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(54) **AIR PURIFYING DEVICE, CONTROL SYSTEM AND METHOD FOR OPERATING THE AIR PURIFYING DEVICE**

(57) Provided is a method for operating an air purifying device (100) to output treated air, which air purifying device comprises a flow path (104) along which air is displaceable, a gas treatment unit (106) for treating gaseous pollutants in the air displaced along the flow path, and a particulates treatment unit (108) for treating particulate pollutants, including bioaerosols, in the air displaced along the flow path. The method comprises obtaining data indicative of bioaerosol exposure risk in a vicinity of the air purifying device; and controlling, based on the data, arrangement of the gas treatment unit in relation to the flow path and to the particulates treatment unit in the flow path to adjust flow of treated air outputted by the air purifying device that has been displaced through the particulates treatment unit. Further provided is a related computer program, a control system for controlling the air purifying device, and an air purifying device comprising such a control system.

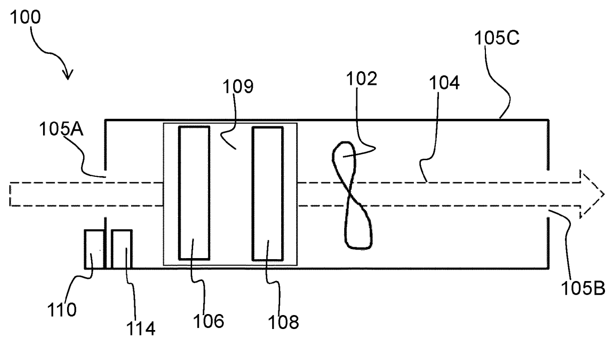


FIG. 1



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## Description

FIELD OF THE INVENTION

**[0001]** This invention relates to a method of operating an air purifying device, a control system for operating such an air purifying device, and an air purifying device comprising such a control system.

BACKGROUND OF THE INVENTION

**[0002]** Various types of air purifying device are known. Portable air purification appliances are devices that generate an airflow through air treatment modules which remove, convert and/or inactivate air pollutants.

**[0003]** Air treatment modules may include, for example, high-efficiency particulate air (HEPA) filter(s) and activated carbon filter(s). The performance of an air purification appliance is commonly expressed as the Clean Air Delivery Rate (CADR) which is defined by the airflow delivered through the air treatment module multiplied by the pollutant removal/conversion efficiency.

**[0004]** Due to the capability of air purifying devices to treat bioaerosols, such devices can be used for giving protection against health risks arising from infectious bioaerosols, e.g. virus aerosols, that are emitted by humans during exhaling, talking, coughing or sneezing. Indeed, air purifying devices have been recommended by authorities like the World Health Organization (WHO), the United States Environmental Protection Agency (EPA) and the German EPA as a protective measure against COVID-19. Moreover, protection afforded by air purifying devices may also be important for other diseases that can spread or are suspected to be spread via infectious virus or bacteria aerosols, such as influenza, the common cold, infant bronchiolitis, croup, measles, tuberculosis and chickenpox.

**[0005]** However, challenges remain in terms of enhancing effectiveness of air purifying devices in treating bioaerosols.

**[0006]** Several national standards consider air purification appliances with a CADR level of 300 $m^3/h$ to be suited for treating regular air pollutants like PM2.5 fine dust in residential rooms and small offices. However, for protection from bioaerosols, e.g. COVID-19 virus aerosols, authorities have issued more stringent performance requirements that may not be fulfilled by a single air purifying device, such as a single portable air purification appliance. For example, for an average sized German classroom of 200 $m^3$, German authorities have recommended to clean air with a CADR of 800 $m^3/h$ or more. Other authorities have issued the same or similar stringent requirements.

**[0007]** This may mean installing a plurality of air purification appliances in such a room, e.g. classroom, in order to reach this CADR target. For example, over six air purification appliances may be required for a 209 $m^2$ meeting room, and over one twenty nine purification appliances may be needed for a 875 $m^2$ area. These numbers can further increase in case of additional noise level requirements. Such a large number of air purification appliances can provide practical difficulties, as well as posing safety risks. Such safety risks can relate to the air purification appliances providing tripping hazards and/or blocking exit routes. Installing such high numbers of air purification appliances in order to satisfy CADR targets may also be relatively costly.

**[0008]** It is correspondingly desirable to enhance CADR performance of an air purifying device, particularly with respect to bioaerosols. Such enhancement of CADR performance would ideally be realized in a way that retains relatively small device dimensions, relatively low energy consumption, low total cost of ownership and/or involves minimal maintenance effort, for example by filter lifetimes being prolonged.

SUMMARY OF THE INVENTION

**[0009]** The invention is defined by the claims.

**[0010]** According to examples in accordance with a first aspect of the invention, there is provided a method for operating an air purifying device to output treated air, which air purifying device comprises: a flow path along which air is displaceable; a gas treatment unit for treating gaseous pollutants in the air displaced along the flow path, arrangement of the gas treatment unit in relation to the flow path being controllable; and a particulates treatment unit for treating particulate pollutants, including bioaerosols, in the air displaced along the flow path, the method comprising: obtaining data indicative of bioaerosol exposure risk in a vicinity of the air purifying device; and controlling, based on said data, arrangement of the gas treatment unit in relation to the flow path and to the particulates treatment unit in the flow path to adjust flow of treated air outputted by the air purifying device that has been displaced through the particulates treatment unit.

**[0011]** By controlling arrangement of the gas treatment unit in relation to the flow path, e.g. along, into and/or out of the flow path, and in relation to the particulates treatment unit, adjustment of flow of treated air outputted by the air purifying device that has been displaced through the particulates treatment unit can be implemented. This may be due to the gas treatment unit's arrangement in relation to the flow path influencing the flow of treated air outputted by the air purifying device, due to the flow resistance provided by the gas treatment unit.

**[0012]** This control of the arrangement of the gas treatment unit can provide a way of prioritizing either (i) bioaerosol treatment and higher flow or (ii) combined bioaerosol and gaseous pollutant treatment at lower flow.

**[0013]** By, for example, arranging the gas treatment unit out of the flow path or so that the gas treatment unit is bypassed, a higher flow of air may be outputted by the air purifying device that has been displaced through the particulates treatment unit.

**[0014]** Importantly, the control of the arrangement of the gas treatment unit is based on data indicative of bioaerosol exposure risk. Such data may, for instance, be indicative of infectious virus levels in air to be purified by the air purifying device.

**[0015]** For example, a relatively high bioaerosol exposure risk may justify prioritizing bioaerosol treatment and higher flow, while lower bioaerosol exposure risk may warrant combined bioaerosol and gaseous pollutant treatment at lower flow.

**[0016]** It is noted that the arrangement of the gas treatment unit in relation to the flow path may be controllable in any suitable manner. In some embodiments, the air purifying device comprises an actuator arranged to enable movement of the gas treatment unit along, into and/or out of the flow path.

**[0017]** The gas treatment unit may be configured to treat, e.g. convert and/or remove, gaseous pollutants typically present in air, such as one or more volatile organic components (VOCs), e.g. formaldehyde, and/or inorganic gas(es), e.g. nitrogen oxides and/or ozone.

**[0018]** In some embodiments, the air purifying device comprises one or more further gas treatment unit(s) for treating gaseous pollutants in the air displaced along the flow path, in addition to the gas treatment unit whose arrangement in relation to the flow path is required to be adjustable/controllable.

**[0019]** Alternatively or additionally, the air purifying device may comprise one or more further particulates treatment unit(s) for treating particulate pollutants in the air displaced along the flow path.

**[0020]** The one or more further particulates treatment unit(s) may be configured to treat the same or different type(s) of particulate pollutants compared to the particulate pollutants treated by the particulates treatment unit.

**[0021]** The further particulates treatment unit(s) may, for example, include a dust filter for removing dust, e.g. coarse dust particles visible to the naked eye, from the air displaced along the flow path, e.g. upstream of the particulates treatment unit.

**[0022]** In such embodiments, the dust filter may be a coarser filter than filter(s), such as high-efficiency particulate air (HEPA) filter(s), included in the particulates treatment unit for filtering bioaerosols.

**[0023]** More generally, the particulates treatment unit may be of any suitable type provided that the particulates treatment unit is capable of treating bioaerosols. To this end, the particulates treatment unit may, for example, be configured to remove particles having a size of a few microns or smaller, e.g. <5 microns.

**[0024]** In some embodiments, the particulates treatment unit comprises a HEPA filter and/or an electrostatic precipitator (ESP).

**[0025]** The one or more further gas treatment unit(s) may be configured to treat the same or different type(s) of gaseous pollutants compared to the gaseous pollutants treated by the gas treatment unit.

**[0026]** For example, the gas treatment unit may be configured to treat, e.g. convert and/or remove, one or more VOCs and/or ozone, and the further gas treatment unit(s) may be configured to treat one or more VOCs, nitrogen oxides, and/or ozone.

**[0027]** At least one, e.g. each, of such one or more further gas treatment unit(s) may be controllably arranged in relation to the flow path, similarly to the above-described gas treatment unit.

**[0028]** It is noted that the gas treatment unit may have any suitable shape, such as a cuboidal, cylindrical or irregular shape.

**[0029]** Similarly, the particulates treatment unit may have any suitable shape, such as a cuboidal, cylindrical or irregular shape.

**[0030]** It is noted, more generally, that the gas treatment unit may arranged to treat air displaced along the flow path upstream or downstream of the particulates treatment unit.

**[0031]** In some embodiments, the gas treatment unit is configured to treat ozone in the air displaced along the flow path. Controlling the arrangement of such an ozone-treating gas treatment unit in relation to the flow path may have an additional effect of enabling adjustment of a concentration of ozone in the air outputted by the air purifying device, and thus control over ozone inactivation of bioaerosols based on the bioaerosol exposure risk.

**[0032]** By the ozone-treating gas treatment unit being, for instance, arranged such that air displaced along the flow path bypasses the ozone-treating gas treatment unit based on the data being indicative of elevated risk of bioaerosol exposure, a higher concentration of ozone may be accordingly present in the outputted air, due to ozone in the displaced air bypassing, rather than being treated by, the gas treatment unit. Such an elevated ozone concentration in the air outputted from the air purifying device may, in turn, assist to inactivate bioaerosols in the vicinity of the air purifying device.

**[0033]** Any suitable type of ozone-treating gas treatment unit can be contemplated. In some embodiments, the ozone-treating gas treatment unit comprises activated carbon.

**[0034]** In some embodiments, the air purifying device does not include ozone-generating units. For example, the air purifying device may only include HEPA filter(s) as the particulates treatment unit and activated carbon gas treatment unit(s) as the gas treatment unit.

**[0035]** In such embodiments, ozone levels may not increase when the air purifying device is operating beyond a reference value corresponding to an ozone level in the vicinity of the air purifying device, e.g. in a room, established when the air purifying device is not operating.

**[0036]** In some embodiments, the obtaining data indicative of bioaerosol exposure risk comprises receiving sensory data from a sensor. Such sensory data, which may be directly or indirectly indicative of infectious bioaerosol level, e.g. infectious virus level, in air to be purified by the air purifying device, may provide a convenient and reliable basis on which to control the arrangement of the gas treatment unit in relation to the flow path and to the particulates treatment unit.

**[0037]** In some embodiments, the sensor comprises a $CO_2$ sensor and the sensory data comprises a $CO_2$ concentration in air, e.g. in air to be treated by the air purifying device. $CO_2$ concentration has been found to serve as a convenient proxy for infectious bioaerosol level, e.g. infectious virus level, since $CO_2$ concentration may increase with higher occupancy of a vicinity/space in which the air purifying device is being used, and bioaerosol exposure risk, e.g. infectious bioaerosol level, may increase with higher occupancy, due to bioaerosol release from occupants of the space.

**[0038]** Alternatively or additionally, the sensor may comprise a microphone for acoustic detection of occupancy of a vicinity/space in which the air purifying device is being used.

**[0039]** Alternatively or additionally, the sensor may comprise a movement sensor for detecting movement of occupant(s) in a vicinity/space in which the air purifying device is being used.

**[0040]** In some embodiments, the controlling comprises arranging the gas treatment unit in relation to the flow path and to the particulates treatment unit in the flow path to increase flow of treated air outputted by the air purifying device that has been displaced through the particulates treatment unit based on the data being indicative of the bioaerosol exposure risk equaling or exceeding a given threshold.

**[0041]** Thus, bioaerosol treatment and higher flow may be prioritized over combined bioaerosol and gaseous pollutant treatment at lower flow when the bioaerosol exposure risk, e.g. infectious bioaerosol levels, equals or exceeds such a given threshold.

**[0042]** In some embodiments, the arranging comprises positioning the gas treatment unit to provide a bypass around the gas treatment unit for the air displaced along the flow path.

**[0043]** Such a bypass may provide a relatively straightforwardly implementable and compact way of achieving controllable arrangement of the gas treatment unit in relation to the flow path.

**[0044]** Providing the bypass may be implemented in any suitable manner, such as by moving the gas treatment unit along the flow path in a direction away from a mounting element for the gas treatment unit, with the bypass being provided between the displaced gas treatment unit and the mounting element.

**[0045]** Alternative possibilities can also be contemplated, such as moving the gas treatment unit into and out of the flow path along directions transverse to the flow path, pivoting the gas treatment unit against and away from a sidewall that delimits the flow path, and so on.

**[0046]** More generally, controlling the gas treatment unit's arrangement in relation to the flow path by providing a bypass around the gas treatment unit, e.g. by removing the gas treatment unit from the flow path, preferably reduces airflow through the gas treatment unit by at least 10%, preferably by at least 90%, most preferably by at least 99%.

**[0047]** In some embodiments, the arranging the gas treatment unit in relation to the flow path and to the particulates treatment unit to increase flow of treated air outputted by the air purifying device that has been displaced through the particulates treatment unit is based on the $CO_2$ concentration in air being equal to or above a given threshold $CO_2$ concentration.

**[0048]** In such embodiments, the given threshold $CO_2$ concentration may, for example, be in a range of 900 to 1100 ppm, e.g. about 1000 ppm.

**[0049]** Thus, when the $CO_2$ concentration is sufficiently high to indicate an elevated bioaerosol exposure risk, e.g. infectious bioaerosol level, bioaerosol treatment and higher flow may be prioritized over combined bioaerosol and gaseous pollutant treatment at lower flow.

**[0050]** In some embodiments, the controlling comprises arranging the gas treatment unit in relation to the flow path and to the particulates treatment unit to cause more of the air displaced along the flow path to be treated by the gas treatment unit based on the data being indicative of the bioaerosol exposure risk equaling or being below a defined threshold.

**[0051]** Thus, combined bioaerosol and gaseous pollutant treatment at lower flow may be prioritized over bioaerosol treatment and higher flow when the bioaerosol exposure risk, e.g. infectious bioaerosol level, is equal to or lower than such a defined threshold.

**[0052]** The arranging the gas treatment unit in relation to the flow path and to the particulates treatment unit to cause more of the air displaced along the flow path to be treated by the gas treatment unit may, for example, be implemented by removing the above-mentioned bypass around the gas treatment unit for the air displaced along the flow path.

**[0053]** In some embodiments, the arranging the gas treatment unit in relation to the flow path and to the particulates treatment unit to cause more of the air displaced along the flow path to be treated by the gas treatment unit is based on the $CO_2$ concentration in air being equal to or lower than a defined threshold $CO_2$ concentration.

**[0054]** In such embodiments, the defined threshold $CO_2$ concentration may, for example, be in a range of 500 to 1000 ppm, e.g. about 600 ppm.

**[0055]** Thus, when the $CO_2$ concentration is sufficiently low to indicate an acceptable bioaerosol exposure risk, e.g. infectious bioaerosol level, combined bioaerosol and gaseous pollutant treatment at lower flow may be prioritized.

**[0056]** In at least some embodiments, the gas treatment unit is configured to convert and/or remove gaseous pollutants in the air displaced along the flow path.

**[0057]** In at least some embodiments, the particulates treatment unit is configured to convert, remove and/or inactivate particulate pollutants in the air displaced along the flow path.

**[0058]** It is also noted that the above-mentioned further gas treatment unit(s) may be configured to convert and/or remove gaseous pollutants in the air displaced along the flow path.

**[0059]** Alternatively or additionally, the above-mentioned further particulates treatment unit(s) may be configured to convert, remove and/or inactivate particulate pollutants in the air displaced along the flow path.

**[0060]** In some embodiments, arrangement of the particulates treatment unit in relation to the flow path is controllable.

**[0061]** In such embodiments, the method may further comprise controlling arrangement of the particulates treatment unit in relation to the flow path and to the gas treatment unit to adjust flow of treated air outputted by the air purifying device that has been displaced through the gas treatment unit based on the data indicative of bioaerosol exposure risk and/or further data indicative of concentration in air of one or more pollutants other than bioaerosol.

**[0062]** Thus, the method may additionally comprise controlling arrangement of the particulates treatment unit based on the data indicative of infectious bioaerosol level, e.g. infectious virus level, and/or based on further data indicative of one or more pollutants other than bioaerosol, for example, PM2.5 and/or other particulates, indoor and/or outdoor gas concentrations, with such gas(es) comprising one or more VOCs, such as formaldehyde, and nitrogen oxides.

**[0063]** It is noted that at least one, e.g. each, of the one or more further particulates treatment unit(s) may be controllably arranged in relation to the flow path, for example similarly to the above-described particulates treatment unit.

**[0064]** According to a second aspect there is provided a method for operating an air purifying device to output treated air, which air purifying device comprises: a flow path along which air is displaceable; and a gas treatment unit for treating gaseous pollutants, including ozone, in the air displaced along the flow path, arrangement of the gas treatment unit in relation to the flow path being controllable, the method comprising: obtaining data indicative of bioaerosol exposure risk in a vicinity of the air purifying device; and controlling, based on said data, arrangement of the gas treatment unit in relation to the flow path to control ozone concentration in the treated air outputted by the air purifying device.

**[0065]** Controlling the arrangement of such an ozone-treating gas treatment unit in relation to the flow path, e.g. along, into and/or out of the flow path, enables adjustment of a concentration of ozone in the air outputted by the air purifying device and thus control over ozone inactivation of bioaerosols based on the bioaerosol exposure risk.

**[0066]** This second aspect can therefore be regarded as an alternative solution to the same problem solved by the above-described first aspect in which flow of treated air outputted by the air purifying device that has been displaced through a bioaerosol-treating particulates treatment unit is controlled based on bioaerosol exposure risk.

**[0067]** The gas treatment unit may be configured to convert and/or remove gaseous pollutants, including ozone, in the air displaced along the flow path. In addition to ozone, the gas treatment unit may convert and/or remove one or more volatile organic components (VOCs), e.g. formaldehyde, and/or inorganic gas(es), e.g. nitrogen oxides.

**[0068]** Any suitable type of ozone-treating gas treatment unit can be contemplated. In some embodiments, the ozone-treating gas treatment unit comprises activated carbon, for example comprises an activated carbon filter.

**[0069]** In some embodiments, the air purifying device does not include ozone-generating units. For example, the air purifying device may only include activated carbon gas treatment unit(s) as the gas treatment unit, and optionally HEPA filter(s) as a particulates treatment unit.

**[0070]** In such embodiments, ozone levels may not increase when the air purifying device is operating beyond a reference value corresponding to an ozone level in the vicinity of the air purifying device, e.g. in a room, established when the air purifying device is not operating.

**[0071]** In some embodiments, the obtaining data indicative of bioaerosol exposure risk comprises receiving sensory data from a sensor. For example, the sensor comprises a $CO_2$ sensor and the sensory data comprises a $CO_2$ concentration in air.

**[0072]** As already explained above in relation to the first aspect, $CO_2$ concentration has been found to serve as a convenient proxy for infectious bioaerosol level, e.g. infectious virus level, since $CO_2$ concentration may increase with higher occupancy of a vicinity/space in which the air purifying device is being used, and bioaerosol exposure risk, e.g. infectious bioaerosol level, may increase with higher occupancy, due to bioaerosol release from occupants of the space.

**[0073]** In some embodiments, the controlling comprises arranging the gas treatment unit in relation to the flow path to cause less of the air displaced along the flow path to be treated by the gas treatment unit based on the data being indicative of the bioaerosol exposure risk equaling or exceeding a given threshold.

**[0074]** Thus, there may be a higher ozone concentration in the air outputted by the air purifying device, which higher ozone concentration may assist to mitigate the elevated bioaerosol exposure risk by causing greater ozone inactivation of bioaerosols.

**[0075]** In some embodiments, the arranging may comprise positioning the gas treatment unit to provide a bypass around the gas treatment unit for the air displaced along the flow path.

**[0076]** In some embodiments, the arranging of the gas treatment unit in relation to the flow path to cause less of the air displaced along the flow path to be treated by the gas treatment unit is based on the $CO_2$ concentration in air being equal to or above a given threshold $CO_2$ concentration.

**[0077]** In such embodiments, the given threshold $CO_2$ concentration may, for example, be in a range of 900 to 1100 ppm, e.g. about 1000 ppm.

**[0078]** In some embodiments, the controlling comprises arranging the gas treatment unit in relation to the flow path to cause more of the air displaced along the flow path to be treated by the gas treatment unit based on the data being indicative of the bioaerosol exposure risk equaling or being below a defined threshold.

**[0079]** Thus, there may be a lower ozone concentration in the air outputted by the air purifying device, e.g. as well as a lower concentration of other gaseous pollutants.

**[0080]** This scenario may be justified when there is relatively low bioaerosol exposure risk, in other words when less ozone inactivation of bioaerosols is required. Gaseous pollutant treatment may be correspondingly prioritized.

**[0081]** In some embodiments, the arranging the gas treatment unit in relation to the flow path to cause more of the air displaced along the flow path to be treated by the gas treatment unit is based on the $CO_2$ concentration in air being equal to or lower than a defined threshold $CO_2$ concentration.

**[0082]** In such embodiments, the defined threshold $CO_2$ concentration may, for example, be in a range of 500 to 1000 ppm, e.g. about 600 ppm.

**[0083]** In some embodiments, the air purifying device further comprises a particulates treatment unit for treating particulate pollutants, including bioaerosols, in the air displaced along the flow path.

**[0084]** In such embodiments, the controlling arrangement of the gas treatment unit in relation to the flow path may comprise controlling arrangement of the gas treatment unit in relation to the particulates treatment unit in the flow path to adjust flow of treated air outputted by the air purifying device that has been displaced through the particulates treatment unit.

**[0085]** By controlling arrangement of the gas treatment unit in relation to the flow path, e.g. along, into and/or out of the flow path, and in relation to the particulates treatment unit, adjustment of flow of treated air outputted by the air purifying device that has been displaced through the particulates treatment unit can be implemented, as previously described in relation to first aspect. In this way, ozone inactivation control of bioaerosols can be combined with bioaerosol treatment control via the particulates treatment unit.

**[0086]** In some embodiments, arrangement of the particulates treatment unit in relation to the flow path is controllable, with the method further comprising controlling arrangement of the particulates treatment unit in relation to the flow path and to the gas treatment unit to adjust flow of treated air outputted by the air purifying device that has been displaced through the gas treatment unit based on the data indicative of bioaerosol exposure risk and/or further data indicative of concentration in air of one or more pollutants other than bioaerosol.

**[0087]** Thus, and similarly to the description provided above in relation to the first aspect, the method may additionally comprise controlling arrangement of the particulates treatment unit based on the data indicative of infectious bioaerosol level, e.g. infectious virus level, and/or based on further data indicative of one or more pollutants other than bioaerosol, for example, PM2.5 and/or other particulates, indoor and/or outdoor gas concentrations, with such gas(es) comprising one or more VOCs, such as formaldehyde, and nitrogen oxides.

**[0088]** According to a third aspect there is provided an air purifying device control system for controlling operation of an air purifying device that has a flow path along which air is displaceable, a gas treatment unit for treating gaseous pollutants in the air displaced along the flow path, with arrangement of the gas treatment unit in relation to the flow path being controllable, and a particulates treatment unit for treating particulate pollutants, including bioaerosols, in the air displaced along the flow path, the system comprising a controller configured to: obtain data indicative of bioaerosol exposure risk in a vicinity of the air purifying device; and control, based on said data, arrangement of the gas treatment unit in relation to the flow path and to the particulates treatment unit in the flow path to adjust flow of treated air outputted by the air purifying device that has been displaced through the particulates treatment unit.

**[0089]** Similarly to embodiments described above in relation to the method of operating such an air purifying device, the controller may be configured to receive sensory data from a sensor, which sensory data is indicative of the bioaerosol exposure risk, e.g. indicative of infectious bioaerosol level in air to be purified by the air purifying device.

**[0090]** In some embodiments, the sensor comprises a $CO_2$ sensor and the sensory data comprises a $CO_2$ concentration in air.

**[0091]** It is reiterated that, as an alternative or in addition to the $CO_2$ sensor, the sensor may comprise a microphone for acoustic detection of occupancy of a vicinity/space in which the air purifying device is being used and/or a movement sensor for detecting movement of occupant(s) in a vicinity/space in which the air purifying device is being used.

**[0092]** More generally, the sensor may be included in the air purifying device control system. In such embodiments, the sensor may communicate, e.g. in a wired and/or wireless manner, with the controller.

**[0093]** Alternatively or additionally, the sensor may be included in the air purifying device.

**[0094]** According to a fourth aspect, there is provided an air purifying device comprising: a flow path along which air is displaceable; a gas treatment unit for treating gaseous pollutants in the air displaced along the flow path, arrangement of the gas treatment unit in relation to the flow path being controllable; a particulates treatment unit for treating particulate pollutants, including bioaerosols, in the air displaced along the flow path; and an air purifying device control system according to any of the embodiments described herein.

**[0095]** It is reiterated that in some embodiments, the gas treatment unit is configured to treat ozone in the air displaced along the flow path.

**[0096]** In at least some embodiments, the air purifying device further comprises an air displacement system for displacing air along the flow path.

**[0097]** Any suitable type of air displacement system can be contemplated, such as an air displacement system comprising a fan whose rotation displaces air along the flow path, and/or an ionic wind generator.

**[0098]** According to a fifth aspect there is provided an air purifying device control system for controlling operation of an air purifying device that has a flow path along which air is displaceable, and a gas treatment unit for treating gaseous pollutants, including ozone, in the air displaced along the flow path, with arrangement of the gas treatment unit in relation to the flow path being controllable, the system comprising a controller configured to: obtain data indicative of bioaerosol exposure risk in a vicinity of the air purifying device; and control, based on said data, arrangement of the gas treatment unit in relation to the flow path to control ozone concentration in the treated air outputted by the air purifying device.

**[0099]** Similarly to embodiments described above in relation to the methods of operating such an air purifying device, the controller may be configured to receive sensory data from a sensor, which sensory data is indicative of the bioaerosol exposure risk, e.g. indicative of infectious bioaerosol level in air to be purified by the air purifying device.

**[0100]** In some embodiments, the sensor comprises a $CO_2$ sensor and the sensory data comprises a $CO_2$ concentration in air.

**[0101]** It is reiterated that, as an alternative or in addition to the $CO_2$ sensor, the sensor may comprise a microphone for acoustic detection of occupancy of a vicinity/space in which the air purifying device is being used and/or a movement sensor for detecting movement of occupant(s) in a vicinity/space in which the air purifying device is being used.

**[0102]** More generally, the sensor may be included in the air purifying device control system. In such embodiments, the sensor may communicate, e.g. in a wired and/or wireless manner, with the controller.

**[0103]** Alternatively or additionally, the sensor may be included in the air purifying device.

**[0104]** According to a sixth aspect there is provided an air purifying device comprising: a flow path along which air is displaceable; a gas treatment unit for treating gaseous pollutants, including ozone, in the air displaced along the flow path, arrangement of the gas treatment unit in relation to the flow path being controllable; and an air purifying device control system according to embodiments described herein, with the air purifying device control system comprising a controller configured to obtain data indicative of bioaerosol exposure risk in a vicinity of the air purifying device; and control, based on said data, arrangement of the gas treatment unit in relation to the flow path to control ozone concentration in the treated air outputted by the air purifying device.

**[0105]** In at least some embodiments, the air purifying device further comprises an air displacement system for displacing air along the flow path.

**[0106]** Any suitable type of air displacement system can be contemplated, such as an air displacement system comprising a fan whose rotation displaces air along the flow path, and/or an ionic wind generator.

**[0107]** In some embodiments, an air purification appliance, e.g. a portable air purification appliance, for purifying air in a building comprises the air purifying device according to any of the aspects and embodiments described herein.

**[0108]** Such an air purification appliance may include a humidification module and/or a dehumidification module, e.g. in addition to an air displacement system.

**[0109]** Alternatively or additionally, the air purification appliance may include a heating system and/or a cooling system, e.g. in addition to an air displacement system.

**[0110]** In embodiments in which the air purification appliance includes a heating system, a humidification module and/or a dehumidification module, one or more of these components may be controlled based on the data indicative of bioaerosol exposure risk.

**[0111]** Controlling the temperature and/or humidity at comfortable levels can assist to control, e.g. increase, an inactivation rate of bioaerosols.

**[0112]** In some embodiments, a vehicular air purifying assembly for purifying air in a vehicle's cabin comprises the air purifying device according to any of the aspects and embodiments described herein.

**[0113]** Such a vehicular air purifying assembly may include a humidification module and/or a dehumidification module, e.g. in addition to an air displacement system.

**[0114]** Alternatively or additionally, the vehicular air purifying assembly may include a heating system and/or a cooling system, e.g. in addition to an air displacement system.

**[0115]** In some embodiments, a face mask comprises the air purifying device according to any of the aspects and embodiments described herein.

**[0116]** Further provided is a computer program comprising computer program code which is configured, when said computer program is run on one or more processors, to cause said one or more processors to implement the method of any of the aspects and embodiments described herein.

**[0117]** One or more non-transitory computer readable media may be provided, which non-transitory computer readable media have a computer program stored thereon, with the computer program comprising computer program code which is configured, when the computer program is run on the one or more processors, to cause the one or more processors to implement the method according to any of the aspects and embodiments described herein.

**[0118]** More generally, embodiments described herein in relation to the method for operating the air purifying device may be applicable to the air purifying device control system, the air purifying device and the computer program, embodiments described herein in relation to the air purifying device control system may be applicable to the method, the air purifying device and the computer program, embodiments described herein in relation to the air purifying device may be applicable to the method, the air purifying device control system and the computer program, and embodiments described herein in relation to the computer program may be applicable to the method, the air purifying device control system and the air purifying device.

**[0119]** These and other aspects will be apparent from and elucidated with reference to the embodiment(s) described hereinafter.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0120]** 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:

FIG. 1 schematically depicts an air purifying device according to an example;
FIG. 2 provides a flowchart of a first example of a method of operating an air purifying device;
FIG. 3 provides a flowchart of a second example of a method of operating an air purifying device;
FIG. 4 provides a flowchart of a third example of a method of operating an air purifying device;
FIG. 5 provides a flowchart of a fourth example of a method of operating an air purifying device;
FIGs. 6A and 6B schematically depict an example of controlling of arrangement of a gas treatment unit of an air purifying device in relation to a flow path along which air is displaceable;
FIGs. 7A and 7B schematically depict another example of controlling of arrangement of a cylindrical gas treatment unit of an air purifying device in relation to a flow path along which air is displaceable;
FIG. 8 provides a flowchart of a fifth example of a method of operating an air purifying device;
FIG. 9 provides a flowchart of a sixth example of a method of operating an air purifying device;
FIG. 10 provides a flowchart of a seventh example of a method of operating an air purifying device;
FIG. 11 provides a flowchart of an eighth example of a method of operating an air purifying device;
FIG. 12 provides a flowchart of a ninth example of a method of operating an air purifying device;
FIG. 13 provides a flowchart of a tenth example of a method of operating an air purifying device;
FIG. 14 provides a flowchart of an eleventh example of a method of operating an air purifying device; and
FIG. 15 provides a flowchart of a twelfth example of a method of operating an air purifying device.

## DETAILED DESCRIPTION OF THE EMBODIMENTS

**[0121]** The invention will be described with reference to the Figures.

**[0122]** 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.

**[0123]** Provided is a method for operating an air purifying device to output treated air, which air purifying device comprises a flow path along which air is displaceable, a gas treatment unit for treating gaseous pollutants in the air displaced along the flow path, and a particulates treatment unit for treating particulate pollutants, including bioaerosols, in the air displaced along the flow path. The method comprises obtaining data indicative of bioaerosol exposure risk in a vicinity of the air purifying device; and controlling, based on the data, arrangement of the gas treatment unit in relation to the flow path and to the particulates treatment unit in the flow path to adjust flow of treated air outputted by the air purifying device that has been displaced through the particulates treatment unit. Further provided is a related computer program, a control system for controlling the air purifying device, and an air purifying device comprising such a control system.

**[0124]** Further provided is a method for operating an air purifying device to output treated air, which air purifying device comprises a flow path along which air is displaceable, a gas treatment unit for treating gaseous pollutants, including ozone, in the air displaced along the flow path. The method comprises obtaining data indicative of bioaerosol exposure risk in a vicinity of the air purifying device; and controlling, based on said data, arrangement of the gas treatment unit in relation to the flow path to control ozone concentration in the treated air outputted by the air purifying device. Further provided is a related computer program, a control system for controlling the air purifying device, and an air purifying device comprising such a control system.

**[0125]** FIG. 1 schematically depicts an air purifying device 100 according to an example. In at least some embodiments, the air purifying device 100 comprises an air displacement system 102 for displacing air along a flow path 104.

**[0126]** The air displacement system 102 can generally be regarded as a unit that creates an airflow. Any suitable type of air displacement system 102 can be employed for displacing air along the flow path 104. In some embodiments, such as shown in FIG. 1, the air displacement system 102 comprises a fan and a motor (not visible) for driving rotation of the fan to cause displacement of air along the flow path 104.

**[0127]** Alternatively or additionally, the air displacement system 102 may include an ionic wind generator for displacing air along the flow path 104. Such an ionic wind generator may generate air movement by ionizing the air and accelerating the resulting ions in an electric field.

**[0128]** More generally, the flow path 104 may extend within the air purifying device 100 between an air inlet 105A at which air is admitted and an air outlet 105B at which air is outputted from the air purifying device 100.

**[0129]** The air inlet 105A and the air outlet 105B may, for example, be delimited by a housing 105C of the air purifying device 100.

**[0130]** The housing 105C can be formed from any suitable material. In some embodiments, the housing 105C is formed from plastic.

**[0131]** The air purifying device 100 comprises a gas treatment unit 106 for treating gaseous pollutants in the air displaced along the flow path 104. In at least some embodiments, the gas treatment unit 106 is configured to convert and/or remove such gaseous pollutants in the air displaced along the flow path 104. The gas treatment unit 106 can therefore be regarded as a purification element that converts and/or removes gaseous air pollutants.

**[0132]** The gas treatment unit 106 may be configured to treat, e.g. convert and/or remove, gaseous pollutants typically present in air, such as one or more volatile organic components (VOCs), e.g. formaldehyde, and/or inorganic gas(es), e.g. nitrogen oxides and/or ozone.

**[0133]** Conversion of gaseous pollutants may involve reacting the gaseous pollutants to convert them into species that are not harmful, or at least less harmful than the gaseous pollutants.

**[0134]** Removal of gaseous pollutants may involve absorption or adsorption of the gaseous pollutants to remove the gaseous pollutants from, or at least lower the concentration of the gaseous pollutants in, the treated air outputted from the air purifying device 100.

**[0135]** In some embodiments, the gas treatment unit 106 comprises an activated carbon filter, for example an activated carbon filter that might be impregnated with chemical additives.

**[0136]** Alternatively or additionally, the gas treatment unit 106 may include filter(s) comprising porous material, e.g. impregnated porous material. Examples of such porous materials include zeolites, silicas, and metal organic frameworks.

**[0137]** Alternatively or additionally, the gas treatment unit 106 may include a plasma generator configured to generate plasma, for example to convert VOCs.

**[0138]** Alternatively or additionally, the gas treatment unit 106 may include a photocatalytic oxidation (PCO) device. Such a PCO device may photocatalytically oxidize gaseous pollutants, such as VOCs.

**[0139]** Particular mention is made of an activated carbon filter being included in, e.g. defining, the gas treatment unit 106 due to the capability of such an activated carbon filter to treat ozone in the air displaced along the flow path 104, as will be described in more detail herein below.

**[0140]** More generally, arrangement of the gas treatment unit 106 in relation to the flow path 104 is controllable. The arrangement of the gas treatment unit 106 in relation to the flow path 104 may be controllable in any suitable manner. In some embodiments, the air purifying device 100 comprises an actuator (not visible) arranged to enable movement of the gas treatment unit 106 along, into and/or out of the flow path 104. The significance of the controllable arrangement of the gas treatment unit 106 in relation to the flow path 104 will be discussed in more detail herein below.

**[0141]** In some embodiments, the air purifying device 100 includes one or more further gas treatment unit(s) (not visible) for treating gaseous pollutants in the air displaced along the flow path 104, in addition to the gas treatment unit 106 whose arrangement in relation to the flow path 104 is required to be adjustable/controllable.

**[0142]** The further gas treatment unit(s) may be configured to convert and/or remove gaseous pollutants in the air displaced along the flow path 104.

**[0143]** The one or more further gas treatment unit(s) may be configured to treat the same or different type(s) of gaseous pollutants compared to the gaseous pollutants treated by the gas treatment unit 106.

**[0144]** For example, the gas treatment unit 106 may be configured to treat, e.g. convert and/or remove, one or more VOCs and/or ozone, and the further gas treatment unit(s) may be configured to treat one or more VOCs, nitrogen oxides, and/or ozone.

**[0145]** More generally, the air purifying device 100 comprises a particulates treatment unit 108 for treating particulate pollutants, including bioaerosols, in the air displaced along the flow path 104. The particulates treatment unit 108 may be of any suitable type provided that the particulates treatment unit 108 is capable of treating bioaerosols. To this end, the particulates treatment unit 108 may, for example, be configured to remove particles having a size of a few microns or smaller, e.g. <5 microns.

**[0146]** In at least some embodiments, the particulates treatment unit 108 is configured to convert, remove and/or inactivate particulate pollutants in the air displaced along the flow path 104. The particulates treatment unit 108 can therefore be regarded as a purification element which converts, removes and/or inactivates particulate air pollutants.

**[0147]** In some embodiments, the particulates treatment unit 108 comprises a high-efficiency particulate air (HEPA) filter and/or an electrostatic precipitator (ESP).

**[0148]** For example, electrostatically charged non-woven filters, sometimes called "electret filters" can be employed in the particulates treatment unit 108.

**[0149]** HEPA H13 particle filters and/or HEPA H14 particle filters can alternatively or additionally be employed in the particulates treatment unit 108.

**[0150]** In some embodiments, the particulates treatment unit 108 comprises a HEPA filter with an ionizer downstream of the HEPA filter, or a HEPA filter with an ionizer upstream of the HEPA filter.

**[0151]** As an alternative or in addition to the HEPA filter and/or an electrostatic precipitator, the particulates treatment unit 108 may include an optical element, e.g. an ultraviolet germicidal irradiation (UVGI) element, for optically inactivating bioaerosols.

**[0152]** For example, the particulates treatment unit 108 may comprise an optical element, e.g. UVGI element, configured to emit UV-C and/or radiation from other spectral regions to inactivate bioaerosols.

**[0153]** In a non-limiting example, the particulates treatment unit 108 comprises a HEPA filter and an optical element, e.g. UVGI element.

**[0154]** As an alternative or in addition to the HEPA filter, the electrostatic precipitator and/or the optical element, the particulates treatment unit 108 may include a plasma unit configured to generate plasma for inactivating bioaerosols.

**[0155]** It is noted, more generally, that in addition to treating bioaerosols, the particulates treatment unit 108 may treat, e.g. remove, PM2.5 and/or other particulates.

**[0156]** In some embodiments, the air purifying device 100 comprises one or more further particulates treatment unit(s) (not visible) for treating particulate pollutants in the air displaced along the flow path 104.

**[0157]** The further particulates treatment unit(s) may be configured to convert, remove and/or inactivate particulate pollutants in the air displaced along the flow path 104.

**[0158]** The one or more further particulates treatment unit(s) may be configured to treat the same or different type(s) of particulate pollutants compared to the particulate pollutants treated by the particulates treatment unit 108.

**[0159]** The further particulates treatment unit(s) may, for example, include a dust filter for removing dust, e.g. coarse dust particles visible to the naked eye, from the air displaced along the flow path, e.g. upstream of the particulates treatment unit 108.

**[0160]** In such embodiments, the dust filter may be a coarser filter than filter(s), such as HEPA filter(s), included in the particulates treatment unit 108 for filtering bioaerosols.

**[0161]** In some embodiments, arrangement of the particulates treatment unit 108 in relation to the flow path 104 is controllable. The arrangement of the particulates treatment unit 108 in relation to the flow path 104 may be controllable in any suitable manner. In some embodiments, the air purifying device 100 comprises a further actuator (not visible) arranged to enable movement of the particulates treatment unit 108 along, into and/or out of the flow path 104.

**[0162]** In such embodiments, the arrangement of the particulates treatment unit 108 in relation to the flow path 104 may be controllable independently of the arrangement of the gas treatment unit 106 in relation to the flow path 104.

**[0163]** It is noted that at least one, e.g. each, of the above-described one or more further particulates treatment unit(s) may be controllably arranged in relation to the flow path 104, for example similarly to the particulates treatment unit 108.

**[0164]** In some embodiments, such as shown in FIG. 1, the gas treatment unit 106 may be arranged to treat air displaced along the flow path 104 upstream of the particulates treatment unit 108.

**[0165]** Alternatively, the gas treatment unit 106 may be arranged to treat air displaced along the flow path 104 downstream of the particulates treatment unit 108. An example of the latter will be described herein below with reference to FIGs. 7A and 7B.

**[0166]** In some embodiments, such as shown in FIG. 1, the air purifying device 100 comprises an air treatment module 109 comprising the gas treatment unit 106 and the particulates treatment unit 108.

**[0167]** It is noted that the air treatment module 109 can, for example, be alternatively termed a "purification module".

**[0168]** In a non-limiting example, the air treatment module 109 comprises an activated carbon filter as the gas treatment unit 106 and a HEPA filter as the particulates treatment unit 108.

**[0169]** In such an example, the activated carbon filter and the HEPA filter can be regarded as being combined in one component, namely the air treatment module 109.

**[0170]** The above-mentioned further gas treatment unit(s) and/or further particulates treatment unit(s) can, for instance, be included, together with the gas treatment unit 106 and the particulates treatment unit 108, in the air treatment module 109.

**[0171]** It is noted that the gas treatment unit 106 may have any suitable shape, such as a cuboidal, cylindrical or irregular shape. A cuboidal shape for the gas treatment unit 106 is shown in FIG. 1, while a cylindrically shaped gas treatment unit 106 is schematically depicted in FIGs. 7A and 7B.

**[0172]** Similarly, the particulates treatment unit 108 may have any suitable shape, such as a cuboidal, cylindrical or irregular shape. A cuboidal shape for the particulates treatment unit 108 is shown in FIG. 1, while a cylindrically shaped particulates treatment unit 108 is schematically depicted in FIGs. 7A and 7B.

**[0173]** FIG. 2 provides a flowchart of a method 200 of operating the air purifying device 100. In at least some embodiments, and referring again to FIG. 1, steps of the method 200 may be implemented by a controller 114, e.g. a controller 114 comprising one or more data processors.

**[0174]** Such a controller 114 may be included in an air purifying device control system that controls operation of the air purifying device 100.

**[0175]** In some embodiments, such as shown in FIG. 1, the controller 114 is included in, e.g. integrated into, the air purifying device 100.

**[0176]** Alternatively or additionally, the controller 114 is included in a user device, such as a smartphone, tablet computer or sensing unit, that is separate from, in other words not integrated into, the air purifying device 100.

**[0177]** In such embodiments, the user device may be digitally connected, e.g. via a wired and/or wireless link, to the air purifying device 100.

**[0178]** The user device can be regarded as enabling separate remote device control over operation of the air purifying device 100.

**[0179]** Whilst not shown in FIG. 1, the air purifying device 100 and/or the air purifying device control system may include a user interface. Such a user interface may be configured to enable a user to input commands and/or data for controlling operation of the air purifying device 100. Alternatively or additionally, the user interface may be configured to communicate data, such as data relevant to operation of the air purifying device 100, to the user.

**[0180]** Such a user interface may, for example, be included in the above-mentioned user device, such as a smartphone or tablet computer, external to the air purifying device 100.

**[0181]** More generally, and referring again to FIG. 2, the method 200 comprises obtaining 202 data indicative of bioaerosol exposure risk in a vicinity of the air purifying device 100.

**[0182]** The vicinity of the air purifying device 100 may be, for instance, a space, e.g. an enclosed space, in which the air purifying device 100 is situated.

**[0183]** The bioaerosol exposure risk may be a risk of exposure of person(s) in the vicinity of the air purifying device 100 to bioaerosols, such as infectious virus aerosols.

**[0184]** The method 200 further comprises controlling 204, based on the data indicative of bioaerosol exposure risk in a vicinity of the air purifying device 100, arrangement of the gas treatment unit 106 in relation to the flow path 104 and to the particulates treatment unit 108 in the flow path 104 to adjust flow of treated air outputted by the air purifying device 100 that has been displaced through the particulates treatment unit 108.

**[0185]** By controlling 204 arrangement of the gas treatment unit 106 in relation to the flow path 104, e.g. along, into and/or out of the flow path 104, and in relation to the particulates treatment unit 108 in the flow path 104, adjustment of flow of treated air outputted by the air purifying device 100 that has been displaced through the particulates treatment unit 108 can be implemented. This may be due to the gas treatment unit's 106 arrangement in relation to the flow path 104 influencing the flow of treated air outputted by the air purifying device 100, due to the flow resistance provided by the gas treatment unit 106.

**[0186]** This control 204 of the arrangement of the gas treatment unit 106 can provide a way of prioritizing either (i) bioaerosol treatment and higher flow or (ii) combined bioaerosol and gaseous pollutant treatment at lower flow.

**[0187]** Airflow outputted by the air purifying device 100 may at least partly depend on a pressure drop resulting from the gas treatment unit 106, e.g. activated carbon filter, and the particulates treatment unit 108, e.g. HEPA filter, when the air displaced along the flow path 104 is treated by both the gas treatment unit 106 and the particulates treatment unit 108. As an example, a relatively high pressure drop resulting in significant reduction in airflow is observed with HEPA H13 and HEPA H14 filters.

**[0188]** Air purifying devices 100 tend to be equipped with gas treatment and particulates treatment units 106, 108 that provide relatively high purification performance at low pressure drop.

**[0189]** However, the pressure drop from the gas treatment unit 106 can be controlled, e.g. reduced or removed, by controlling 204 the arrangement of the gas treatment unit 106 in relation to the flow path 104, e.g. along, into and/or out of the flow path 104. In particular, by reducing or removing the pressure drop from the gas treatment unit 106, airflow through the particulates treatment unit 108 remaining in the flow path 104 can be increased.

**[0190]** In this way, the higher airflow through the particulates treatment unit 108 can accelerate reduction and/or inactivation of bioaerosols.

**[0191]** The cleaning speed of an air purifier is commonly expressed as the Clean Air Delivery Rate (CADR). In particular, CADR of an air purifying device 100 with respect to pollutant x is given by: $CADR_x = V * \eta_x$.

**[0192]** V is airflow through the treatment unit(s) 106, 108, in other words airflow outputted by the air purifying device 100, and $\eta = C_{after,x}/C_{before,x}$.

**[0193]** $C_{after,x}$ is concentration of pollutant x downstream of the treatment unit(s) 106, 108, and $C_{before,x}$ is concentration of pollutant x upstream of the treatment unit(s) 106, 108.

**[0194]** As an illustrative non-limiting example, the effect of removing the activated carbon filter of a Philips AC2887 air purifier that contains a HEPA filter in addition to, and separate from, the activated carbon filter is shown in Table 1.

Table 1

| HEPA filter in device? | Activated carbon filter in device? | CADR of device with respect to PM2.5 [$m^3/h$] |
|---|---|---|
| Yes | Yes | 333 |
| Yes | No | 411 |

**[0195]** In this example, removing the activated carbon filter resulted in a 23% increase of CADR with respect to PM2.5. CADR with respect to PM2.5 can represent the rate at which the air purifying device 100 can remove virus aerosols from the air.

**[0196]** In this respect, reference is made to Erik Uhde, Tunga Salthammer, Sebastian Wientzek, Jochen Schulz, Annette Springorum "Effectiveness of air-cleaning devices and measures to reduce the exposure to bioaerosols in school classrooms", Indoor Air; Asbach, C., et al. "Position paper of the Gesellschaft für Aerosolforschung on understanding the role of aerosol particles in SARS-CoV-2 infection" (2021); Liu, David T., et al. "Portable HEPA purifiers to eliminate airborne SARS-CoV-2: a systematic review" Otolaryngology-Head and Neck Surgery 166.4 (2022): 615-622; and Foarde, Karin K. "Methodology to perform clean air delivery rate type determinations with microbiological aerosols" Aerosol science and technology 30.2 (1999): 235-245.

**[0197]** The above example demonstrates that controlling 204 arrangement of the gas treatment unit 106, in this case in the form of an activated carbon filter, in relation to the flow path 104, e.g. along, into and/or out of the flow path 104, and in relation to the particulates treatment unit 108 in the flow path 104, can lead to a significant CADR increase with respect to particulates, in particular bioaerosols.

**[0198]** It is noted that the precise magnitude of the CADR increase may depend on various factors, such as pressure drop of the gas treatment unit 106 and characteristics of the air displacement system 102, e.g. motor-fan characteristics.

**[0199]** The controlling 204, based on the data indicative of bioaerosol exposure risk in a vicinity of a given air purifying device 100, of arrangement of the gas treatment unit 106 in relation to the flow path 104 and to the particulates treatment unit 108 in the flow path to adjust flow of treated air outputted by the air purifying device 100 that has been displaced through the particulates treatment unit 108 can be directly and positively verified by, for example, positioning such an air purifying device 100 in a standard 30 $m^3$ test chamber and adjusting factors indicative of bioaerosol exposure risk, such as levels of $CO_2$, and monitoring controlling of arrangement of the device's gas treatment unit 106 in relation to the flow path 104 and flow of treated air outputted by the air purifying device 100 that has been displaced through the particulates treatment unit 108. The skilled person is, for example, capable of determining whether filter(s) is or are automatically removed from the flow path 104 and measuring concomitant changes of airflow.

**[0200]** In some embodiments, the air purifying device 100 comprises instructions for the user to obtain 202 data, e.g. check factors, indicative of bioaerosol exposure risk, such as levels of $CO_2$, and to control 204 arrangement of the device's gas treatment unit 106 in relation to the flow path 104 while the particulates treatment unit 108 is in the flow path 104 based on such factors. For example, the user may be instructed to remove the gas treatment unit 106 from the airflow should the user identify relevant high pollution conditions, e.g. relatively high levels of $CO_2$.

**[0201]** It is reiterated that in some embodiments, the gas treatment unit 106 is configured to treat ozone in the air displaced along the flow path 104. Controlling 204 the arrangement of such an ozone-treating gas treatment unit 106 in relation to the flow path 104 may have an additional effect of enabling adjustment of a concentration of ozone in the air outputted by the air purifying device 100, and thus control over ozone inactivation of bioaerosols based on the bioaerosol exposure risk.

**[0202]** In relation to ozone accelerating inactivation of bioaerosols, such as virus aerosols, reference is made to Bayarri, Bernardi, et al. "Can ozone inactivate SARS-CoV-2? A review of mechanisms and performance on viruses" Journal of hazardous materials 415 (2021): 125658; Dubuis, Marie-Eve, et al. "Ozone efficacy for the control of airborne viruses: Bacteriophage and norovirus models" PLoS One 15.4 (2020): e0231164; and Tseng, Chun-Chieh, and Chih-Shan Li "Ozone for inactivation of aerosolized bacteriophages." Aerosol science and technology 40.9 (2006): 683-689.

**[0203]** It is noted that fewer COVID-19 cases were reported in China when outdoor ozone levels were elevated, referring to Yao, Maosheng, et al. "On airborne transmission and control of SARS-Cov-2" Science of The Total Environment 731 (2020): 139178 ; and Farooq, Saima, and Chedly Tizaoui "A critical review on the inactivation of surface and airborne SARS-CoV-2 virus by ozone gas" Critical Reviews in Environmental Science and Technology (2022): 1-23.

**[0204]** Further, median indoor ozone level may be approximately equal to 0.25 * outdoor ozone level. Naturally ventilated homes may have higher indoor ozone levels ($\approx$ 0.3 - 0.4 * outdoor level). This implies that indoor ozone levels may increase with outdoor levels, and thus accelerate virus aerosol inactivation. In this connection, reference is made to Nazaroff, William W., and Charles J. Weschler "Indoor ozone: Concentrations and influencing factors" Indoor air 32.1 (2022): e12942.

**[0205]** By the ozone-treating gas treatment unit 106 being, for instance, arranged such that air displaced along the flow path 104 bypasses the ozone-treating gas treatment unit 106 based on the data being indicative of elevated risk of bioaerosol exposure, a higher concentration of ozone may be accordingly present in the outputted air, due to ozone in the displaced air bypassing, rather than being treated by, the gas treatment unit 106. Such an elevated ozone concentration in the air outputted from the air purifying device 100 may, in turn, assist to inactivate bioaerosols in the vicinity of the air purifying device 100.

**[0206]** Any suitable type of ozone-treating gas treatment unit 106 can be contemplated. In some embodiments, the ozone-treating gas treatment unit 106 comprises activated carbon, e.g. an activated carbon filter.

**[0207]** As an illustrative non-limiting example, in situations in which particulate species such as infectious virus aerosols are considered to offer a far larger health risk than gaseous pollutants, an activated gas filter-comprising gas treatment unit 106 can be preferentially removed from the airflow. Activated carbon filters have two key properties that are relevant for the control of infectious virus and bacteria aerosols: they increase the pressure drop of the air treatment module 109, thus reducing the CADR with respect to particulates; and they remove ozone and other reactive oxygen species from the air. Ozone can inactivate virus and bacteria bioaerosols, as previously described. Hence, lower levels of ozone and other reactive oxygen species can result in increased infectious bioaerosol levels.

**[0208]** A conventional Philips air purifier model AC4236 comprising an activated carbon filter has been found to remove ozone with a CADR of 191 $m^3/h$. In this respect, reference is made to IUTA report UN2-210415-T5599900-059 "Air cleaner tests according to GB/T 18801-2015 with ozone and $NO_2$" July 9, 2021. In a 100 $m^3$ room that is naturally ventilated at a rate of 0.5 $h^{-1}$ with outdoor air containing 100 $\mu g/m^3$ ozone and an ozone indoor surface deposition rate of 2 $h^{-1}$, the Philips AC4236 can reduce the indoor ozone level by 60%, from 20 to 12 $\mu g/m^3$, in 36 minutes, assuming well-mixed indoor air.

**[0209]** It is noted that in some embodiments, the air purifying device 100 does not include ozone-generating units. For example, the air purifying device 100 may only include HEPA filter(s) as the particulates treatment unit 108 and activated carbon filter(s) as the gas treatment unit 106. In such embodiments, ozone levels may not increase when the air purifying device 100 is operating beyond a reference value corresponding to an ozone level in the vicinity of the air purifying device 100, e.g. in a room, established when the air purifying device 100 is not operating.

**[0210]** The controlling 204 arrangement of the gas treatment unit 106 in relation to the flow path 104, e.g. along, into and/or out of the flow path 104, and in relation to the particulates treatment unit 108 in the flow path 104 may be implemented in any suitable manner, such as by the controller 114 sending a control signal to the actuator to cause the actuator to move the gas treatment unit 106 along, into and/or out of the flow path 104.

**[0211]** In embodiments in which arrangement of the particulates treatment unit 108 in relation to the flow path 104 is controllable, the controller 114 may be configured to ensure, e.g. by sending a further control signal to the above-mentioned further actuator, that the particulates treatment unit 108 is arranged in the flow path 104.

**[0212]** Thus, it can be ensured that the treated air outputted by the air purifying device 100 has passed through the particulates treatment unit 108.

**[0213]** In some embodiments, and referring again to FIG. 1, the obtaining 202 data indicative of bioaerosol exposure risk comprises receiving sensory data from a sensor 110. Such sensory data, which may be directly or indirectly indicative of infectious bioaerosol level, e.g. infectious virus level, in air to be purified by the air purifying device 100, may provide a convenient and reliable basis on which to control 204 the arrangement of the gas treatment unit 106 in relation to the flow path 104 and to the particulates treatment unit 108 in the flow path 104.

**[0214]** In some embodiments, the sensor 110 comprises a $CO_2$ sensor and the sensory data comprises a $CO_2$ concentration in air. $CO_2$ concentration has been found to serve as a convenient proxy for infectious bioaerosol level, e.g. infectious virus level, since $CO_2$ concentration may increase with higher occupancy of a vicinity/space in which the air purifying device 100 is being used, and bioaerosol exposure risk, e.g. infectious bioaerosol level, may increase with higher occupancy, due to bioaerosol release from occupants of the space.

**[0215]** In respect of correlation of $CO_2$ levels with risk of airborne transmission of infectious diseases, including COVID-19, reference is made to Rudnick, S. N., and D. K. Milton "Risk of indoor airborne infection transmission estimated from carbon dioxide concentration" Indoor air 13.3 (2003): 237-245. Reference is further made to Hartmann, Anne, et al. "Practical application of CO2 as an indicator regarding the risk of infection" medRxiv (2022); and Peng, Zhe, and Jose L. Jimenez "Exhaled CO2 as a COVID-19 infection risk proxy for different indoor environments and activities" Environmental Science & Technology Letters 8.5 (2021): 392-397.

**[0216]** As an alternative or in addition to the sensor 110 comprising the $CO_2$ sensor, the sensor 110 may comprise a microphone for acoustic detection of occupancy of a vicinity/space in which the air purifying device 100 is being used.

**[0217]** Alternatively or additionally, the sensor 110 may comprise a movement sensor for detecting movement of occupant(s) in a vicinity/space in which the air purifying device 100 is being used.

**[0218]** It is noted that optical particle sensors may not provide a suitable indication of bioaerosol exposure risk because such optical particle sensors may not distinguish bioaerosols from other forms of particulate matter, particularly given that the number of bioaerosol, e.g. virus, particles may only constitute a fraction of a total amount of airborne particles detected by such optical particle sensors.

**[0219]** Thus, the sensor 110 may not include an optical particle sensor on the basis that sensory data provided by such an optical particle sensor is not indicative of bioaerosol exposure risk.

**[0220]** In some embodiments, such as shown in FIG. 1, the sensor 110 is included in the air purifying device 100.

**[0221]** Alternatively or additionally, the sensor 110 may be included in the air purifying device control system. In such embodiments, the sensor 110 may communicate, e.g. in a wired and/or wireless manner, with the controller 114.

**[0222]** In some embodiments, the sensor 110 may not be included in/integrated into the air purifying device 100 that has the gas treatment unit 106 and the particulates treatment unit 108. For example, the sensor 110 may be included in/integrated into another air purifying device. Alternatively, the sensor 110 may be included in the above-mentioned user device, e,g, smartphone, tablet computer or sensing unit, that is separate from, in other words not integrated into, the air purifying device 100.

**[0223]** In some embodiments, the obtaining 202 data indicative of bioaerosol exposure risk may include obtaining data from an outdoor air quality sensing station. Such data from the outdoor air quality sensing station may be obtained in addition to the sensory data from the sensor 110.

**[0224]** The data from such an outdoor air quality sensing station may be transmitted to and/or made available to the controller 114.

**[0225]** It is noted, more generally, in relation to the sensor 110, that sensory data other than sensory data indicative of bioaerosol exposure risk may be obtainable from the sensor 110. For example, the sensor 110 may include sensor(s) configured to sense one or more of Total Suspended Matter, PM10, PM2.5, PM1, UFP and/or Black Carbon, one or more VOCs, such as formaldehyde, benzene, toluene and/or xylene, total volatile organic components (TVOC), and/or inorganic gas(es), such as ozone and nitrogen oxides, radon or radon progenies. Sensor(s) that detect one or more of such or other pollutants may, for example, be placed in outdoor air and connected, e.g. digitally connected, to the air purifying device 100 and/or the controller 114.

**[0226]** In some embodiments, such as shown in FIG. 3, the controlling 204 comprises arranging 204A the gas treatment unit 106 in relation to the flow path 104 and to the particulates treatment unit 108 in the flow path 104 to increase flow of treated air outputted by the air purifying device 100 that has been displaced through the particulates treatment unit 108 based on the data being indicative of the bioaerosol exposure risk equaling or exceeding a given threshold.

**[0227]** Thus, bioaerosol treatment and higher flow may be prioritized over combined bioaerosol and gaseous pollutant treatment at lower flow when the bioaerosol risk, e.g. infectious bioaerosol level, equals or exceeds such a given threshold.

**[0228]** In some embodiments, the arranging 204A the gas treatment unit 106 in relation to the flow path 104 and to the particulates treatment unit 108 to increase flow of treated air outputted by the air purifying device 100 that has been displaced through the particulates treatment unit 108 is based on the $CO_2$ concentration in air being equal to or above a given threshold $CO_2$ concentration.

**[0229]** In such embodiments, the given threshold $CO_2$ concentration may, for example, be in a range of 900 to 1100 ppm, e.g. about 1000 ppm.

**[0230]** Thus, when the $CO_2$ concentration is sufficiently high to indicate an elevated bioaerosol exposure risk, e.g. infectious bioaerosol level, bioaerosol treatment and higher flow may be prioritized over combined bioaerosol and gaseous pollutant treatment at lower flow.

**[0231]** For example, if $CO_2$ levels are high enough to reach or exceed the given threshold $CO_2$ concentration, e.g. about 1000 ppm, the actuator may be triggered to arrange/position the gas treatment unit 106 out of the airflow.

**[0232]** In some embodiments, such as shown in FIG. 4, the controlling 204 comprises arranging 204B the gas treatment unit 106 in relation to the flow path 104 and to the particulates treatment unit 108 in the flow path 104 to cause more of the air displaced along the flow path 104 to be treated by the gas treatment unit 106 based on the data being indicative of the bioaerosol exposure risk equaling or being below a defined threshold.

**[0233]** Thus, combined bioaerosol and gaseous pollutant treatment at lower flow may be prioritized over bioaerosol treatment and higher flow when the bioaerosol exposure risk, e.g. infectious bioaerosol level, is equal to or lower than such a defined threshold.

**[0234]** In some embodiments, the arranging 204B the gas treatment unit 106 in relation to the flow path 104 and to the particulates treatment unit 108 in the flow path 104 to cause more of the air displaced along the flow path 104 to be treated by the gas treatment unit 106 is based on the $CO_2$ concentration in air being equal to or lower than a defined threshold $CO_2$ concentration.

**[0235]** In such embodiments, the defined threshold $CO_2$ concentration may, for example, be in a range of 500 to 1000 ppm, e.g. about 600 ppm.

**[0236]** Thus, when the $CO_2$ concentration is sufficiently low to indicate a relatively low/safe bioaerosol exposure risk, e.g. infectious bioaerosol level, combined bioaerosol and gaseous pollutant treatment at lower flow may be prioritized.

**[0237]** For example, if $CO_2$ levels are low enough to reach or fall below the defined threshold $CO_2$ concentration, e.g. about 600 ppm, the actuator may be triggered to arrange/position the gas treatment unit 106 in, e.g. back into, the airflow.

**[0238]** In some embodiments, such as shown in FIG. 5, the controlling 204 comprises arranging 204A the gas treatment unit 106 in relation to the flow path 104 and to the particulates treatment unit 108 in the flow path 104 to increase flow of treated air outputted by the air purifying device 100 that has been displaced through the particulates treatment unit 108 based on the data being indicative of the bioaerosol exposure risk equaling or exceeding a given threshold, followed by arranging 204B the gas treatment unit 106 in relation to the flow path 104 and to the particulates treatment unit 108 in the flow path 104 to cause more of the air displaced along the flow path 104 to be treated by the gas treatment unit 106 based on the data being indicative of the bioaerosol exposure risk equaling or being below a defined threshold.

**[0239]** An initially elevated risk of bioaerosol exposure can therefore be reduced by, for example, arranging 204A, e.g. bypassing, the gas treatment unit 106 so that a higher flow is outputted by the air purifying device 100 that has passed through the particulates treatment unit 108. After a given time period has passed and/or in response to the bioaerosol exposure risk equaling or being below the defined threshold, the gas treatment unit 106 may be arranged 204B back in the flow path 104 to provide combined bioaerosol and gaseous pollutant treatment.

**[0240]** In some embodiments, and referring to FIGs. 6A, 6B, 7A and 7B, the arranging 204A comprises positioning the gas treatment unit 106 to provide a bypass 112 around the gas treatment unit 106 for the air displaced along the flow path 104.

**[0241]** The arranging 204B the gas treatment unit 106 in relation to the flow path 104 and to the particulates treatment unit 108 to cause more of the air displaced along the flow path 104 to be treated by the gas treatment unit 106 may, for example, be implemented by removing the bypass 112.

**[0242]** The bypass 112 may provide a relatively straightforwardly implementable and compact way of achieving controllable arrangement of the gas treatment unit 106 in relation to the flow path 104.

**[0243]** Providing the bypass 112 may be implemented in any suitable manner. In some embodiments, such as shown in FIGs. 6A and 6B, providing the bypass 112 comprises moving the gas treatment unit 106 along the flow path 104 in a direction, e.g. in an upstream direction, away from a mounting element 115. The bypass 112 may be provided between the displaced gas treatment unit 106 and the mounting element 115, as shown in FIG. 6B.

**[0244]** The gas treatment unit 106 may be sealingly mountable in the mounting element 115. Thus, the mounting element 115 can be regarded as a leak-free holder for the gas treatment unit 106.

**[0245]** Lifting/displacing the gas treatment unit 106 from the mounting element 115 in this manner may create a low-pressure air leakage.

**[0246]** In some embodiments, such as shown in FIGs. 7A and 7B, providing the bypass 112 comprises moving the gas treatment unit 106 along the flow path 104 in a downstream direction.

**[0247]** Alternative possibilities can also be contemplated, such as moving the gas treatment unit 106 into and out of the flow path 104 along directions transverse to the flow path 104, pivoting the gas treatment unit 106 against and away from a sidewall that delimits the flow path 104, and so on.

**[0248]** It is noted that in the non-limiting example shown in FIGs. 7A and 7B, the gas treatment unit 106 and the particulates treatment unit 108 are each cylindrically shaped.

**[0249]** In such embodiments, controlling 204 arrangement of the gas treatment unit 106 in relation to the flow path 104 and the gas treatment unit 108 may comprise axial movement of the gas treatment unit 106 in direction(s) parallel with the cylinder axis of the cylindrical gas treatment unit 106.

**[0250]** Such cylindrically shaped treatment units 106, 108 may, for example, be arranged to fit into a cylindrical housing 105C of the air purifying device 100.

**[0251]** In some embodiments, such as shown in FIGs. 7A and 7B, air to be treated may enter the housing 105C via the air inlet 105A in radial directions, as denoted by the arrows 116, but may be redirected in an axial direction, as denoted by the arrow 117, towards the air outlet 105B.

**[0252]** More generally, controlling 204 the gas treatment unit's 106 arrangement in relation to the flow path 104 by bypassing the gas treatment unit 106, e.g. removing the gas treatment unit 106 from the flow path 104, preferably reduces airflow through the gas treatment unit 106 by at least 10%, preferably by at least 90%, most preferably by at least 99%.

**[0253]** Referring to FIGs. 8 and 9, in embodiments in which arrangement of the particulates treatment unit 108 in relation to the flow path 104 is controllable, the method 200 may further comprise controlling 206 arrangement of the particulates treatment unit 108 in relation to the flow path 104 and to the gas treatment unit 106 to adjust flow of treated air outputted by the air purifying device 100 that has been displaced through the gas treatment unit 106 based on the data indicative of bioaerosol exposure risk and/or further data indicative of concentration in air of one or more pollutants other than bioaerosol.

**[0254]** Thus, the method 200 may additionally comprise controlling 206 arrangement of the particulates treatment unit 108 based on the data indicative of infectious bioaerosol level, e.g. infectious virus level, and/or based on further data indicative of one or more pollutants other than bioaerosol, for example, PM2.5 and/or other particulates, indoor and/or outdoor gas concentrations, with such gas(es) comprising one or more VOCs, such as formaldehyde, and/or nitrogen oxides.

**[0255]** For example, and referring to FIG. 8, should the particulates treatment unit 108 be initially arranged in the flow path 104 in step 204, the particulates treatment unit 108 may subsequently be rearranged 206 in relation to the flow path 104, e.g. out of the flow path 104, in response to the data indicative of infectious bioaerosol level, e.g. infectious virus level, and/or based on further data indicative of one or more pollutants other than bioaerosol.

**[0256]** Alternatively, and referring to FIG. 9, should the particulates treatment unit 108 be initially arranged 206 out of the flow path 104, e.g. via a bypass around the particulates treatment unit 108 of the type described herein in respect of the gas treatment unit 106, the particulates treatment unit 108 may subsequently be arranged 204 in relation to the flow path 104 in response to the data indicative of infectious bioaerosol level, e.g. infectious virus level, and/or based on further data indicative of one or more pollutants other than bioaerosol.

**[0257]** More generally, and referring to FIG. 10, an aspect of the present disclosure concerns a method 300 for operating an air purifying device 100 to output treated air, which air purifying device 100 comprises: a flow path 104 along which air is displaceable, and a gas treatment unit 106 for treating gaseous pollutants, including ozone, in the air displaced along the flow path 104. As in the embodiments described above, arrangement of the gas treatment unit 106 in relation to the flow path 104 is controllable.

**[0258]** It is noted that the air purifying device 100 in this aspect may be according to any of the embodiments described above but subject to the gas treatment unit 106 being capable of treating ozone in the air displaced along the flow path 104. Moreover, in this aspect inclusion of the particulates treatment unit 108 in the air purifying device 100 is optional.

**[0259]** The method 300 comprises obtaining 302 data indicative of bioaerosol exposure risk in a vicinity of the air purifying device 100, and controlling 304, based on said data, arrangement of the gas treatment unit 106 in relation to the flow path 104 to control ozone concentration in the treated air outputted by the air purifying device 100.

**[0260]** As described above in relation to the method 200 shown in FIGs. 2 to 5, 8 and 9, the vicinity of the air purifying device 100 may be, for instance, a space, e.g. an enclosed space, in which the air purifying device 100 is situated, and/or the bioaerosol exposure risk may be a risk of exposure of person(s) in the vicinity of the air purifying device 100 to bioaerosols, such as infectious virus aerosols.

**[0261]** Controlling 304 the arrangement of such an ozone-treating gas treatment unit 106 in relation to the flow path 104, e.g. along, into and/or out of the flow path 104, enables adjustment of a concentration of ozone in the air outputted by the air purifying device 100 and thus control over ozone inactivation of bioaerosols based on the bioaerosol exposure risk.

**[0262]** The method 300 can therefore be regarded as an alternative solution to the same problem solved by the method 200 shown in FIGs. 2 to 5, 8 and 9 in which flow of treated air outputted by the air purifying device 100 that has been displaced through a bioaerosol-treating particulates treatment unit 108 is controlled based on bioaerosol exposure risk.

**[0263]** The gas treatment unit 106 may be configured to convert and/or remove gaseous pollutants, including ozone, in the air displaced along the flow path 104. In addition to ozone, the gas treatment unit 106 may convert and/or remove one or more volatile organic components (VOCs), e.g. formaldehyde, and/or inorganic gas(es), e.g. nitrogen oxides.

**[0264]** Any suitable type of ozone-treating gas treatment unit 106 can be contemplated. In some embodiments, the ozone-treating gas treatment unit 106 comprises activated carbon, for example comprises an activated carbon filter.

**[0265]** In some embodiments, the air purifying device 100 does not include ozone-generating units. For example, the air purifying device 100 may only include activated carbon gas treatment unit(s) as the gas treatment unit 106, and optionally HEPA filter(s) as a particulates treatment unit 108.

**[0266]** In such embodiments, ozone levels may not increase when the air purifying device 100 is operating beyond a reference value corresponding to an ozone level in the vicinity of the air purifying device 100, e.g. in a room, established when the air purifying device 100 is not operating.

**[0267]** In some embodiments, the obtaining 302 data indicative of bioaerosol exposure risk comprises receiving sensory data from a sensor. For example, the sensor comprises a $CO_2$ sensor and the sensory data comprises a $CO_2$ concentration in air.

**[0268]** As already explained above, $CO_2$ concentration has been found to serve as a convenient proxy for infectious bioaerosol level, e.g. infectious virus level, since $CO_2$ concentration may increase with higher occupancy of a vicinity/space in which the air purifying device 100 is being used, and bioaerosol exposure risk, e.g. infectious bioaerosol level, may increase with higher occupancy, due to bioaerosol release from occupants of the space.

**[0269]** In some embodiments, such as shown in FIG. 11, the controlling 304 comprises arranging 304A the gas treatment unit 106 in relation to the flow path 104 to cause less of the air displaced along the flow path 104 to be treated by the gas treatment unit 106 based on the data being indicative of the bioaerosol exposure risk equaling or exceeding a given threshold.

**[0270]** Thus, there may be a higher ozone concentration in the air outputted by the air purifying device 100, which higher ozone concentration may assist to mitigate the elevated bioaerosol exposure risk by causing greater ozone inactivation of bioaerosols.

**[0271]** In some embodiments, the arranging 304A may comprise positioning the gas treatment unit 106 to provide a bypass 112 around the gas treatment unit 106 for the air displaced along the flow path 104, as previously described in relation to FIGs. 6A, 6B, 7A and 7B.

**[0272]** In some embodiments, the arranging 304A of the gas treatment unit 106 in relation to the flow path 104 to cause less of the air displaced along the flow path 104 to be treated by the gas treatment unit 106 is based on the $CO_2$ concentration in air being equal to or above a given threshold $CO_2$ concentration.

**[0273]** In such embodiments, the given threshold $CO_2$ concentration may, for example, be in a range of 900 to 1100 ppm, e.g. about 1000 ppm.

**[0274]** In some embodiments, such as shown in FIG. 12, the controlling 304 comprises arranging 304B the gas treatment unit 106 in relation to the flow path 104 to cause more of the air displaced along the flow path 104 to be treated by the gas treatment unit 106 based on the data being indicative of the bioaerosol exposure risk equaling or being below a defined threshold.

**[0275]** Thus, there may be a lower ozone concentration in the air outputted by the air purifying device 100, e.g. as well as a lower concentration of other gaseous pollutants. This scenario may be justified when there is relatively low bioaerosol exposure risk, in other words when less ozone inactivation of bioaerosols is required.

**[0276]** In some embodiments, the arranging 304B the gas treatment unit 106 in relation to the flow path 104 to cause more of the air displaced along the flow path 104 to be treated by the gas treatment unit 106 is based on the $CO_2$ concentration in air being equal to or lower than a defined threshold $CO_2$ concentration.

**[0277]** In such embodiments, the defined threshold $CO_2$ concentration may, for example, be in a range of 500 to 1000 ppm, e.g. about 600 ppm.

**[0278]** In some embodiments, such as shown in FIG. 13, the controlling 304 comprises arranging 304A the gas treatment unit 106 in relation to the flow path 104 to cause less of the air displaced along the flow path 104 to be treated by the gas treatment unit 106 based on the data being indicative of the bioaerosol exposure risk equaling or exceeding a given threshold, followed by arranging 304B the gas treatment unit 106 in relation to the flow path 104 to cause more of the air displaced along the flow path 104 to be treated by the gas treatment unit 106 based on the data being indicative of the bioaerosol exposure risk equaling or being below a defined threshold.

**[0279]** An initially elevated risk of bioaerosol exposure can therefore be reduced by, for example, arranging 204A, e.g. bypassing, the gas treatment unit 106 so that less of the air outputted by the air purifying device 100 has passed through the gas treatment unit 106, and hence has a high ozone concentration so that bioaerosol inactivation can be enhanced. After a given time period has passed and/or in response to the bioaerosol exposure risk equaling or being below the defined threshold, the gas treatment unit 106 may be arranged 304B back in the flow path 104 to prioritize gaseous pollutant treatment.

**[0280]** In embodiments in which the air purifying device 100 further comprises a particulates treatment unit 108 for treating particulate pollutants, including bioaerosols, in the air displaced along the flow path, the controlling 304 arrangement of the gas treatment unit 106 in relation to the flow path 104 may comprise controlling arrangement of the gas treatment unit 106 in relation to the particulates treatment unit 108 in the flow path 104 to adjust flow of treated air outputted by the air purifying device 100 that has been displaced through the particulates treatment unit 108.

**[0281]** By controlling 304 arrangement of the gas treatment unit 106 in relation to the flow path 104, e.g. along, into and/or out of the flow path, and in relation to the particulates treatment unit 108, adjustment of flow of treated air outputted by the air purifying device 100 that has been displaced through the particulates treatment unit 108 can be implemented, as previously described in relation to the method 200 shown in FIGs. 2 to 5, 8 and 9. In this way, ozone inactivation control of bioaerosols can be combined with bioaerosol treatment control via the particulates treatment unit 108.

**[0282]** Referring to FIGs. 14 and 15, in embodiments in which arrangement of the particulates treatment unit 108 in relation to the flow path 104 is controllable, the method 300 may further comprise controlling 306 arrangement of the particulates treatment unit 108 in relation to the flow path 104 and to the gas treatment unit 106 to adjust flow of treated air outputted by the air purifying device 100 that has been displaced through the gas treatment unit 106 based on the data indicative of bioaerosol exposure risk and/or further data indicative of concentration in air of one or more pollutants other than bioaerosol.

**[0283]** Thus, the method 300 may additionally comprise controlling 306 arrangement of the particulates treatment unit 108 based on the data indicative of infectious bioaerosol level, e.g. infectious virus level, and/or based on further data indicative of one or more pollutants other than bioaerosol, for example, PM2.5 and/or other particulates, indoor and/or outdoor gas concentrations, with such gas(es) comprising one or more VOCs, such as formaldehyde, and/or nitrogen oxides.

**[0284]** For example, and referring to FIG. 14, should the particulates treatment unit 108 be initially arranged in the flow path 104 in step 304, the particulates treatment unit 108 may subsequently be rearranged 306 in relation to the flow path 104, e.g. out of the flow path 104, in response to the data indicative of infectious bioaerosol level, e.g. infectious virus level, and/or based on further data indicative of one or more pollutants other than bioaerosol.

**[0285]** Alternatively, and referring to FIG. 15, should the particulates treatment unit 108 be initially arranged 306 out of the flow path 104, e.g. via a bypass around the particulates treatment unit 108 of the type described herein in respect of the gas treatment unit 106, the particulates treatment unit 108 may subsequently be arranged 304 in relation to the flow path 104 in response to the data indicative of infectious bioaerosol level, e.g. infectious virus level, and/or based on further data indicative of one or more pollutants other than bioaerosol.

**[0286]** The present disclosure generally contemplates operation modes of the air purifying device 100 in which arrangement of a treatment unit 106, 108 in the flow path 104 is controlled 204, 206, for example by being removed from the airflow.

**[0287]** The pressure drop from the air treatment module 109 can be reduced by removing the gas treatment unit 106 or the particulates treatment unit 108. The reduced pressure drop can then increase the airflow through the remaining treatment unit 106, 108, which can accelerate the reduction of the corresponding target pollutant(s) treated by the remaining treatment unit 106, 108.

**[0288]** The control 204, 206; 304, 306 may assist to make the air purifying device 100 more effective in treating air pollutants, such as bioaerosols, PM2.5, VOCs and/or inorganic gases.

**[0289]** In a non-limiting example, a HEPA filter-comprising particulates treatment unit 108 could be removed from the flow path 104/airflow while a UVGI element remains in its position in the flow path 104.

**[0290]** Table 2 lists exemplary operation modes of the air purifying device 100 to offer increased protection with respect to bioaerosols, particles, VOCs and/or inorganic gases.

Table 2

| Protection purpose | Trigger pollutant | Trigger response level | Treatment unit 106, 108 removed from airflow | Trigger end-of-response level (element returns in airflow) |
|---|---|---|---|---|
| Infectious bioaerosols | $CO_2$ | 1000 ppm | 106 | 600 |
| PM2.5 / other particulates | PM2.5 | 5 $\mu g/m^3$ [1]<br>12 $\mu g/m^3$ [2]<br>20 $\mu g/m^3$ [3] | 106 | 50% of trigger response level |
| Indoor / Outdoor gases | Formaldehyde | 25 $\mu g/m^3$ (25% of [4]) | 108 | 50% of trigger response level |
| | $NO_2$ (indoor or outdoor value) | Indoor: 10 $\mu g/m^3$ [5]<br>Outdoor: 20 $\mu g/m^3$ [6] | 108 | 50% of trigger response level |
| Infectious bio-aerosols + PM2.5 + VOCs / gases | $CO_2$ | See above | | |
| | If $CO_2$ is acceptable: PM2.5 | See above | | |
| | If $CO_2$ and PM2.5 are acceptable: formaldehyde / $NO_2$ | See above | | |

[1] World Health Organization. WHO global air quality guidelines: particulate matter (PM2. 5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. World Health Organization, 2021.

[2] 2012_aqi_factsheet.pdf (epa.gov)
[3] EU air quality standards (europa.eu)
[4] World Health Organization. WHO guidelines for indoor air quality: selected pollutants. World Health Organization. Regional Office for Europe, 2010.
[5] If triggered by measured indoor $NO_2$ levels. $NO_2$ guideline value from [1]
[6] If triggered on outdoor $NO_2$ levels. Based on $NO_2$ guideline value from [1] and average Indoor/Outdoor $NO_2$ ratio of 0.3 - 0.6 in low ventilated spaces [7]
[7] Salonen, Heidi, Tunga Salthammer, and Lidia Morawska "Human exposure to $NO_2$ in school and office indoor environments" Environment international 130 (2019): 104887.

**[0291]** Table 2 illustrates how the operation modes of the air purifying device 100 can be suitable for increasing effectiveness of the air purifying device 100 with respect to treatment of air pollutants besides bioaerosols/infectious bioaerosols.

**[0292]** Table 2 also illustrates how the operation modes of the air purifying device 100 can be suitable for enhancing effectiveness of the air purifying device 100 with respect to treatment of more than one pollutant.

**[0293]** For example, the user may select, e.g. via the above-mentioned user interface, what pollutants they desire to be prioritized for removal, e.g. removed first.

**[0294]** In the context of the non-limiting example provided in Table 2, bioaerosol, e.g. virus aerosol, protection is considered most important, with second priority being lowering high PM levels, and lowest priority being lowering elevated gaseous pollutant, e.g. VOCs, levels.

**[0295]** In Table 2, an operation mode is described that first reduces particulate levels and afterwards removes the particulates treatment unit 108, e.g. particle filter, to enhance the performance of the air purifying device 100 with respect to gaseous pollutants, e.g. VOCs. This order is reflected in, for example, the flowchart shown in FIG. 8.

**[0296]** This order of operation may help to increase lifetime of the gas treatment unit 106, e.g. activated carbon filter, since otherwise performance of the gas treatment unit 106, e.g. activated carbon filter, may decrease relatively rapidly due to particulate deposition on surfaces of the gas treatment unit 106, e.g. activated carbon surfaces.

**[0297]** Table 2 further lists suggested trigger response values and trigger end-of-response values. These values can be chosen differently depending on the safety concerns from the user, use conditions, energy cost considerations, etc.

**[0298]** When the trigger value is reached, the air purifying device 100, e.g. the air displacement system 102 thereof, can be switched on to generate a fixed flow of purified air, or the airflow can be adjusted from a lower fixed value to a higher fixed value. Alternatively, the airflow can increase (and decrease) with the trigger value.

**[0299]** It is noted that the controlling 204/206; 304/306 steps can be implemented automatically, e.g. via the control exerted by the controller 114. For example, the actuator/further actuator being triggered to remove the gas treatment unit 106/particulates treatment unit 108 out of the airflow can be done automatically and mechanically within the air purifying device 100.

**[0300]** Alternatively, when a threshold is reached or passed, the controller 114 may control a user interface, e.g. a user interface included in the air purifying device 100 and/or in the above-mentioned user device, to issue a notification, e.g. warning, to prompt the user to control 204/206 the treatment unit(s) 106, 108, for example by removing the gas treatment unit 106 or the particulates treatment unit 108 from the flow path 104.

**[0301]** Such a notification can take any suitable form. For example, the notification may include a textual, acoustic/audio, haptic and/or visual notification.

**[0302]** The threshold may, for example, correspond to a trigger response value or a trigger end-of-response value, e.g. as listed in Table 2.

**[0303]** In some embodiments, an air purification appliance, e.g. a portable air purification appliance, for purifying air in a building comprises the air purifying device 100.

**[0304]** Such an air purification appliance may include a humidification module and/or a dehumidification module, e.g. in addition to an air displacement system 102.

**[0305]** The air displacement system 102 might also humidify the air using certain technologies, such as via ultrasonic nebulizers.

**[0306]** Alternatively or additionally, the air purification appliance may include a heating system and/or a cooling system, e.g. in addition to an air displacement system 102.

**[0307]** In embodiments in which the air purification appliance includes a heating system, a humidification module and/or a dehumidification module, one or more of these components may be controlled 204; 304 based on the data indicative of bioaerosol exposure risk.

**[0308]** Controlling the temperature and humidity at comfortable levels can assist to control, e.g. increase, an inactivation rate of bioaerosols. In this connection, reference is made to Guo, L., et al. "Systematic review of the effects of environmental factors on virus inactivation: implications for coronavirus disease 2019" International Journal of Environmental Science and Technology 18 (2021): 2865-2878. Reference is further made to Wolkoff, Peder, Kenichi Azuma, and Paolo

Carrer "Health, work performance, and risk of infection in office-like environments: The role of indoor temperature, air humidity, and ventilation" International Journal of Hygiene and Environmental Health 233 (2021): 113709.

**[0309]** In some embodiments, a vehicular air purifying assembly for purifying air in a vehicle's cabin comprises the air purifying device 100.

**[0310]** Such a vehicular air purifying assembly may include a humidification module and/or a dehumidification module, e.g. in addition to an air displacement system 102.

**[0311]** Alternatively or additionally, the vehicular air purifying assembly may include a heating system and/or a cooling system, e.g. in addition to an air displacement system 102.

**[0312]** In some embodiments, a face mask comprises the air purifying device 100.

**[0313]** Further provided a computer program comprising computer program code which is configured, when said computer program is run on one or more processors, to cause said one or more processors to implement the method 200; 300 of any of the embodiments described herein.

**[0314]** The one or more processors may, for example, be included in the controller 114.

**[0315]** It is noted that the one or more processors can be implemented in numerous ways, with software and/or hardware, to perform the various functions required. The processor(s) may, for example, employ one or more microprocessors programmed using software (e.g., microcode) to perform the required functions. Examples of processor 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).

**[0316]** In various implementations, the one or more processors 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 may be fixed within a processor or controller or may be transportable, such that the one or more programs stored thereon can be loaded into the one or more processors.

**[0317]** The following numbered embodiments are also disclosed:

1. A method (300) for operating an air purifying device (100) to output treated air, which air purifying device comprises:

   a flow path (104) along which air is displaceable; and
   a gas treatment unit (106) for treating gaseous pollutants, including ozone, in the air displaced along the flow path, arrangement of the gas treatment unit in relation to the flow path being controllable, the method comprising:

   obtaining (302) data indicative of bioaerosol exposure risk in a vicinity of the air purifying device; and
   controlling (304), based on said data, arrangement of the gas treatment unit in relation to the flow path to control ozone concentration in the treated air outputted by the air purifying device.

2. The method (300) according to embodiment 1, wherein the obtaining (302) data indicative of bioaerosol exposure risk comprises receiving sensory data from a sensor (110).

3. The method (300) according to embodiment 2, wherein the sensor (110) comprises a $CO_2$ sensor and the sensory data comprises a $CO_2$ concentration in air.

4. The method (300) according to any one of embodiments 1 to 3, wherein the gas treatment unit (106) comprises activated carbon.

5. The method (300) according to any one of embodiments 1 to 4, wherein the controlling (304) comprises arranging (304A) the gas treatment unit (106) in relation to the flow path (104) to cause less of the air displaced along the flow path to be treated by the gas treatment unit based on the data being indicative of the bioaerosol exposure risk equaling or exceeding a given threshold.

6. The method (300) according to embodiment 5, wherein the arranging (304A) comprises positioning the gas treatment unit (106) to provide a bypass (112) around the gas treatment unit (106) for the air displaced along the flow path (104).

7. The method (300) according to embodiment 5 or embodiment 6 when dependent from embodiment 3, wherein said arranging (204A) the gas treatment unit (106) in relation to the flow path (104) to cause less of the air displaced along the flow path to be treated by the gas treatment unit is based on the $CO_2$ concentration in air being equal to or above a given threshold $CO_2$ concentration; optionally wherein the given threshold $CO_2$ concentration is in a

range of 900 to 1100 ppm.

8. The method (300) according to any one of embodiments 1 to 7, wherein the controlling (304) comprises arranging (304B) the gas treatment unit (106) in relation to the flow path (104) to cause more of the air displaced along the flow path (104) to be treated by the gas treatment unit based on the data being indicative of the bioaerosol exposure risk equaling or being below a defined threshold.

9. The method (300) according to embodiment 8 as according to embodiment 3, wherein said arranging (204B) the gas treatment unit (106) in relation to the flow path (104) to cause more of the air displaced along the flow path to be treated by the gas treatment unit is based on the $CO_2$ concentration in air being equal to or lower than a defined threshold $CO_2$ concentration; optionally wherein the defined threshold $CO_2$ concentration is in a range of 500 to 1000 ppm.

10. The method (300) according to any one of embodiments 1 to 9, wherein the gas treatment unit (106) is configured to convert and/or remove gaseous pollutants, including ozone, in the air displaced along the flow path (104).

11. The method (300) according to any one of embodiments 1 to 10, wherein the air purifying device (100) further comprises a particulates treatment unit (108) for treating particulate pollutants, including bioaerosols, in the air displaced along the flow path (104), wherein said controlling (304) arrangement of the gas treatment unit (106) in relation to the flow path comprises controlling arrangement of the gas treatment unit in relation to the particulates treatment unit in the flow path to adjust flow of treated air outputted by the air purifying device that has been displaced through the particulates treatment unit.

12. The method (300) according to embodiment 11, wherein arrangement of the particulates treatment unit (108) in relation to the flow path (104) is controllable, the method further comprising controlling (306) arrangement of the particulates treatment unit in relation to the flow path and to the gas treatment unit (106) to adjust flow of treated air outputted by the air purifying device that has been displaced through the gas treatment unit based on said data and/or further data indicative of concentration in air of one or more pollutants other than bioaerosol.

13. An air purifying device control system for controlling operation of an air purifying device (100) that has a flow path (104) along which air is displaceable, and a gas treatment unit (106) for treating gaseous pollutants, including ozone, in the air displaced along the flow path, with arrangement of the gas treatment unit in relation to the flow path being controllable, the system comprising a controller (114) configured to:

obtain data indicative of bioaerosol exposure risk in a vicinity of the air purifying device; and
control, based on said data, arrangement of the gas treatment unit in relation to the flow path to control ozone concentration in the treated air outputted by the air purifying device.

14. The air purifying device control system according to embodiment 13, wherein the controller (114) is configured to receive sensory data from a sensor (110), which sensory data is indicative of said bioaerosol exposure risk; optionally wherein the sensor comprises a $CO_2$ sensor and the sensory data comprises a $CO_2$ concentration in air.

15. An air purifying device (100) comprising:

a flow path (104) along which air is displaceable;
a gas treatment unit (106) for treating gaseous pollutants, including ozone, in the air displaced along the flow path, with arrangement of the gas treatment unit in relation to the flow path being controllable; and
an air purifying device control system according to embodiment 13 or 14.

16. A computer program comprising computer program code which is configured, when said computer program is run on one or more processors, to cause said one or more processors to implement the method (300) of any of embodiments 1 to 12.

**[0318]** 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.
**[0319]** A single processor or other unit may fulfill the functions of several items recited in the claims.
**[0320]** 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.

**[0321]** A computer program may be stored/distributed on a suitable medium, such as an optical storage medium or a solid-state medium supplied together with or as part of other hardware, but may also be distributed in other forms, such as via the Internet or other wired or wireless telecommunication systems.

**[0322]** 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".

**[0323]** Any reference signs in the claims should not be construed as limiting the scope.

## Claims

1. A method (200) for operating an air purifying device (100) to output treated air, which air purifying device comprises:

   a flow path (104) along which air is displaceable;
   a gas treatment unit (106) for treating gaseous pollutants in the air displaced along the flow path, arrangement of the gas treatment unit in relation to the flow path being controllable; and
   a particulates treatment unit (108) for treating particulate pollutants, including bioaerosols, in the air displaced along the flow path, the method comprising:

      obtaining (202) data indicative of bioaerosol exposure risk in a vicinity of the air purifying device; and
      controlling (204), based on said data, arrangement of the gas treatment unit in relation to the flow path and to the particulates treatment unit in the flow path to adjust flow of treated air outputted by the air purifying device that has been displaced through the particulates treatment unit.

2. The method (200) according to claim 1, wherein the gas treatment unit (106) is configured to treat ozone in the air displaced along the flow path (104).

3. The method (200) according to claim 1 or claim 2, wherein the obtaining (202) data indicative of bioaerosol exposure risk comprises receiving sensory data from a sensor (110).

4. The method (200) according to claim 3, wherein the sensor (110) comprises a $CO_2$ sensor and the sensory data comprises a $CO_2$ concentration in air.

5. The method (200) according to any one of claims 1 to 4, wherein the controlling (204) comprises arranging (204A) the gas treatment unit (106) in relation to the flow path (104) and to the particulates treatment unit (108) in the flow path to increase flow of treated air outputted by the air purifying device (100) that has been displaced through the particulates treatment unit based on the data being indicative of the bioaerosol exposure risk equaling or exceeding a given threshold.

6. The method (200) according to claim 5, wherein the arranging (204A) comprises positioning the gas treatment unit (106) to provide a bypass (112) around the gas treatment unit (106) for the air displaced along the flow path (104).

7. The method (200) according to claim 5 or claim 6 when dependent from claim 4, wherein said arranging (204A) the gas treatment unit (106) in relation to the flow path (104) and to the particulates treatment unit (108) in the flow path to increase flow of treated air outputted by the air purifying device (100) that has been displaced through the particulates treatment unit is based on the $CO_2$ concentration in air being equal to or above a given threshold $CO_2$ concentration; optionally wherein the given threshold $CO_2$ concentration is in a range of 900 to 1100 ppm.

8. The method (200) according to any one of claims 1 to 7, wherein the controlling (204) comprises arranging (204B) the gas treatment unit (106) in relation to the flow path (104) and to the particulates treatment unit (108) in the flow path to cause more of the air displaced along the flow path (104) to be treated by the gas treatment unit based on the data being indicative of the bioaerosol exposure risk equaling or being below a defined threshold.

9. The method (200) according to claim 8 as according to claim 4, wherein said arranging (204B) the gas treatment unit (106) in relation to the flow path (104) and to the particulates treatment unit (108) in the flow path to cause more of the air displaced along the flow path (104) to be treated by the gas treatment unit is based on the $CO_2$ concentration in air being equal to or lower than a defined threshold $CO_2$ concentration; optionally wherein the defined threshold $CO_2$ concentration is in a range of 500 to 1000 ppm.

**10.** The method (200) according to any one of claims 1 to 9, wherein the gas treatment unit (106) is configured to convert and/or remove gaseous pollutants in the air displaced along the flow path (104); and/or wherein the particulates treatment unit (108) is configured to convert, remove and/or inactivate particulate pollutants in the air displaced along the flow path.

**11.** The method (200) according to any one of claims 1 to 10, wherein arrangement of the particulates treatment unit (108) in relation to the flow path (104) is controllable, the method further comprising controlling (206) arrangement of the particulates treatment unit in relation to the flow path and to the gas treatment unit (106) to adjust flow of treated air outputted by the air purifying device that has been displaced through the gas treatment unit based on said data and/or further data indicative of concentration in air of one or more pollutants other than bioaerosol.

**12.** A method (300) for operating an air purifying device (100) to output treated air, which air purifying device comprises:

a flow path (104) along which air is displaceable; and
a gas treatment unit (106) for treating gaseous pollutants, including ozone, in the air displaced along the flow path, arrangement of the gas treatment unit in relation to the flow path being controllable, the method comprising:

obtaining (302) data indicative of bioaerosol exposure risk in a vicinity of the air purifying device; and
controlling (304), based on said data, arrangement of the gas treatment unit in relation to the flow path to control ozone concentration in the treated air outputted by the air purifying device.

**13.** An air purifying device control system for controlling operation of an air purifying device (100) that has a flow path (104) along which air is displaceable, a gas treatment unit (106) for treating gaseous pollutants in the air displaced along the flow path, with arrangement of the gas treatment unit in relation to the flow path being controllable, and a particulates treatment unit (108) for treating particulate pollutants, including bioaerosols, in the air displaced along the flow path, the system comprising a controller (114) configured to:

obtain data indicative of bioaerosol exposure risk in a vicinity of the air purifying device; and
control, based on said data, arrangement of the gas treatment unit in relation to the flow path and to the particulates treatment unit in the flow path to adjust flow of treated air outputted by the air purifying device that has been displaced through the particulates treatment unit.

**14.** The air purifying device control system according to claim 13, wherein the controller (114) is configured to receive sensory data from a sensor (110), which sensory data is indicative of said bioaerosol exposure risk; optionally wherein the sensor comprises a $CO_2$ sensor and the sensory data comprises a $CO_2$ concentration in air.

**15.** An air purifying device (100) comprising:

a flow path (104) along which air is displaceable;
a gas treatment unit (106) for treating gaseous pollutants in the air displaced along the flow path, arrangement of the gas treatment unit in relation to the flow path being controllable, optionally wherein the gas treatment unit is configured to treat ozone in the air displaced along the flow path;
a particulates treatment unit (108) for treating particulate pollutants, including bioaerosols, in the air displaced along the flow path; and
an air purifying device control system according to claim 13 or 14.

**16.** A computer program comprising computer program code which is configured, when said computer program is run on one or more processors, to cause said one or more processors to implement the method (200; 300) of any of claims 1 to 12.

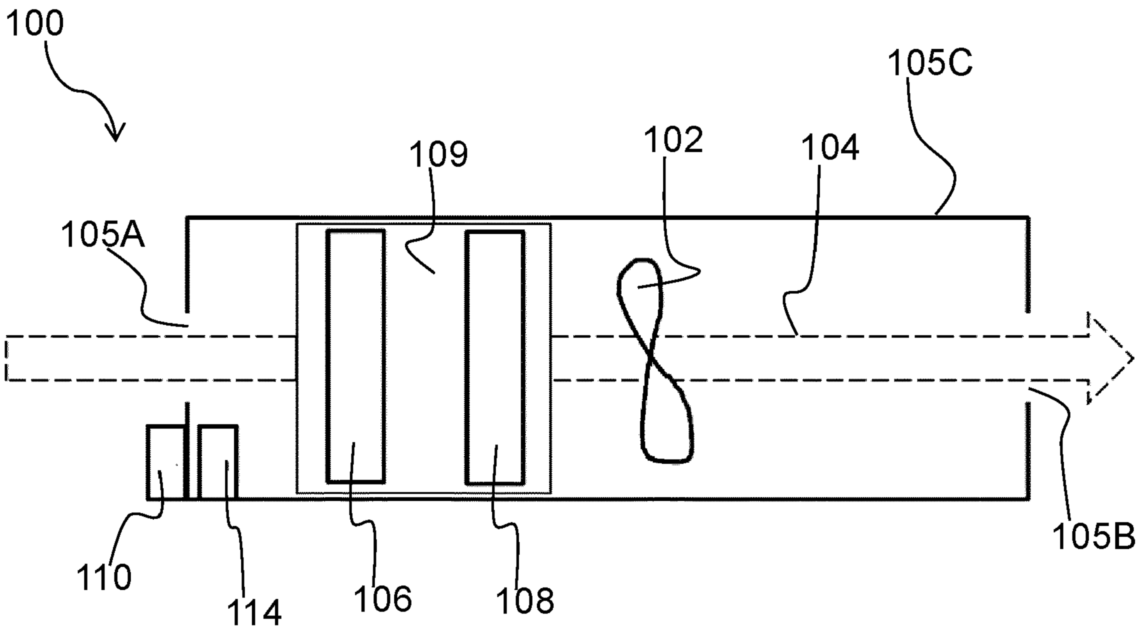


FIG. 1

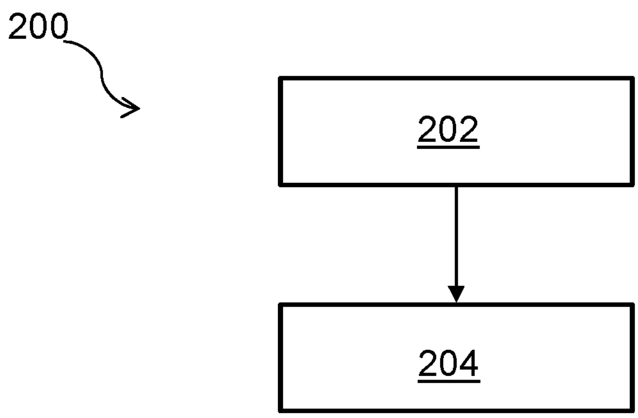


FIG. 2

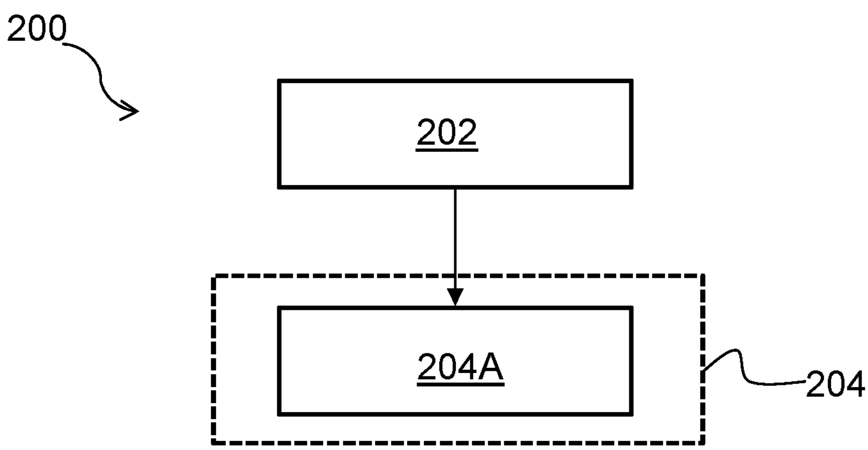


FIG. 3

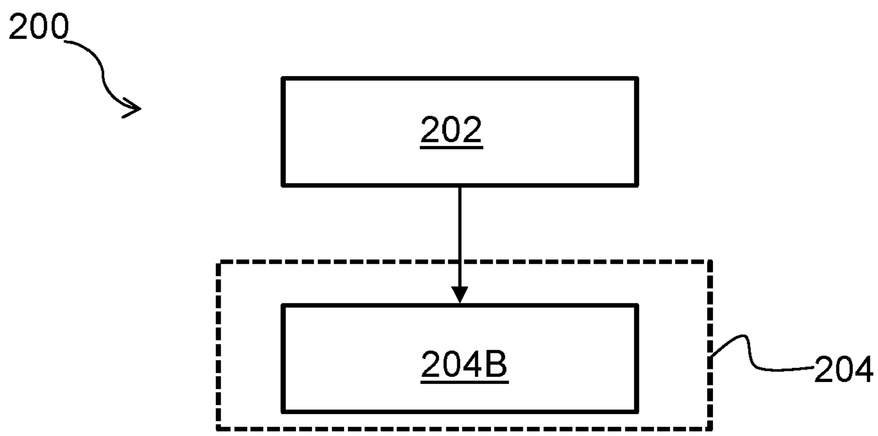


FIG. 4

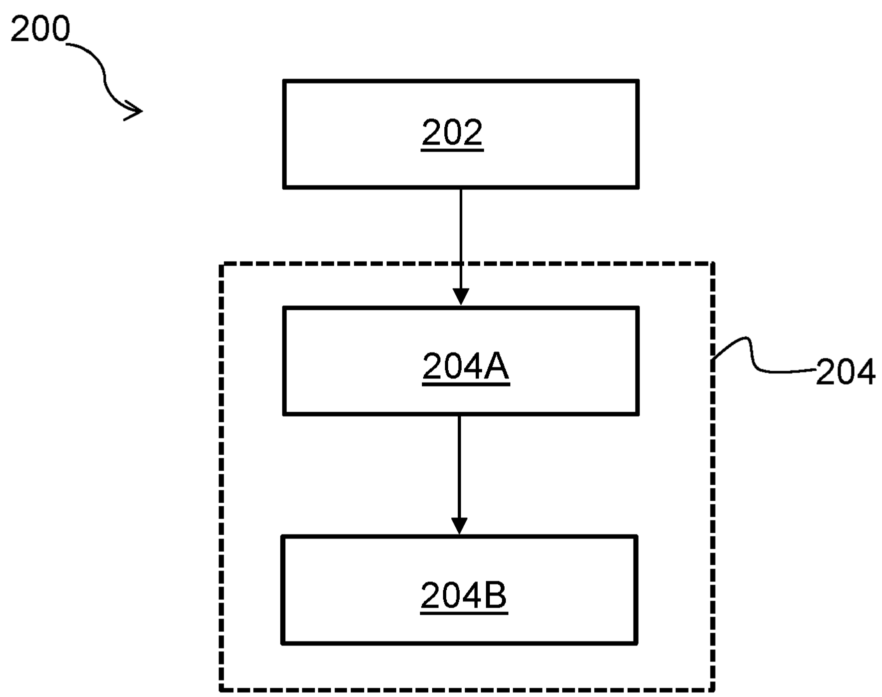


FIG. 5

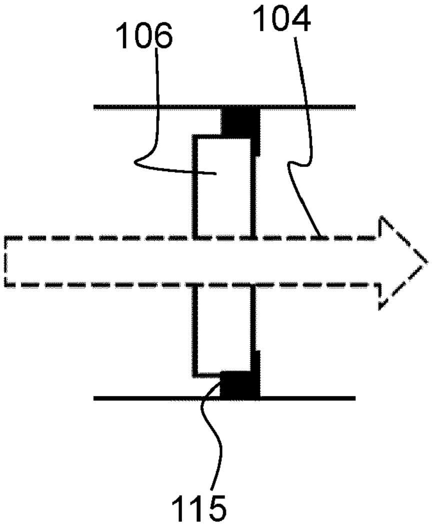


FIG. 6A

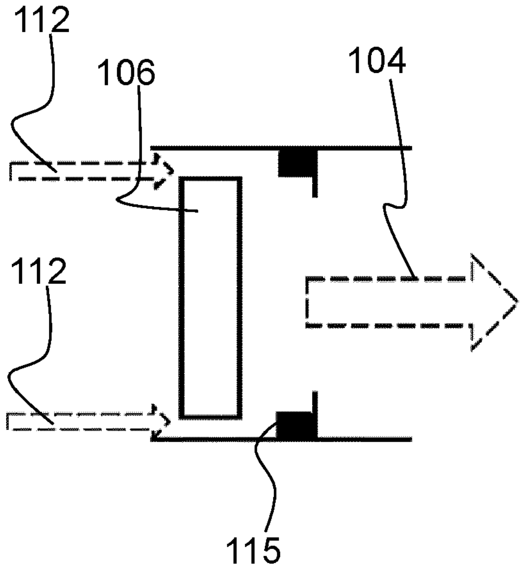


FIG. 6B

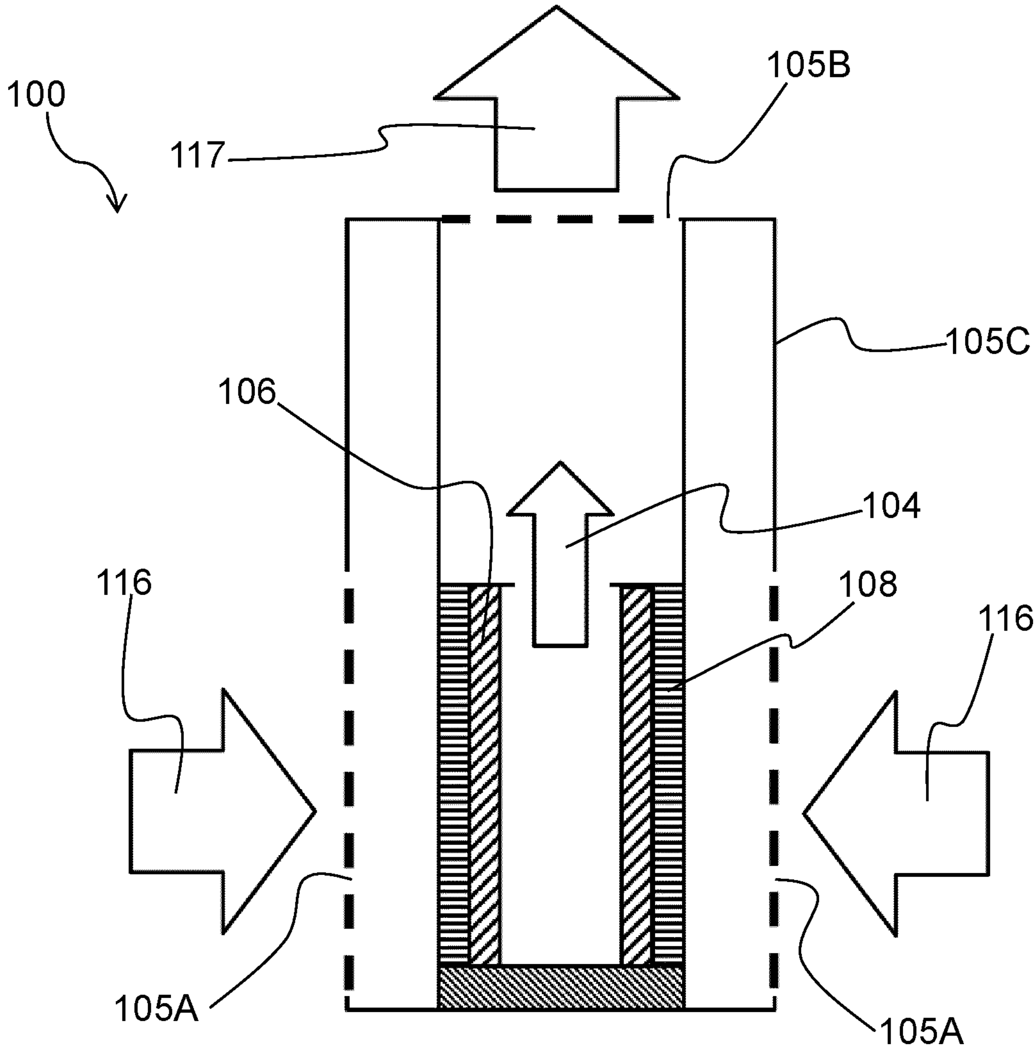


FIG. 7A

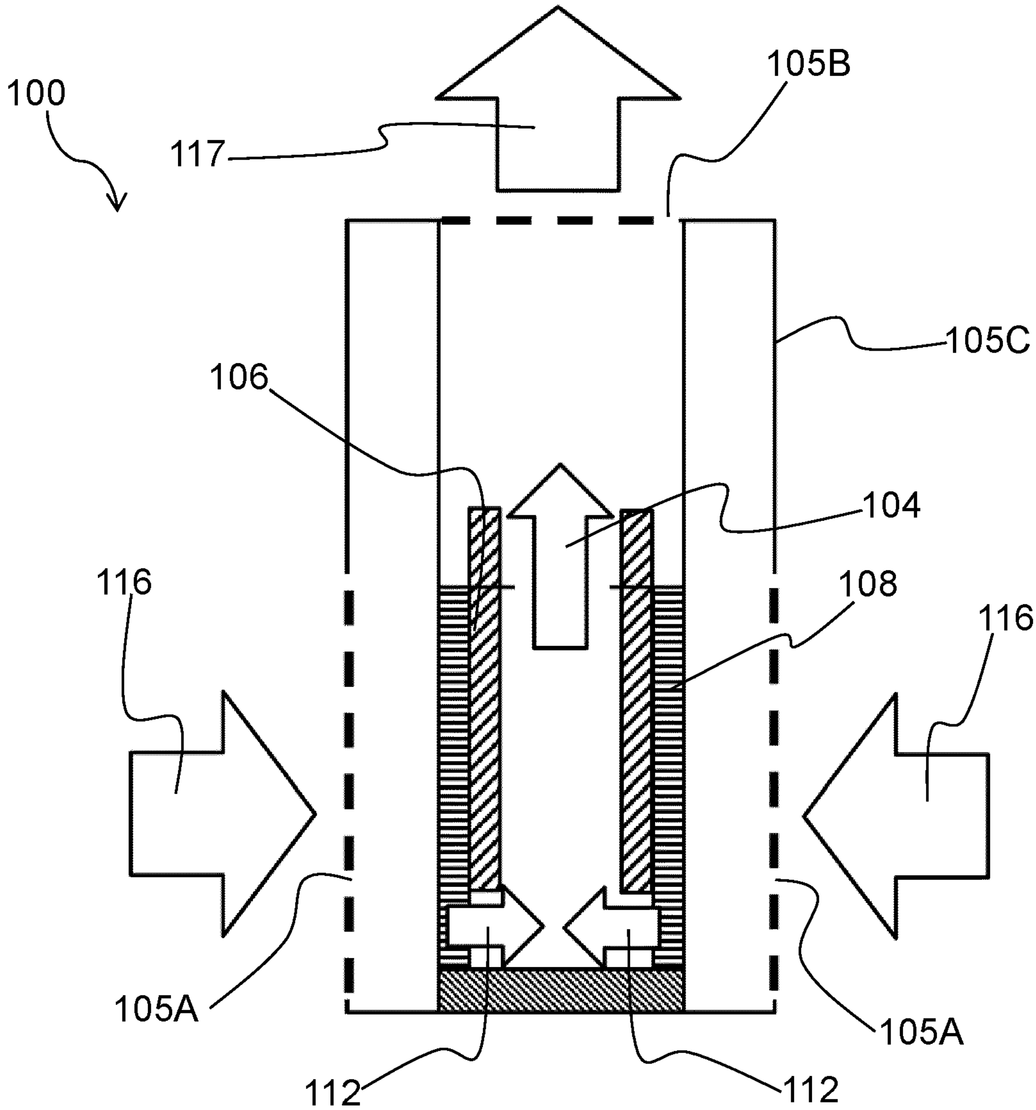


FIG. 7B

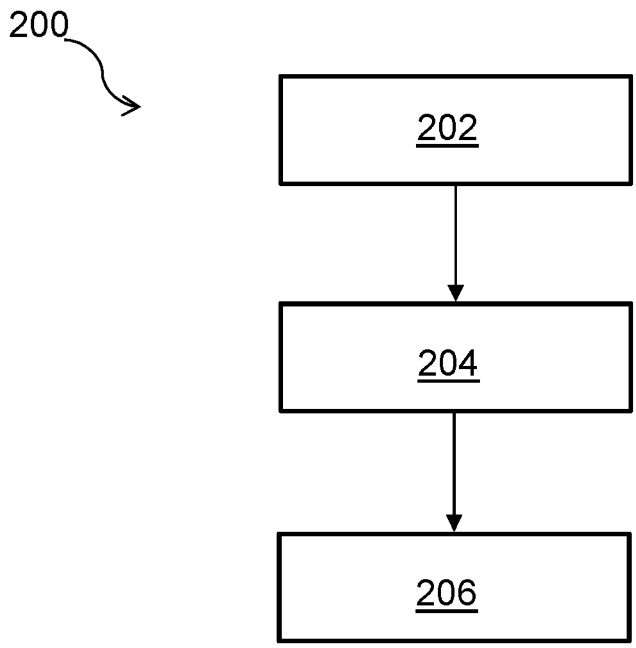


FIG. 8

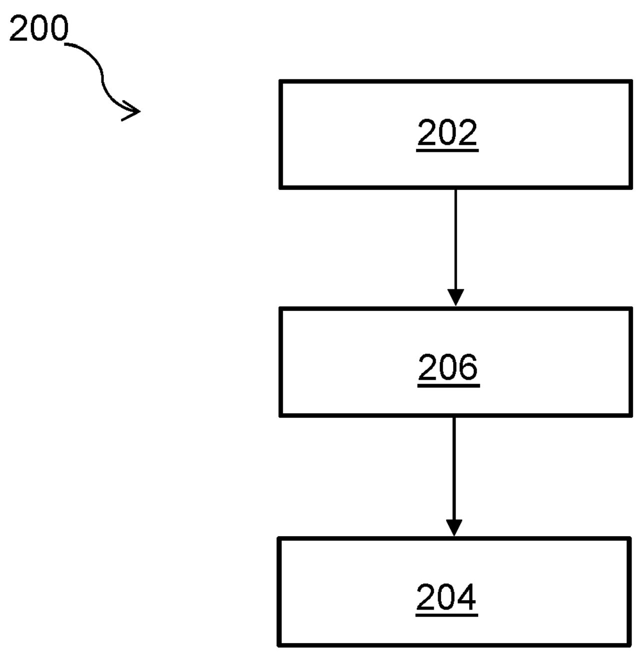


FIG. 9

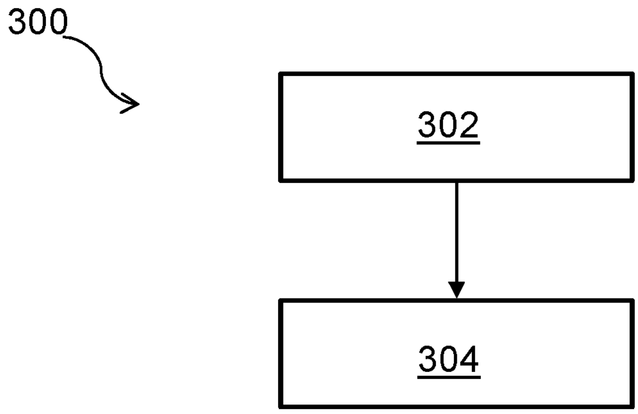


FIG. 10

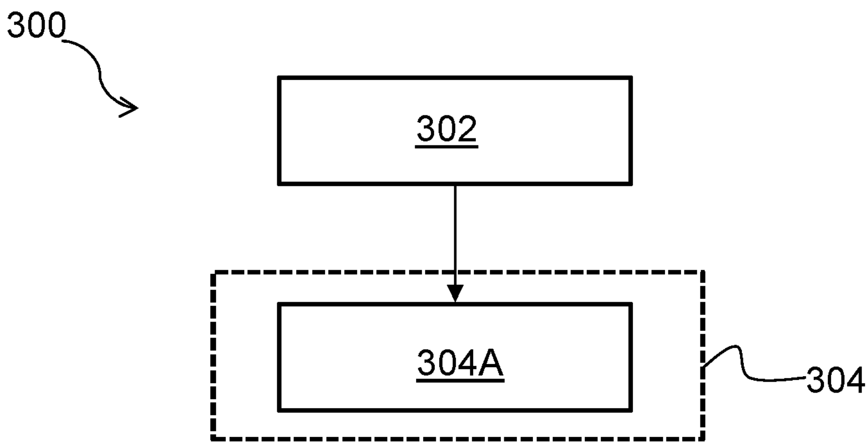


FIG. 11

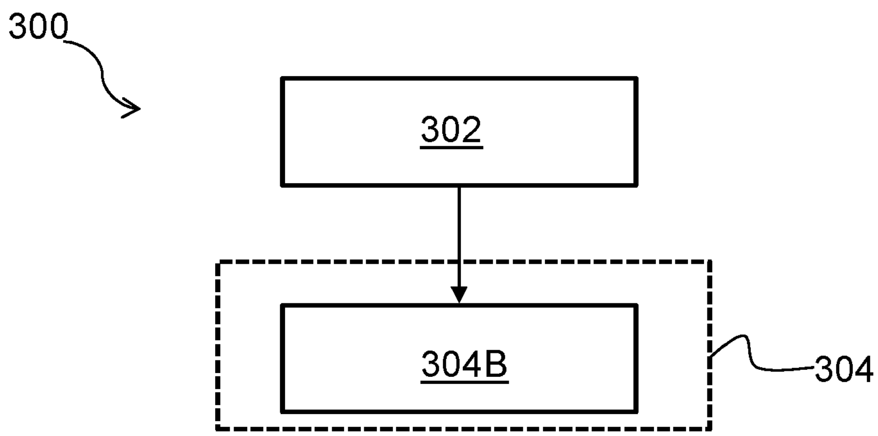


FIG. 12

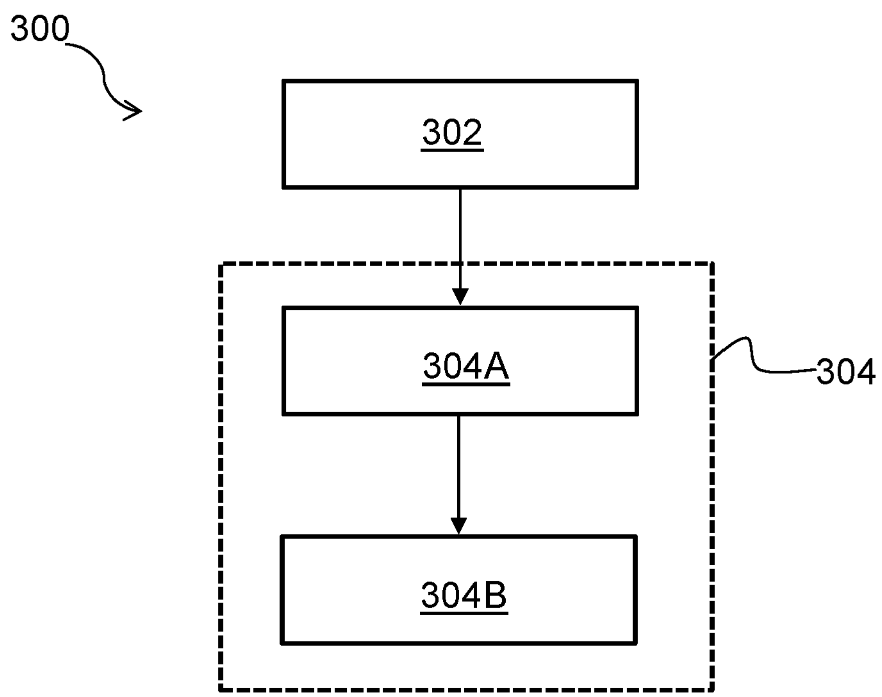


FIG. 13

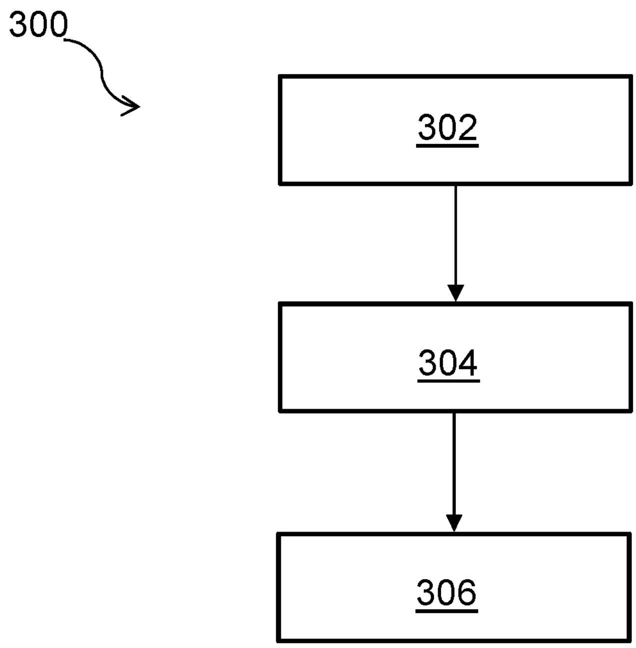


FIG. 14

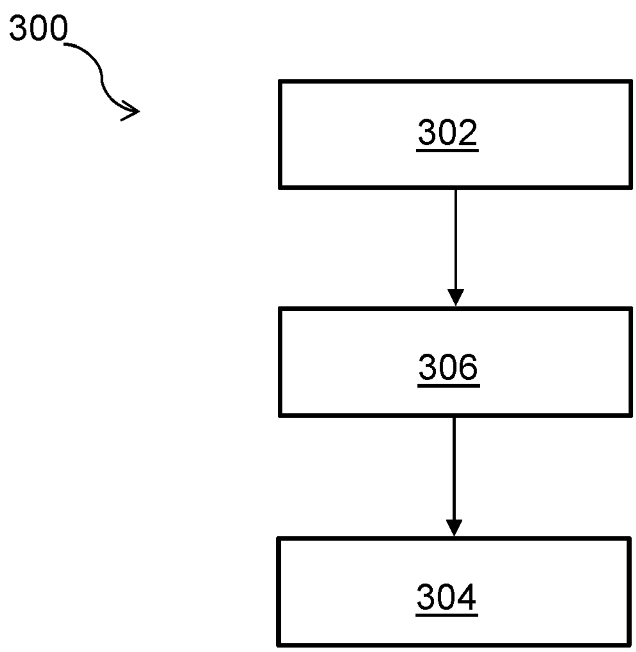


FIG. 15

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# EUROPEAN SEARCH REPORT

Application Number
EP 23 16 7230

## 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 | WO 2012/066453 A1 (KONINKL PHILIPS ELECTRONICS NV [NL]; VAN DER GRAAF TIMOTHY [NL] ET AL.) 24 May 2012 (2012-05-24)<br>* pages 5-21; figures 1-5 * | 1-16 | INV.<br>F24F8/108<br>B01D46/52<br>F24F8/158<br>F24F8/22<br>F24F8/40<br>F24F13/28 |
| A | WO 2023/042213 A1 (INPHLOX WATER SYSTEMS PRIVATE LTD [IN])<br>23 March 2023 (2023-03-23)<br>* pages 2-16; figures 1-4 * | 1-16 | |
| A | US 2021/231344 A1 (ZHAO JIANWEI [CN] ET AL) 29 July 2021 (2021-07-29)<br>* paragraphs [0003] - [0027]; figure 1 * | 1-16 | |
| | | | TECHNICAL FIELDS SEARCHED (IPC) |
| | | | F24F<br>B01D |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 15 September 2023 | Ismail, Youssef |

1

CATEGORY OF CITED DOCUMENTS

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## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 23 16 7230

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15-09-2023

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| WO 2023042213 A1 | 23-03-2023 | NONE | |
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| | | EP 3850276 A1 | 21-07-2021 |
| | | US 2021231344 A1 | 29-07-2021 |
| | | WO 2020055690 A1 | 19-03-2020 |

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

## REFERENCES CITED IN THE DESCRIPTION

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- **HARTMANN, ANNE et al.** Practical application of CO2 as an indicator regarding the risk of infection. *medRxiv,* 2022 **[0215]**
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