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(54) A POLLUTION MASK AND CONTROL METHOD

(57) An active fan-assisted pollution mask makes use of an optical sensor for detecting rotation of the fan and, during fan rotation, the speed of rotation. Breathing cycle detection and/or an automatic turn on and/or turn off function of the fan are implemented based on the analysis of the optical sensor signal. The use of an optical sensor provides a low cost and compact way to implement an automatic control function. It avoids the need for any particular fan design, since the detection is based on optical analysis of the fan rotation rather than analysis of electrical fan signals.

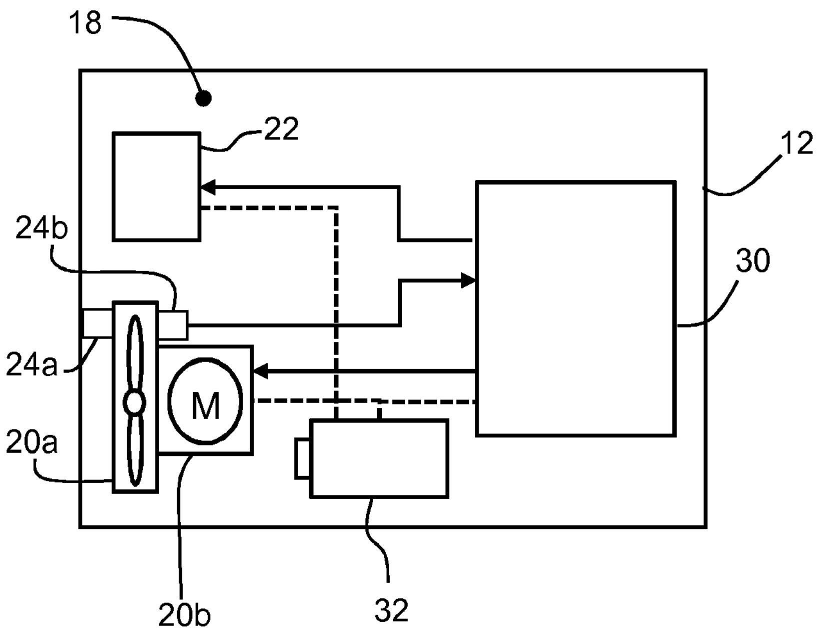

FIG. 2

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Description

FIELD OF THE INVENTION

[0001] This invention relates to a pollution mask, for providing filtered air to the wearer of the mask, with the flow assisted by a fan.

BACKGROUND OF THE INVENTION

[0002] 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. The worst in class are Indian cities like Delhi that have an annual pollution level more than 10 times the recommended level. Well known is Beijing with an annual average 8.5 times the recommended safe levels. However, even in European cities like London, Paris and Berlin, the levels are higher than recommended by the WHO.

[0003] Since this problem will not improve significantly on a short time scale, the only way to deal with this problem is to wear a mask which provides cleaner air by filtration. To improve comfort and effectiveness one or two fans can be added to the mask.

[0004] The benefit to the wearer of using a 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.

[0005] Furthermore, in a conventional non-powered mask, inhalation also causes a slight negative pressure within the mask which leads to leakage of the contaminants into the mask, which leakage could prove dangerous if these are toxic substances. A powered mask delivers a steady stream of air to the face and may for example provide a slight positive pressure, which may be determined by the resistance of an exhale valve, to ensure that any leakage is outward rather than inward.

[0006] There are several advantages if the fan operation or speed is regulated. This can be used to improve comfort by more appropriate ventilation during the inhalation and exhalation sequence or it can be used to improve the electrical efficiency. The latter translates into longer battery life or increased ventilation. Both of these aspects need improvement in current designs.

[0007] To regulate the fan speed, the pressure inside the mask can be measured and both pressure as well as pressure variation can be used to control the fan.

[0008] For example, the pressure inside a mask can be measured by a pressure sensor and the fan speed can be varied in dependence on the sensor measurements, for example based on detecting the inhalation and exhalation phases. A pressure sensor is costly so it would be desirable to provide an alternative method.

[0009] Fan-operated masks are battery-operated devices, so that it is desirable to reduce power consumption to a minimum as well as keeping the cost to a minimum. One issue is that the fan may be left on when the mask is not being worn, and this results in unnecessary power consumption. It is possible to provide sensors dedicated to detecting when the mask is worn, but this increases the cost of the breathing mask.

[0010] When the putting on the mask, a user typically activates a switch to switch on the fan. This switch adds cost to the mask, takes up space and switching on is inconvenient. An automatic electronic switch-on function would avoid these disadvantages. However, this normally also requires a dedicated sensor that senses the use of the mask.

[0011] It would therefore be desirable to find a lower cost solution at least for providing automatic turn on and/or turn off functions, for example based on detecting that the mask is worn or not.

SUMMARY OF THE INVENTION

[0012] The invention is defined by the claims.

[0013] According to examples in accordance with an aspect of the invention, there is provided a pollution mask comprising:

- an air chamber;
- a fan for drawing air from outside the air chamber into the air chamber and/or drawing air from inside the air chamber to the outside;
- an optical sensor for detecting rotation of the fan and, during fan rotation, to detect the speed of rotation; and
- a controller (30) which is adapted, based on an analysis of the optical sensor signal, to:
    - implement an automatic turn on and/or turn off function of the fan; and/or
    - detect the breathing cycles of a user.

[0014] The invention relates to a pollution mask. By this is meant a device which has the primary purpose of filtering ambient air to be breathed by the user. The mask does not perform any form of patient treatment. In particular, the pressure levels and flows resulting from the fan operation are intended solely to assist in providing comfort (by influencing the temperature or relative humidity in the air chamber) and/or to assist in providing a flow across a filter without requiring significant additional breathing effort by the user. The mask does not provide overall breathing assistance compared to a condition in which the user does not wear the mask.

[0015] The fan may be for providing an increased pressure in the air chamber (e.g. a flow into the air chamber during inhalation). In such a case, it is only required to provide a small increased pressure, for example for assisting inhalation of the user.

[0016] The fan may instead be only for drawing air from inside the air chamber to the outside. In this way, it may promote a supply of fresh filtered air to the air chamber even during exhalation, which improves user comfort. In this case, the pressure in the air chamber may for example be below the outside (atmospheric) pressure at all times so that fresh air is always supplied to the face. During exhalation, the pressure may still however be higher than the ambient pressure if there is a slow fan speed or high exhalation volume.

[0017] Thus, there are different possible intended functions of the fan.

[0018] The use of an optical sensor provides a low cost and compact way to implement an automatic turn on function and/or an automatic turn off function. It avoids the need for any particular fan design, since the detection is based on optical analysis of the fan rotation rather that analysis of electrical fan signals.

[0019] The controller is adapted to implement an automatic control function.

[0020] The automatic control function may comprise an automatic turn on function of the fan based on detecting fan rotation caused by a user's breath while the fan is not activated. In this way, only the optical sensor needs to be powered to detect the fan rotation, and the user's breath will create enough fan movement to be detected.

[0021] The controller is for example adapted to operate in a discontinuous optical sensing mode when the fan is turned off. This saves power.

[0022] The automatic control function implemented by the controller may be an automatic turn off function of the fan based on detecting a uniform fan speed.

[0023] This uniform speed is indicative that the mask is not worn.

[0024] By determining if the mask is not worn, the mask design enables power to be saved. In particular, if the fan speed is not modulated by the user's breathing, it indicates that the mask is not worn. The fan may be turned off when it is detected that the mask is not worn.

[0025] The automatic control function implemented by the controller may for example be to detect the breathing cycles of a user based on detecting changes in fan speed over time.

[0026] In this way, the fan is able to be controlled based on the user's breathing pattern. Additionally or alternatively, an outlet valve may be controlled in dependence on the phase of the respiration cycle, or the fan may be turned off during an inhalation time. This may be used to save power. Shutting down the fan during inhalation may be desirable for a user who does not have difficulty breathing through the filter, to save power if configured in such a way.

[0027] The controller may be adapted to detect a breathing frequency of a user based on detecting a changes in fan speed over time and control the fan in dependence on the breathing frequency. The fan speed may for example be increased if the user is breathing more rapidly, which may indicate that the user is exercising.

[0028] The mask may further comprise a filter which forms a boundary directly between the air chamber and the ambient surroundings outside the air chamber. The user thus breathes through the filter. The filter may comprise an outer wall of the air chamber.

[0029] The filter forms a boundary directly between the air chamber and the ambient surroundings outside the air chamber. This provides a compact arrangement which avoids the need for flow transport passageways. It means the user is able to breathe in through the filter. The filter may have multiple layers. For example, an outer layer may form the body of the mask (for example a fabric layer), and an inner layer may be for removing finer pollutants. The inner layer may then be removable for cleaning or replacement, but both layers may together be considered to constitute the filter, in that air is able to pass through the structure and the structure performs a filtering function.

[0030] The filter thus preferably comprises an outer wall of the air chamber and optionally one or more further filter layers. This provides a particularly compact arrangement and enables a large filter area, because the mask body performs the filtering function. The ambient air is thus provided directly to the user, when the user breathes in, through the filter.

[0031] The mask may further comprise an outlet valve for controllably venting the air chamber to the outside, or an inlet valve to introduce air from outside into the air chamber, wherein the valve comprises a passive pressure-regulated check valve or an actively driven electrically controllable valve.

[0032] This may be used to make the mask more comfortable. During inhalation, by closing the valve (actively or passively), it is prevented that unfiltered air is drawn in. During exhalation, the valve is opened so that breathed out air is expelled.

[0033] The optical sensor may comprise:

a light source and a light detector, on opposite sides of the fan; or

a light source and a light detector on one side of the fan, and a reflector on the fan.

[0034] Thus, there are different options for the optical sensor.

[0035] The invention also provides a non-therapeutic method of controlling a pollution mask, comprising:

drawing air from outside an air chamber into the air chamber and/or drawing air from inside the air chamber to the outside using a fan;

using an optical sensor to detect rotation of the fan and, during rotation, detect the speed of rotation; and, based on an analysis of the detected rotation:

implementing an automatic turn on and/or turn off function of the fan; and/or

detecting the breathing cycles of a user.

[0036] The method may comprise:

implementing an automatic turn on function of the fan by detecting fan rotation caused by a user's breath while the fan is not activated; and/or

implementing an automatic turn off function of the fan by detecting a uniform fan speed.

[0037] The method may comprise:

detecting the breathing cycles of a user based on detecting changes in fan speed over time; and/or

detecting a breathing frequency of a user based on detecting changes in fan speed over time and controlling the fan in dependence on the breathing frequency.

[0038] The invention also provides a computer program which comprises computer program code means which is adapted, when said program is run on a computer, to implement the method defined above.

BRIEF DESCRIPTION OF THE DRAWINGS

[0039] Examples of the invention will now be described in detail with reference to the accompanying drawings, in which:

Figure 1 shows a face mask in which fan rotation may be detected;

Figure 2 shows one example of the components of the system of Figure 1;

Figure 3 shows a typical waveform of the optical sensor signal;

Figure 4 shows various possible light intensity patterns;

Figure 5 is used to explain an automatic turn on function;

Figure 6 is used to explain an automatic turn off function; and

Figure 7 shows a mask operating method.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0040] The invention will be described with reference to the Figures.

[0041] 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.

[0042] The invention provides an active fan-assisted pollution mask which makes use of an optical sensor for detecting rotation of the fan and, during fan rotation, the speed of rotation. Breathing cycle detection and/or an automatic turn on and/or turn off function of the fan are implemented based on the analysis of the optical sensor signal. The use of an optical sensor provides a low cost and compact way to implement an automatic control function. It avoids the need for any particular fan design, since the detection is based on optical analysis of the fan rotation rather than analysis of electrical fan signals.

[0043] The automatic control function is thus based on detecting respiration characteristics of the user from an optical analysis of the fan rotation. These respiration characteristics for example include whether or not the user is breathing into the mask, and/or the timing of their inhalation and exhalation.

[0044] Figure 1 shows a face mask in which fan rotation may be detected.

[0045] A subject 10 is shown wearing a face mask 12 which covers the nose and mouth of the subject. The purpose of the mask is to filter air before it is breathed in the subject. For this purpose, the mask body itself acts as an air filter 16. Air is drawn in to an air chamber 18 formed by the mask by inhalation. In one example, during inhalation, an outlet valve 22 such as a check valve is closed due to the low pressure in the air chamber 18.

[0046] The filter 16 may be formed only by the body of the mask, or else there may be multiple layers. For example, the mask body may comprise an external cover formed from a porous textile material, which functions as a pre-filter. Inside the external cover, a finer filter layer is reversibly attached to the external cover. The finer filter layer may then be removed for cleaning and replacement, whereas the external cover may for example be cleaned by wiping. The external cover also performs a filtering function, for example protecting the finer filter from large debris (e.g. mud), whereas the finer filter performs the filtering of fine particulate matter. There may be more than two layers. Together, the multiple layers function as the overall filter of the mask.

[0047] Taking the exhalation fan for example, when the subject breathes out, air is exhausted through the outlet valve 22. This valve is opened to enable easy exhalation, but is closed during inhalation. A fan 20 assists in the removal of air through the outlet valve 22. Preferably, more air is removed than exhaled so that additional air is supplied to the face. This increases comfort due to lowering relative humidity and cooling. During inhalation, by closing the valve, it is prevented that unfiltered air is drawn in.

[0048] The timing of the outlet valve 22 is thus dependent on the breathing cycle of the subject. The outlet valve may be a simple passive check valve operated by the pressure difference across the filter 16. However, it may instead be an electronically controlled valve.

[0049] The pressure inside the closed chamber when the mask is worn will vary as a function of the breathing cycle of the subject. When the subject breathes out, there will be a slight pressure increase and when the subject breathes in there will be a slight pressure reduction.

[0050] If the fan is driven with a constant drive level (i.e. voltage), the different prevailing pressure will manifest itself as a different load to the fan, since there is a different pressure drop across the fan. This altered load will then result in a different fan speed.

[0051] The invention makes use of optical detection of the rotation speed of the fan. An optical sensor 24 is provided for detecting rotation of the fan and, during fan rotation, to detect the speed of rotation.

[0052] Figure 2 shows one example of the components of the system. The same components as in Figure 1 are given the same reference numbers.

[0053] In addition to the components shown in Figure 1, Figure 2 shows a controller 30 and a local battery 32 and it also shows that the optical sensor 24 comprises a light source 24a and a light detector 24b.

[0054] The fan 20 comprises a set of fan blades 20a and a fan motor 20b. In one example, the fan motor 20b is an electronically commutated brushless motor.

[0055] The optical sensor 24 comprises a light source 24a on one side of the fan blades and a light detector on the opposite side of the fan blades. Thus, light reaches the detector when a gap between fan blades is present, and light is blocked when a fan blade is in the space.

[0056] Figure 3 shows a typical waveform of the optical sensor signal, as light intensity versus time. The peaks of light intensity correspond to the light passing through the gaps between the fan blades, and the troughs correspond to the light being blocked by the fan blades. The time period T is representative of the fan speed.

[0057] Thus, by monitoring the time period, the fan speed can be monitored. This in turn enables the fan load to be monitored, which differs as between inhaling and exhaling when the mask is worn, whereas it will be more constant when the mask is not worn. Taking an exhalation fan for example, during exhalation, the rotation speed of the fan will be increased due to the exhaled air flow, resulting a higher frequency. During inhalation, the rotation speed of the fan will be decreased (compared to exhalation).

[0058] Figure 4 shows various possible light intensity patterns.

[0059] Figure 4(A) shows a fully off state in which the light sensor is turned off and there is no light sensor signal.

[0060] Figure 4(B) shows the light intensity during inhalation.

[0061] Figure 4(C) shows the light intensity during exhalation, giving a faster fan speed compared to inhalation (for the example of an exhalation fan).

[0062] Figure 4(D) shows how the frequency (corresponding to the inverse of the time period T in Figure 3) varies over time during normal breath.

[0063] The invention makes use of the fan speed information to provide automatic fan control. The most basic function is an automatic turn-on function or an automatic turn off function.

[0064] However, in addition automatic adjustment of the fan rotation may be implemented according to the breathing pattern (i.e. inhalation and exhalation). Furthermore, on-demand air flow delivery may be implemented according to the user activity, e.g., sitting, walking, running, bicycling.

[0065] These features provide a fully customized experience to consumers and meet their needs of comfort, enough air flow, and power saving under diverse user scenarios.

[0066] Figure 5 is used to explain the automatic turn on function.

[0067] From time t0 to t1, the fan is off and the mask is not worn, so that there is no fan rotation.

[0068] The user wears the mask from time t1. There is a rotation of the fan caused by the breathing of the user. The user may for example be required to blow into the fan to start the fan rotation to be detected. The optical sensor periodically performs a measurement so at time t2 the fan rotation is detected. The fan is then turned on and continues without the user needing to blow into the fan.

[0069] The automatic turn on function of the fan is thus based on detecting fan rotation caused by a user's breath while the fan is not activated (before time t1) and there may be a discontinuous optical sensing mode when the fan is turned off.

[0070] The discontinuous sensing mode provides power saving and is present during off or standby states. The sensor is for example woken up every several seconds, e.g., 2 seconds, 4 seconds or even longer.

[0071] Figure 6 is used to explain the automatic turn off function.

[0072] From time t0 to t1, the fan is on and the mask is worn. The fan rotation speed follows a cycle which depends on the user's breathing pattern, so that there is a maximum frequency f_{max} and a minimum frequency f_{min}.

[0073] This represents a normal operation of the mask, which may be defined as a continuous mode during which the optical sensor continuously records and processes the light intensity signals of the photodetector.

[0074] The user takes off the mask at time t1. The fan is still driven, but the modulation of the fan speed caused by the breathing of the user is no longer present. This change is detected and the fan is turned off.

[0075] For example, during normal use, a period of fan rotation is recorded, such as 4 seconds, or 8 seconds and the frequency is calculated during this period. The maximum and minimum frequencies f_{max} and f_{min} are determined during this period.

[0076] A difference value $f_{max} - f_{min}$ may then be compared with a threshold $f_{threshold}$ which is pre-determined based on real tests.

[0077] If the difference $f_{max} - f_{min}$ is less than the threshold $f_{threshold}$, it means there is no breathing sensed, and an OFF signal is sent to the controller to turn off the fan.

[0078] The automatic turn off function of the fan is thus based on detecting a uniform fan speed.

[0079] As explained above (and shown most clearly in Figures 4 and 6), the breathing pattern changes the fan rotation speed.

[0080] This means the optical sensing may be used to detect the respiration cycle, i.e. inhalation and exhalation timing.

[0081] If an electronically switched outlet valve is used, the respiration cycle timing information may then be used to control the outlet valve 22 in dependence on the phase of the respiration cycle. In addition to controlling the outlet valve, the controller may turn off the fan during an inhalation time or an exhalation time.

[0082] The fan speed may also be used to monitor activity levels of the user. For example, when the frequency of the light intensity pattern increases, and reaches a certain value, it may be determined that the user is performing high intensity activities. The fan rotation speed may be increased to assist the user's breathing further.

[0083] The light source of the optical sensor may take any suitable form. One example is that an existing light output indicator may be used so that there is no extra component cost. Small low cost photodetectors are also available.

[0084] Figure 2 shows the light source and detector on opposite sides of the fan but a reflective fan blade, or reflecting pad applied to the fan blade, may be used so that the light source and detector may be on the same side, to give a more compact arrangement.

[0085] As a further alternative, a light guide maybe used to transfer light from a light source (which may for example be mounted on the top of a PCB) to the region of the fan blades. The light detector may then either detect light directly or detect reflected light. The light guide may deliver light in a radial inward direction from the radial outer side of the fan blades, and the fan blades may then reflect that radial light to the detector, which is for example on the bottom side of the PCB). The light source may have other functions, such as an ON indicator light, and the light guide simply taps off some of the output light for use as the sensing light.

[0086] The fan is typically a centrifugal or axial fan.

[0087] Figure 7 shows a mask operating method, comprising:

in step 70, drawing air from outside an air chamber into the air chamber and/or drawing air from inside the air chamber to the outside using a fan;
in step 72 detecting rotation of the fan and, during rotation, detecting the speed of rotation; and
in step 74 implementing an automatic turn on and/or turn off function of the fan based on the analysis of the detected rotation.

[0088] The method may also comprise:

in step 76 detecting the breathing cycles of a user based on detecting changes in fan speed over time; and/or
in step 78 detecting a breathing frequency of a user based on detecting changes in fan speed over time and controlling the fan in dependence on the breathing frequency.

[0089] It will be seen that the invention may be applied to many different mask designs, with fan-assisted inhalation or exhalation, and with an air chamber formed by a filter membrane or with a sealed hermetic air chamber.

[0090] One option as discussed above is thus the use of the fan only for drawing air from inside the air chamber to the outside, for example when an exhaust valve is open. In such a case, the pressure inside the mask volume may be maintained by the fan below the external atmospheric pressure so that there is a net flow of clean filtered air into the mask volume during exhalation. Thus, low pressure may be caused by the fan by during exhalation and by the user during inhalation (when the fan may be turned off).

[0091] An alternative option is the use of the fan only for drawing air from the ambient surroundings to inside the air chamber. In such a case, the fan operates to increase the pressure in the air chamber, but the maximum pressure in the air chamber in use remains below 4 cmH_2O higher than the pressure outside the air chamber, in particular because no high pressure assisted breathing is intended. Thus, a low power fan may be used.

[0092] In all cases, the pressure inside the air chamber preferably remains below 2 cmH_2O, or even below 1 cmH_2O or even below 0.5 cmH_2O, above the external atmospheric pressure. The pollution mask is thus not for use in providing a continuous positive airway pressure, and is not a mask for delivering therapy to a patient.

[0093] The mask is preferably battery operated so the low power operation is of particular interest.

[0094] As discussed above, embodiments make use of a controller, which can be implemented in numerous ways, with software and/or hardware, to perform the various functions required. A processor is one example of a controller which employs one or more microprocessors that maybe programmed using software (e.g., microcode) to perform the required functions. A controller may however be implemented with or without employing a processor, and also may be implemented as a combination of dedicated hardware to perform some functions and a processor (e.g., one or more programmed microprocessors and associated circuitry) to perform other functions.

[0095] Examples of controller components that may be employed in various embodiments of the present disclosure include, but are not limited to, conventional microprocessors, application specific integrated circuits (ASICs), and field-programmable gate arrays (FPGAs).

[0096] In various implementations, a processor or controller may be associated with one or more storage media such as volatile and non-volatile computer memory such as RAM, PROM, EPROM, and EEPROM. The storage media may be encoded with one or more programs that, when executed on one or more processors and/or controllers, perform the required functions. Various storage media maybe fixed within a processor or controller or may be transportable, such that the one or more programs stored thereon can be loaded into a processor or controller.

[0097] Other 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. Any reference signs in the claims should not be construed as limiting the scope.

Claims

1. A pollution mask comprising:

an air chamber (18);
a fan (20) for drawing air from outside the air chamber (18) into the air chamber and/or drawing air from inside the air chamber to the outside;
an optical sensor (24) for detecting rotation of the fan and, during fan rotation, to detect the speed of rotation; and
a controller (30) which is adapted, based on an analysis of the optical sensor signal, to:

implement an automatic turn on and/or turn off function of the fan; and/or
detect the breathing cycles of a user.

2. A mask as claimed in claim 1, wherein the controller (30) is adapted to implement an automatic turn on function of the fan based on detecting fan rotation caused by a user's breath while the fan is not activated.

3. A mask as claimed in claim 2, wherein the controller (30) is adapted to operate in a discontinuous optical sensing mode when the fan is turned off.

4. A mask as claimed in any one of claims 1 to 3, wherein the controller (30) is adapted to implement an automatic turn off function of the fan based on detecting a uniform fan speed.

5. A mask as claimed in any one of claims 1 to 4, wherein the controller (30) is adapted to detect the breathing cycles of a user based on detecting changes in fan speed over time.

6. A mask as claimed in any one of claims 1 to 5, wherein the controller (30) is adapted to detect a breathing frequency of a user based on detecting a changes in fan speed over time and control the fan in dependence on the breathing frequency.

7. A mask as claimed in any one of claims 1 to 6, further comprising a filter (16) which forms a boundary directly between the air chamber and the ambient surroundings outside the air chamber;

8. A mask as claimed in claim 7, wherein the filter comprises an outer wall (16) of the air chamber.

9. A mask as claimed in any one of claims 1 to 8, wherein the fan (20) is either for drawing air from inside the air chamber to the outside, or for introducing air from the outside into inside the air chamber.

10. A mask as claimed in any one of claims 1 to 9, further comprising a valve (22) for controllably venting the air chamber (18) to the outside or introducing air from the outside into the air chamber, wherein the valve (22) comprises a passive pressure-regulated check valve or an actively driven electrically controllable valve.

11. A mask as claimed in any one of claims 1 to 10, wherein the optical sensor (24) comprises:

a light source (24a) and a light detector (24b), on opposite sides of the fan; or
a light source (24a) and a light detector (24b) on one side of the fan, and a reflector on the fan.

12. A non-therapeutic method of controlling a pollution mask, comprising:

(70) drawing air from outside an air chamber (18) into the air chamber and/or drawing air from inside the air chamber to the outside using a fan;
(72) using an optical sensor to detect rotation of the fan and, during rotation, detect the speed of rotation; and, based on an analysis of the detected rotation:

(74) implementing an automatic turn on and/or turn off function of the fan and/or
(76) detecting the breathing cycles of a user.

13. A method as claimed in claim 12, comprising:

implementing an automatic turn on function of the fan by detecting fan rotation caused by a user's breath while the fan is not activated; and/or implementing an automatic turn off function of the fan by detecting a uniform fan speed.

14. A method as claimed in claim 12 or 13, comprising:

(76) detecting the breathing cycles of a user based on detecting changes in fan speed over time and/or
(78) detecting a breathing frequency of a user based on detecting a changes in fan speed over time and controlling the fan in dependence on the breathing frequency.

15. A computer program comprises computer program code means which is adapted, when said program is run on a computer, to implement the method of any one of claims 11 to 14.

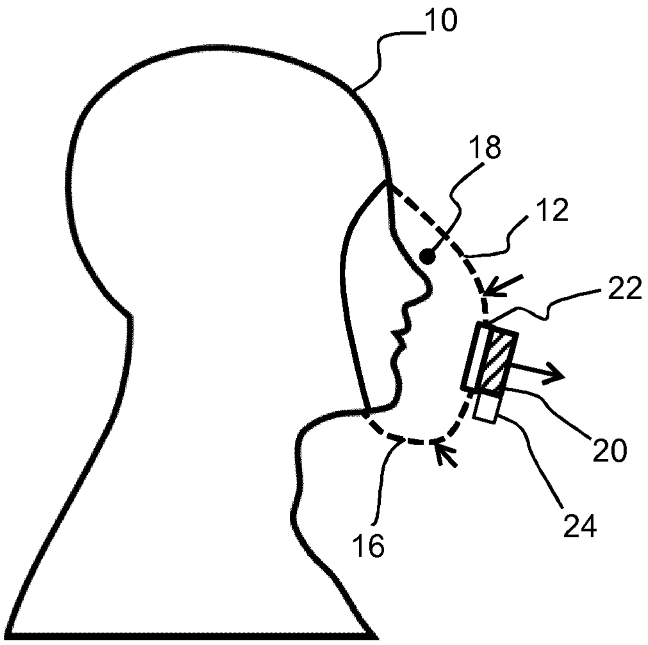

FIG. 1

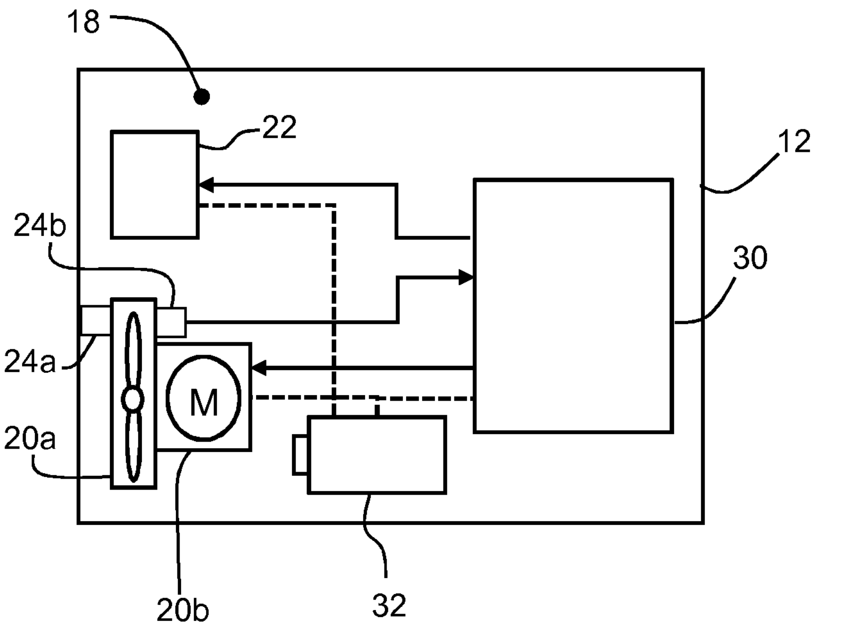

FIG. 2

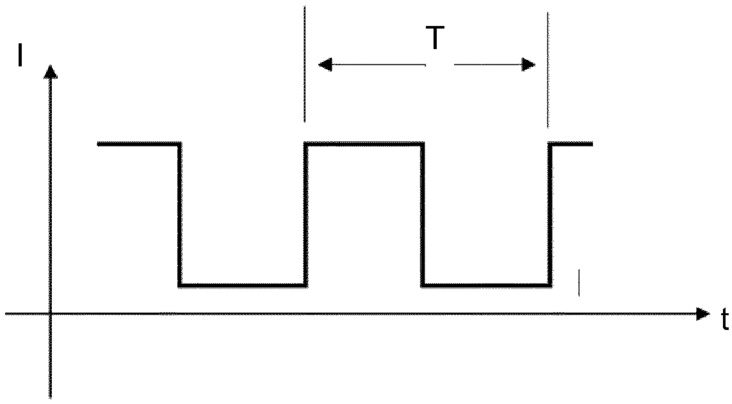

FIG. 3

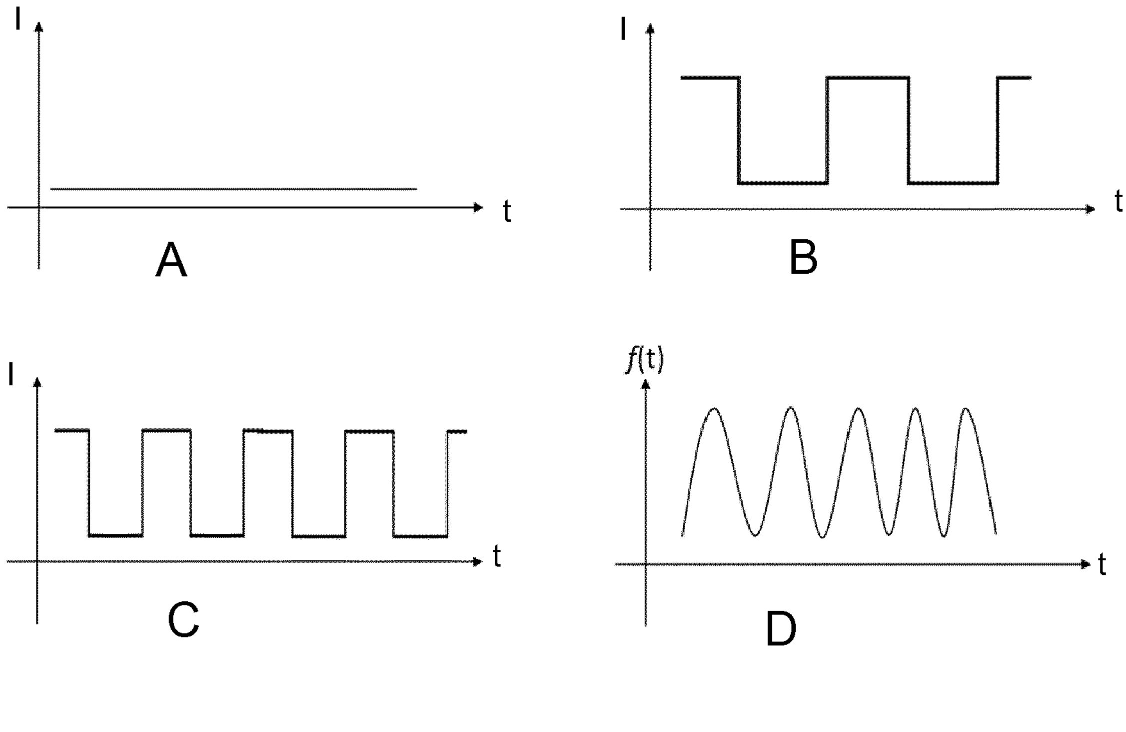

FIG. 4

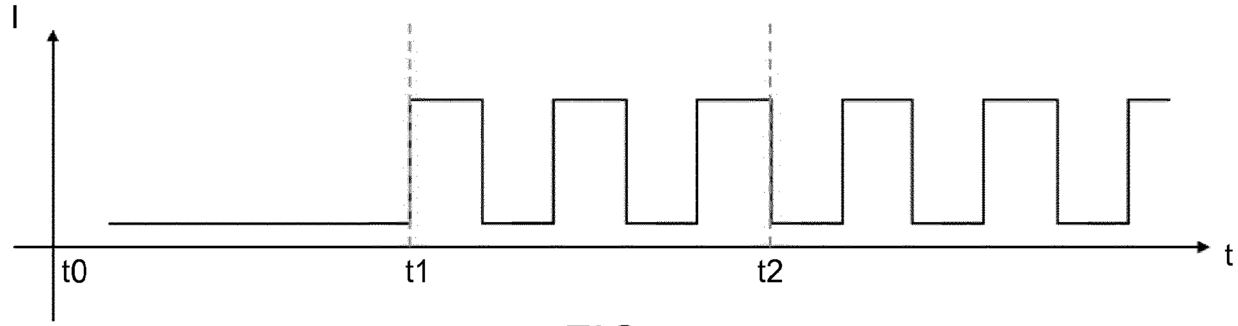

FIG. 5

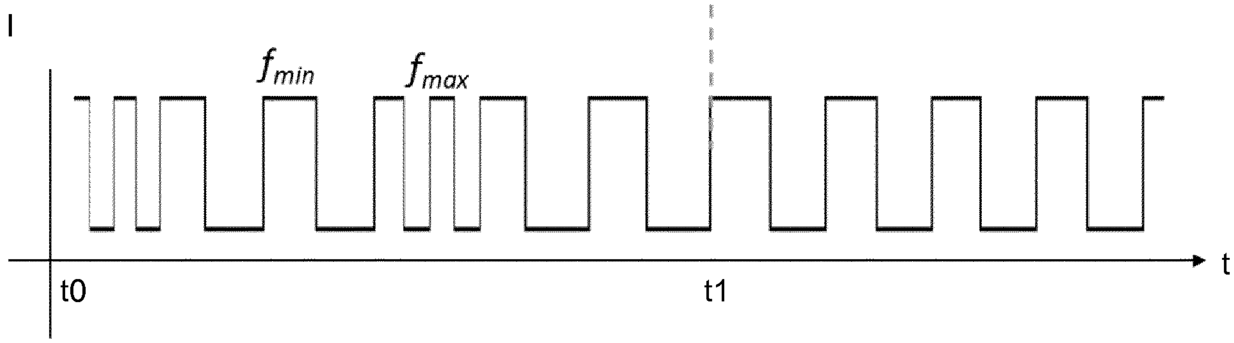

FIG. 6

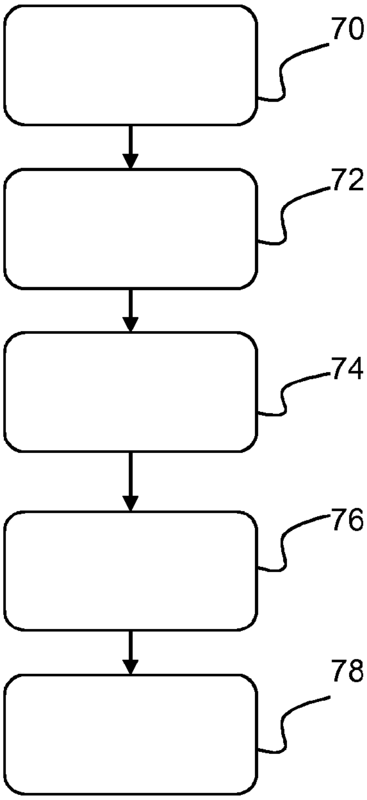

FIG. 7

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EUROPEAN SEARCH REPORT

Application Number
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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2015/114389 A1 (SERNFÄLT MATS ULRIK [SE] ET AL) 30 April 2015 (2015-04-30) * paragraphs [0024], [0028]; figures * -----	1-15	INV. A62B18/00
A	US 2012/055815 A1 (TRUEX BRYAN I [US] ET AL) 8 March 2012 (2012-03-08) * paragraph [0086]; figures * -----	1-15	

TECHNICAL FIELDS SEARCHED (IPC)
A62B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	8 July 2019	Vervenne, Koen

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08-07-2019

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015114389 A1	30-04-2015	AU 2014340355 B2	13-07-2017
		CA 2926397 A1	30-04-2015
		CN 105636631 A	01-06-2016
		EP 3060284 A1	31-08-2016
		KR 20160077112 A	01-07-2016
		RU 2016113766 A	29-11-2017
		US 2015114389 A1	30-04-2015
		WO 2015061186 A1	30-04-2015
US 2012055815 A1	08-03-2012	CA 2810649 A1	15-03-2012
		CN 103189089 A	03-07-2013
		CN 105194777 A	30-12-2015
		EP 2613832 A1	17-07-2013
		HK 1219449 A1	07-04-2017
		JP 2013537812 A	07-10-2013
		US 2012055815 A1	08-03-2012
		US 2014283840 A1	25-09-2014
		WO 2012033852 A1	15-03-2012

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