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(54) **A VENTILATION SYSTEM**

(57) A modular ventilation system ventilates an occupant zone having a ceiling, a floor and lateral boundaries. The ventilation system comprises a common overhead supply duct; a common overhead extract duct; a supply fan connected to the common overhead supply duct; an extract fan connected to the common overhead extract duct; and a ventilation module associated with each occupant zone. Each ventilation module includes a high-level supply vent mounted proximate the ceiling that is connected to the common overhead supply duct and an extract conduit located within the occupant zone connected to the extract duct at its upper end to the common overhead supply duct. A low-level extract vent is located at the lower end of the extract conduit having a vent aperture arranged to allow low level extraction of air from the occupant zone into the extract conduit.

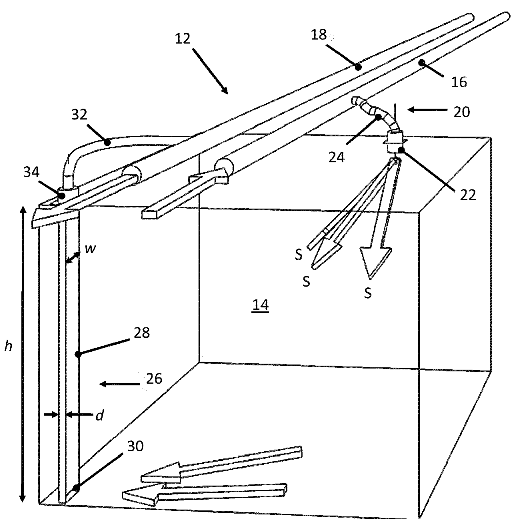

FIG. 2

Description

FIELD OF INVENTION

[0001] The present invention relates to a ventilation system, and in particular a ventilation system that is configured to improve ventilation efficiency and that may be easily reconfigured to accommodate a change in occupancy.

BACKGROUND

[0002] In the built environment, the provision of a ventilation system for an occupied space or room is a requirement based on creating and maintaining a healthy and comfortable environment for the occupants.

[0003] For natural ventilation systems, outdoor or "fresh" air is supplied to the space on the assumption that it has low pollutant levels. With mechanical ventilation systems, the same assumption can be made, but the air can also be treated if desired by direct filtration or other cleaning processes to actively remove pollutants.

[0004] The flow rate of supply air is either fixed at a level determined by reference to regulatory requirements based on the size of the space and the number and density of occupants. Alternatively, the airflow may be supplied at a variable rate determined by monitoring pollutant levels within the space against target values.

[0005] Ventilation systems are also provided with an extraction capability for removing internally generated pollutants. Air extraction systems may remove vitiated air actively, for example using an air pump to draw air from the space. Passive extraction systems may also be used to remove vitiated air from within a space and discharge the air to the exterior of the building. In certain circumstances the ventilation system may include air recirculation, whereby extracted room air is mixed with the incoming outdoor air and returned to the room. This enables an increase in the general air movement levels within the space while allows the system to more efficiently moderate the temperature of the air supplied to the space.

[0006] The ventilation system will nominally be installed with ventilation terminals located so as to provide beneficial air circulation in the space enabling the fresh air to continuously replace the vitiated air around the occupants, and to collect, remove and discharge pollutants.

[0007] The degree to which this is successful is termed the Ventilation Effectiveness. Ventilation effectiveness is an indicator of the quality of the air supply to a ventilated space and human exposure within that space, representing how well the space is ventilated compared to a perfect air mixing condition. A fully effective system in assigned a VE rating of 1, and a totally ineffective system (e.g. where fresh supply air is directly extracted without entering the space), would be considered as a VE rating of 0. Unfortunately, the ventilation effectiveness of a ventilation system is not a regulated target, and whilst there exists a great deal information on air distribution design, methods and devices, there are currently no regulatory requirements for the adequacy of air distribution within a ventilated space.

[0008] The commissioning regulations for a ventilation system simply require the commissioning engineer to establish by measurement that the air volume flow rate entering and / or leaving the ventilated space or room meets a target value based on the overall occupancy of the space. There is no regulatory requirement to re-check the system if occupancy levels change. Therefore, this approach provides a ventilation flow rate that is suitable for a theoretical occupancy level as designed for the space but may not be suitable for the actual occupancy levels in practice. An originally well-designed ventilation system may not be appropriate as the use of the space, the position and/or the number of personnel within the space changes.

[0009] In addition to ensuring that each occupant of a space receives the correct amount of supply and extract ventilation for their general health, comfort and the promotion of well-being, it is also desirable to limit mixing of air flow between occupancy zones. A typical ventilation system, as described above, causes air to flow from a supply inlet above one occupancy zone across one or more other occupancy zones before being extracted. This is little or no consideration or control over the flowpath of the ventilated air within space, providing the required ventilation flow rate is achieved. As a result, pollutants or airborne pathogens may be readily transmitted between occupants of multiple occupancy zones, and between occupants of the same zones.

[0010] Figure 1 shows a typical ventilation system of the prior art. The multiple occupancy space 1 includes a plurality of supply terminals 2 located at the ceiling supplying fresh air to the space 1 from ducting located within the ceiling void. The supply air flow, as indicated by arrows S, enters downwardly and is deflected in multiple directions by airflow dampers. Air extract terminals 4, also located at the ceiling, draw air from within the space to ensure continuous replacement of the air within the space by the incoming fresh air. Supply and extract terminals are traditionally mounted within the ceiling for proximity to the ventilation ductwork, most commonly located with the ceiling void. The air flow into the extract terminals is indicated by arrows E. The airflow between the supply terminals 2 and the extract terminals 4 is indicated by arrows C. Occupant zones 8 are defined within the space, which may represent a desk or collection of desks for housing one or more occupants.

[0011] The supply terminals 2 are located over certain occupant zones 8a -f. Once installed and commissioned, the number, location and flow rate of the extract terminals remains unchanged. Air supplied at a first occupant zones 8a flows to adjacent second and third occupant zones 8b and 8c where it is extracted. Consequently, any pathogens or pollutants within the first occupant zones 8a are transmitted to the second occupant zones 8b. Furthermore, as can be seen, the location of both the supply terminals 2 and extract terminals 4 at ceiling height does not promote effective downward airflow into the occupant zone, resulting in inefficient mixing of the fresh are with the vitiated air. A significant proportion of fresh air may be drawn directly to the extract terminals at height without any effective mixing within the occupant space.

[0012] It is therefore desirable to provide an improved ventilation system which addresses the above described problems and/or which offers improvements generally.

SUMMARY

[0013] According to the present invention there is provided a ventilation system and a method of ventilating a space as described in the accompanying claims.

[0014] In an embodiment of the invention there is provided a ...

[0015] A modular ventilation system for ventilating an enclosed space comprising a plurality of occupant zones, each occupant zone having a ceiling, a floor and lateral boundaries, the ventilation system comprising;

- a common overhead supply duct;
- a common overhead extract duct;
- a supply fan connected to the common overhead supply duct;
- an extract fan connected to the common overhead extract duct; and
- a ventilation module associated with each occupant zone, each ventilation module including:
  - a high-level supply vent mounted proximate the ceiling of the occupant zone arranged for supplying air to the occupant zone;
  - a supply vent connector fluidly connecting the supply vent to the common overhead supply duct;
  - an extract conduit located within the occupant zone, the extract conduit having an upper end that connects to the extract duct and a lower end;
  - an extract conduit connector for connecting the upper end of the extract conduit to the common overhead supply duct; and
  - a low-level extract vent located at the lower end of the extract conduit, the extract vent comprising an aperture arranged to allow fluid flow from the occupant zone into the extract conduit.

[0016] A conventional ventilation system may be modified only with considerable effort due to the dedicated ventilation network installed at ceiling height. In contrast, the above described system of the present invention uses modular components to form ventilation modules. Common supply and extract ducts are provided, and each ventilation module uses flexible conduits to link a low-level extract vent to the common extract duct and a high-level supply vent to the supply duct. Ventilation modules may be selectively added or removed based on the occupancy of the ventilated space. Furthermore, the use of a high-level supply and low-level extract within each occupancy zone causes the fresh supply air to be drawn through the occupancy zone, which significantly improves the ventilation efficiency. This arrangement also ensures that airflow is supplied and extracted within the confines of the occupancy zone, which minimises the spread of airborne contaminants to adjacent occupancy zones. Each occupancy zone has its own separate, dedicated supply vent and extract vent. This ensures that the supply and extract of air is zonally limited withing the occupancy zone avoid cross flow between occupancy zones. Ventilation systems utilising common supply vents and/or extract vents within a space cause air to be drawn across occupancy zones from or to the common vents.

[0017] The above system provides a straightforward means of ensuring that each occupant of a space receives the correct amount of supply and extract ventilation for their general health, comfort and the promotion of well-being. In addition, and in relation to the health of other occupants, the system will reduce or prevent pollutants and pathogens emitted by each occupant from being spread to other occupants in the space or in adjacent spaces.

[0018] The extract vent may be located below occupant head height and may be located below one meter from the floor of the occupant zone, such that it is below head height of a seated occupant. Fresh air is therefore able to be drawn down to and past occupant head height when the occupant is seated within the occupant zone. Preferably the extract vent is located proximate the floor of the occupant zone.

[0019] The modular ventilation system may further comprise a fan controller operative to control the supply fan, to maintain a constant static pressure within the supply ducts. This enables the airflow to the supply ducts to be easily regulated by controlling the main fan, rather than requiring independent control at each vent.

[0020] The fan controllers may also be operative to control the extract fan, to maintain a constant static pressure within the extract ducts.

[0021] Each occupancy zone may comprise a designated occupant location which in use accommodates an occupant in a seated and/or standing position. The occupant location is a notional position intended to accommodate the occupant in use, which enables the ventilation module to be configured on the basis of that position.

[0022] The supply vent may comprise a directional flow controller configured to guide the supply air flow in one or more directions and the directional flow controller is arranged to direct at least part of the supply air flow towards the occupant location. The location of the low-level extract duct on the opposing side of the occupant location will naturally draw the air flow across this location. The use of a directional flow controller improves and focusses the directionality and avoids air flow to adjacent spaces.

[0023] The directional controller is adjustable to vary the flow direction, enabling the ventilation module to be reconfigured in response to a change in the occupancy space if required.

[0024] The supply vent and extract vent may be located on opposing sides of the occupant location and air flow from the supply vent is directed to the extract vent via the occupant location.

[0025] Each ventilation module may include a flow meter for measuring the air flow through the supply vent and a flow controller for varying the supply air flow rate through the supply vent.

[0026] Each ventilation module preferably includes a visual display operatively connected to the flow meter to provide an indication of the supply air flow rate. The visual display enables an operator to observe and modify the flow rate if required.

[0027] The visual display may be operative to provide an audio and/or visual alert if the flow rate falls below a threshold level.

[0028] The ventilation system may further comprise an occupancy sensor arranged to detect occupancy of the occupant zone, wherein the occupancy sensor is operatively connected to the flow controller and the flow controller is operative to vary the supply air flow rate based on the occupancy of the ventilation. For example, the controller may decrease the flow rate if no occupant is detected.

[0029] The ventilation system may further comprise an air quality sensor operative to detect one or more airborne contaminants within the occupancy zone, wherein the air quality sensor is operatively connected to the flow controller and the flow controller is operative to vary the supply air flow rate and/or the extract flow rate based on the one or more detected airborne contaminants exceeding a threshold value. The one or more air quality sensor may measure quantities of relevant contaminants in the supply airstream such as particulate matter or nitrogen dioxide, or contaminants such as carbon dioxide in the extract airstream.

[0030] The dimensions of the high-level components, which may be the supply vents and/or air supply terminals are based on typical ceiling tile dimensions, enabling the ventilation modules to be easily retro-fitted within existing spaces. In addition, the use of semi-rigid ducting for connection between the main ducts and final supply terminals, and vertical extract conduits located within the ventilated space, allows flexible re-positioning of the supply and extract terminals to ensure ventilation based on the actual occupancy and layout of the space.

[0031] The ventilation system thereby provides one or more of fresh air supply and extract air main distribution ducts; location adaptable local terminal ductwork (per occupant / occupant group); a directionally adjustable supply distributor (per occupant / occupant group); extract collector and integral terminal (per occupant / occupant group); a supply and extract unit with heat recovery (unitary, co-located, separately located or centralised); and a constant pressure fan control system.

[0032] The ventilation system may further include one or more of a zonal supply air filtration and air treatment module (particulate / gaseous / biocidal treatment) per occupant zone; terminal supply air filtration and air treatment module (particulate / gaseous / biocidal treatment) per occupant or occupant zone; an air quality monitoring and indication system; air quality demand control system and/or a local controller in each ventilation space configured to provide limited control to the local user without the ability to override the system outside predetermined parameters.

[0033] In another aspect of the invention a method of ventilating an enclosed space comprises:

dividing the space into a plurality of occupancy zones based on the number and arrangement of occupants within the space, each occupant zone having a ceiling, a floor and lateral boundaries;
providing a common overhead supply duct;
providing a common overhead extract duct;
providing a ventilation module in each occupant zone, each ventilation module including:

a high-level supply vent mounted proximate the ceiling of the occupant zone arranged for supplying air to the occupant zone;
a supply vent connector fluidly connecting the supply vent to the common overhead supply duct;
an extract conduit located within the occupant zone, the extract conduit having an upper end that connects to the extract duct and a lower end;
an extract conduit connector for connecting the upper end of the extract conduit to the common overhead supply duct; and
a low-level extract vent located at the lower end of the extract conduit, the extract vent comprising an aperture arranged to allow fluid flow from the occupant zone into the extract conduit;

the method further comprising supplying fresh air to each occupant zone via the associated high-level supply duct and extracting vitiated air from each occupant zone via the associated extract vent such that the supply and extraction of air for each occupant zone is contained within the occupant zone to improve ventilation efficiency for occupants within the occupant zone and limit transmission of airborne pathogens and pollutants between occupant zones.

[0034] Air may be supplied to the supply duct by a supply fan and the method further comprises controlling the fan to maintain a constant static pressure within the supply duct.

[0035] The method further comprising defining at least one occupant location with the occupant zone, arranging the supply vent and extract vent on opposing sides of the occupant zone, and directing at least part of the air flow from the supply vent to the extract vent via the occupant zone.

[0036] The method further comprises varying the number and/or size of the occupant zones in response to a change in number and/or arrangement of occupants within the space, and changing the number of associated ventilation modules when the number and/or size of the occupant zones is varied.

[0037] It will be appreciated that while the invention is described in the context of commercial office space, it is not limited to these applications and may be applied in numerous other commercial or residential environments where ventilation of multiple occupants is required.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] The present invention will now be described by way of example only with reference to the following illustrative figures in which:

Figure 1 shows an office ventilation system of the prior art;

Figure 2 shows an occupant zone and ventilation module according to an embodiment of the invention;

Figure 3 shows a series of occupant zones in an office environment with associated ventilation modules according to an embodiment of the invention;

Figure 4 shows a ventilation system according to an embodiment of the invention in a high-density office environment;

Figure 5 shows a ventilation system according to an embodiment of the invention in a single office environment; and

Figure 6 shows a ventilation system according to an embodiment of the invention in a meeting room environment.

DESCRIPTION OF EMBODIMENTS

[0039] Referring to Figure 2, a ventilation system is provided for ventilating a space. The ventilation system is a modular system that may be readily scaled to ventilate any required space, with any given occupancy level. The arrangement of Figure 2 represents a single ventilation module 12 for a single occupancy zone 14. The ventilation module 12 includes a supply duct 16 and an extract duct 18. The supply duct 16 and extract 18 are preferably semi-rigid ducting housed within the ceiling void. The use of semi-rigid ducting enables the ducting system to be easily installed, and for the configuration to be easily modified and reconfigured as the layout and/or number of occupants in the space changes over time.

[0040] The supply duct 16 and extract duct 18 are connected to a supply fan and extract fan respectively. The supply fan and extract fan may be contained within a common housing as part of a combined supply/extract fan unit. The supply fan is configured to maintain a constant static pressure within the supply duct 16. To achieve this the supply fan includes a controller configured to monitor the static pressure within the supply duct 16 and to vary the supply fan speed / performance to maintain constant pressure.

[0041] If the ventilated space is well constructed and suitably separated from other parts of the building, control of the supply air flow rate to the space will be sufficient to regulate the system. If the ventilated space is not self-contained in this regard, the extract system may be controlled in addition to the supply system by monitoring the static pressure with the extract duct 18 and by similarly varying the speed / performance of the extract fan to modify the extract rate.

[0042] An air supply distributor 20 includes a supply vent 22 configured to penetrate and be mounted to the ceiling, and a supply duct connector 24 for connecting the supply vent 22 to the supply duct 16. The supply duct connector 24 is a length of flexible ducting that is able to be readily and easily fitted between the supply duct 16 and the supply vent 22. The supply vent 20 is connected to the supply duct 16 such that pressurised air flows from the supply duct 16 to the supply vent 20 and into the occupancy zone 14. The flow rate through the supply vent 20 is determined by the static pressure within the supply duct 16.

[0043] The supply vent 22 may include one or more baffles or dampers for directing the airflow through the supply vent 20 into the occupancy zone 14 in one or more directions as indicated by the arrows S. The baffles or dampers are directionally adjustable to ensure good air distribution at an occupant level, and to enable the direction of airflow to be adjusted if required.

[0044] The ventilation module 12 further includes one or more extract collectors 26 for the extraction of vitiated air from the occupancy zone. The extract collector 26 comprises an extract conduit 28, an extract vent 30 and a flexible extract duct connector 32. The extract conduit 28 comprises a length of rigid ducting, although it will be appreciated that in other embodiments the extract conduit 28 may be formed from flexible ducting. The rigid ducting of the extract conduit may have a low profile, rectangular form that has a width w, a depth d and a height h. In the configuration of Figure 2 the conduit 28 is arranged against a wall or partition of the occupancy zone. The width w is greater than the depth d to limit the distance to which the conduit projects from the wall. The width w and depth d define the cross-sectional flow area of the conduit 28. The conduit extends vertically within the occupancy zone.

[0045] The extract vent 30 comprises an aperture arranged at the lower end of the extract conduit 26 that defines an opening to the extract conduit 28. The extract vent 30 is preferably arranged below occupant height, being the height of a typical occupant when seated, which may lower than 1.5m and preferably lower than 1m. Expelled breath and particulates from the occupant(s) are drawn downwardly away from the occupant and out of the breathable air space within the occupancy zone. In the arrangement of Figure 2 the extract vent is located proximate the floor, meaning it is close to or at floor height. The extract duct connector 32 includes a ceiling penetration 34 connected and a flexible extract ducting section 36. The ceiling penetration connects to the upper end of the conduit and extends the conduit 28 through the ceiling to the ceiling void. The flexible extract ducting section 36 connects the ceiling penetration to the extract duct 18. A T-connector or other suitable fixing may be located along the extract ducting for connection with the flexible extract ducting section 36.

[0046] Figure 3 shows a first application of the ventilation system to a ventilation space comprising a general office environment with multiple occupancy. The ventilation space is segregated into a series of occupancy zones a-d. Each occupancy zone is configured to be occupied by a single worker and includes a desk or similar workstation distributed within the space, local storage, telephone and a computer system with screens or terminals. The equipment within the workstation has some limited impact on ventilation system to the extent that it may generate thermal emissions or pollutants. More pertinent is the number of occupants within each occupancy zone and the number of occupancy zones within the occupancy.

[0047] Each occupancy zone a-d is provided with a ventilation module 12. A supply duct 16 and extract duct 18 extend across each occupancy zone a-d within the ceiling void. The supply duct 16 and extract duct 18 function as common supply and extract ducts for each occupancy zone. Each occupancy zone a-d is provided with a supply distributor 20 and an extract collector 26. It will however be appreciated at least one supply distributor 20 and at least one extract collector 26 is required, and in other embodiments more of either may be provide. The vent 22 of the supply distributor 20 is arranged in the ceiling such that it is located above and in front of the occupant when seated at the desk. The conduit 28 of the extract collector is located against a wall, which may be a partition panel, on the opposing side of the occupant seating position to the supply vent 22. The conduit 26 extends from the floor to the ceiling. The extract vent 30 is located at the lower end of the conduit 26 proximate the floor. The supply vent is arranged to direct the supply airflow towards the extract vent 30. Consequently, an airflow pathway is created between the supply vent 22 and the extract vent 30 that flows downwardly and across the occupant to provide the occupant with a constantly replenished fresh air supply, significantly improving the ventilation effectiveness within each occupancy zone a-d.

[0048] Because a dedicated ventilation module 12 (including a supply vent 22 and extract vent 30) is provided within each occupancy zone, the air supplied to each occupancy zone a-d is extracted within the same occupancy zone. Vitiated air within an occupancy zone is extracted within that zone, preventing it from flowing to adjacent occupancy zones. As a result, mixing of airflow between occupancy zones is minimised, and the risk of transmission of pathogens or pollutants between occupancy zones is significantly reduced.

[0049] Adjacent occupancy zones a and b, and adjacent occupancy zones c and d are configured with desks immediately adjacent and separated by partitions, such that the occupants are facing each other when seated. The supply vents 22 of the adjacent occupancy zones are arranged such that the supply airflows are directed away towards the associated occupants and away in opposing directions. That is to say, the incoming air from the supply vent 22 of occupancy zone a is directed in a first direction and the incoming air from the supply vent 22 of occupancy zone b is directed in a second direction that opposes the first. Therefore, the supply airflow of the first occupancy zone a is directed towards the occupant of occupancy zone a and away from the occupant of occupancy zone b.

[0050] The use of a common supply duct 16 and extract duct 18 enables any number of ventilation modules 12 to be selectively connected along the ducts to create new occupancy zones, to vary the capacity of the ventilation system in response to a change in occupancy and/or configuration of a space. Similarly, ventilation modules 12 may be easily removed from or moved along the common supply and extract ducts 16,18 to change configuration or reduce capacity as required.

[0051] The arrangement of Figure 4 represents a high occupancy, high density space such as a call centre. In such environments, occupants are provided with very limited working spaces, and the density of the working spaces is high to maximise the number of workers within an office space. As a result, occupants work in much closer proximity to each other with minimal physical separation. The space is nonetheless divided in to multiple occupancy zones, each of which is configured for a single occupant. Each occupancy zone is provided with a supply vent 22 and an extract vent 30. However, to accommodate the more limited space available for ventilation infrastructure, each supply vent 22 is configured to supply two adjacent occupancy zones. The baffles of the supply vents 22 are configured to generate a multi-directional airflow, which a first airflow supply directed into a first occupancy zone a and second airflow supply directed into an adjacent second occupancy zone b. It is therefore possible to provide an independent air supply to two or more adjacent occupancy zones using a common air supply distributor 20.

[0052] Multiple air supply vents 22 connect to a common air supply duct 16. The occupancy zones may be arranged in blocks, with a block consisting of two rows of adjacent occupancy zones arranged such that the occupants are facing each other. The occupancy zones are separated by partitions at the adjacent font ends and open for access at their opposing rear ends. Multiple blocks may be arranged within a space, with the blocks being separated by corridors to allow the passage of workers to and from the occupancy zones. The supply ducts 16 may be arranged to run centrally along the block and supply multiple occupancy zones within a block. Two adjacent blocks are supplied by a common distributor 20 which connects to the supply duct 16 which runs parallel with each block.

[0053] Adjacent occupancy zones, which need not be the same first and second occupancy zones, may similarly share an extract conduit 26 in a similar manner, which still supplies an independent air extract function to that occupancy space. In the arrangement of Figure 4, a common extract conduit 26a is vertically arranged between two side-by-side second and third occupancy zones b and c. The extract conduit 26a include a first extract vent 30b that opens into the second occupancy zone b and a second extract vent 30c on the opposing side of the conduit 26a at a vertically aligned position that opens into the third occupancy zone c. A vacuum applied to the extract conduit 26a is therefore able to simultaneously extract vitiated air from the second and third occupancy zones b and c. Addition extract ducts 26b-f supply other adjacent pairs of occupancy zones in a similar manner. A pair of extract ducts 18a and 18b are provided that are arranged in parallel on opposite sides of the common supply duct 16. The first extract duct 18a is connected to extract conduits 26a-c for the first row of occupant zones and the second extract duct 18b is connected to extract conduits 26d-f for the adjacent second row of occupant zones. In this embodiment, each ventilation module 12 includes a supply distributor 20 and extract collector 30 but the invention covers arrangements in which supply distributors and extract collectors may be shared between occupancy zones, while each occupancy zone is provided with a supply air flow and extract air flow that remain within the confines of the occupancy zone.

[0054] Figure 5 represents an individual office, which is enclosed by walls and is not open to a wider space. Physical separation from other workers is assured by physical walls and door, with other workers only occasionally entering the space. The office space is defined as an occupancy zone and is configured to accommodate a primary occupant and occasional additional occupants. The occupancy zone is provided with a supply distributor 40 and an extract collector 46. The supply distributor 40 includes a supply vent 42, which may comprise basic vent having an aperture and diffuser or may comprise an air supply terminal unit including air treatment elements such as heating, cooling, filtration, and/or disinfectant means such as UV treatment. Due to the size of an office and its distance from a main supply duct 16, the air supply ducting connector 44 may comprise a semi rigid ducting connector arranged as a spur from the semi rigid supply duct 16, rather than a short, flexible ducting connector of the above embodiments.

[0055] The supply vent 42 is arranged above and in front of the occupant seating position. The extract collector 46 is located behind the occupant seated position 47 and includes an extract conduit 48 arranged vertically between the floor and ceiling with the extract vent 50 proximate the floor. The extract ducting connector 52 may comprise a semi rigid ducting connector arranged as a spur from the semi rigid extract duct 18.

[0056] The supply vent 42 is configured to direct supply airflow towards and past the occupant to the extract vent 50. The occupant zone also includes a seating position for visitors/additional occupants and the supply vent 42 is also configured to direct a secondary airflow in the direction of the additional seating position and away from the primary occupant. This ensures that transmission between the primary occupant and the additional occupant(s) is minimised.

[0057] Figure 6 shows a meeting room which comprises an occupancy zone configured for multiple occupancy. Typically meeting rooms are spaces of nominally fixed dimensions for accommodating a variable number of occupants to be temporarily co-located in preset locations within the space, which may be locations around a meeting room table. The meeting room may be notionally sub divided into multiple occupancy zones and provided with multiple ventilation modules. In the arrangement of Figure 6 the meeting room comprises two occupancy zones a and b and is provided with two ventilation modules. Accordingly, the meeting room includes two supply distributors 40 having supply vents 42 that comprise multidirectional air supply terminals. The supply vents are located above the table at spaced locations and are configured to direct airflow across the occupants seated around the table in a direction away from the table and away from other occupants. Both supply distributors are connected in series along a supply duct 16. Each occupant zone includes two outlets located in opposing corners of the room, on opposing sides of the occupants to the supply distributors 40. Floor level extract vents 50 are located at the lower ends of extract conduits 46, which connect to extract ducts 18. Two extract ducts connectors 52 are provided either side of the supply duct connector 44 in parallel arrangement to service the four extract conduits.

[0058] The ventilation system of the present invention creates occupant ventilation zones dedicated to individual users or small groups of users according to the setting. Each occupant zone is provided with a ventilation module. A ceiling mounted supply distributor is sized to supply air to the designated occupant zone and is directionally adjustable to ensure air distribution is optimised at occupant level depending on the location of the occupant within the occupant zone. One of more extract collectors are arranged within the ventilation zone below occupant level to extract vitiated air from the occupant zone and transfer the air to a ceiling level extract duct.

[0059] The principle of occupant zone serviced by dedicated ventilation modules enables the ventilation system to be optimised for the number and arrangement of occupants. It also enables the ventilation system to be easily modified by adding or removing ventilation modules depending on the ventilation requirements at any given time. The ventilation modules ensure optimised fresh air supply to the occupants and mitigate the risk of cross contamination within a space by supplying and extracting within the same occupant zone, with the ability to control air ingress and egress in a zone-by-zone basis.

[0060] One of the costly elements of a traditional ventilation installation is the need to balance the system to ensure that the correct flow rates are obtained. The use of a constant pressure fan and control unit to main a constant static pressure within the supply duct enables ventilation modules to be easily added or removed without unbalancing the rest of the ventilation system. Above the ceiling level, an extensive range of fittings and semi-rigid ducting enables quick and leakage free connection to the zonal ductwork. The flexible ducting connectors of the ventilation modules may be readily connected or disconnected from the main ducts as required, with only small penetrations of the ceiling fabric being required for each ventilation module. In this way, the system may be easily reconfigured as the layout of occupants in the space changes over time.

[0061] Ideally the fresh air supply feeding the system should be relatively free of contaminants, but it is prudent to make provision for the incorporation of filters of various grades and types and other air treatment types. With this system, the typical standard grade filters associated with the ventilation units may be dispensed with or downgraded to provide protection of the mechanical components only, and higher-grade or more specialised filters fitted at the terminal position, or at another readily accessible location. This approach reduces pressure losses in the system overall relative to filter grade and encourages proactive filter maintenance. An additional benefit of locating the room filter at the supply terminal, as opposed to filtering at the main supply fan, is that any contaminants contained or originating in the supply duct system itself will be captured and prevented from entering the occupied space.

[0062] A given work area or similar space will have dimensions associated with the type of activity and the approximate number of occupants that may be accommodated when carrying out that activity. The designer of the ventilation system may not have knowledge of the actual layout of personnel in the space when occupied, instead having to rely on assumptions about use. This may mean that the system does not reflect the ventilation needs of the occupants other than in general terms.

[0063] The ventilation fans are specified to be capable of delivering air flow rates based on the maximum possible occupancy of the space, but then by dimensioning the main duct runs as low loss plena, the addition of further supply or extract points does not significantly alter the operating static pressure of the system. Therefore, additional supply or extract ports may easily be added to the main ducts by the installer / end user of the system and supply / extract terminals installed. The system is programmed to self-compensate for the additional flow demand, negating the need for an expensive re-commissioning service.

[0064] Similarly, the system components are dimensioned such that a reduction or an extension in length of the semi rigid ducting between the limits of 300 and 3000mm will still provide acceptable performance. This means that the relocation of the supply and extract terminals to suit additional or re-located personnel is very straightforward.

Claims

1. A modular ventilation system for ventilating an enclosed space comprising a plurality of occupant zones, each occupant zone having a ceiling, a floor and lateral boundaries, the ventilation system comprising;

    a common overhead supply duct;
    a common overhead extract duct;
    a supply fan connected to the common overhead supply duct;
    an extract fan connected to the common overhead extract duct; and
    a ventilation module associated with each occupant zone, each ventilation module including:

        a high-level supply vent mounted proximate the ceiling of the occupant zone arranged for supplying air to the occupant zone;
        a supply vent connector fluidly connecting the supply vent to the common overhead supply duct;
        an extract conduit located within the occupant zone, the extract conduit having an upper end that connects to the extract duct and a lower end;
        an extract conduit connector for connecting the upper end of the extract conduit to the common overhead supply duct; and
        a low-level extract vent located at the lower end of the extract conduit, the extract vent comprising an aperture arranged to allow fluid flow from the occupant zone into the extract conduit.

2. A modular ventilation system according to claim 1 wherein the extract vent is located below occupant head height.

3. A modular ventilation system according to claim 2 wherein the extract vent is located proximate the floor of the occupant zone.

4. A modular ventilation system according to any preceding claim further comprising a fan controller operative to control the supply fan to maintain a constant static pressure within the supply ducts and/or to maintain a constant static pressure within the extract ducts.

5. A modular ventilation system according to any preceding claim wherein each occupancy zone comprises a designated occupant location which in use accommodates an occupant in a seated and/or standing position, the supply vent comprises a directional flow controller configured to guide the supply air flow in one or more directions and the directional flow controller is arranged to direct at least part of the supply air flow towards the occupant location

6. A modular ventilation system according to claim 5 wherein the directional controller is adjustable to vary the flow direction.

7. A ventilation system according to claim 5 or 6 wherein the supply vent and extract vent are located on opposing sides of the occupant location and air flow from the supply vent is directed to the extract vent via the occupant location.

8. A ventilation system according to any preceding claim wherein each ventilation module includes a flow meter for measuring the air flow through the supply vent and a flow controller for varying the supply air flow rate through the supply vent.

9. A ventilation system according to claim 8 wherein each ventilation module includes a visual display operatively connected to the flow meter to provide an indication of the supply air flow rate and/or wherein the visual display is operative to provide an audio and/or visual alert if the flow rate falls below a threshold level.

10. A ventilation system according to claim 8 or 9 further comprising an occupancy sensor arranged to detect occupancy of the occupant zone, wherein the occupancy sensor is operatively connected to the flow controller and the flow controller is operative to vary the supply air flow rate based on the occupancy of the ventilation.

11. A ventilation system according to any one of claims 8 to 10 further comprising an air quality sensor operative to detect one or more airborne contaminants within the occupancy zone, wherein the air quality sensor is operatively connected to the flow controller and the flow controller is operative to vary the supply air flow rate based on the one or more detected airborne contaminants exceeding a threshold value.

12. A method of ventilating an enclosed space, the method comprising:

dividing the space into a plurality of occupancy zones based on the number and arrangement of occupants within the space, each occupant zone having a ceiling, a floor and lateral boundaries;
providing a common overhead supply duct;
providing a common overhead extract duct;
providing a ventilation module in each occupant zone, each ventilation module including:

a high-level supply vent mounted proximate the ceiling of the occupant zone arranged for supplying air to the occupant zone;
a supply vent connector fluidly connecting the supply vent to the common overhead supply duct;
an extract conduit located within the occupant zone, the extract conduit having an upper end that connects to the extract duct and a lower end;
an extract conduit connector for connecting the upper end of the extract conduit to the common overhead supply duct; and
a low-level extract vent located at the lower end of the extract conduit, the extract vent comprising an aperture arranged to allow fluid flow from the occupant zone into the extract conduit;

the method further comprising supplying fresh air to each occupant zone via the associated high-level supply duct and extracting vitiated air from each occupant zone via the associated extract vent such that the supply and extraction of air for each occupant zone is contained within the occupant zone to improve ventilation efficiency for occupants within the occupant zone and limit transmission of airborne pathogens and pollutants between occupant zones.

13. A method according to claim 11 wherein air is supplied to the supply duct by a supply fan and the method further comprises controlling the fan to maintain a constant static pressure within the supply duct.

14. A method according to claim 12 or 13 further comprising defining at least one occupant location with the occupant zone, arranging the supply vent and extract vent on opposing sides of the occupant zone, and directing at least part of the air flow from the supply vent to the extract vent via the occupant zone.

15. A method according to any one of claims 12 to 14 further comprising varying the number and/or size of the occupant zones in response to a change in number and/or arrangement of occupants within the space, and changing the number of associated ventilation modules when the number and/or size of the occupant zones is varied.

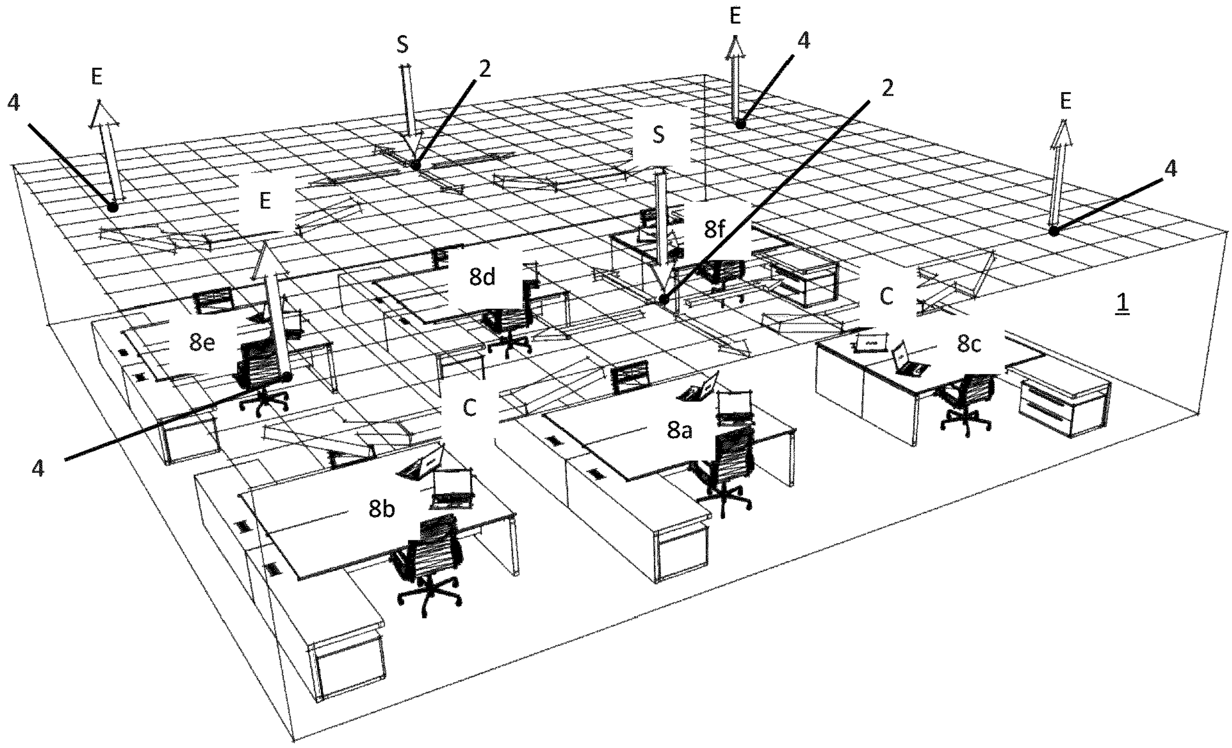

FIG. 1 - PRIOR ART

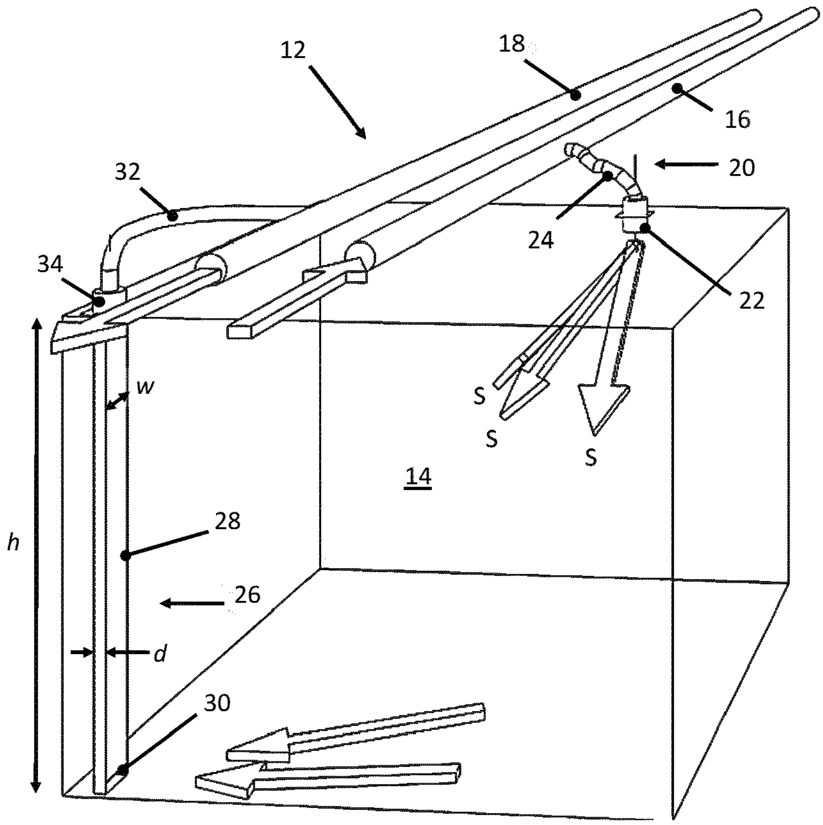

FIG. 2

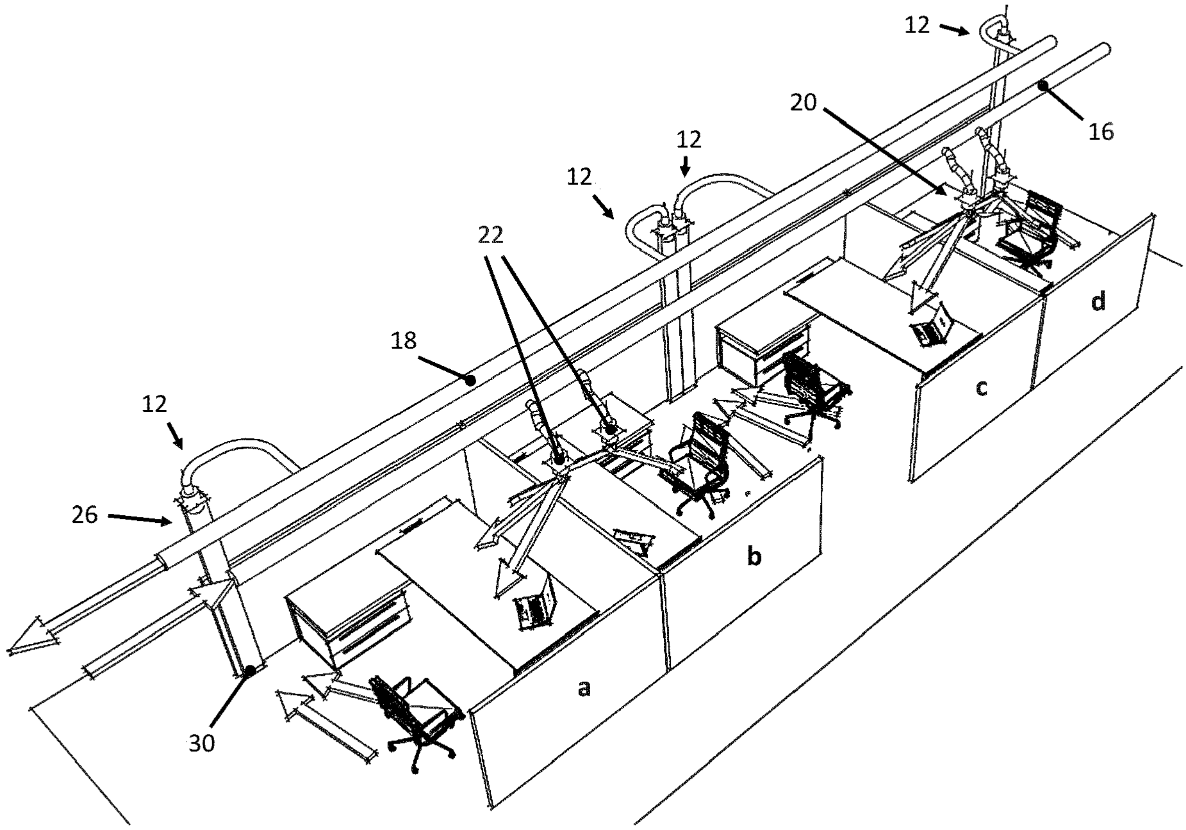

FIG. 3

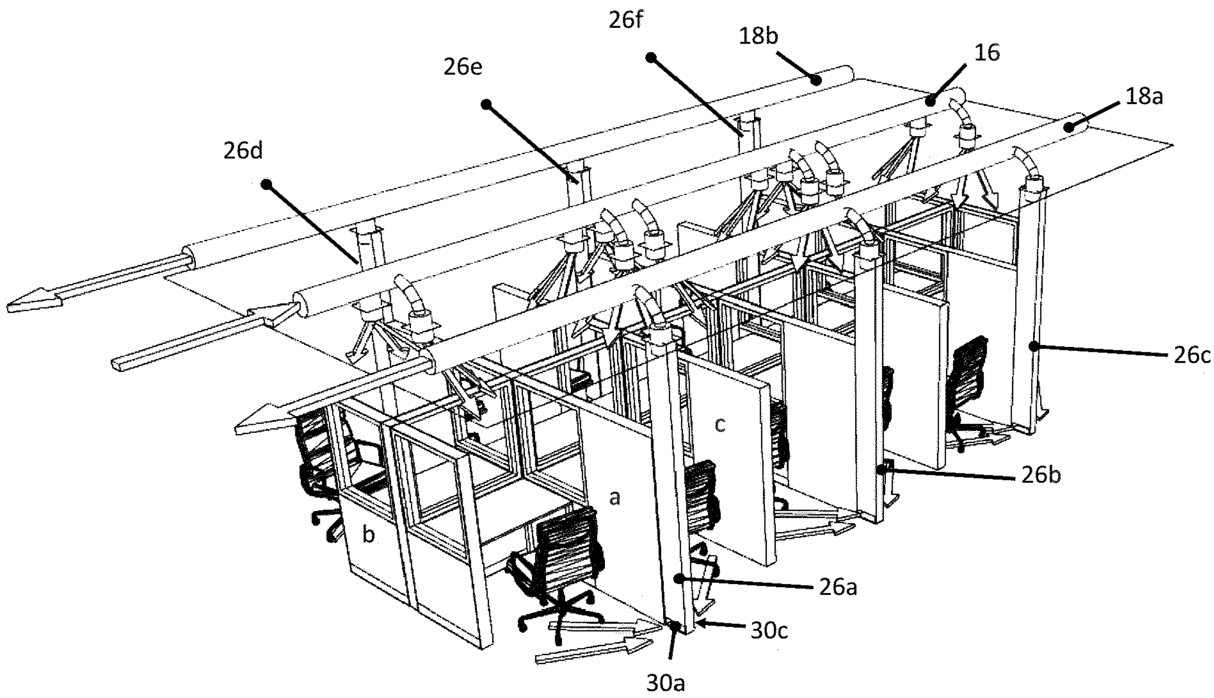

FIG. 4

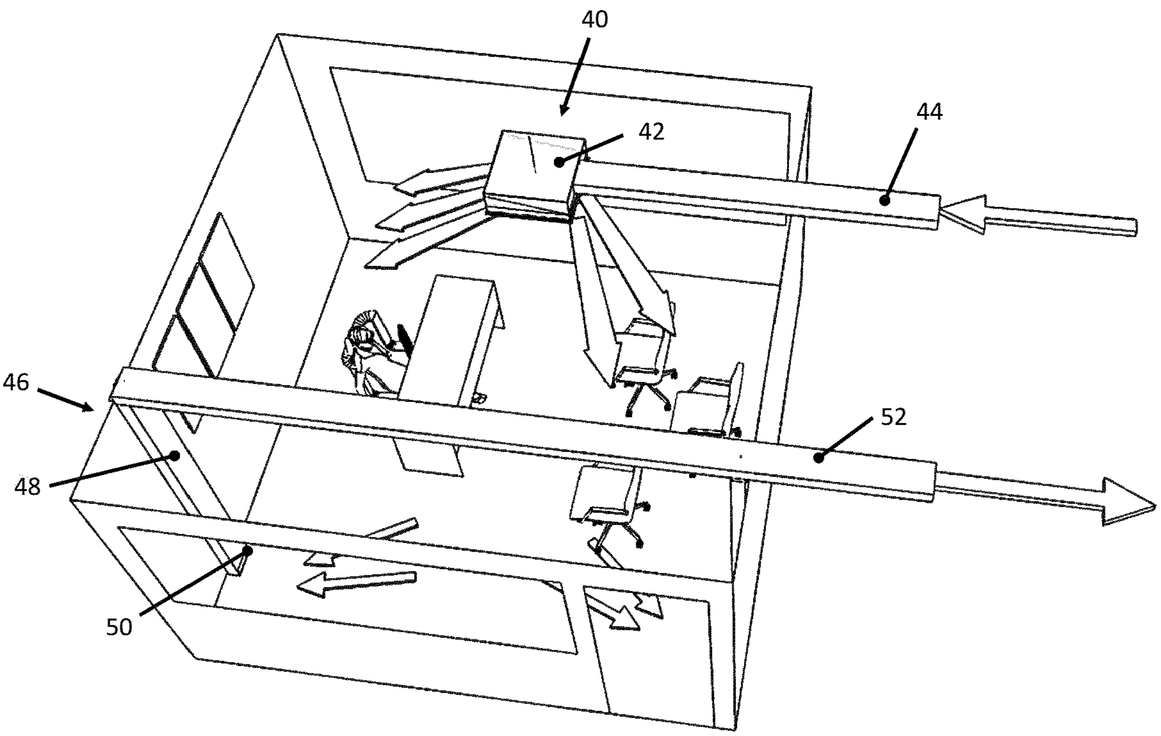

FIG. 5

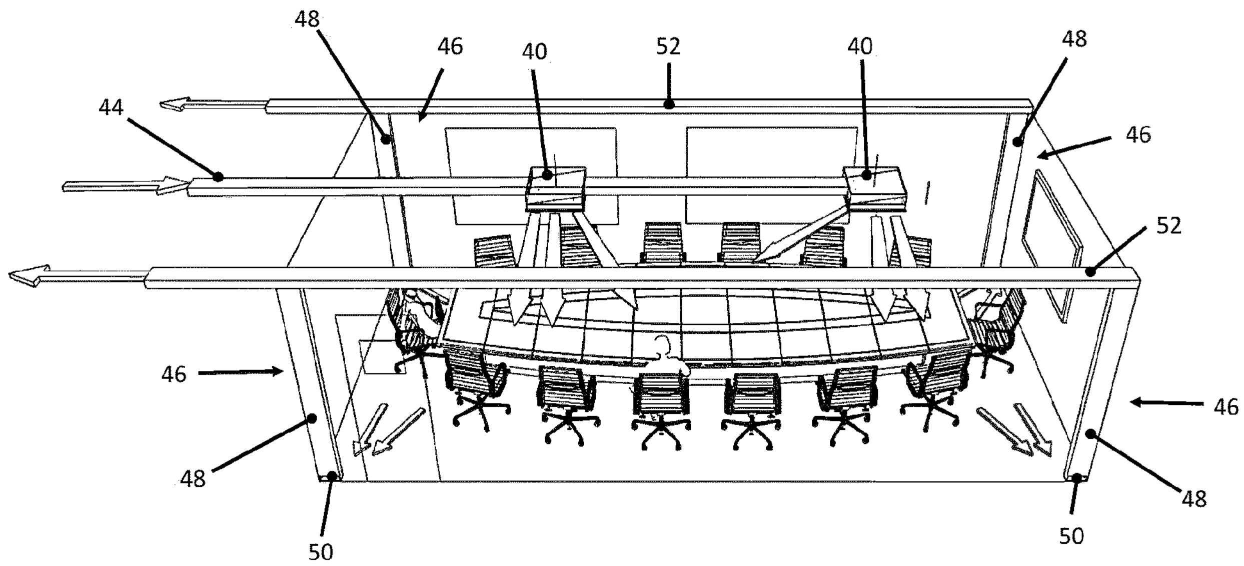

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 21 21 1292

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Place of search	Date of completion of the search	Examiner
Munich	22 March 2022	Blot, Pierre-Edouard

CATEGORY OF CITED DOCUMENTS

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