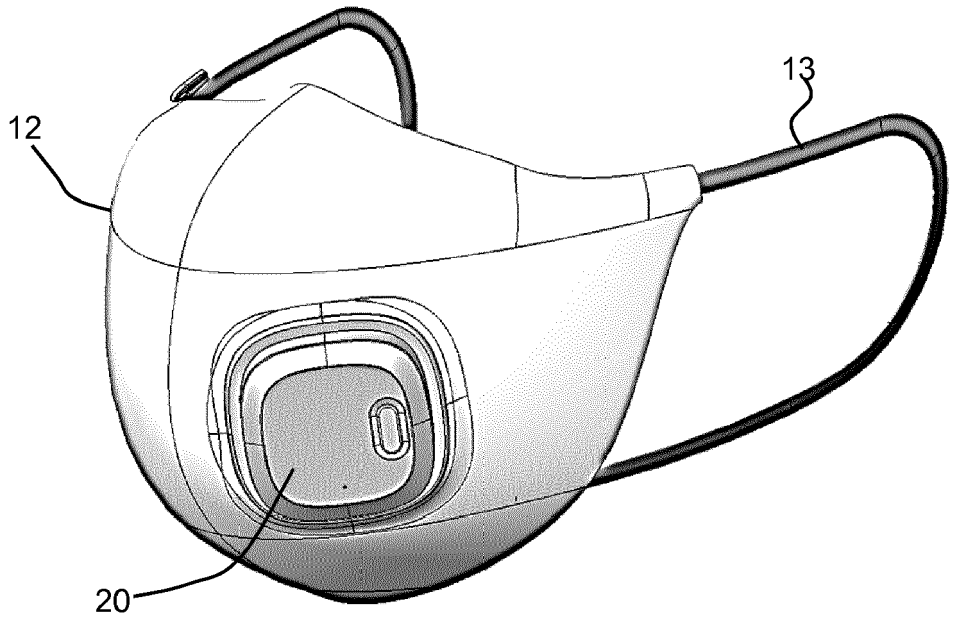

FIG. 2

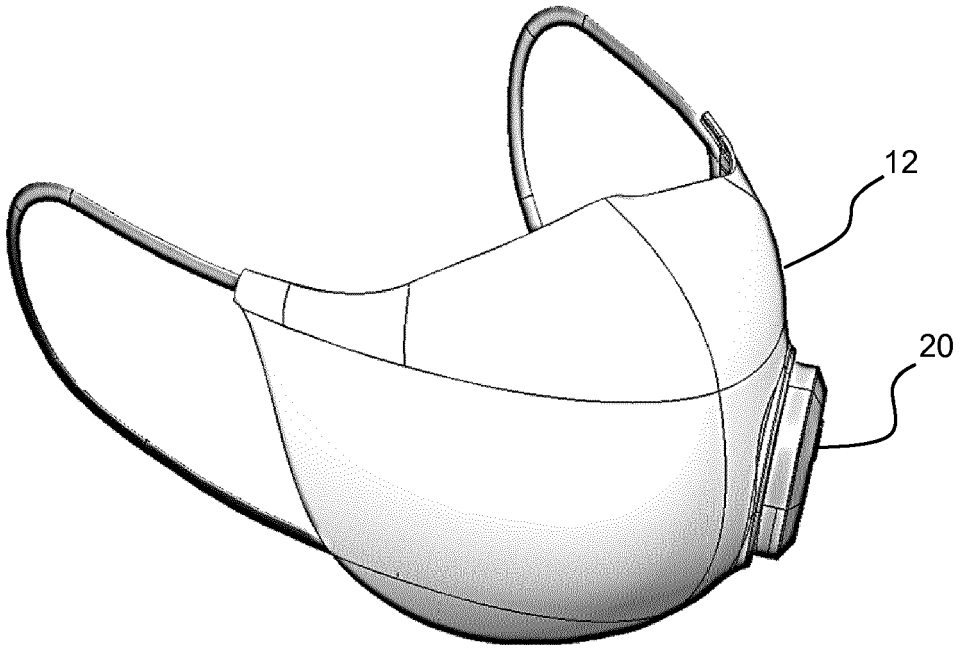

FIG. 3

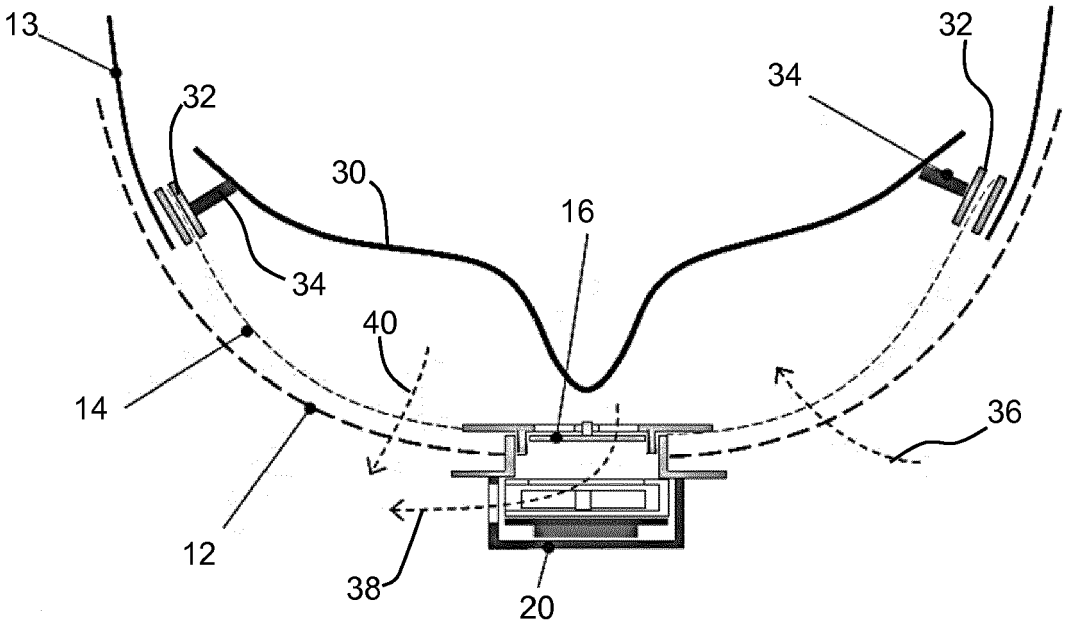

FIG. 4

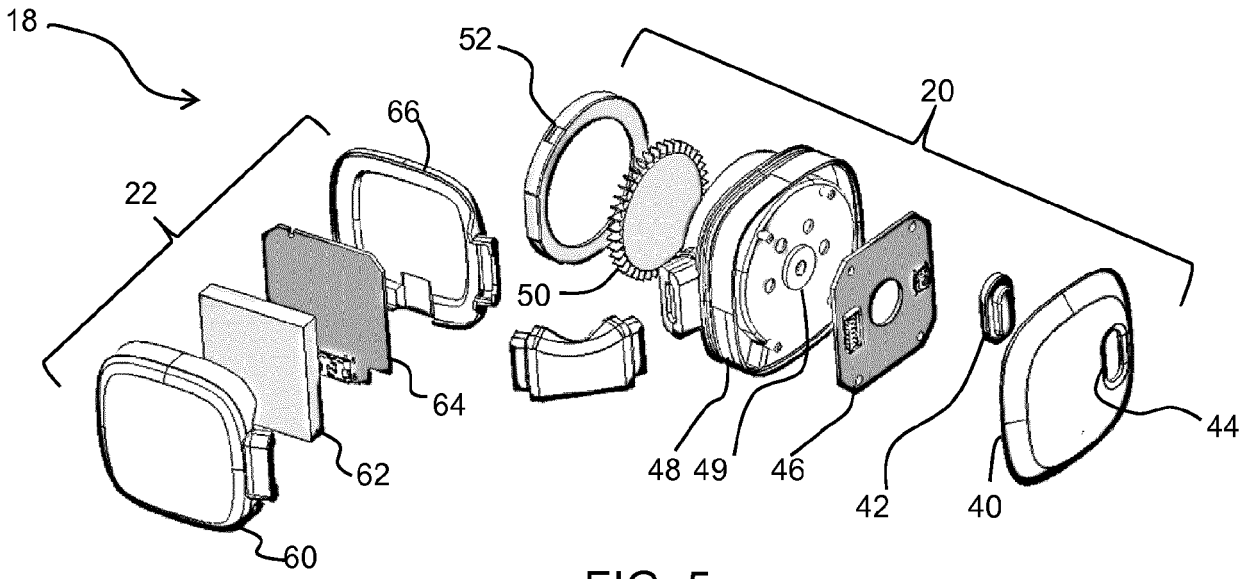
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FIG. 5

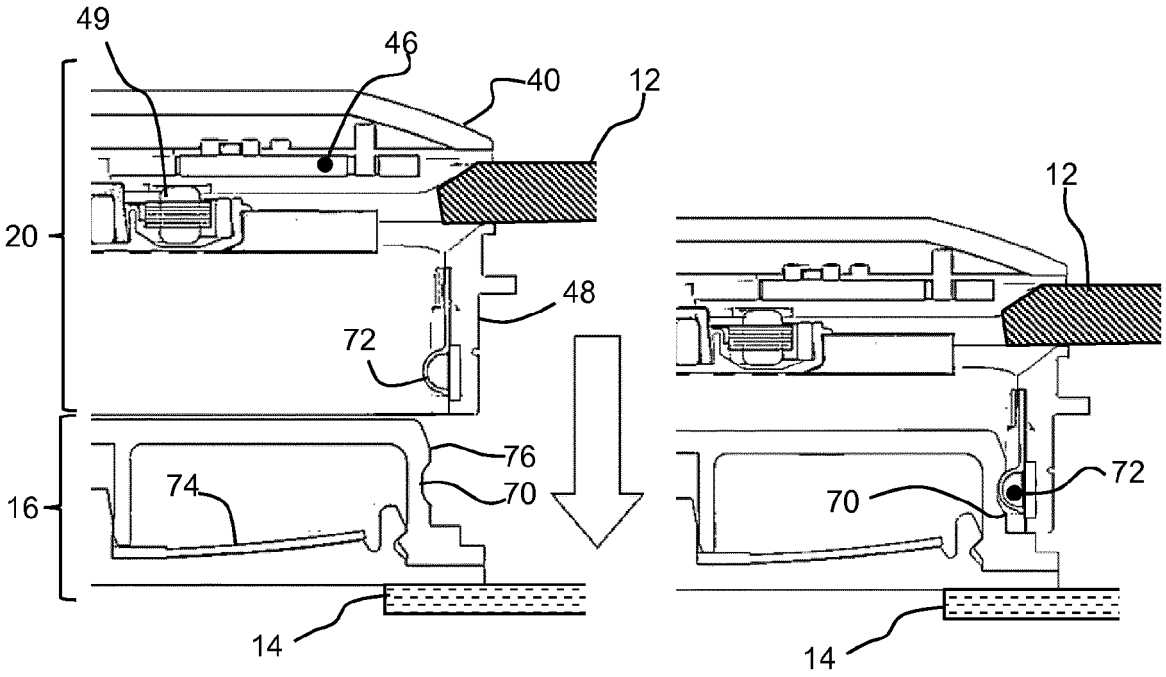
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FIG. 6

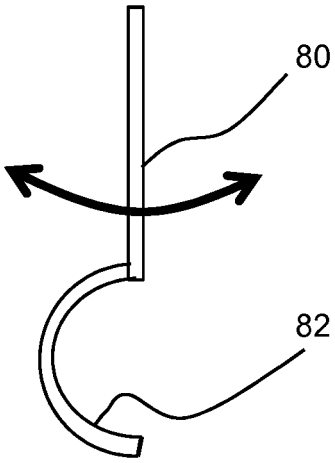

FIG. 7

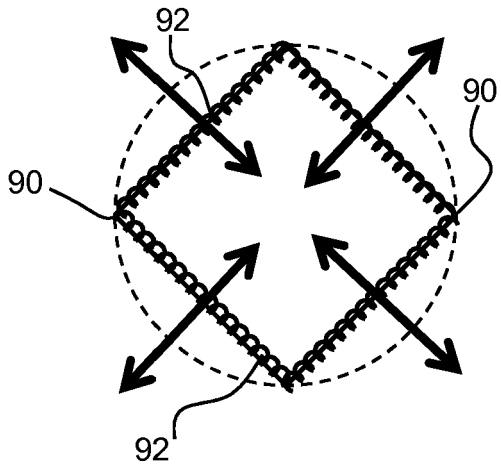

FIG. 8

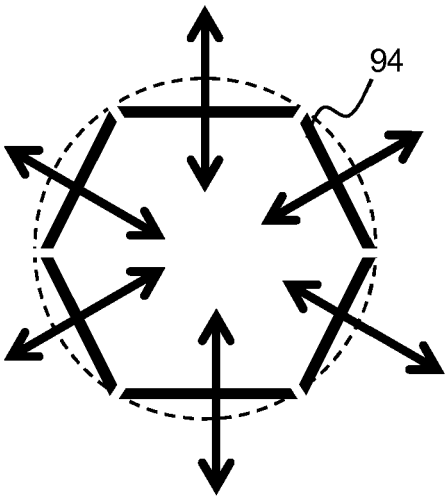

FIG. 9

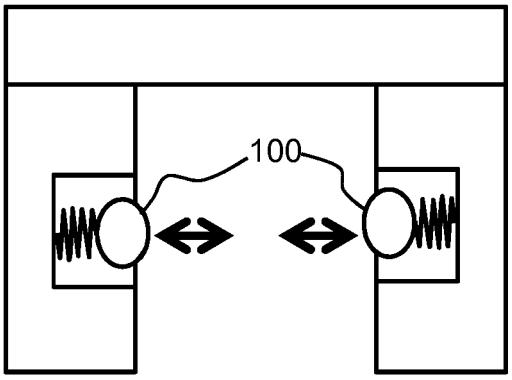

FIG. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 19 19 7162

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 0 352 113 A2 (EAGLE MILITARY GEAR OVERSEAS L [IL]) 24 January 1990 (1990-01-24) * figures * * figures 5,6,8 * * page 2, lines 46-49 * -----	1-4,6, 11,13-15	INV. A62B18/00 A62B18/02

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	6 March 2020	Andlauer, Dominique

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

Europäisches Patentamt
European Patent Office
Office européen des brevets

Application Number
EP 19 19 7162

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-4, 6, 11, 13-15

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

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LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 19 19 7162

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-4, 6, 11, 13-15

   Group 1: mask with a spring ring; a set of ball bearings

   ---

2. claim: 5

   Group 2: mask with check valve

   ---

3. claim: 7

   Group 3: mask with exhaust fan

   ---

4. claims: 8-10, 12

   Group 4: mask with control unit.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 19 7162

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

06-03-2020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0352113 A2	24-01-1990	EP 0352113 A2	24-01-1990
		IL 87156 A	13-05-1993
		US 5022900 A	11-06-1991

EPO FORM P0459

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