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(71) Applicant: **Natural Dynamics Oy**
10300 Karjaa (FI)

(72) Inventors:
• **Brezgin, Vladimir**
10300 Karjaa (FI)
• **Dmitriev, Nikolai**
02200 Espoo (FI)

(74) Representative: **Kolster Oy Ab**
Salmisaarenaukio 1
P.O. Box 204
00181 Helsinki (FI)

(54) **DIFFUSER**

(57) The present invention relates to a diffuser (2) for ventilating a space comprising a diffusing surface (6) to disperse air (10) coming into the space in use. A sensor (8) is configured to determine an air quality of the space, and where the sensor (8) is provided on a portion of the diffuser (2) exposed to the air in the space and segregated from the incoming air (10) in use.

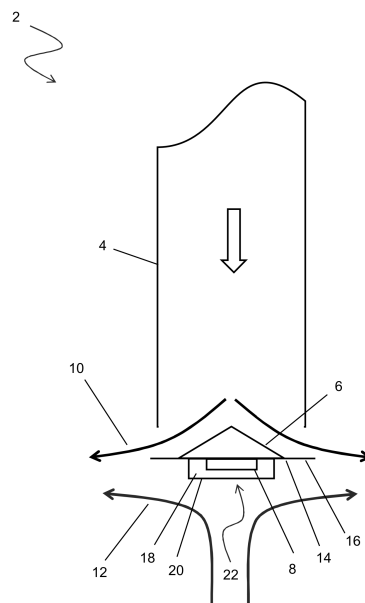


Figure 1

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Description

[0001] The present disclosure relates to an air diffuser and a sensor system therefor.

Background of the Invention

[0002] Air diffusers may be used to controlling and/or distributing air flow into and/or out from a room. Diffusers may be connected to a ventilation system, for example, a mechanical ventilation heat recovery (MVHR) system.

[0003] A prior art ventilation system is shown in F1131156. The system may selectively open/close a partition in a manifold unit to selectively monitor the air quality in a plurality of connected rooms. However, the inventor has found that the system can only monitor a single room at a time, and therefore has limited data collection capabilities.

[0004] The present invention aims to ameliorate or overcome the problems with the prior art systems.

Statement of Invention

[0005] According to first aspect, there is provided: a diffuser for a ventilating a space comprising: a diffusing surface to disperse air coming into the space in use; a sensor configured to determine an air quality of the space, and where the sensor is provided on a portion of the diffuser exposed to the air in the space and segregated from the incoming air in use.

[0006] The diffuser may comprise a shield configured to segregate the air coming into the space and sensor in use. The shield may comprise a rim or plate. The shield may be interposed the diffusing surface and the sensor. The sensor may be provided in a sensor housing. The sensor housing may comprise an opening facing toward the space and/or away from the diffusing surface in use.

[0007] The sensor may be provided in a position facing the space in use (i.e. opposing a duct or diffusing surface).

[0008] A housing may surround the diffusing surface (e.g. the lateral sides thereof). The sensor may be provided on the housing (e.g. an external surface thereof). The housing may comprise one or more aperture to allow the incoming air to flow therethrough. The aperture may face the space in use. The sensor may be provided on a side of the housing displaced from the apertures.

[0009] The air quality may comprise one or more of: humidity; temperature; CO₂ level; odours; VOC level; or CO level. The diffuser may comprise a sensor configured to determine a pressure difference between air in the diffuser and in the space. The diffuser may comprise an airflow sensor.

[0010] The diffuser may comprise a communications interface. The diffuser may be configured to transmit/re-

ceive data from the sensor to/from a further device. The communications interface may comprise a wireless or wired interface.

[0011] The diffuser may comprise a damper configured to vary the airflow through the diffuser. An actuation mechanism may control position of the damper. The actuation mechanism may be configured to receive a data to control position of the damper. The actuation mechanism may be configured to receive data to control position of the damper from a remote device (e.g. a controller).

[0012] The diffuser may comprise a controller. The controller may receive and/or store air quality data from the sensor. The controller may be configured to control the airflow through the diffuser in accordance with said air quality data. The controller may be configured to transmit a signal to the actuation mechanism to control the position of the damper and vary airflow through the diffuser accordingly. The controller may receive signals to control the damper from a remote device (e.g. a remote controller).

[0013] The diffusion surface may provide the damper. The diffusion surface may be movable (e.g. to vary a gap through which air passes). The diffusion surface may be driven by an actuator.

[0014] The diffuser may be operatively connected to a duct. The diffuser may be mounted to/on a ceiling. The diffuser may be mounted to/on a wall. The diffuser may comprise an exhaust and/or supply type of diffuser.

[0015] A portion of the incoming air pathway may be obstructed at the diffusing surface. A portion of the space between the diffusing surface and the duct may be obstructed. The diffusing surface may be supported via a bridge or arm configured to provide said obstruction. The bridge may extend between the diffusing surface and the duct. Said obstruction may draw room air toward the sensor.

[0016] According to a further aspect, there is provided: a ventilation system comprising: a diffuser comprising a sensor configured to measure an air quality in a space; a damper configured to vary airflow through diffuser; and a controller configured to receive air quality information from the sensor, and control the damper in accordance with said air quality.

[0017] The system may comprise a plurality of diffusers having respective air quality sensors. The system may comprise a plurality of dampers configured to vary airflow through the respective diffusers. The controller may be configured to receive air quality information from each of the respective sensors. The controller may be configured to control the respective damper in accordance with said air quality. The airflow rate through the diffuser may be configured to be varied in accordance with the air quality (e.g. low air quality has greater airflow and vice versa).

[0018] The damper may be provided in/on the diffuser. The damper may be provided in/on an air sup-

ply/exhaust.

[0019] The controller may be configured to operatively connect to a remote device. The controller may transmit air quality data to the remote device. The controller may receive commands to control the damper and/or air supply/exhaust system from the remote device. The controller may be provided on the diffuser or the air supply/exhaust system. The controller may be provided as a separate unit. The controller may be operatively connected to an actuation mechanism of the damper. The controller may be operatively connected to a controller on the diffuser.

[0020] The controller may be configured to control the air supply/exhaust system. The controller may transmit a signal to control one or more: the airspeed; airflow volume; or air temperature of the air supply/exhaust system.

[0021] The controller may be operatively connected to one or more appliance. The appliance may comprise one or more of: a water heating system; space heating system; cleaning apparatus (e.g. a robotic vacuum cleaner).

[0022] According to a further aspect, there is provided: a ventilation method comprising: providing a diffuser comprising a sensor and measuring an air quality in a space; providing a damper configured to vary airflow through diffuser; receiving air quality information from the sensor, and controlling the damper in accordance with said air quality.

[0023] Any aspect of the invention may be combined with any other aspect of the invention where practicable.

Description

[0024] Embodiments of the present invention are described below, by way of example only, with reference to the accompanying drawings:

Figure 1 shows a sectional side view of a first diffuser system;

Figure 2 shows a sectional side view of a second diffuser system;

Figure 3A shows a sectional side view of a third diffuser system;

Figure 3B shows a front view of the third diffuser system;

Figure 4 shows a schematic view of a ventilation system.

[0025] A diffuser 2 is shown in figure 1. The diffuser 2 is configured to disperse air into a room. In the present embodiment, the diffuser 2 is configured to be placed, for example, in or on the ceiling of a room in use. The diffuser 2 is connected to an air duct 4 in use. The duct 4 may be provided within the ceiling (e.g. within cavity therein) or may be suspended therefrom (e.g. in an exposed system). The duct 4 is operatively connected

to a ventilation system. The ventilation system may comprise any suitable arrangement or configuration, for example, mechanical ventilation heat recovery (MVHR) system. The diffuser may be removable attached to the duct 4 or may form an integral part thereof.

[0026] The diffuser 2 comprises a diffusion surface 6. The diffusion surface 6 is typically configured to disperse/diffuse the air coming out the diffuser 2 in a radial or outward direction (e.g. parallel to the ceiling). The diffusing surface 6 comprises an angled/conical surface. In the present embodiment, a single conical surface is provided, however, in other embodiments, multiple surfaces may be provided. The multiple surfaces may be provided adjacent one another and/or in a concentric arrangement.

[0027] The diffusion surface 6 may be movable to increase/decrease airflow through the diffuser 2. For example, the diffusion surface 6 may be mounted via a screw mechanism, and the user may rotate the diffusion surface 6 to move the diffusion surface 6 toward/away from the duct 4. Movement can be automatic and can be carried out by means of an actuator.

[0028] In some embodiments, the diffuser 2 and/or duct 4 may comprise a damper to control the flow of air therethrough. The damper may comprise a movable flap or partition. The damper may be manually and/or electronically controllable to allow adjustment of the airflow therethrough. The damper may comprise an actuation mechanism configured to move the damper. The actuation mechanism may comprise any of: an electric motor; actuator; throttle; or the like. The damper may provide feedback on the position of the damper (e.g. an extent of opening thereof).

[0029] In some embodiments, the damper may be provided by the diffusion surface 6. The diffusion surface 6 is configured to move and/or change the outlet cross-section, and thus regulate the air flow. The diffuser 6 may act as a valve that adjusts its position and thus the size of the gap through which air enters. The diffusion surface 6 is driven by an integrated actuator.

[0030] The diffuser 2 comprises a sensor 8. The sensor 8 may comprise one or more of: CO₂ sensor; temperature sensor; odour sensor; humidity sensor; volatile organic compounds (VOC); a carbon monoxide sensor; a pressure sensor; smoke sensor; or other sensor indicative of quality. The sensor 8 is positioned such it may measure the quality of the air in room in which it is placed. The sensor 8 is placed on the underside of the diffuser 2 (e.g. the diffusion surface 6). In use, air coming through the diffuser 10 creates a low pressure area due to the Bernoulli effect. This causes air from the room 12 to be drawn toward the sensor 8. The air quality of the room can therefore be determined with improved accuracy as the diffusers causes airflow in the room. The accuracy may be increased, for example, with respect to conventional air quality sensors which may be provided in a static air environment.

[0031] Typically, the sensor 8 is only required to measure the room air quality. The sensor 8 is therefore separated/segregated from the incoming air 10. A shield 14 may separate the incoming air 10 from the sensor 8. The shield 14 may comprise a plate or the like. The shield 14 is interposed the diffusing surface 6 and the sensor 8. The shield 14 may comprise a laterally outstanding rim 16 (i.e. laterally outstanding from diffusing surface 6). The shield 14 is typically air impermeable. In some embodiments, the shield 14 may be provided by diffusing surface 6 (e.g. the diffusing surface 6 is sufficiently sized/shaped to prevent incoming air 10 contacting the sensor 8).

[0032] The sensor 8 may be provided in a housing 18. The housing 18 may protect the sensor 8 from damage or the like. The housing 18 may further help to prevent the incoming air 10 contacting the sensor 8. For example, the housing 18 may only comprise openings on an underside 20 thereof. The sensor 8 is provided at a lateral central point 22 on the diffuser 2. Again, this helps to ensure the incoming air 10 does not contact the sensor 8.

[0033] The diffuser 2 may comprise a controller. The controller may receive, process and/or store data from the sensor. The controller may control operation of the damper. The controller may be configured to control the damper actuation mechanism.

[0034] A second embodiment of the diffuser 2 is shown in figure 2. The second embodiment, for example, is configured to be provided on/in a vertical wall 24. The second embodiment is similar to the previous embodiment, and like features will not be repeated for the sake of brevity. A duct 4 is provided in/on the wall 24. A diffusing surface 6 diffuses the incoming air 10. A housing or casing 26 surrounds the diffusing surface 6. The housing 26 comprises a plurality of apertures 30 to allow the incoming air 10 to pass therethrough. The apertures 30 may be provided by any suitable arrangement, for example: a grid/array of apertures; grille; mesh; grating; or the like. The housing 26 covers/encloses the sides 32 of the diffusing surface 6. The apertures 30 are provided on a side of the housing 26 opposing the duct 4 (i.e. facing the room in use). This helps to direct the incoming air 10 away from the wall 24.

[0035] Again, the incoming air 10 creates low pressure around the diffuser 2. This draws room air 12 toward the diffuser 2 (e.g. the housing 26). A sensor 8 is provided to determine the quality of the room air 12, as previously described.

[0036] The sensor 8 is provided on a side 34 of the housing. The housing 26 and/or the side 34 thereof act to shield the sensor 8 from the incoming air 10.

[0037] The position of the sensor 8 may be dependent on the location of the diffuser 2. Typically, the sensor 8 is located to provide a representative sample of the room air 8. For example, when the diffuser 2 is placed high up in the room, the sensor 8 is provided on a lower side of the housing 26 (e.g. as shown in figure

2). When the diffuser 2 is placed low down in the room, the sensor 8 is provided on an upper side of the housing 26 and so on. A plurality of sensors 8 may be provided around the housing 26 (for example, to determine air quality at different directions).

[0038] In some embodiments, the sensor 8 may be configured to measure the air pressure difference between the diffuser 2 and the room space. A pressure difference sensor may be operatively connected to both the room and the space inside the diffuser. Alternatively, respective pressure sensors may be operatively connected to the space in the diffuser and the room space. The respective sensors may measure the absolute pressure and measure a difference between the two spaces.

[0039] In some embodiments, an airflow sensor may be provided. The airflow sensor measures the airflow through the diffuser 2. The sensor may be provided in any suitable position, for example in or next to the duct 4. The airflow sensors and/or pressure sensors may be used to control/regulate airflow into the room space.

[0040] In some embodiments, a sensor may be provided to measure the quality of the incoming air 10. The sensor is likewise separated/segregated from the room 12. For example, the sensor may be provided on the diffusing surface 6 and/or in the duct.

[0041] A third embodiment of the diffuser 2 is shown in figures 3A and 3B. The third embodiment is configured to be provided on/in a vertical wall 24. The diffuser 2 comprises a diffusing surface 6. A sensor 8 is provided on or exposed to an outer surface of the diffusing surface 6. The sensor 8 may be provided near a centre of the diffusing surface. The sensor 8 may be located between the shield 14 and the diffusing surface 6. The sensor may be mounted on the shield 14 or to an opening therein. The diffuser 2 may comprise a similar diffuser arrangement to that shown in figure 1.

[0042] Incoming air 10 is configured to flow around the diffusing surface 6. At least a portion of the space or air pathway around the diffusing surface 6 is obstructed. This causes a low-pressure area near the outer surface of the diffuser 2 near the obstruction. This draws air 12 toward the sensor 8. The obstruction 44 may comprise any suitable arrangement to block an area of airflow around the diffusing surface 6. The obstruction 44 may be provided at a lower side of the diffusing surface. In other embodiments, the obstruction 44 is provided at top or sides of the diffuser 2.

[0043] In the present embodiment, the obstruction 44 is provided by a bridge. The bridge 44 is configured to span between the diffusing surface 6 and the duct 4. This provides said obstruction, whilst also supporting the diffusing surface 6 and sensor 8. The diffusing surface 6 may be detachable from the bridge 44. In other embodiments, the diffusing surface may be integral therewith. In some embodiments, the obstruction 44 may be removable/detachable from the diffuser 2. For example, this may allow the user to reposition the ob-

struction 44. The obstruction 44 may comprise a triangular/wedge shape.

[0044] An airflow space 46 is generally defined between the diffusing surface 6 and the duct 4 to allowing the incoming airflow 10 to pass therethrough. The obstruction 44 blocks a portion of said space 46 (i.e. around the circumference of the diffusing surface 6); preferably, less than or equal to 40% of said space; preferably, less than 30% of the said space. The obstruction may block at least 5% of said space; preferably, at least 10%. This allows incoming air 10 to flow through the diffuser, whilst providing sufficient blocking to encourage room air to flow toward the sensor 8. The obstruction 44 may only provide a partial obstruction. For example, obstruction 44 may extend only partially between the duct 4 and the diffusing surface 6. The obstruction 44 may only extend less than or equal to 80% of the distance between the duct 4 and the diffusing surface 6; preferably, less than or equal to 50%. It can be appreciated that the exact proportions of the obstruction 44 may vary according to the desired use case and the above ranges are merely exemplary.

[0045] A ventilation system 36 is shown in figure 4. The ventilation system 36 comprise a one or more diffuser 2A,2B. It can be appreciated that the system 36 may comprises any number of diffusers 2. The diffusers 2 comprises a power supply. The power supply may comprise an external power supply (e.g. wired). The power supply may comprise a battery or rechargeable battery. The power supply may provide power to the sensors 8 and/or damper actuation mechanism.

[0046] The diffusers 2 are operatively connected to a controller or control system 38. The controller 38 may comprise any suitable processing or processing apparatus (e.g. microprocessor, microcontroller, programmable logic, SoC etc.). The diffusers 2 may be connected via a communications interface. The diffusers 2 may be connected via wired and/or wireless interface (e.g. Wifi, Bluetooth, NFC, cellular, 3G, 4G, 5G etc.). The diffusers 2 may be configured to communicate with one another as described above (e.g. to form a mesh network or the like). In some embodiments, the controller 38 may be integral or otherwise form part of the diffuser 2.

[0047] A remote device 40 may be operatively connected to the controller 38. The remote device 40 may comprise any suitable device, for example, any of: a mobile/cellular device; tablet computer; laptop/desktop computer; server; dedicated control panel; or cloud device. Data from the sensors 8 and/or other operating parameters may be transmitted to the remote device 40. For example, air quality measurements may be transmitted to the remote device 40, such that the user can see the air quality in one or more room.

[0048] The remote device 40 may be connected to the controller 38 using any suitable means. For example, a wireless or wired interface. The remote device 40

may comprise a remote server or cloud server. This may allow the user to control the system 36 via the internet.

[0049] The diffusers 2 are connected to a supply/exhaust system 42. The supply/exhaust system may comprise any suitable to extracted or supply air, for example any of: MVHR system; heat pump/air conditioner; fan system; or any suitable ventilation system. The diffusers 2 are connected to the supply/exhaust system 42 via ducts 4.

[0050] The controller 38 is configured to receive sensor data from the sensors 8 on the diffusers 2A,2B. The controller 38 may then control airflow to the diffusers in accordance with said sensor data. The airflow is typically controlled in accordance with desired parameters of the air quality measured in the particular room. For example, if the air in a particular room is excessively humid or has high CO₂ levels, then airflow may be increased. Where heating or cooling is provided, the airflow and/or the temperature thereof may be adjusted to maintain the room at a desired temperature.

[0051] The controller 38 may control the diffusers directly. For example, where the diffusers 2 comprise a damper, the controller 38 sends a signal to the diffuser 2 to varying the opening of the damper. The diffuser 2 comprises a communications interface to receive said signal. The controller may receive the signal and then control the damper actuation mechanism accordingly.

[0052] In some embodiments, the controller 38 may control the dampers directly (i.e. sensor data is collected by the diffuser 2, however, control of airflow is only controlled by the controller 38). This may be provided where the dampers are separate from the diffuser 2. A controller and/or communication interface may be embedded with the damper actuation mechanism.

[0053] In some embodiments, the controller 38 may be configured to control supply/exhaust system 42 (e.g. where the diffuser 2 does not have a damper). For example, the supply/exhaust system 42 may comprise means to selectively control airflow to each diffuser. The controller 38 then sends a signal to the supply/exhaust system 42 to control how the supply/exhaust system 42 control airflow to the respective diffusers 2. For example, supply/exhaust system 42 may comprise a damper for each respective duct connected to the diffuser 2 and supply/exhaust system 42 may control the dampers for each respective duct. The supply/exhaust system 42 may control any of: the airflow volume; airflow speed; air temperature; or air humidity in accordance with said signal. The controller 38 may control both the diffusers 2 and the supply/exhaust system 42. For example, the controller may control the damper and further control the air speed/temperature provided by supply/exhaust system 42.

[0054] In some embodiments, the controller 38 may be the controller provided on/in the diffuser 2. The diffuser 2 may therefore control the damper in accordance with the measurements measured by the diffuser. The

diffuser 2 may therefore operate substantially independently. The controller 38 may provide information to the remote device 40 and/or provide control signals to the supply/exhaust system 42.

[0055] In some embodiments, the controller 38 forms part of the supply/exhaust system 42. The controller 38 may receive air quality data from the diffusers 2 and control the supply/exhaust system 42 accordingly. For example, the supply/exhaust system 42 may comprise a damper for each respective duct connected to the diffuser 2. The controller 38 may control the dampers for each respective duct.

[0056] In other embodiments, the controller 38 is provided as a separate/dedicated device. For example, the controller 38 may be provided by a control unit, control panel, or the like. The controller 38 is operatively connected to the diffusers 2 and/or supply/exhaust as previously described.

[0057] The controller 38 may control the ventilation system automatically. For example, predetermined air quality parameters are input into the controller 38. The parameters may be programmed via the remote device 40. For example, the user may set a desired temperature via a mobile device. The parameters may comprise any of: a temperature value or range; a humidity value or range; and/or a maximum CO₂ or CO value. The above parameters may be provided over a given time period and/or may vary across a time period. For example, the predetermined temperature may be at a first temperature in the day and a second temperature at night.

[0058] In some embodiments, the remote device 40 may comprise a further appliance, for example, any of: a water heating system; space heating system; cleaning apparatus (e.g. a robotic vacuum cleaner). The controller 38 may be configured to send signals or commands to the remote device 40 to control the remote device in accordance with said sensor data. For example, if the sensor 8 detects that the temperature is too low, then the controller 38 may be configured to control a space heating system to increase the temperature.

[0059] The controller 38 may receive commands from the remote device 40. For example, the user may wish to shutdown the system 36 or put the system into a low-power mode "holiday" mode. The remote device 40 may receive electricity price data (e.g. spot-price data). The controller 38 may then control operation of the system 36 in accordance with said price. For example, when prices are high, the system 36 may reduce temperature, airflow or otherwise reduce power consumption. The user may be able to manually control the position of the dampers. The user may also input desired temperatures or overall airflow rates etc.

[0060] The present system provides a "smart" diffuser. The diffusers can measure the air quality in a given space without the need to provide external sensors and/or further air intakes. The diffusers are connected to a control system that allows controlling of the air into the

space in accordance with data provided by the diffusers. The system may control either or both of a diffusers and an air supply/exhaust system to manage airflow within a space. The diffuser system provides a simple means to maintain air quality in a space with minimal impact on the aesthetics or design of the space.

10 Claims

1. A diffuser (2) for a ventilating a space comprising:
 - a diffusing surface (6) to disperse air (10) coming into the space in use;
 - a sensor (8) configured to determine an air quality of the space, and where the sensor (8) is provided on a portion of the diffuser (2) exposed to the air in the space and segregated from the incoming air (10) in use.
2. A diffuser according to claim 1, comprising a shield (14) configured to segregate the air (10) coming into the space and sensor (8) in use.
3. A diffuser according to claim 2, where the shield (14) comprises a rim or plate (16) interposed the diffusing surface (6) and the sensor (8).
4. A diffuser according to any preceding claim, where the sensor (8) is provided in a sensor housing (18), the sensor housing (20) comprises an opening facing toward the space in use.
5. A diffuser according to any preceding claim, where a housing (26) surrounds the diffusing surface (6), and the sensor (8) is provided on the housing (26).
6. A diffuser according to claim 5, where the housing (26) comprises one or more aperture (30) to allow the incoming air (10) to flow therethrough, and the sensor (8) is provided on a side (32) of the housing (26) displaced from the apertures (30).
7. A diffuser according to any preceding claim, where the air quality comprises one or more of: humidity; temperature; CO₂ level; or CO level; VOC level.
8. A diffuser according to any preceding claim, comprising a sensor configured to determine a pressure difference between air in the diffuser (2) and in the space, and an airflow sensor.
9. A diffuser according to any preceding claim, comprising a communications interface, and the diffuser (2) is configured to transmit/receive data from the sensor to/from a remote device.

10. A diffuser according to any preceding claim, comprising a damper configured to vary the airflow through the diffuser.
11. A diffuser according to claim 10, comprising an actuation mechanism to control position of the damper. 5
12. A diffuser according to claim 11, where the actuation mechanism is configured to receive data to control a position of the damper from a remote device (38,40). 10
13. A ventilation system comprising: 15
- a diffuser (2) according to any preceding claim comprising a sensor (8) configured to measure an air quality in a space;
- a damper configured to vary airflow through diffuser (2); and 20
- a controller (38) configured to receive air quality information from the sensor (8), and control the damper in accordance with said air quality.
14. A ventilation system according to claim 13, comprising 25
- a plurality of diffusers according to any of claims 1-12 (2A,B) having respective air quality sensors (8), 30
- a plurality of dampers configured to vary airflow through the respective diffusers (2); and
- the controller is configured to receive air quality information from each of the respective sensors (8), and control the respective damper in accordance with said air quality. 35
15. A ventilation system according to claim 13 or 14, where the damper is provided on the diffuser (2) and/or is provided in/on an air supply/exhaust (42). 40

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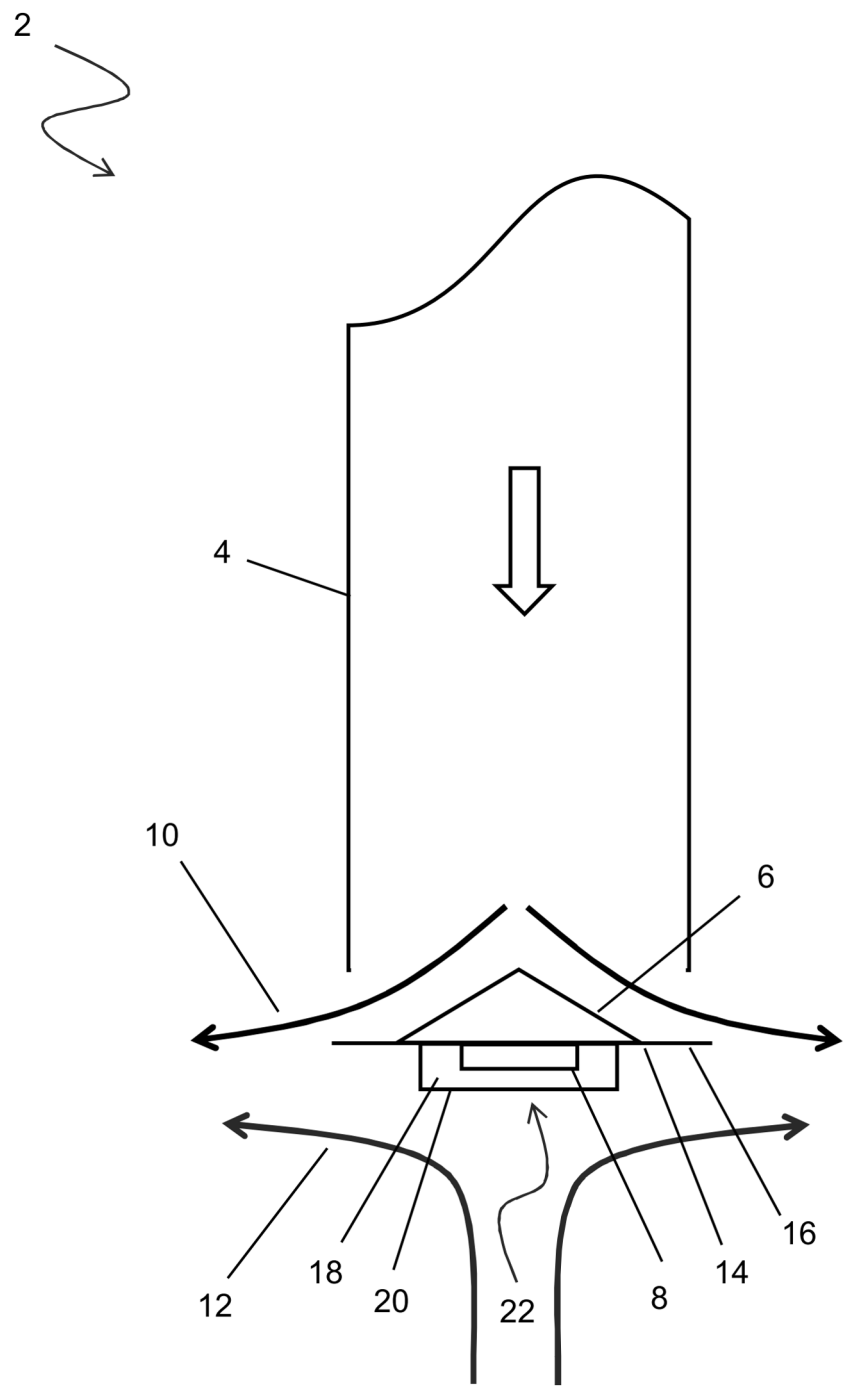


Figure 1

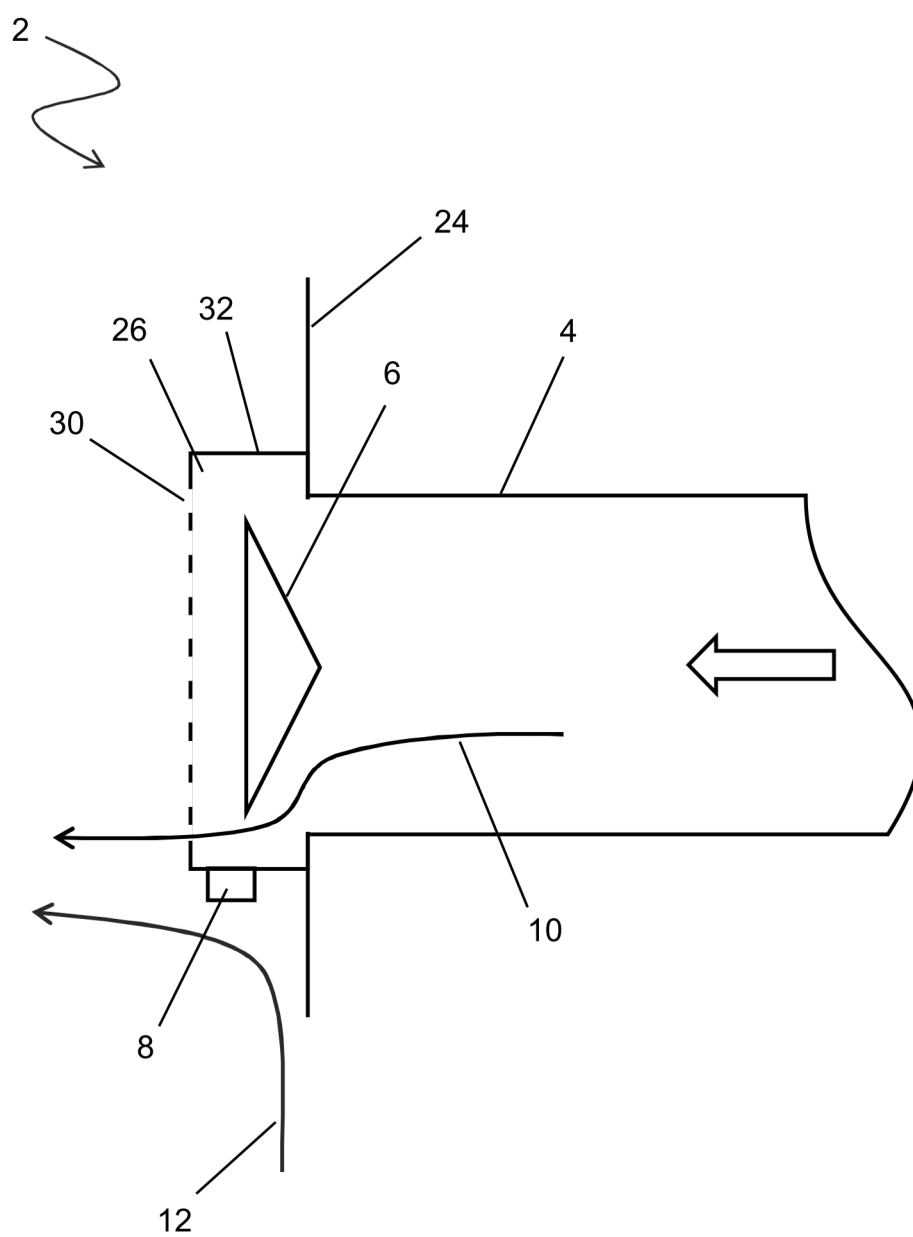


Figure 2

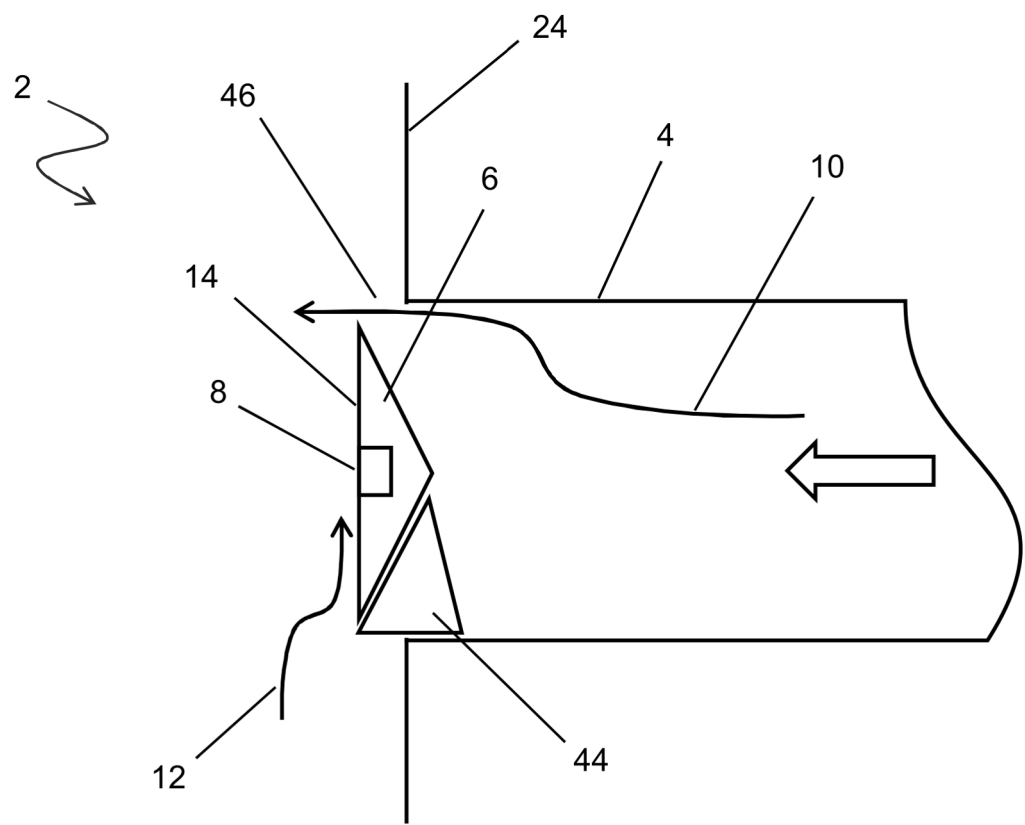


Figure 3A

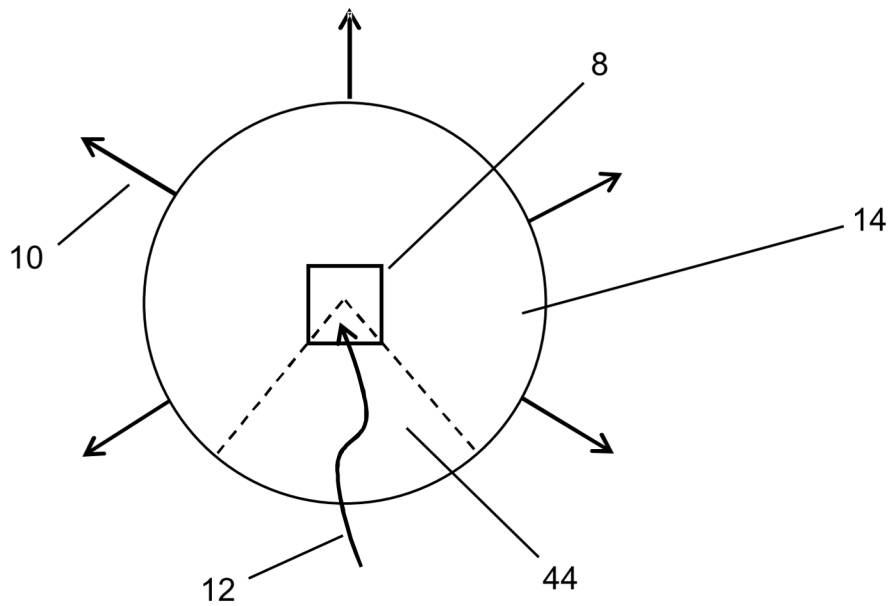


Figure 3B

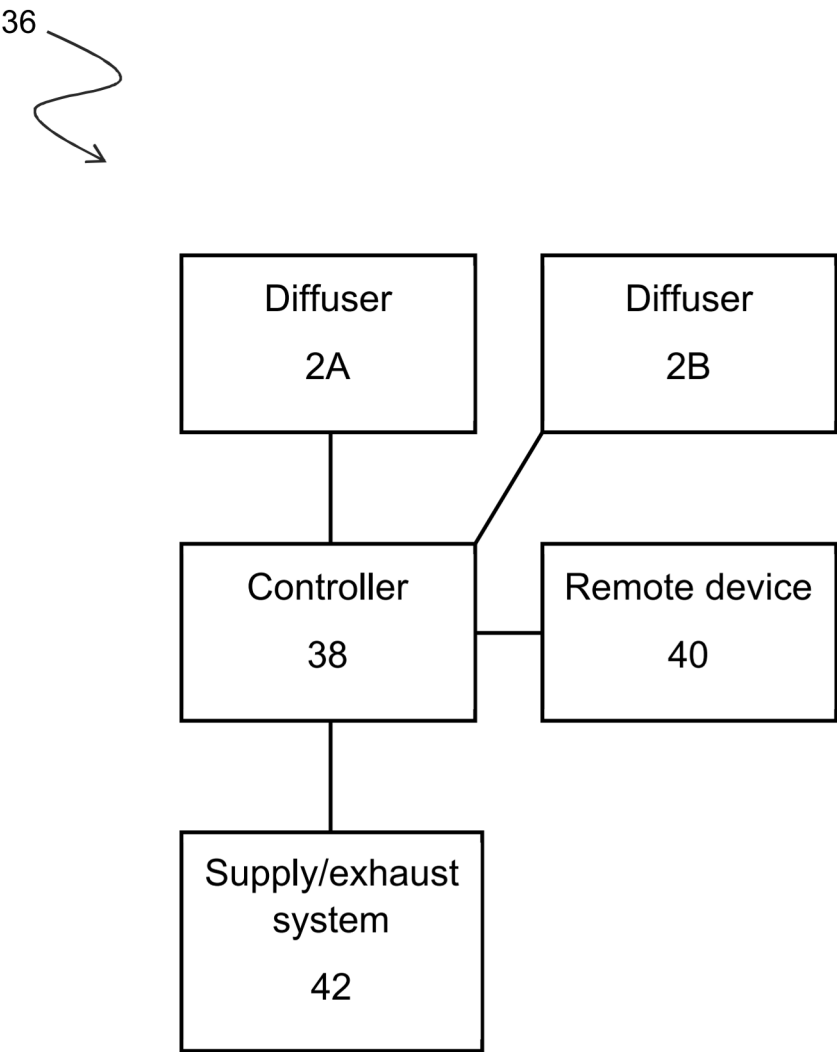


Figure 4



EUROPEAN SEARCH REPORT

Application Number

EP 26 17 2197

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	CN 117 308 243 A (INNOAIL CO LTD) 29 December 2023 (2023-12-29) * paragraphs [0059] - [0068], [0099] - [0125]; figures 1-8c *	1-5,7-15	INV. F24F13/06 F24F11/00 F24F11/56 F24F11/72
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