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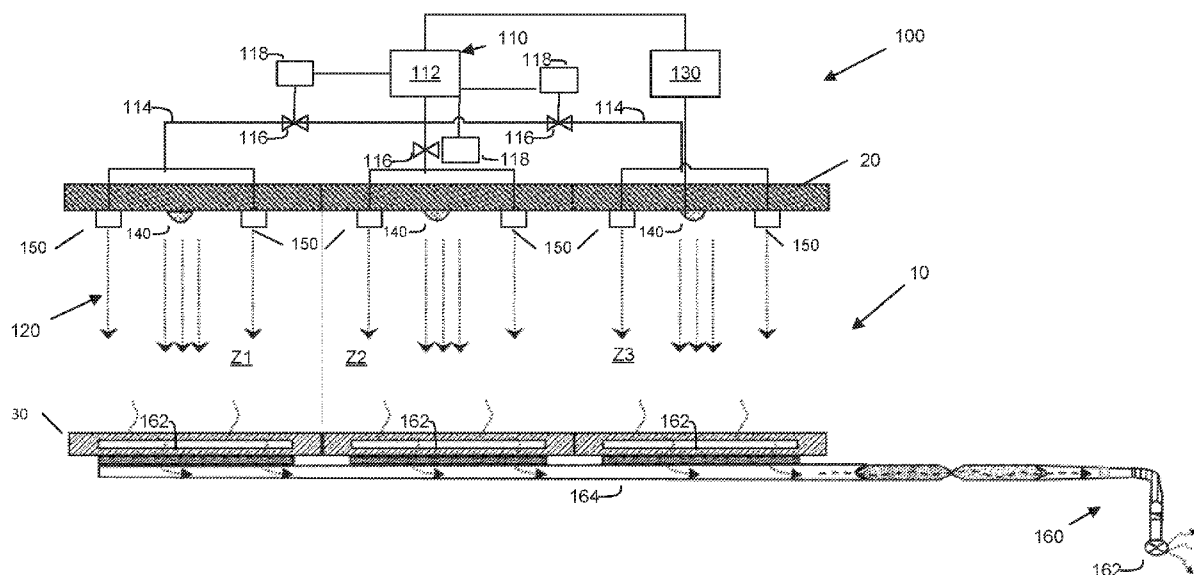


FIG. 1

(57) Abstract: An air cleaning system includes an ionizing system, a sensor system, and a controller operably coupled to the sensor system and the ionizing system. The ionizing system is configured to introduce a flow of ionized air into a room. The ionizing system is configured to ionize air. The ionizing system includes a plurality of inlets and air is introduced into the room through the plurality of inlets. The sensor system is configured to detect the presence of an occupant at a location in the room. The controller is configured to alter the flow of air at one or more of the plurality of inlets corresponding to the location of the occupant in the room.

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INDOOR AIR CLEANING SYSTEM AND METHOD

The present disclosure relates to an indoor air cleaning system and method. The present disclosure relates to an indoor air cleaning system with occupancy detection and a method of altering air cleaning based on the presence of people. The present disclosure relates to an indoor air cleaning system that introduces ionized air through the ceiling of a room and removes ionized air through a floor of the room.

A number of systems exist for removing particles from indoor air. Such systems may include high-efficiency particulate air (HEPA) filters, air curtains or laminar flow apparatuses, or other known apparatuses or components. These existing systems tend to require frequent maintenance or replacement of filtering components due to clogged or decreased filtering efficiency over time. Maintenance or replacing filtering components may be time consuming and costly and significantly interrupt the functionality of a clean room.

Other systems for removing particles from indoor air may include ionizers that ionize air. Ionizer-based systems tend to require less maintenance and less part replacement than filter-based systems. However, ionizer-based systems tend to result in drawbacks associated with particles that precipitate when ionized. For example, frequent cleaning of the floor to remove the precipitated ionized particles may be needed to prevent the precipitated particles from being returned to the air due to movement in the room. In addition, the act of cleaning, whether manual or robotic, may disturb the particles and reintroduce the particles into the air.

It is desirable to provide indoor air cleaning based on the presence or absence of people inside the space receiving the cleaned air. It is desirable to provide indoor air cleaning based on a location of any people present inside the space receiving the cleaned air, so that the air cleaning or air movement may be optimized. It is desirable to provide an indoor air cleaning system or method that mitigates or prevents occupant exposure to ionized air.

According to an aspect of the present invention, there is provided an air cleaning system comprising: an ionizing system, a sensor system, and a controller operably coupled to the sensor system and the ionizing system. The ionizing system is configured to introduce a flow of ionized air into a room. The ionizing system is configured to ionize air. The ionizing system includes a plurality of inlets and air is introduced into the room through the plurality of inlets. The sensor system is configured to detect the presence of an occupant at a location in the room. The controller is configured to alter the flow of air at one or more of the plurality of inlets corresponding to the location of the occupant in the room.

According to an aspect of the present invention, there is provided an air cleaning system comprising: an ionizing system configured to introduce a flow of ionized air into a room through a

plurality of inlets positioned at a ceiling of the room; and a ventilation system configured to vent the flow of ionized air from the room through a plurality of outlets positioned at a floor of the room.

According to an aspect of the present invention, there is provided a method comprising: introducing a flow of ionized air into a room through a plurality of inlets; detecting a presence of an occupant at a location in the room; and altering the flow of ionized air into the room through one or more of the plurality of inlets corresponding to the location of the occupant in the room.

Advantageously, the disclosed system and method may reduce reintroduction of precipitated particles into the air, which may be associated with use of currently available ionizer-based filtration systems. Advantageously, the use of sensors to detect the position and movement of people or occupants in the room to selectively inactivate portions of the ionization system aids in minimizing reintroducing of precipitated particles into the air. Advantageously, the use of sensors to detect the position and thus movement of people or occupants in the room to selectively inactivate portions of the ionization system aids in reducing or minimizing occupant exposure of ionized air.

This disclosure is directed to an indoor air cleaning system with occupancy detection and a method of altering air cleaning based on the presence of people. The present disclosure relates to an indoor air cleaning system that introduces ionized air through the ceiling of a room and removes ionized air through a floor of the room.

The air cleaning system may provide a “smart” ventilation array to a room. An ionizing system is configured to flow ionized air into the room. A sensor system in the room may detect the presence or absence of an occupant in the room. A controller is operably coupled to the sensor system and the ionizing system. The controller is configured to cause the ionizing system to alter the flow of ionized air into the room based on the presence or absence of an occupant in the room.

The air cleaning system may provide a “smart” ventilation array to two or more rooms, or a plurality of rooms. An ionizing system is configured to flow ionized air into the rooms. A sensor system in each of the rooms may detect the presence or absence of an occupant or occupants in the two or more rooms, or plurality of rooms. A controller is operably coupled to the sensor system and the ionizing system. The controller is configured to cause the ionizing system to alter the flow of ionized air into each of the rooms based on the presence or absence of an occupant in each of the specific rooms.

The controller may be configured to cause the ionizing system to continue introducing the flow of air at one or more of the plurality of inlets corresponding to a location at which the occupant is not present. The controller is operably coupled to the ionizing system. The controller may be configured to cause the ionizing system to reduce or stop an amount of ionization of air corresponding to the location of the occupant in the room.

Preferably the flow ionized air into the room enters the room through an inlet on the ceiling and exits the room through an outlet on the floor and flow from the inlet to the outlet with a generally laminar flow of air forming an “air curtain” between the corresponding inlet and outlet. This “air curtain” quickly replaces itself as air flow with little turbulence between the inlet and outlet. One or more inlet and outlet pairs may form two or more zones that may be selectively and independently controlled with the air cleaning system. Thus, air flow characteristics in each of the zones forming a room may be selectively and independently controlled with the air cleaning system.

The plurality of inlets may be grouped into two or more zones. The room may be defined by at least 2 zones, or at least 3 zones, or at least 4 zones, or at least 5 zones, or at least 10 zones, or at least 15 zones, or at least 20 zones, or at least 25 zones, or at least 30 zones, or from 2 to 30 zones, or from 3 to 25 zones, or from 4 to 20 zones, or from 5 to 15 zones, or from 5 to 10 zones.

The controller may be configured to cause the ionizing system to reduce or stop an amount of ionization of air to one or more zones corresponding to the location of the occupant in the room. The controller may be configured to cause the ionizing system to continue an amount of ionization of air at one or more zones corresponding to a location at which the occupant is not present.

Each zone may include a separate ionizing source. Each ionizing source may be operably coupled to the controller. The controller may be configured to alter an amount of ionization of air independently of each ionizing source.

The air cleaning system may reduce or stop the flow of ionized air into the room based on the presence of an occupant in the room. The air cleaning system may maintain or increase the flow of ionized air into the room based on the absence of an occupant in the room.

The air cleaning system may selectively alter the flow of ionized air into one or more of a plurality of zones defining the interior volume of the room. The air cleaning system may selectively alter the flow of ionized air into one or more of a plurality of zones based on the presence or absence of an occupant in the room and based on a location of the occupant in the room.

The air cleaning system may detect the presence of an occupant in a zone, forming an occupied zone. The air cleaning system may interrupt or reduce or stop the flow of ionized air into the occupied zone. The air cleaning system may maintain or reduce (to a lesser degree than flow the occupied zone) the flow of ionized air or the amount of ionization of the air into the zones that are not occupied.

For example, the air cleaning system detects the presence of an occupant in a zone, forming an occupied zone. The air cleaning system reduces or stops the flow of ionized air or the amount of ionization of the air into the occupied zone. The air cleaning system maintains the flow of ionized air or the amount of ionization of the air into the zones that are not occupied.

In another example, the air cleaning system detects the presence of an occupant in a zone, forming an occupied zone. The air cleaning system reduces or stops the flow of ionized air or the amount of ionization of the air into the occupied zone. The air cleaning system reduces the flow of ionized air or the amount of ionization of the air into the zones that are directly adjacent or contacting the occupied zone. The air cleaning system maintains the flow of ionized air or the amount of ionization of the air into the zones that are not occupied and the zones that are not directly adjacent or contacting the occupied zone.

In another example, the air cleaning system detects the presence of an occupant in a zone, forming an occupied zone, and may anticipate the movement of the occupant and further alter the flow of ionized air or amount of ionization of the air in the zone or zones where the system anticipates the occupant to move into from the occupied zone.

For example, in a clean room, some processes have an occupant to do a set number of processes in a specific order, because the process units are at fixed locations, the motion path of the occupant may be predefined as he or she will always go from unit one to unit two after having completed the work at the unit. Therefore, the system could already have a map ready and once the occupant moves away from station one, it automatically clears the path to unit two and any further units. This may also be triggered by a user, or automatically by the unit the occupant currently uses, like hitting a button or the unit being aware that the process has finished, thus indicating to the controller that it is likely that the occupant will move to the next station in a few moments, enough time to “clear the path” to the next station.

The air cleaning system may detect the presence of more than one occupant in the room. The air cleaning system may detect the presence of two or more occupants in a zone or two or more zones, forming an occupied zone, or occupied zones. The air cleaning system may interrupt or reduce or stop the flow of ionized air or the amount of ionization of the air into the occupied zone, or occupied zones. The air cleaning system may maintain or reduce (to a lesser degree than flow the occupied zone, or occupied zones) the flow of ionized air or the amount of ionization of the air into the zones that are not occupied.

For example, the air cleaning system detects the presence of two or more occupants in a zone, or two or more zones, forming an occupied zone or occupied zones. The air cleaning system reduces or stops the flow of ionized air or the amount of ionization of the air into the occupied zone, or occupied zones. The air cleaning system maintains the flow of ionized air or the amount of ionization of the air into the zones that are not occupied.

In another example, the air cleaning system detects the presence of two or more occupants in a zone, or two or more zones, forming an occupied zone, or occupied zones. The air cleaning system reduces or stops the flow of ionized air or the amount of ionization of the air into the occupied zone, or occupied zones. The air cleaning system reduces the flow of ionized

air or the amount of ionization of the air into the zones that are directly adjacent or contacting the occupied zone, or occupied zones. The air cleaning system maintains the flow of ionized air or the amount of ionization of the air into the zones that are not occupied and the zones that are not directly adjacent or contacting the occupied zone, or occupied zones.

5 The air cleaning system includes an ionizing system configured to introduce a flow of ionized air into a room through a plurality of inlets; a sensor system configured to detect the presence of an occupant at a location in the room; and a controller operably coupled to the sensor system and the ionizing system. The controller is configured to alter the flow of ionized air at one or more of the plurality of inlets corresponding to the location of the occupant in the room.

10 The ionizing system may include one or more ionization sources to form the flow of ionized air. Ionization sources create ions which attach themselves to dust and dirt particles. The charged particles precipitate out of the air flow and fall onto a collection surface. The air cleaning system precipitates particles and these particles fall to the floor of the room.

 The air cleaning system described includes air flow outlets that are preferably formed
15 through the floor of the room. These air flow outlets draw the precipitated particles out of the room and may prevent these precipitated particles from collecting on the floor of the room and may prevent or mitigate re-entrainment of the precipitated particles back into the air space of the room.

 The controller may be configured to cause the ionizing system to continue introducing the flow of ionized air at one or more of the plurality of inlets corresponding to a location at which the
20 occupant is not present. The controller may be configured to cause the ionizing system to reduce or stop the flow of ionized air at one or more of the plurality of inlets corresponding to a location at which the occupant is present. The inlets are preferably located in the ceiling of the room.

 The sensor system may include a sensor configured to detect presence of an occupant or motion in the room. The sensor may be a motion or pressure sensor. The pressure sensor may
25 be located at the floor of the room and detect the weight of an occupant in the room. Preferably the sensor comprises an infrared motion sensor.

 The sensor system includes two or more sensors. The sensor system may include a plurality of sensors forming an array of sensors. The array of sensors may be configured to detect location or movement of an occupant within the room. For example, one sensor may monitor one
30 zone and each sensor in the array of sensors monitor a corresponding zone. Each sensor in the array of sensors is operably coupled to the controller and ionizing system to alter the flow of ionized air at one or more of zones corresponding to the location of the occupant or occupants in the room.

 Preferably, the flow of ionized air flow to each zone forming the total room volume is
35 independently controllable. Each zone may have an ionization system operably coupled to the controller to alter the flow of ionized air to specified zone or zones.

Alternatively, the air cleaning system may have a single ionization system providing the flow of ionized air and single ionization system is in airflow communication with the plurality of inlets providing the flow of ionized air to the room. The single ionization system includes a plurality of air ducts, where each air duct is independently coupled to one or more of the plurality of inlets.

5 The plurality of inlets may be grouped into sectors and referred to herein as “zones”. The one or more of the plurality of inlets that to which each air duct is coupled are in a separate zone.

The ionizing system may include a plurality of baffles. Each air duct may be operably coupled to a baffle. The baffle may be operably coupled to the controller. The controller may be configured to move the baffle from a first position that permits air flow through the one or more of
10 the plurality of inlets to which the air duct is coupled to a second position that restricts air flow through the one or more of the plurality of inlets to which the air duct is coupled.

The ionizing system may include a plurality of motors. Each motor may be operably coupled to one of the plurality of baffles. The controller may be operably coupled to each motor to cause the baffle to move from the first position to the second position and from the second
15 position to the first position.

The air cleaning system may include a ventilation system to remove air or ionized air (and precipitated particles) from the room. The ventilation system may include a plurality of outlets through which the flow of ionized air is vented from the room. The plurality of outlets is preferably located or defined on the floor of the room.

20 The controller may be operably coupled to the ventilation system. The controller may be configured to cause the ventilation system to reduce or stop the flow of air through one or more of the plurality of outlets corresponding to the location of the occupant in the room. The controller may be configured to cause the ventilation system to continue the flow of air from the room through one or more of the plurality of outlets corresponding to a location at which the occupant
25 is not present.

The air cleaning system may detect the presence of an occupant in a zone, forming an occupied zone. The air cleaning system may interrupt or reduce or stop the flow of air out of the occupied zone. The air cleaning system may maintain or reduce (to a lesser degree than flow the occupied zone) the flow of air out of the zones that are not occupied.

30 For example, the air cleaning system detects the presence of an occupant in a zone, forming an occupied zone. The air cleaning or ventilation system reduces or stops the flow of air out of the occupied zone. The air cleaning or ventilation system maintains the flow of air out of the zones that are not occupied.

In another example, the air cleaning system or ventilation system detects the presence of
35 an occupant in a zone, forming an occupied zone. The air cleaning system or ventilation system reduces or stops the flow of air out of the occupied zone. The air cleaning system or ventilation

system reduces the flow of air out of the zones that are directly adjacent or contacting the occupied zone. The air cleaning system or ventilation system maintains the flow of air out of the zones that are not occupied and the zones that are not directly adjacent or contacting the occupied zone.

5 The air cleaning system or ventilation system may detect the presence of more than one occupant in the room. The air cleaning system or ventilation system may detect the presence of two or more occupants in a zone or two or more zones, forming an occupied zone, or occupied zones. The air cleaning system or ventilation system may interrupt or reduce or stop the flow of air out of the occupied zone, or occupied zones. The air cleaning system or ventilation system
10 may maintain or reduce (to a lesser degree than flow the occupied zone, or occupied zones) the flow of air out of the zones that are not occupied.

 For example, the air cleaning system or ventilation system detects the presence of two or more occupants in a zone, or two or more zones, forming an occupied zone or occupied zones. The air cleaning system or ventilation system reduces or stops the flow of air out of the occupied
15 zone, or occupied zones. The air cleaning system maintains the flow of air out of the zones that are not occupied.

 The ventilation system may include a plurality of vent air ducts. Each vent air duct may be independently coupled to one or more of the plurality of outlets. Preferably the outlets are formed or defined in the floor of the room. Preferably the ventilation system includes a floor tile defining
20 one or more of the plurality of outlets. Preferably the one or more of the plurality of outlets are defined by gaps between adjacent floor tiles.

 The ventilation system may have a vacuum system providing the flow of air out of the room. The vacuum system is in airflow communication with the plurality of outlets providing the flow of air out of the room. The ventilation system may include a plurality of air ducts, where each
25 air duct is independently coupled to one or more of the plurality of outlets. The plurality of outlets may be grouped into sectors and referred to as “zones”, as described above. The one or more of the plurality of outlets that to which each air duct is coupled are in a separate zone.

 The ventilation system may include a plurality of baffles. Each air duct may be operably coupled to a baffle. The baffle may be operably coupled to the controller. The controller may be
30 configured to move the baffle from a first position that permits air flow through the one or more of the plurality of outlets to which the air duct is coupled to a second position that restricts air flow through the one or more of the plurality of outlets to which the air duct is coupled.

 The ventilation system may include a plurality of motors. Each motor may be operably coupled to one of the plurality of baffles. The controller may be operably coupled to each motor
35 to cause the baffle to move from the first position to the second position and from the second position to the first position.

In another aspect, the air cleaning system includes: an ionizing system configured to introduce a flow of ionized air into a room through a plurality of inlets positioned at a ceiling of the room; and a ventilation system configured to vent the flow of ionized air from the room through a plurality of outlets positioned at a floor of the room.

5 The ventilation system includes a floor tile defining one or more of the plurality of outlets. The one or more of the plurality of outlets are defined by gaps between adjacent floor tiles.

The ventilation system comprises a vacuum pump operably coupled to the plurality of outlets. The vacuum pump is configured to vent the flow of air from the room through the outlets.

10 In another aspect, a method includes: introducing a flow of ionized air into a room through a plurality of inlets; detecting a presence of an occupant at a location in the room; and altering the flow of ionized air into the room through one or more of the plurality of inlets corresponding to the location of the occupant in the room.

15 The detecting step may include detecting a presence of an occupant, and if the presence of the occupant is detected, then detecting the location of the occupant in the room. The detecting step may utilize the array of sensors described above. The sensor system or array of sensors are may be located on the ceiling of the room. The sensor system or array of sensors preferably include at least one sensor located in each zone of the room being monitored.

20 The altering step may include reducing the flow of ionized air into the room through one or more of the plurality of inlets corresponding to the location of the occupant in the room. The altering step may include stopping the flow of ionized air or ionization of the air into the room through one or more of the plurality of inlets corresponding to the location of the occupant in the room.

25 The detecting and altering steps may be repeated a plurality of times during a time interval. For example, the detecting and altering steps are repeated at least 4 times during a one-hour time interval. For example, the detecting and altering steps are repeated at least 12 times or at least 30 times, or at least 60 times during a one-hour time interval. The detecting and altering steps may be constantly repeated. Thus, the air cleaning system may dynamically alter the flow of ionized air into each of the zones of the room as the system monitors and detects an occupant and the movement of the occupant within the room.

30 The method may further include continuing to introduce the flow of ionized air through one or more of the plurality of inlets corresponding to a location at which the occupant is not present, as described above. The method may further include venting the flow of air from the room through a plurality of outlets, as described above.

35 The method may further include reducing the flow of air from the room at one or more of the plurality of outlets corresponding to the location of the occupant in the room. The method may further include stopping the flow of air from the room at one or more of the plurality of outlets

corresponding to the location of the occupant in the room. The method may further include continuing to vent the flow of air from the room through one or more of the plurality of outlets corresponding to a location at which the occupant is not present.

5 The plurality of outlets are preferably located at a floor of the room. The one or more inlets are preferably located at a ceiling of the room.

The method may further include increasing the flow of ionized air into the room or increasing an amount of ionization energy applied to air entering the room, through one or more of the plurality of inlets if an occupant is not detected in the room.

10 All values reported as a percentage are presumed to be weight percent based on the total weight.

All scientific and technical terms used herein have meanings commonly used in the art unless otherwise specified. The definitions provided herein are to facilitate understanding of certain terms used frequently herein.

15 As used herein, the singular forms "a", "an", and "the" encompass embodiments having plural referents, unless the content clearly dictates otherwise.

As used herein, "or" is generally employed in its sense including "and/or" unless the content clearly dictates otherwise. The term "and/or" means one or all of the listed elements or a combination of any two or more of the listed elements.

20 As used herein, "have", "having", "include", "including", "comprise", "comprising" or the like are used in their open-ended sense, and generally mean "including, but not limited to". It will be understood that "consisting essentially of", "consisting of", and the like are subsumed in "comprising," and the like.

25 The words "preferred" and "preferably" refer to embodiments of the invention that may afford certain benefits, under certain circumstances. However, other embodiments may also be preferred, under the same or other circumstances. Furthermore, the recitation of one or more preferred embodiments does not imply that other embodiments are not useful and is not intended to exclude other embodiments from the scope of the disclosure, including the claims.

30 The term "substantially" as used here has the same meaning as "significantly," and can be understood to modify the relevant term by at least about 90 percent, at least about 95 percent, or at least about 98 percent. The term "not substantially" as used here has the same meaning as "not significantly," and can be understood to have the inverse meaning of "substantially," i.e., modifying the relevant term by not more than 10 percent, not more than 5 percent, or not more than 2 percent.

35 The invention is defined in the claims. However, below there is provided a non-exhaustive listing of non-limiting examples. Any one or more of the features of these examples may be

combined with any one or more features of another example, embodiment, or aspect described herein.

Example Ex1. An air cleaning system comprising: an ionizing system configured to introduce a flow of ionized air into a room, wherein the ionizing system is configured to ionize air, wherein the ionizing system comprises a plurality of inlets and wherein air is introduced into the room through the plurality of inlets; a sensor system configured to detect the presence of an occupant at a location in the room; and a controller operably coupled to the sensor system and the ionizing system, wherein the controller is configured to alter the flow of air at one or more of the plurality of inlets corresponding to the location of the occupant in the room.

Example Ex2. The air cleaning system of Ex1, wherein the controller is configured to cause the ionizing system to continue introducing the flow of air at one or more of the plurality of inlets corresponding to a location at which the occupant is not present.

Example Ex3. The air cleaning system according to any preceding Example, wherein the controller is operably coupled to the ionizing system, and wherein the controller is configured to cause the ionizing system to reduce or stop an amount of ionization of air corresponding to the location of the occupant in the room.

Example Ex4. The air cleaning system of any preceding Example, wherein the plurality of inlets is grouped into two or more zones.

Example Ex5. The air cleaning system of Ex4, wherein the room defines at least 2 zones, or at least 3 zones, or at least 4 zones, or at least 5 zones, or at least 10 zones, or at least 15 zones, or at least 20 zones, or at least 25 zones, or at least 30 zones, or from 2 to 30 zones, or from 3 to 25 zones, or from 4 to 20 zones, or from 5 to 15 zones, or from 5 to 10 zones.

Example Ex6. The air cleaning system of Ex4 or Ex5, wherein the controller is configured to cause the ionizing system to reduce or stop an amount of ionization of air to one or more zones corresponding to the location of the occupant in the room.

Example Ex7. The air cleaning system of any of Ex4 to Ex6, wherein the controller is configured to cause the ionizing system to continue an amount of ionization of air at one or more zones corresponding to a location at which the occupant is not present.

Example Ex8. The air cleaning system of any of Ex4 to Ex7, wherein each zone comprises an ionizing source and each ionizing source is operably coupled to the controller, wherein the controller is configured to alter an amount of ionization of air independently of each ionizing source.

Example Ex9. The air cleaning system of any preceding Example, wherein the ionizing system comprises a plurality of air ducts, each air duct independently coupled to one or more of the plurality of inlets.

Example Ex10. The air cleaning system of Ex9, wherein the ionizing system comprises a plurality of baffles, wherein each air duct is operably coupled to a baffle, wherein the baffle is operably coupled to the controller, and wherein the controller is configured to move the baffle from a first position that permits air flow through the one or more of the plurality of inlets to which the air duct is coupled to a second position that restricts air flow through the one or more of the plurality of inlets to which the air duct is coupled.

Example Ex11. The air cleaning system of Ex10, wherein the ionizing system comprises a plurality of motors, wherein each motor is operably coupled to one of the plurality of baffles, and wherein the controller is operably coupled to each motor to cause the baffle to move from the first position to the second position and from the second position to the first position.

Example Ex12. The air cleaning system of any preceding Example, wherein the plurality of inlets is positioned at a ceiling of the room.

Example Ex13. The air cleaning system of any preceding Example, further comprising a ventilation system comprising a plurality of outlets through which air is vented from the room.

Example Ex14. The air cleaning system of Ex13, wherein the plurality of outlets is grouped into two or more zones.

Example Ex15. The air cleaning system of Ex14, wherein the two or more zones correspond to the two or more zones formed by the plurality of inlets.

Example Ex16. The air cleaning system of Ex13, wherein the controller is operably coupled to the ventilation system, and wherein the controller is configured to cause the ventilation system to reduce or stop the flow of air through one or more of the plurality of outlets corresponding to the location of the occupant in the room.

Example Ex17. The air cleaning system of Ex16, wherein the controller is configured to cause the ventilation system to continue the flow of air from the room through one or more of the plurality of outlets corresponding to a location at which the occupant is not present.

Example Ex18. The air cleaning system of Ex14 or Ex15, wherein the controller is operably coupled to the ventilation system, and wherein the controller is configured to cause the ventilation system to reduce or stop the flow of air through one or more zones corresponding to the location of the occupant in the room.

Example Ex19. The air cleaning system of Ex18, wherein the controller is configured to cause the ventilation system to continue the flow of air from the room through one or more zones corresponding to a location at which the occupant is not present.

Example Ex20. The air cleaning system of any of Ex13 to Ex19, wherein the ventilation system comprises a plurality of vent air ducts, each vent air duct independently coupled to one or more of the plurality of outlets.

Example Ex21. The air cleaning system of Ex20, wherein the plurality of outlets is grouped into zones, and wherein the one or more of the plurality of outlets that to which each air duct is coupled are in a separate zone.

Example Ex22. The air cleaning system of Ex20 or Ex21, wherein the ventilation system comprises a plurality of baffles, wherein each vent air duct is operably coupled to a baffle, wherein the baffle is operably coupled to the controller, and wherein the controller is configured to move the baffle from a first position that permits air flow through the one or more of the plurality of outlets to which the air duct is coupled to a second position that restricts the flow of air through the one or more of the plurality of outlets to which the air duct is coupled.

Example Ex23. The air cleaning system of Ex22, wherein the ventilation system comprises a plurality of motors, wherein each motor is operably coupled to one of the plurality of baffles, and wherein the controller is operably coupled to each motor to cause the baffle to move from the first position to the second position and from the second position to the first position.

Example Ex24. The air cleaning system of any of Ex13 to Ex23, wherein the plurality of outlets is positioned at a floor of the room.

Example Ex25. The air cleaning system of Ex24, wherein the ventilation system comprises a floor tile defining one or more of the plurality of outlets.

Example Ex26. The air cleaning system of Ex25, wherein one or more of the plurality of outlets are defined by gaps between adjacent floor tiles.

Example Ex27. The air cleaning system of any of Ex13 to Ex26, wherein the ventilation system comprises a vacuum pump operably coupled to the plurality of outlets.

Example Ex28. The air cleaning system of any preceding Example, wherein the sensor system comprises a sensor configured to detect motion in the room.

Example Ex29. The air cleaning system of Ex28, wherein the sensor comprises an infrared motion sensor.

Example Ex30. The air cleaning system of any preceding Example, wherein the sensor system comprises a pressure sensor configured to detect an occupant in the room.

Example Ex31. An air cleaning system comprising: an ionizing system configured to introduce a flow of ionized air into a room through a plurality of inlets positioned at a ceiling of the room; and a ventilation system configured to vent the flow of ionized air from the room through a plurality of outlets positioned at a floor of the room.

Example Ex32. The air cleaning system according to Ex31, wherein the ventilation system comprises a floor tile defining one or more of the plurality of outlets.

Example Ex33. The air cleaning system according to Ex31 or Ex32, wherein one or more of the plurality of outlets are defined by gaps between adjacent floor tiles.

Example Ex34. The air cleaning system of any of Ex31 to Ex33, wherein the ventilation system comprises a vacuum pump operably coupled to the plurality of outlets, the vacuum pump is configured to vent air from the room through the outlets.

5 Example Ex35. A method comprising: introducing a flow of ionized air into a room through a plurality of inlets; detecting a presence of an occupant at a location in the room; and altering the flow of ionized air into the room through one or more of the plurality of inlets corresponding to the location of the occupant in the room.

Example Ex36. The method according to Ex35, wherein the detecting step comprises detecting a presence of an occupant, and if the presence of the occupant is detected, then
10 detecting the location of the occupant in the room.

Example Ex37. The method according to Ex35 or Ex36, wherein the altering step comprises reducing the flow of ionized air into the room through one or more of the plurality of inlets corresponding to the location of the occupant in the room.

Example Ex38. The method according to Ex35 or Ex37, wherein the altering step
15 comprises stopping the flow of ionized air into the room through one or more of the plurality of inlets corresponding to the location of the occupant in the room.

Example Ex39. The method according to any of Ex35 to Ex38, wherein the detecting and altering steps are repeated a plurality of times during a time interval.

Example Ex40. The method according to Ex39, wherein the detecting and altering steps
20 are repeated at least 4 times during a one-hour time interval.

Example Ex41. The method according to any of Ex35 to Ex40, further comprising continuing to introduce the flow of ionized air through one or more of the plurality of inlets corresponding to a location at which the occupant is not present.

Example Ex42. The method according to any of Ex35 to Ex41, further comprising venting
25 the flow of ionized air from the room through a plurality of outlets.

Example Ex43. The method according to Ex42, further comprising reducing the flow of air from the room at one or more of the plurality of outlets corresponding to the location of the occupant in the room.

Example Ex44. The method according to Ex42, further comprising stopping the flow of air
30 from the room at one or more of the plurality of outlets corresponding to the location of the occupant in the room.

Example Ex45. The method according to Ex43 or Ex44, further comprising continuing to vent air from the room through one or more of the plurality of outlets corresponding to a location at which the occupant is not present.

35 Example Ex46. The method according to any of Ex42 to Ex45, wherein the plurality of outlets is located at a floor of the room.

Example Ex47. The method according to any of Ex35 to Ex46, wherein the one or more inlets are located at a ceiling of the room.

Example Ex48. The method according to any of Ex35 to Ex47, further comprising increasing the flow of ionized air into the room or increasing an amount of ionization energy applied to air entering the room, through one or more of the plurality of inlets if an occupant is not detected in the room.

Example Ex49. The method according to any one of claims 35 to 48, wherein a controller is operably coupled to the ionizing system, and wherein the controller is configured to cause the ionizing system to reduce or stop the amount of ionization of air corresponding to the location of the occupant in the room.

Example Ex50. The method according to any one of claims 35 to 49, wherein altering step altering the flow of ionized air into the room through one or more of the plurality of inlets corresponding to a trajectory of the occupant in the room based on the location of the occupant in the room and movement detected of the occupant in the room.

The Examples will now be further described with reference to the figures in which:

FIG. 1 is a side elevation schematic diagram of an illustrative air cleaning system; and

FIG. 2 is a perspective view schematic diagram of an illustrative air cleaning system.

The schematic drawings are not necessarily to scale and are presented for purposes of illustration and not limitation. The drawings depict one or more aspects described in this disclosure. However, it will be understood that other aspects not depicted in the drawing fall within the scope and spirit of this disclosure.

FIG. 1 is a side elevation schematic diagram of an illustrative air cleaning system **100**. **FIG. 2** is a perspective view schematic diagram of an illustrative air cleaning system **100**. The air cleaning system **100** includes: an ionizing system **110** configured to introduce a flow of ionized air **120** into a room **10** through a plurality of inlets **150**; a sensor **140** system configured to detect the presence of an occupant at a location in the room **10**; and a controller **130** operably coupled to the sensor **140** system and the ionizing system **110**. The controller **130** is configured to alter the flow of ionized air **120** at one or more of the plurality of inlets **150** corresponding to the location of the occupant in the room **10**.

The room **10** includes a ceiling **20** defining an upper room boundary and a floor **30** defining a lower room boundary. The room **10** defines an open space having one or more, or two or more zones. Each zone may be defined by an area on the floor **30** and corresponding area on the ceiling **20**. The flow of ionized air **120** preferably enters the room from the ceiling **20** and exits the room through the floor **30**.

For example, **FIG. 2** illustrates a room **10** having eight zones. Zone 1 **Z1** is defined by floor area **31** and ceiling area **21**. Zone 2 **Z2** is defined by floor area **32** and ceiling area **22**. Zone

3 **Z3** is defined by floor area **33** and ceiling area **23**. Zone 4 is defined by floor area **34** and ceiling area **24**. Zone 5 is defined by floor area **35** and ceiling area **25**. Zone 6 is defined by floor area **36** and ceiling area **26**. Zone 7 is defined by floor area **37** and ceiling area **27**. Zone 8 is defined by floor area **38** and ceiling area **28**.

5 Each zone may preferably include a sensor **140**. The sensors **140** may form an array of sensors **140** to detect and monitor location and movement of an occupant in the room **10**. For example, **FIG. 2** illustrates a room **10** having eight sensors **140**. One sensor **140** per zone is illustrated.

10 The controller **130** may be configured to cause the ionizing system **110** to continue introducing the flow of ionized air **120** at one or more of the plurality of inlets **150** corresponding to a location or zone at which the occupant is not present. For example, if the sensor **140** system detects an occupant in Zone 1, the flow of ionized air **120** into a Zone 1 may be reduced or stopped, and the flow of ionized air **120** into an adjacent Zone 2 and adjacent Zone 8 may be reduced (in anticipation of movement of the occupant) or maintained, and the flow of ionized air
15 **120** into the remaining Zones 3-7 may be maintained.

20 The ionizing system **110** may include an ionizing source **112**. The ionizing system **110** may include a plurality of air ducts **114**. Each air duct **114** may be independently coupled to one or more of the plurality of inlets **150**. The plurality of inlets **150** may be grouped into zones, and the one or more of the plurality of inlets **150** that to which each air duct **114** is coupled are in a separate zone.

25 The ionizing system **110** may include a plurality of baffles **116** to control the air flow through the air ducts **114**. Each air duct **114** may be operably coupled to a baffle **116**. The baffle **116** may be operably coupled to the controller **130**. The controller **130** may be configured to move the baffle **116** from a first position that permits air flow through the one or more of the plurality of
30 inlets **150** to which the air duct **114** is coupled to a second position that restricts air flow through the one or more of the plurality of inlets **150** to which the air duct **114** is coupled. The ionizing system **110** may include a plurality of motors **118**. Each motor **118** may be operably coupled to one of the plurality of baffles **116**, and the controller **130** may be operably coupled to each motor **118** to cause the baffle **116** to move from the first position to the second position and from the
30 second position to the first position.

35 The air cleaning system **100** may further include a ventilation system **160** including a plurality of outlets **164** through which the flow of ionized air **120** is vented from the room **10**. The controller **130** may be operably coupled to the ventilation system **160**. The controller **130** may be configured to cause the ventilation system **160** to stop the flow of ionized air **120** through one or
35 more of the plurality of outlets **164** corresponding to the location of the occupant in the room **10**. The controller **130** may be configured to cause the ventilation system **160** to continue the flow of

ionized air **120** from the room **10** through one or more of the plurality of outlets **164** corresponding to a location at which the occupant is not present in the room **10**. The plurality of outlets **164** are grouped into zones, as described above.

5 The ventilation system **160** may include a vacuum pump **162** operably coupled to the plurality of plurality of outlets **164**. As described above, the ventilation system **160** may be configured to selectively remove or vent the flow of ionized air **120** from zones that are not occupied and stop or reduce ventilation of the flow of ionized air **120** from zones that are occupied.

10 For the purpose of the present description and of the appended claims, except where otherwise indicated, all numbers expressing amounts, quantities, percentages, and so forth, are to be understood as being modified in all instances by the term “about.” Also, all ranges include the maximum and minimum points disclosed and include any intermediate ranges therein, which may or may not be specifically enumerated herein. In this context, therefore, a number A is understood as $A \pm 2$ percent of A. Within this context, a number A may be considered to include numerical values that are within general standard error for the measurement of the property that
15 the number A modifies. The number A, in some instances as used in the appended claims, may deviate by the percentages enumerated above provided that the amount by which A deviates does not materially affect the basic and novel characteristic(s) of the claimed invention. Also, all ranges include the maximum and minimum points disclosed and include any intermediate ranges therein, which may or may not be specifically enumerated herein.

CLAIMS

1. An air cleaning system comprising:

an ionizing system configured to introduce a flow of ionized air into a room, wherein the ionizing system is configured to ionize air, wherein the ionizing system comprises a plurality of inlets and wherein air is introduced into the room through the plurality of inlets;

a sensor system configured to detect a presence of an occupant at a location in the room; and

a controller operably coupled to the sensor system and the ionizing system, wherein the controller is configured to alter the flow of air at one or more of the plurality of inlets corresponding to the location of the occupant in the room.
2. The air cleaning system according to claim 1, wherein the controller is configured to cause the ionizing system to continue introducing the flow of air at one or more of the plurality of inlets corresponding to a location at which the occupant is not present.
3. The air cleaning system according to claim 1 or 2, wherein the ionizing system comprises a plurality of air ducts, each air duct independently coupled to one or more of the plurality of inlets, and the plurality of inlets are positioned at a ceiling of the room.
4. The air cleaning system according any preceding claim, further comprising a ventilation system comprising a plurality of outlets through which the flow of air is vented from the room, the plurality of outlets are positioned at a floor of the room.
5. The air cleaning system according to claim 4, wherein the controller is operably coupled to the ventilation system, and wherein the controller is configured to cause the ventilation system to reduce or stop the flow of air through one or more of the plurality of outlets corresponding to the location of the occupant in the room.
6. The air cleaning system according to claim 5, wherein the controller is configured to cause the ventilation system to continue the flow of air from the room through one or more of the plurality of outlets corresponding to a location at which the occupant is not present.

7. The air cleaning system according to any preceding claim, wherein the controller is operably coupled to the ionizing system, and wherein the controller is configured to cause the ionizing system to reduce or stop an amount of ionization of air corresponding to the location of the occupant in the room.
8. An air cleaning system comprising:
an ionizing system configured to introduce a flow of ionized air into a room through a plurality of inlets positioned at a ceiling of the room; and
a ventilation system configured to vent the flow of ionized air from the room through a plurality of outlets positioned at a floor of the room.
9. The air cleaning system according to claim 8, wherein the ventilation system comprises a floor tile defining one or more of the plurality of outlets.
10. A method comprising:
introducing a flow of ionized air into a room through a plurality of inlets;
detecting a presence of an occupant at a location in the room; and
altering the flow of ionized air into the room through one or more of the plurality of inlets corresponding to the location of the occupant in the room.
11. The method according to claim 10, wherein the detecting step comprises detecting a presence of an occupant, and if the presence of the occupant is detected, then detecting the location of the occupant in the room.
12. The method according to claim 10 or 11, wherein the altering step comprises reducing the flow of ionized air into the room through one or more of the plurality of inlets corresponding to the location of the occupant in the room.
13. The method according to any one of claims 10 to 12, further comprising continuing to introduce the flow of ionized air through one or more of the plurality of inlets corresponding to a location at which the occupant is not present.

14. The method according to any one of claims 10 to 14, further comprising reducing the flow of ionized air from the room at one or more outlets corresponding from a location at which the occupant is present, and continuing to vent the flow of ionized air from the room through one or more outlets corresponding from a location at which the occupant is not present.
15. The method according to any one of claims 10 to 14, wherein a controller is operably coupled to an ionizing system, and wherein the controller is configured to cause the ionizing system to reduce or stop an amount of ionization of air corresponding to the location of the occupant in the room.

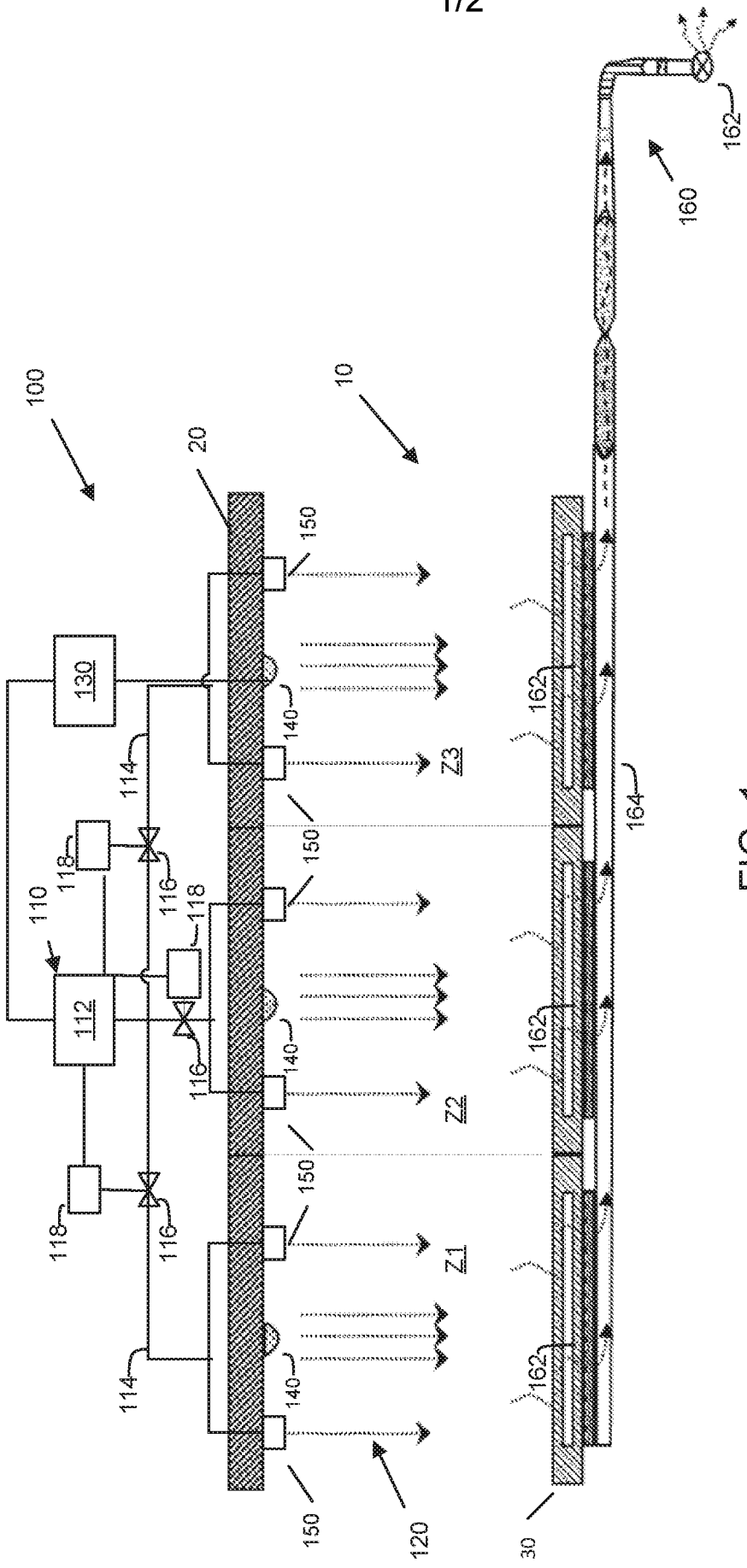


FIG. 1

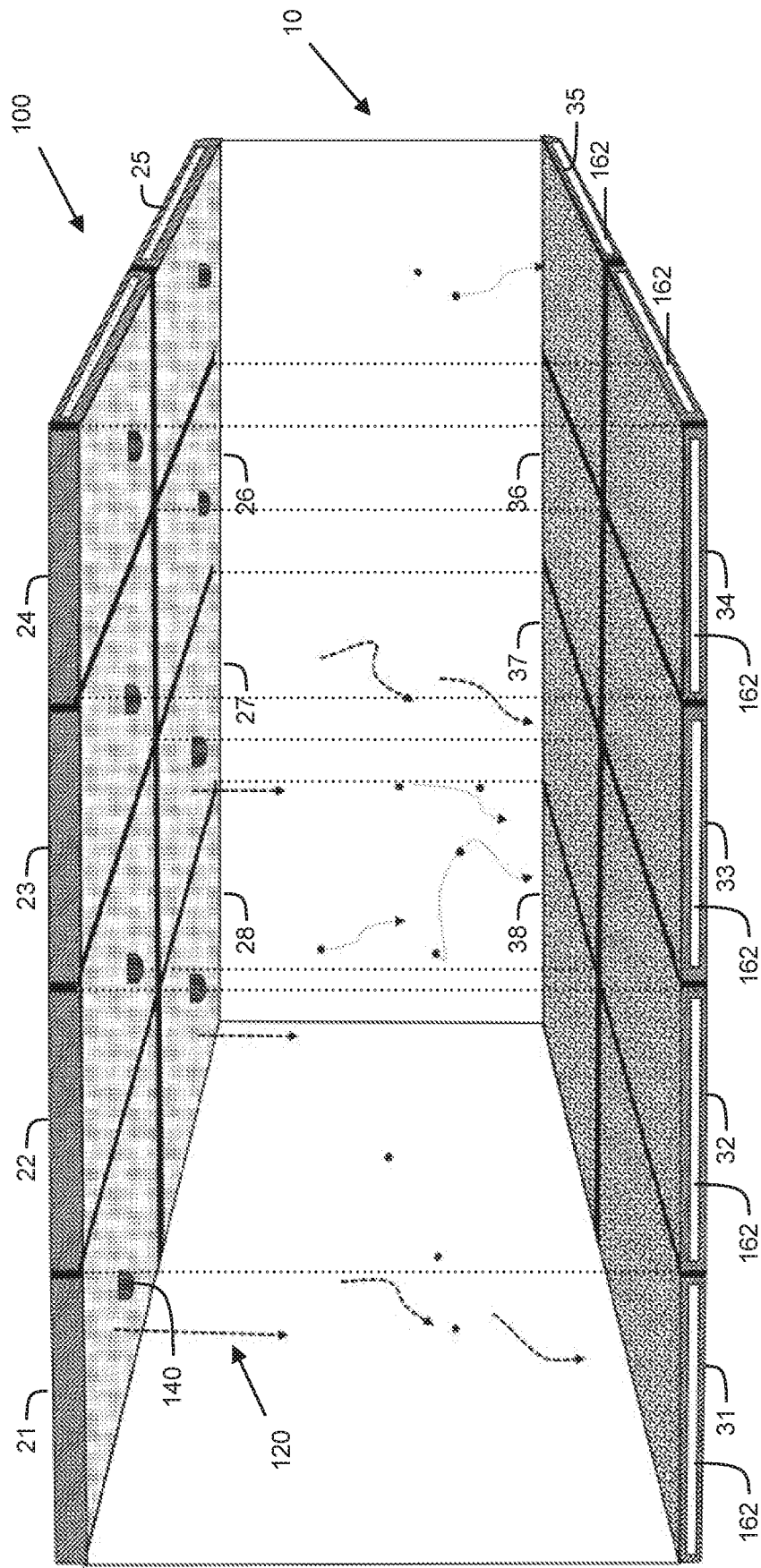


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2021/061862

A. CLASSIFICATION OF SUBJECT MATTER INV. F24F3/163 F24F7/06 F24F7/10 F24F8/30 F24F11/72 F24F11/74 F24F120/12 ADD. According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) F24F Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2004 108097 A (KAKUDAI KENCHIKU SEKKEI KENKYU) 8 April 2004 (2004-04-08)	8, 9
Y	paragraph [0007] - paragraph [0022]; figures 1-2 -----	1-7, 10-15
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Y	WO 2015/164599 A1 (FELLOWES INC [US]) 29 October 2015 (2015-10-29) paragraph [0010] - paragraph [0091]; figures 1-12 ----- -/--	1-7, 10-15
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 9 March 2022		Date of mailing of the international search report 23/03/2022
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Ast, Gabor

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2021/061862

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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