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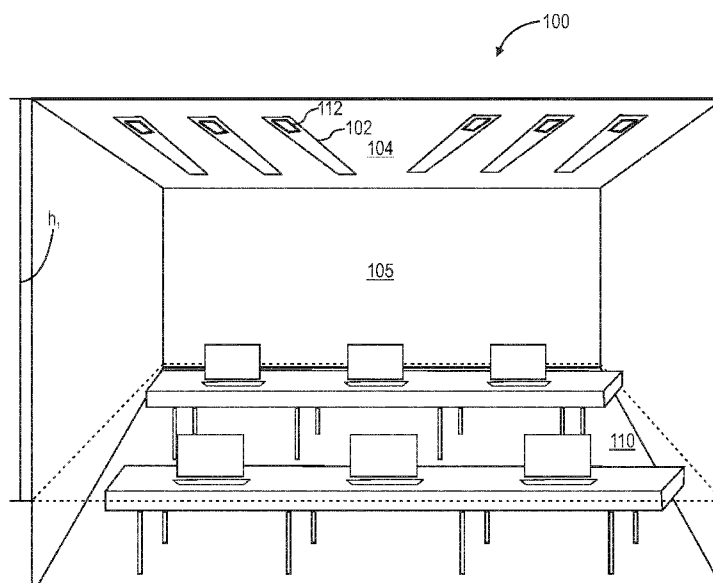


Fig. 1

(57) Abstract: A method (500) for providing air ionization in a lighttable environment. The method includes collocating (501) ion generating units with illumination devices within one or more illumination planes. At least one illumination device is configured to provide a lighting effect in a spatially separated plane and each ion generating unit is configured to provide ions in the air surrounding the spatially separated plane and on at least one surface in the spatially separated plane. The method further includes generating (502) the ions at a first level of operation to generate a first density of ions; receiving (503) information about at least one location within the space indicating that the at least one location requires a second density of ions; and controlling (504) at least one ion generating unit associated with the at least one location within the space to provide the second density of ions.



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Systems and methods for providing ionized air environments

FIELD OF THE DISCLOSURE

The present disclosure is directed generally to systems and methods for providing ionized air within illuminated environments accessible to the public. More particularly, the present disclosure is directed to systems and methods for providing surface
5 and air disinfection simultaneously using air ionization techniques.

BACKGROUND

The recent and pandemic outbreak of COVID-19 has exposed an urgent need to improve the systems and methods used to fight infectious diseases, particularly those
10 diseases that are transmitted from human-to-human via short distance particle transmission and surface transmission. Viruses and viral materials can survive for days on surfaces such as desks, tables, chairs, stainless steel door handles, etc. Areas that are frequented by large numbers of infected people (e.g., operating rooms and medical examination rooms) are particularly prone to facilitate disease transmission. Additionally, places where infected
15 people meet with individuals having lowered immunological status (e.g., homes for the elderly) are similarly prone to facilitate disease transmission. Even supermarkets and other retail spaces are prone to facilitate disease transmission since they can be patronized by infected individuals who are in close proximity to others.

Typically, areas are cleaned with soap and water or chemicals such as alcohol,
20 but such cleaning methods cannot be provided continuously, and they might result in chemical residues. More sophisticated systems can include non-contact UV-C based light or a pulsed Xenon UV flashlamp used to generate broad-spectrum, high-intensity ultra-violet light. Some disinfection robots for hospitals include a UV light source and moisturizer guns to distribute hydrogen peroxide. However, germicidal UV propositions cannot be used while
25 the room is occupied. Additionally, germicidal UV radiation can cause serious material degradation.

Consumer products feature individual air purifying devices that include ionizing generators to kill bacteria and viruses when the air ion density is at the correct level. While individual air purifying devices are effective in the areas immediately surrounding the

device, their effectiveness quickly decreases at distances farther away from the ionizing air purifying device. Effectiveness is based on a measurement of an adequate ion density in the air. Individual air purifying devices are configured to be effective in the horizontal directions but are limited to shorter distances. For example, if a device is placed in a corner of a room with four corners, the area surrounding the corner where the device is placed may achieve the correct air ion density level, but the three other corners would be expected to have insufficient or insignificant levels of ionized air because they are located farther from the device. Moreover, the area above the corner where the device is placed would be expected to have insufficient or insignificant levels of ionized air because the device is designed primarily for horizontal distribution not vertical distribution.

Additionally, since individual air purifying devices are designed to pass large volumes of air over active elements within the air purifying devices, they are bulky and can obstruct passages in a room. Further, some purifying devices incorporate other cleaning functions that require physical filtering of the air and, therefore, air flow needs to be created. The creation of the air flow adds audible disturbances due to the fans, blowers, or equivalent structures in the device. Plus, the filters needed in such devices must be replaced regularly which is costly. Furthermore, the air flow is suspected to accelerate spreading the infection in a shared room if one among the occupants is infected.

Accordingly, there is an urgent need in the art for improved disinfection technologies that are unobtrusive and configured to operate on a continuous basis without manual intervention. In contrast to propositions based on UV, ionization can be used while the room is occupied. Additionally, unlike UV radiation, ionization is not expected to cause material degradation.

SUMMARY OF THE INVENTION

The present disclosure is directed to inventive systems and methods for providing effective air ionization in areas where occupancy levels are generally high. In particular, embodiments of the present disclosure are directed to improved systems and methods for providing effective air ionization in open spaces (e.g., crowded open office spaces) that are larger in surface area, height, and in occupancy levels compared to consumer home environments. Various embodiments and implementations herein are directed to methods of providing air ionization by using ion generators integrated in or added to light emitting devices in a connected network of multiple devices in an indoor facility. The multiple ion generators create a more spatially distributed and controllable cloud of ions for

anti-viral and/or anti-bacterial action against surface or airborne species. The individual ion generators can be separately addressed for obtaining an optimal ion cloud, and a feedback loop, including occupancy or air ion density information, can be used to control its anti-viral and/or anti-bacterial operation. Advantageously, the inventive systems and methods provide effective, safe, and unobtrusive solutions to largely reduce the impact of viral or bacterial outbreaks in high risk environments.

Generally, in one aspect, a method for providing air ionization in a space is provided. The method includes the step of collocating a plurality of ion generating units with a plurality of illumination devices within one or more illumination planes such that at least one illumination device of the plurality of illumination devices is associated with at least one ion generating unit of the plurality of ion generating units. The at least one illumination device is configured to provide a lighting effect within a spatially separated plane in the space and each ion generating unit is configured to provide at least negative and/or positive ions in the air surrounding the spatially separated plane and on at least one surface in the spatially separated plane. The method further includes the step of generating the at least negative and/or positive ions from the plurality of ion generating units within the space at a first level of operation to generate a first density of negative and/or positive ions. The method further includes the steps of receiving information about at least one location within the space indicating that the at least one location requires a second density of negative and/or positive ions that is different than the first density of negative and/or positive ions provided at the first level of operation and controlling at least one ion generating unit associated with the at least one location within the space to provide the second density of negative and/or positive ions in the at least one location within the space.

In embodiments, the step of receiving information includes receiving past, current or expected occupancy or activity characteristics information within the at least one location within the space that requires the second density of negative and/or positive ions.

In embodiments, the step of receiving information includes capturing and analyzing signals from one or more context awareness sensors configured to indicate whether a person within the at least one location exhibits sounds, body temperature, gait, body movements, or behaviors that can be associated with an illness or a deviation from homeostasis.

In embodiments, the step of receiving information includes receiving a start date and an end date of a period of time associated with a seasonal illness or a pandemic

outbreak and the step of controlling the at least one ion generating unit applies for the duration of the period of time.

In embodiments, the step of receiving information includes receiving imaging data detecting a presence and a position of an object within the at least one location within
5 the space.

In embodiments, the step of receiving information includes receiving air flow sensor data indicating an air flow of the at least one location is currently or is expected to be affected by one or more HVAC systems or one or more fans.

In embodiments, the step of receiving information includes receiving ion
10 density data indicating an ion density of the at least one location is below a predetermined minimum threshold value or above a predetermined maximum threshold value.

In embodiments, the step of receiving information includes receiving a signal that at least one light source of the plurality of illumination devices is altered to an extent for a minimum amount of time and the step of controlling the at least one ion generating unit
15 includes adjusting the first level of operation to a different level of operation based on the received signal.

In embodiments, the information includes a detection of a mobile handheld or wearable device or a classification of a user or an object.

In embodiments, the step of receiving information includes receiving a control
20 signal to activate a human centric lighting scene and the step of controlling the at least one ion generating unit includes providing the second density of negative and/or positive ions in response to receiving the control signal, wherein the second density of negative and/or positive ions is at least 1000 ions/cm³.

Generally, in another aspect, a system for providing ionized air in a space is
25 provided. The system includes a plurality of ion generating units collocated with a plurality of illumination devices within one or more illumination planes such that at least one illumination device of the plurality of illumination devices is associated with at least one ion generating unit of the plurality of ion generating units. The at least one illumination device is configured to provide a lighting effect within a spatially separated plane in the space and
30 each ion generating unit is configured to provide at least negative and/or positive ions in the air surrounding the spatially separated plane and on at least one surface in the spatially separate plane. The system further includes at least one processor coupled with the plurality of ion generating units, wherein the at least one processor is configured to control the plurality of ion generating units to generate the at least negative and/or positive ions within

the space at a first level of operation to generate a first density of negative and/or positive ions; receive information about at least one location within the space indicating that the at least one location requires a second density of negative and/or positive ions that is different than the first density of negative and/or positive ions provided at the first level of operation;
5 and control at least one ion generating unit associated with the at least one location within the space to provide the second density of negative and/or positive ions in the at least one location within the space.

In embodiments, the plurality of ion generating units are arranged in suspended luminaires.

10 In embodiments, the plurality of ion generating units are arranged in free floor standing luminaires.

In embodiments, the information about the at least one location includes past, current or expected occupancy or activity characteristics within the at least one location.

In embodiments, the information about the at least one location includes an ion
15 density that is below a predetermined minimum threshold value or above a predetermined maximum threshold value.

In various implementations, the processor described herein may take any suitable form, such as, one or more processors or microcontrollers, circuitry, one or more controllers, a field programmable gate array (FPGA), or an application-specific integrated
20 circuit (ASIC) configured to execute software instructions. Memory associated with the processor may take any suitable form or forms, including a volatile memory, such as random-access memory (RAM), static random-access memory (SRAM), or dynamic random-access memory (DRAM), or non-volatile memory such as read only memory (ROM), flash memory, a hard disk drive (HDD), a solid-state drive (SSD), or other non-transitory machine-readable
25 storage media. The term “non-transitory” means excluding transitory signals but does not further limit the forms of possible storage. In some implementations, the storage media may be encoded with one or more programs that, when executed on one or more processors and/or controllers, perform at least some of the functions discussed herein. It will be apparent that, in embodiments where the processor implements one or more of the functions described
30 herein in hardware, the software described as corresponding to such functionality in other embodiments may be omitted. Various storage media may be fixed within a processor or may be transportable, such that the one or more programs stored thereon can be loaded into the processor so as to implement various aspects as discussed herein. Data and software, such as

the algorithms or software necessary to analyze the data collected by the tags and sensors, an operating system, firmware, or other application, may be installed in the memory.

It should be appreciated that all combinations of the foregoing concepts and additional concepts discussed in greater detail below (provided such concepts are not mutually inconsistent) are contemplated as being part of the inventive subject matter disclosed herein. In particular, all combinations of claimed subject matter appearing at the end of this disclosure are contemplated as being part of the inventive subject matter disclosed herein.

10 BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, like reference characters generally refer to the same parts throughout the different views. Also, the drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the present disclosure.

FIG. 1 is an example schematic depiction of an illumination system for providing ionized air in a space according to aspects of the present disclosure;

FIG. 2 is another example schematic depiction of an illumination system for providing ionized air in a space according to aspects of the present disclosure;

FIG. 3 is a further example schematic depiction of an illumination system for providing ionized air in a space according to aspects of the present disclosure;

FIG. 4 is an example luminaire according to aspects of the present disclosure; and

FIG. 5 is an example process for providing ionized air in a space according to aspects of the present disclosure.

25 DETAILED DESCRIPTION OF EMBODIMENTS

The present disclosure describes various embodiments of systems and methods for providing effective air ionization in areas where occupancy levels and/or occupancy turnover levels are generally high. Occupancy turnover levels refer to the movement of people or objects into, through, and out of a space. Applicant has recognized and appreciated that it would be beneficial to provide systems and methods that can operate continuously regardless of whether occupants are present in the area. Applicant has also recognized and appreciated that it would be beneficial to provide systems and methods using air ionization where the ion generators are tamper-proof and out of reach. In public spaces like airports and mass transit stations, it is not feasible to position individual air purifying devices on the floor

as these areas experience heavy traffic and must be clear of bulky obstacles. Additionally, these devices can be easily broken or stolen when positioned on the floor in public spaces. Furthermore, such individual devices cannot provide sufficient horizontal and vertical distribution as discussed above to accommodate such large spaces. Moreover, the HVAC air flow use in such large open spaces may obstruct or even counteract the required air flow patterns from/to one of multiple air purifiers so integration of an ionizer system with such HVAC systems is not preferred. Accordingly, Applicant has provided improved systems and methods using ionized air technology that generate ionized air from the ceiling area of a building space either directly from the ceiling, suspended from the ceiling, from a wall, or from a standing device rather than from a single unit on the floor. The improved systems and methods feature a distributed network of ionizing devices to provide sufficient horizontal and vertical distribution. Exemplary goals of utilization of certain embodiments of the present disclosure are to destroy or inactivate or largely reduce microbiological species, like viruses, spores, bacteria, mold, etc. in an area by at least approximately 50-90%, or even 90-99%, or even greater than 99% using a multi-grid network of ionizing devices from a space above humans or the targeted surface.

The present disclosure describes various embodiments of systems and methods for providing a distributed network of ionizing devices by making use of illumination devices that are already arranged in a multi-grid and connected architecture. Such existing infrastructures can be used as a backbone for the additional anti-viral/bacterial functionality described herein.

Illumination devices are ideally positioned to create a homogenous blanket of light in a specific space. Thus, when the spatially distributed lighting infrastructure is equipped with ionizing units, it will emit an improved volumetric distribution of ions over a specific space. The volumetric distribution is more homogenous and optimal as compared with conventional systems and methods as it provides coverage in both horizontal and vertical directions. Instead of generating ionized air along the floor, the volumetric distribution of ions emanates from above the area to be treated to form a homogenous blanket or shower of ionized air in a specific space. The free movement of ions in the air allows also for disinfection of air and surfaces that are not in the direct line of sight of the ionizing units as is the case with disinfection with germicidal UV.

Referring to FIGS. 1, 2, and 3, schematic depictions of lighting systems 100, 200, and 300 for providing ionized air in a space are illustrated. The lighting systems 100, 200, and 300 include a set of illumination devices 102, 202, and 302 arranged in one or more

illumination planes 104, 204, and 304. The illumination devices in each system may be or include one or more light-emitting diodes (LEDs), which illumination devices hereafter are referred to as LEDs. The LEDs may be active (i.e., turned on); inactive (i.e., turned off); or dimmed by a factor d , where $0 \leq d \leq 1$. The value $d = 0$ means that the LED is turned off
5 whereas $d = 1$ represents an LED that is at its maximum illumination. The LEDs may be arranged in a symmetric grid in the illumination planes 104, 204, and 304, or e.g. in a linear, rectangular, triangular or circular pattern. Alternatively, the LEDs may be arranged in any irregular geometry. The one or more illumination planes 104 may e.g. be the ceiling of a room 105 as shown in FIG. 1. Alternatively, as shown in FIG. 2 the one or more illumination
10 planes 204 may be a plane parallel to and arranged at a distance from the ceiling of the room 205, such that the LEDs are arranged in another plane than the plane of the ceiling itself. In embodiments, the one or more illumination planes may include two or more planes parallel to and arranged at a distance from the ceiling of the room such that the LEDs are arranged at multiple distances from the plane of the ceiling itself as shown in FIG. 3. In still other
15 embodiments, the illumination plane including two or more planes can include the plane of the ceiling itself. For example, a single space can utilize multiple illumination planes, e.g., first and second luminaires may be ceiling luminaires while third and fourth luminaires in the same space may be suspended luminaires or free-standing luminaires (positioned at lower heights) yet any suitable configuration is contemplated.

20 The illumination devices 102, 202, and 302 in the illumination planes 104, 204, 304A, and 304B are arranged to provide one or more lighting effects in spatially separated planes 110, 210, and 310, which may be substantially parallel to the illumination planes 104, 204, 304A, and 304B. It should be appreciated that the lighting effects can include visible lighting effects and non-visible effects; thus, one or more illumination devices
25 can be configured to irradiate in the non-visible part of the spectrum such that the systems can provide ionization and UV light, for example. The spatially separated planes 110, 210, and 310 may e.g. be the floor of a room, or a plane above the floor of the room e.g. above approximately 0.5 m or 1.64 feet from the floor, or planes that are at sitting or standing-desk level height. In embodiments, the spatially separated planes need not be planar at all as long
30 as they are spatially separated from the illumination planes. Additionally, it should be appreciated that the spatially separated planes (whether or not they are planar) can include two or more planes arranged at a distance from the illumination planes. It should also be appreciated that in embodiments the illumination and spatially separated planes can include two or more planes (whether or not they are planar) and the illumination plane(s) can be

adjacent to the spatially separated plane(s). In FIG. 1, the illumination plane 104 and the spatially separated plane 110 are vertically separated by a distance h_1 , and the spatially separated plane 110 in the room 105 may be construed as a plane wherein a person may breathe or a target surface may be touched by a person. In FIG. 2, the illumination plane 204 and the spatially separated plane 210 are vertically separated by a distance h_2 , and the spatially separated plane 210 in the room 205 may be construed as a plane where a person may breathe or a target surface may be touched by a person. The distance h_1 between the illumination plane 104 and the spatially separated plane 110 in FIG. 1 is larger than the distance h_2 between the illumination plane 204 and the spatially separated plane 210 in FIG. 2 since the illumination devices in FIG. 2 are closer to the spatially separated plane 204.

The embodiments and implementations disclosed or otherwise envisioned herein can be utilized with any suitable illumination devices. Examples of suitable illumination devices include luminaires that are connected or connectable and sensor enabled such as ceiling mounted luminaires, suspended luminaires, wall mounted luminaires, and free floor standing luminaires. Signify's SlimBlend[®] suspended luminaire is one example of a suitable illumination device including USB type connector slots for accommodating an ion generating unit as described herein. In embodiments, the illumination device includes USB type connector slots for ionizers or a combination of ionizers and sensors e.g., ion density sensors or occupancy sensors etc. Illumination devices including sensor ready interfaces are particularly well suited and already provide powering, digital addressable lighting interface (DALI) connectivity to the luminaire's functionality and a standardized slot geometry. Suspended luminaires including ion generating units are advantageous because the ionizers are arranged closer to humans and possibly contaminated surfaces as compared with ceiling luminaires. Additionally, it is beneficial to incorporate ion generating units within suspended luminaires because the ionizers and sensors (e.g., ion density or occupancy) can be easily mounted at the top or bottom of the luminaires without being restricted by the ceiling. Free floor standing luminaires are also advantageous when compared with ceiling mounted luminaires because they are positioned closer to the air that is breathed by humans and the potentially contaminated surfaces and the ionizers and sensors can be easily mounted.

Lighting systems 100, 200, and 300 include ion generating units 112, 212, and 312 in the illumination planes 104, 204, 304A, and 304B. Each ion generating unit is collocated with an illumination device. The ion generators are small devices that need little space and therefore are easy to integrate in/onto illumination devices, lighting control devices, switches, and user interfaces. The ion generating units are also easily removable. It

should be appreciated that any suitable ion generating unit is contemplated so long as it can be collocated with at least one of the illumination devices described herein to provide the adequate ion density levels. The ion generating units 112, 212, and 312 are configured to provide an increased level of negative and/or positive ions in the air surrounding the spatially
5 separated plane. In a typical modern office, the density level of negative ions is approximately 150 ions per cm^3 and the density level of positive ions is approximately 200 ions per cm^3 for a total ion density level of approximately 350 ions per cm^3 . Particular embodiments of the present disclosure are designed to increase the density level of negative ions from 150 ions per cm^3 to 750 ions per cm^3 , preferably to 1,500 ions per cm^3 , preferably
10 to 2,000 ions per cm^3 , and most preferably to 2,500 ions per cm^3 . Similarly, embodiments are designed to increase the density level of positive ions from 200 ions per cm^3 to 750 ions per cm^3 , preferably to 1,800 ions per cm^3 , and most preferably to 2,500 ions per cm^3 . In embodiments of the present disclosure, the ion generating units can provide a density level of negative ions of approximately 2,000 ions per cm^3 and a density level of positive ions of
15 approximately 2,500 ions per cm^3 for a total ion density level of 4,500 ions per cm^3 which is approximately the levels available naturally at mountain elevations.

As shown in FIGS. 1, 2, and 3, by positioning ion generating units 112, 212, and 312 in each illumination device 102, 202, and 302, each paired ion generating unit and illumination device is configured to create a homogenous blanket of ions and light in a
20 particular space within the room. Because each ion generating unit is arranged in the illumination plane above the spatially separated plane, it provides both horizontal and vertical coverage of an area extending from the illumination plane to the spatially separated plane and further to the floor. When all of the ion generating units and illumination devices are providing ions and light simultaneously or as otherwise described herein, the horizontal
25 coverage is further improved.

The configurations of the ion generating units and illumination devices shown in FIGS. 1, 2, and 3 should not be construed as limiting. Any suitable configuration is contemplated. Additionally, it should be appreciated that the ion generating units can be moved or rotated within the systems as to obtain an optimized coverage for the specific
30 layout or usage pattern of the space. The movement of the ion generating units can be done automatically or manually.

Unlike conventional systems that contain ionized air generators at a particular singular location in a room on the floor or with large distances between ionizers, the systems depicted in FIGS. 1, 2, and 3 include ionized air generators at regular intervals within the

room or at increased intervals to ensure a sufficient ion density level is maintained throughout the space or areas of the space where it is necessary to maintain a sufficient ion density levels, for example, based on occupancy information or other information as described herein. Positioning the ionized air generators at the one or more illumination planes provides improved vertical distribution as compared with conventional systems. In other words, a highly distributed network of multiple ionizers, from an area located above humans and surfaces brings better coverage (e.g., an ion shower equally over the whole space) in an unobtrusive manner. Additionally, sensors can be used to detect situations that require a higher frequency or intensity of operation (more ion density) of the ionizers. Particular areas within a space having a special usage pattern may require a higher disinfection frequency or intensity and –enabled by the connected network--, some of the ionizers can be addressed differently than others having a much better control over the total space. For example, when one or more lighting devices are switched off or dimmed suggesting that there are no people at that location, as the deactivation of the light(s) is related and driven by the fact that no people or objects are present at that location, the ion generators that are associated with those areas can be operated at a lower or higher frequency or intensity. In some example smart office lighting infrastructures, upon vacancy of a space, a luminaire typically first dims from a task level lighting to a background level lighting (e.g., 30% light output). In examples, the luminaire switches off only after the luminaire stays activated at the background level lighting for a period of time. The period of time is the time during which the luminaire stays at the background level before switching off. In some industry lighting, the period of time is often set to infinite for safety reasons since it is not desirable to have all of the lights off even when an area is unoccupied. In some industry lighting, the period of time can be set to infinite for some of the luminaires and, for other luminaires, the period of time can be set to an amount that is less than infinite such that the area is never completely dark when the area is unoccupied, but it is not required that all of the luminaires stay activated at all times. Similarly, when one or more lighting devices are switched on or brightened from a dimmed level (or switched on or brightened for a predetermined amount of time) suggesting that there are people at that location (rather than a temporary activation which does not necessarily mean there are people at that location), the ion generators that are associated with those areas can be operated at a higher frequency or intensity. In other examples, the light spectrum of one or more lighting devices can be adjusted based on occupancy data. Thus, in examples when a space is unoccupied and one or more lighting devices are adjusted from white light to 405 nm violet light for disinfection suggesting that there are no people at that location, as the

adjustment of the light(s) is related and driven by the fact that no people or objects are present at that location, the ion generators that are associated with those areas can be operated at a lower or higher frequency or intensity as described herein. This granular disinfection is not possible with a single device (or even a few) standing on the floor.

5 In order to carry out the granular control over the total space, each ion generating unit is coupled with at least one processor 402. FIG. 4 shows an example luminaire 400 according to aspects of the present disclosure. It should be appreciated that the components depicted in FIG. 4 need not all be present and that different embodiments described herein include different combinations of the components shown. Additionally, it
10 should be appreciated that the components depicted in FIG. 4 can either be integrated within the luminaire 400 or separately connected to the luminaire 400. In embodiments, the at least one processor 402 is integrated within each ion generating unit 404 associated with a luminaire. In other embodiments, the at least one processor 402 is separate from the ion generating unit 404 and incorporated within the illumination device. The at least one
15 processor 402 can include a microprocessor for controlling the ion density levels generated by the ion generating unit and a memory 406 that can store contents of settings, data from the various sensors described herein, commands for operating the light sources, the ion generating unit, and any other connected system (i.e., HVAC system), and software programs for execution. As described herein, the at least one processor 402 is configured to receive
20 data from a variety of sources including the sensors described herein. Based on the data received, each ion generating unit 404 can be configured to generate ions at different frequency or intensity levels of operation to generate different densities of ions. For example, the ion generating units can be configured to run at a low frequency level of operation which can mean that the ion generating units are activated a minimum number of times per day e.g.,
25 once in the morning, once midday, and another time in the evening. In other examples, the minimum number of times per day can be a single time e.g. once in the morning or evening. The ion generating units can be configured to run at one or more low intensity levels which are below a threshold value that is predetermined or custom set during any of the time periods or regular or irregular intervals described herein. One or more of the ion generating
30 units can be configured to run at higher frequency or intensity levels of operation depending on the data received. For example, an increased frequency level of operation might mean one or more of the ion generating units are activated every 6 hours, or every 4 hours, or every 2 hours etc. In embodiments, one or more of the ion generating units can be activated to run continuously for a period of time e.g., an hour, 2 hours, 4 hours, 6 hours, 8 hours, or 12 or 24

hours. One or more ion generating units can also be activated to run on demand or in accordance with area use which can be at regular or irregular intervals. The ion generating units can also be configured to run at one or more high intensity levels which can be above a threshold value that is predetermined or custom set during any of the time periods or regular or irregular intervals described herein. The ion generating units can also be configured to run at one or more higher intensity levels relative to the one or more low intensity levels that are predetermined or custom set during any of the time periods or regular or irregular intervals described herein.

In example embodiments, the level of ionization in the systems 100, 200, and 300 can be adjusted individually, by a pulsed operation of the ionization generators (time on/off can be adjustable) for all generators in the room, or operating the ion generators in the network that are off, while others in the network are still on. The systems can optimize the lifetime and power consumption of the ion generating units. For example, instead of operating half of the ion generating units at maximum capacity, the systems may operate all of the ion generating units at reduced capacities so that the lifetimes of the units are lengthened, and the power consumption is reduced.

As referenced above, different context awareness sensors such as occupancy sensor 408, audio sensor 410, or camera sensor 412 may be connected with the at least one processor 402 to detect occupancy or a number of occupants in a room or an expected occupancy or number of occupants and the at least one processor 402 can transmit such information to the ion generating units or process such information and transmit instructions based on the processed data. The frequency or intensity of the ion generating units can be adjusted according to this input variable. In other words, the at least one processor 402 can be configured to receive information on the past, current, or expected occupancy level of the space from one or more different sensors and the level of ionization of the ion generating units can be adjusted accordingly. If a space has experienced or will experience high occupancy, the level of ionization can be increased. Thus, usage history information can be used to determine if one or more particular individuals have recently vacated a space or parts of a space and the ion generating units associated with that space or those parts of the space can be adjusted accordingly. Similarly, if a space has not experienced and does not expect to experience high occupancy, the level of ionization can be decreased. Alternatively, the level of ionization can be increased upon vacancy. This might be particularly useful if ionization turns out to cause or exacerbate asthma conditions. In some embodiments, the occupancy of a space is rather predictable, and a fixed program can be used to run the ion generating units.

Occupancy sensors can be integrated in the illumination devices, or they can be located externally from the illumination devices. In embodiments, a current occupancy level of the space with desk-level accuracy can be provided and the ion generating units can adjust their level of ionization accordingly. For example, if one desk is occupied, the ionizer(s) assigned to that specific desk can be activated or deactivated or the level of ionization can be increased or decreased. In embodiments, the occupancy input can be from a program based on expected occupancy, such as, internet-based booking of rooms for meetings and/or events. In embodiments, the occupancy input can be based on a detection of mobile phones or wearable devices of one or more individuals via any suitable sensor 424. In embodiments, the occupancy input can be based on one or more classifications of a user or an object from a lighting sensor, for example, or any suitable classifying occupancy sensor, e.g., PIR or thermopile sensors. Sensors that can detect whether a child or an adult is sitting at a desk can be used for the occupancy input or any suitable sensors that can uniquely identify an individual or object. The systems may also track activities in the space. For instance, if a person is continuously typing at a computer, the contamination of the desk is likely to be less than a person performing a task involving frequent touching of the desk. In embodiments, the occupancy information can include a number of people and/or a type of people occupying the space or characteristics of occupants. For example, people occupying the space can be identified as vulnerable such as elderly versus strong and healthy people. By way of another example, people who are known to be immune to a particular virus can be identified. Additionally, people who are suspected of being infected by a particular virus via contact tracing information can be identified. Occupancy characteristics can also include how long the occupants are expected to be present in an area since a shorter meeting has less risk of a person picking up a sufficient number of viral particles.

Besides occupancy sensors, input from other environmental sensors 420 or information sources (e.g., humidity, temperature, smog, air pollution in particular about particles and dust) can be beneficially used to optimize the ionization system settings.

In embodiments, ion density sensors 422 are included in the systems 100, 200, and 300 to detect the ionization level in the area and the systems are configured to adjust its levels of ionization accordingly. The ion density sensors can be integrated in the illumination devices, or they can be separate from the illumination device, for instance, in a wall switch or a user interface for personalized lighting control or an HVAC thermostat. The ion density sensors can e.g. be integrated in or added to a laptop or desktop computer or any other desktop device of an individual occupying the space to measure the ion density at the table

level. Ion densities are obtained by measuring ion concentration per volume. The ion density input can also be modelled using a program based on expected ion density levels. The systems 100, 200, and 300 can control the ion density of the area by switching on one or more of the ion generating units when the ion density in the air is determined to be below a certain minimum threshold value or switching off one or more of the ion generating units when the ion density in the air is determined to be above a certain maximum threshold value. High ion concentrations may negatively affect people with asthma. Ion concentrations that are too high may generate unacceptable levels of ozone, a known lung irritant that can cause chest pain, coughing, shortness of breath along with throat irritation. The systems 100, 200, and 300 can also control the ion density of one or more areas by adjusting the intensities of one or more of the ion generating units when the ion density in the air is determined to be below a minimum threshold value or above a maximum threshold value.

The luminaire 400 of FIG. 4 also includes one or more LED-based light sources 430 configured to be driven to emit light of a particular character (i.e., color intensity and color temperature) by one or more light source drivers 432. At least one processor 402 can be configured to output one or more signals to drive the light sources and generate varying intensities and/or colors of light from the light sources. At least one processor 402 can also be configured to control other dedicated circuitry such as light source driver 432 which in turn controls the light sources so as to vary their intensities. As discussed above, the ion generating unit 404 can be configured to operate at a first frequency or intensity of operation when the light sources are active, a second frequency or intensity of operation when the light sources are inactive, and at one or more additional frequencies or intensities of operation when the light sources are dimmed at different levels. For example, when the light sources are turned off, the ion generating unit 404 can be configured to reduce its frequency or intensity of operation or cease operating altogether. In contrast, when the light sources are activated the ion generating unit 404 can be configured to increase its frequency or intensity of operation. It should be appreciated that the ion generating units do not need to be co-acting with the light sources.

A timer (time and date) may be used to program either fixed programs (day and night) or even seasonal programs (winter/summer) to optimize use and risk levels, as well as optimizing the human centric benefits of negative ions on the occupant. Links to the Outlook calendars of the users of a room might be used to prepare the room (i.e., perform a disinfection routine) before the users/inhabitants enter the room. The cleaning may be dependent on the requirements of the meeting attendees (e.g., a highly immunosensitive

employee). A program might be available that allows for forced ionization frequencies in case of world-wide pandemics as well as adjusting the HVAC airflow to help the ionization disinfection effectiveness. For specific seasonal infectious species (e.g., flu season), the ionization level might be adapted, because the vulnerability of microbiological species differs from sickness type to type. Some are particle-based spreading, some surface-based spreading, and some might be fully airborne. In example embodiments, algorithms can be used to estimate an infection risk in an area based on an infection level of one person plus a vulnerability level of a second person (immunological level) plus environmental conditions (e.g., humidity, air flow, etc.).

The required temporal and spatial activation of the ion generating units (input) to realize a certain level of ion density in the air (output) can be used with self-learning programs to improve speed of reaction and efficiency of the systems depending on the occupation of the space (variable). In additional embodiments, the infection level of a population of occupants of a certain location could be fed back into the self-learning (AI) system, as to learn if the disinfection measures were sufficient.

In embodiments, luminaire 400 can be equipped with one or more context awareness sensors. For example, context awareness sensors can be configured to detect coughs and sneezes (e.g., with audio analytics) and count the number of people and their physical/medical status based on detection of disease symptoms such as coughing and sneezing, body temperature, gait, body movements, or behaviors present to make predictions about levels of flu-like illnesses as well as the resulting viral contamination level. The context awareness sensors can include audio sensors 410, IR camera sensors, forward-looking infrared (FLIR) camera sensors, passive infrared (PIR) sensors, thermopile sensors, radar sensors indicating that a person is shivering or engaged in some other activity. For example, a person can be determined to be cutting raw meat in an area and the ion generating units associated with that area can be adjusted according to different disinfection strategies. It should be appreciated that systems 100, 200, and 300 are designed to protect individuals after an occupant has sneezed to prevent the surrounding individuals from breathing in pathogens.

In embodiments, systems 100, 200, and 300 adjust its ionization level depending on seasonal epidemics and alike, which have generally consistent yearly start and end points. Additionally, historical data of pandemic outbreaks can be used to adjust the ionization levels for an average amount of time needed to contain an outbreak, for example, a period of four months can be used.

In embodiments, the ionization network can be calibrated or can be self-calibrating, e.g., by means of a suggested on/off periodicity and ionizer intensity, towards the specific set-up of the room. The set-up being variable depending on the presence and position information of certain assets (e.g., arrangement of mobile furniture such as desks in open plan offices or desks that can be changed in height for ergonomics) or impacting other assets such as the presence of a HVAC system, a ventilation system, etc. Objects that can be detected and localized include robots, tools, furniture, equipment, industrial machinery, hospital beds, etc. Optionally, image sensors 412 such as 3D imaging (for assets) and air flow sensors 440 (for detecting e.g., possibly disturbing air flows from HVAC or ceiling fans) sensor functionality can be added for auto-adjusting setting the ionization system. In example systems, fans, e.g., ceiling fans, are used for comfort independent of a HVAC system. Air flow sensor data can be used to indicate affects by such fans on how the ions generated can be distributed. In embodiments where it is desirable to obtain information on the height(s) of assets, sensing principles such as time-of-flight, radar, and ultrawideband can be used as well. Additionally, room set up (e.g., furniture locations) can be programmed during commissioning/adjusting in run time as detected by sensors. Air flow sensing might enable predicting the extension of areas/volumes of ion clouds in the room. For example, the systems 100, 200, and 300 can operate with a HVAC or ventilation system in the space, as to extend the ion cloud towards locations (volumes) that otherwise might be out-of-line-of-sight for the ionizers (the ions being carried in the air flow from the HVAC system). If the HVAC fans are activated, the ionizing units can also be concurrently activated to piggy-back on the increased airflow within the space to distribute the ions. Appropriate additional (of HVAC based) air flow sensors 440 can serve the purpose of controlling this additional functionality.

In embodiments, the ion generating units can be activated based on a detected activity of the illumination devices. For example, if a “bring the nature inside” lighting and audio scene is activated, it may be accompanied by a high ionizer level to simulate nature. In embodiments, a control signal to activate any human centric lighting scene can be accompanied by a corresponding ionizer level. Human centric lighting scenes can include light recipes that simulate nature or natural daylight and/or light recipes that provide energy. For example, certain light recipes that energize can include a high blue content not existing in natural daylight.

In embodiments, the systems can be configured to receive an input from a user to temporarily increase the ion density levels, for example, when people meet during an epidemic/pandemic. Moreover, research supports the proposition that exposure to negative

ions reduces symptoms of depression. Accordingly, a user of the systems 100, 200, and 300 can request that the ion generating units be activated to achieve certain elevated ion density levels. Alternatively, the systems can automatically activate the ion generating units to achieve certain ion density levels based on saved user preferences upon detecting the user in the space. In example embodiments, to achieve this functionality the systems can include a master-slave protocol to define which one or more users or user preferences have the right to play (e.g., the ability to change ion density levels) and/or which one or more users or user preferences have the right to overrule adjustments (e.g., the ability to reject or refuse other requests to change ion density levels).

There is also evidence that negative ions help regulate sleep patterns, mood and reduce stress. Accordingly, the systems can provide certain ion density levels along with a predefined lighting scene configured to enhance relaxation or concentration.

There is also research to support the proposition that negative ions can have an activating influence on some body systems and cognitive performance. Thus, the ion generating units can be activated when the system detects concentrated desk work. On the other hand, if there is only social interaction detected, the ionizer action may be deferred. If the system detects an activity creating air pollution (e.g., in an industrial setting or extensive outdoor activity that influences indoor air quality), negative ions may be employed to counteract the resulting indoor air pollution.

There is also some initial scientific evidence that negative ions may reduce serotonin to help manage anxiety or lower the blood pressure or improve breathing. Hence, the systems may take into account vital signs of the human occupant when deciding when to activate the ionizer.

Negative ions are also produced as a normal growth process for many plants.

The systems 100, 200, and 300 can also take into account the locations of plants in the space.

Air ionization has also been shown to have positive effects on livestock; thus, systems 100, 200, and 300 can also take into account the locations of livestock or locations of livestock at certain times. For example, the systems can be configured to generate negative and/or positive ions as discussed herein during feedings times for the livestock.

FIG. 5 shows an example process 500 for providing ionized air in a space according to aspects of the present disclosure. The space can include any area that has a spatially distributed lighting architecture, including but not limited to a hotel, animal farm, horticulture farm, etc.

At step 501, a plurality of ion generating units (e.g., 112, 212, 312) are collocated with a plurality of illumination devices (e.g., 102, 202, 302) within an illumination plane (e.g., 104, 204, 304A, 304B) such that at least one illumination device is associated with at least one ion generating unit. In embodiments, an illumination device is associated with more than one ion generating unit. In other embodiments, one or more illumination devices may not be associated with an ion generating unit. At least one illumination device of the plurality of illumination devices is configured to provide a lighting effect in a spatially separated plane (e.g., 110, 210, 310) in the space and each ion generating unit is configured to provide negative and/or positive ions in the air surrounding the spatially separated plane and on at least one surface in the spatially separated plane. It should be appreciated that the lighting effect can include task lighting, volumetric lighting, or any other suitable lighting including irradiation in the non-visible part of the spectrum.

At step 502, the plurality of ion generating units are configured to generate negative and/or positive ions within the space at a first frequency level of operation to generate a first density of negative and/or positive ions. It should be appreciated that, in embodiments, at least one ion generating unit can be configured to provide negative ions and at least one other ion generating unit can be configured to provide positive ions.

At step 503, information is received about at least one location within the space indicating that the at least one location requires a second density of negative and/or positive ions that is different than the first density of negative and/or positive ions provided at the first frequency level of operation. The at least one location within the space includes at least one surface and/or a volume of air. Such information can be based on data from ion density sensors 422, occupancy sensors 408, audio sensors 410, image sensors 412, environmental sensors 420, air flow sensors 440, or other information sources described herein.

At step 504, at least one ion generating unit that is associated with the at least one location within the space is controlled to provide the second density of negative and/or positive ions in the at least one location within the space.

It should also be understood that, unless clearly indicated to the contrary, in any methods claimed herein that include more than one step or act, the order of the steps or acts of the method is not necessarily limited to the order in which the steps or acts of the method are recited.

All definitions, as defined and used herein, should be understood to control over dictionary definitions, definitions in documents incorporated by reference, and/or ordinary meanings of the defined terms.

The indefinite articles “a” and “an,” as used herein in the specification and in the claims, unless clearly indicated to the contrary, should be understood to mean “at least one.”

The phrase “and/or,” as used herein in the specification and in the claims, should be understood to mean “either or both” of the elements so conjoined, i.e., elements that are conjunctively present in some cases and disjunctively present in other cases. Multiple elements listed with “and/or” should be construed in the same fashion, i.e., “one or more” of the elements so conjoined. Other elements may optionally be present other than the elements specifically identified by the “and/or” clause, whether related or unrelated to those elements specifically identified.

As used herein in the specification and in the claims, “or” should be understood to have the same meaning as “and/or” as defined above. For example, when separating items in a list, “or” or “and/or” shall be interpreted as being inclusive, i.e., the inclusion of at least one, but also including more than one, of a number or list of elements, and, optionally, additional unlisted items. Only terms clearly indicated to the contrary, such as “only one of” or “exactly one of,” or, when used in the claims, “consisting of,” will refer to the inclusion of exactly one element of a number or list of elements. In general, the term “or” as used herein shall only be interpreted as indicating exclusive alternatives (i.e. “one or the other but not both”) when preceded by terms of exclusivity, such as “either,” “one of,” “only one of,” or “exactly one of.”

As used herein in the specification and in the claims, the phrase “at least one,” in reference to a list of one or more elements, should be understood to mean at least one element selected from any one or more of the elements in the list of elements, but not necessarily including at least one of each and every element specifically listed within the list of elements and not excluding any combinations of elements in the list of elements. This definition also allows that elements may optionally be present other than the elements specifically identified within the list of elements to which the phrase “at least one” refers, whether related or unrelated to those elements specifically identified.

In the claims, as well as in the specification above, all transitional phrases such as “comprising,” “including,” “carrying,” “having,” “containing,” “involving,” “holding,” “composed of,” and the like are to be understood to be open-ended, i.e., to mean including

but not limited to. Only the transitional phrases “consisting of” and “consisting essentially of” shall be closed or semi-closed transitional phrases, respectively.

While several inventive embodiments have been described and illustrated herein, those of ordinary skill in the art will readily envision a variety of other means and/or structures for performing the function and/or obtaining the results and/or one or more of the advantages described herein, and each of such variations and/or modifications is deemed to be within the scope of the inventive embodiments described herein. More generally, those skilled in the art will readily appreciate that all parameters, dimensions, materials, and configurations described herein are meant to be exemplary and that the actual parameters, dimensions, materials, and/or configurations will depend upon the specific application or applications for which the inventive teachings is/are used. Those skilled in the art will recognize or be able to ascertain using no more than routine experimentation, many equivalents to the specific inventive embodiments described herein. It is, therefore, to be understood that the foregoing embodiments are presented by way of example only and that, within the scope of the appended claims and equivalents thereto, inventive embodiments may be practiced otherwise than as specifically described and claimed. Inventive embodiments of the present disclosure are directed to each individual feature, system, article, material, and/or method described herein. In addition, any combination of two or more such features, systems, articles, materials, and/or methods, if such features, systems, articles, materials, and/or methods are not mutually inconsistent, is included within the inventive scope of the present disclosure.

CLAIMS:

1. A method (500) for providing air ionization in a space, comprising:
collocating (501) a plurality of ion generating units with a plurality of
illumination devices, wherein each of the plurality of ion generating units is physically
separated from each other and each located above the space, wherein the at least one
5 illumination device is configured to provide general illumination in the space and each ion
generating unit is associated with at least one location in the space and configured to provide
at least negative and/or positive ions in the air surrounding the at least one location
associated with that corresponding ion generating unit of the plurality of ion generating units;
generating (502) the at least negative and/or positive ions from the plurality of
10 ion generating units within the space at a first level of operation to generate a first density of
negative and/or positive ions having an associated disinfection intensity;
receiving (503) information about the at least one location within the space
indicating that the at least one location requires a second density of negative and/or positive
ions that is different than the first density of negative and/or positive ions provided at the first
15 level of operation, wherein the second density of negative and/or positive ions has a second
disinfection intensity; and
controlling (504) the at least one ion generating unit associated with the at
least one location within the space to provide the second density of negative and/or positive
ions in the at least one location within the space.
20
2. The method of claim 1, wherein the step of receiving information comprises
receiving past, current or expected occupancy or activity characteristics information within
the at least one location within the space that requires the second density of negative and/or
positive ions.
25
3. The method of claim 1, wherein the step of receiving information comprises
capturing and analyzing signals from one or more context awareness sensors configured to
indicate whether a person within the at least one location exhibits sounds, body temperature,

gait, body movements, or behaviors that can be associated with an illness or a deviation from homeostasis.

4. The method of claim 1, wherein the step of receiving information comprises
5 receiving a start date and an end date of a period of time associated with a seasonal illness or a pandemic outbreak and the step of controlling the at least one ion generating unit applies for the duration of the period of time.

5. The method of claim 1, wherein the step of receiving information comprises
10 receiving imaging data detecting a presence and a position of an object within the at least one location within the space.

6. The method of claim 1, wherein the step of receiving information comprises
15 receiving air flow sensor data indicating an air flow of the at least one location is currently or is expected to be affected by one or more HVAC systems or one or more fans.

7. The method of claim 1, wherein the step of receiving information comprises
20 receiving ion density data indicating an ion density of the at least one location is below a predetermined minimum threshold value or above a predetermined maximum threshold value.

8. The method of claim 1, wherein the step of receiving information comprises
25 receiving a signal that at least one light source of the plurality of illumination devices is altered to an extent for a minimum amount of time and the step of controlling the at least one ion generating unit comprises adjusting the first level of operation to a different level of operation based on the received signal.

9. The method of claim 1, wherein the information comprises a detection of a
30 mobile handheld or wearable device or a classification of a user or an object.

10. The method of claim 1, wherein the step of receiving information comprises
receiving a control signal to activate a human centric lighting scene and the step of
controlling the at least one ion generating unit comprises providing the second density of

negative and/or positive ions in response to receiving the control signal, wherein the second density of negative and/or positive ions is at least 1000 ions/cm³.

11. A system (100, 200, 300) for providing ionized air in a space, comprising:
5 a plurality of ion generating units (112, 212, 312) collocated with a plurality of illumination devices (102, 202, 302), wherein each of the plurality of ion generating units is physically separated from each other and each located above the space, wherein the at least one illumination device is configured to provide general illumination in the space and each ion generating unit is configured to provide at least negative and/or positive ions in the air
10 surrounding the at least one location associated with that corresponding ion generating unit of the plurality of ion generating units; and
at least one processor (402) coupled with the plurality of ion generating units, wherein the at least one processor is configured to:
control the plurality of ion generating units to generate the at least negative
15 and/or positive ions within the space at a first level of operation to generate a first density of negative and/or positive ions having an associated first disinfection intensity;
receive information about the at least one location within the space indicating that the at least one location requires a second density of negative and/or positive ions that is different than the first density of negative and/or positive ions provided at the first level of
20 operation, wherein the second density of negative and/or positive ions has a second disinfection intensity; and
control the at least one ion generating unit associated with the at least one location within the space to provide the second density of negative and/or positive ions in the at least one location within the space.
25
12. The system of claim 11, wherein the plurality of ion generating units are arranged in suspended luminaires.
13. The system of claim 11, wherein the plurality of ion generating units are
30 arranged in free floor standing luminaires.
14. The system of claim 11, wherein the information about the at least one location comprises past, current or expected occupancy or activity characteristics within the at least one location.

15. The system of claim 11, wherein the information about the at least one location comprises an ion density that is below a predetermined minimum threshold value or above a predetermined maximum threshold value.

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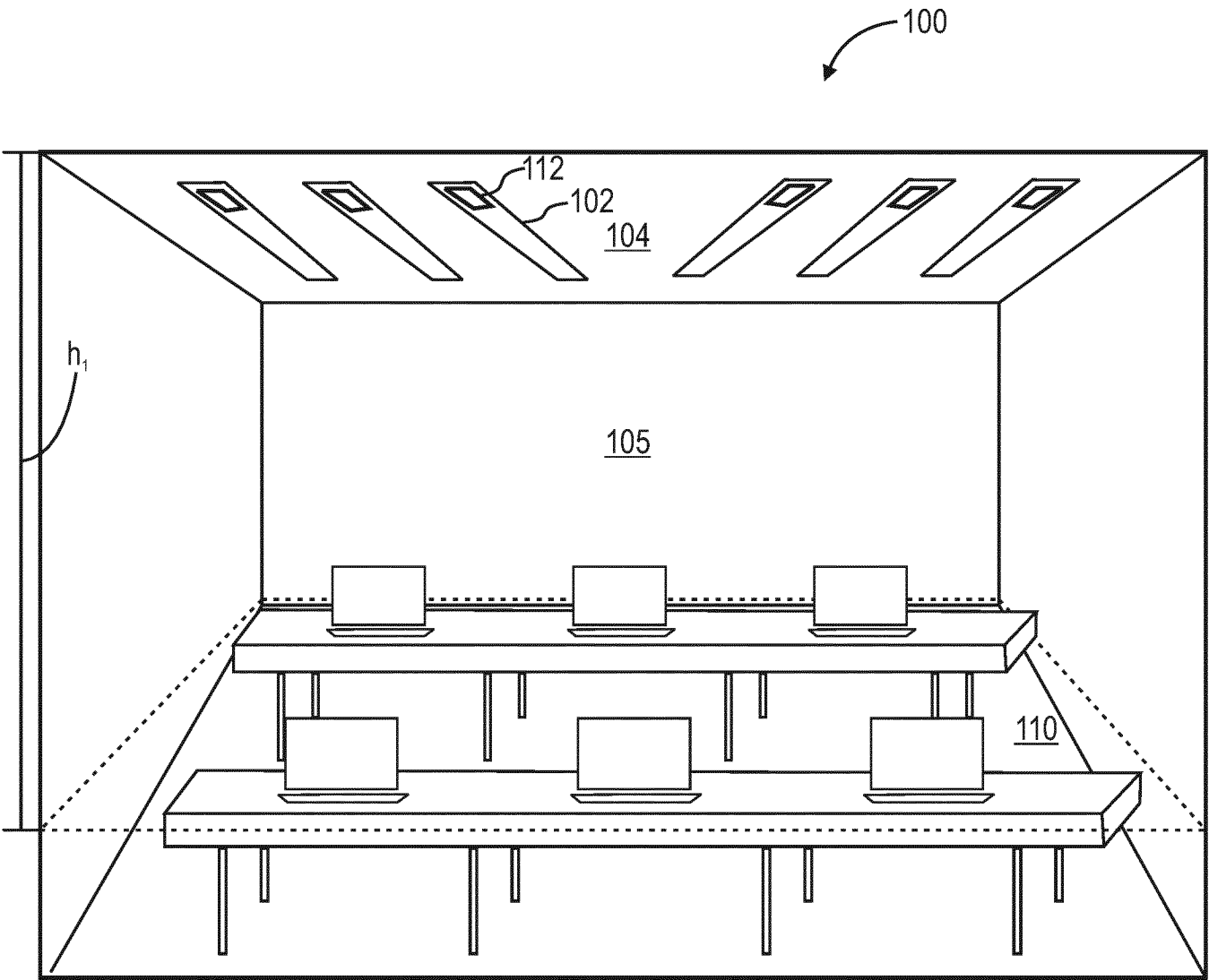


Fig. 1

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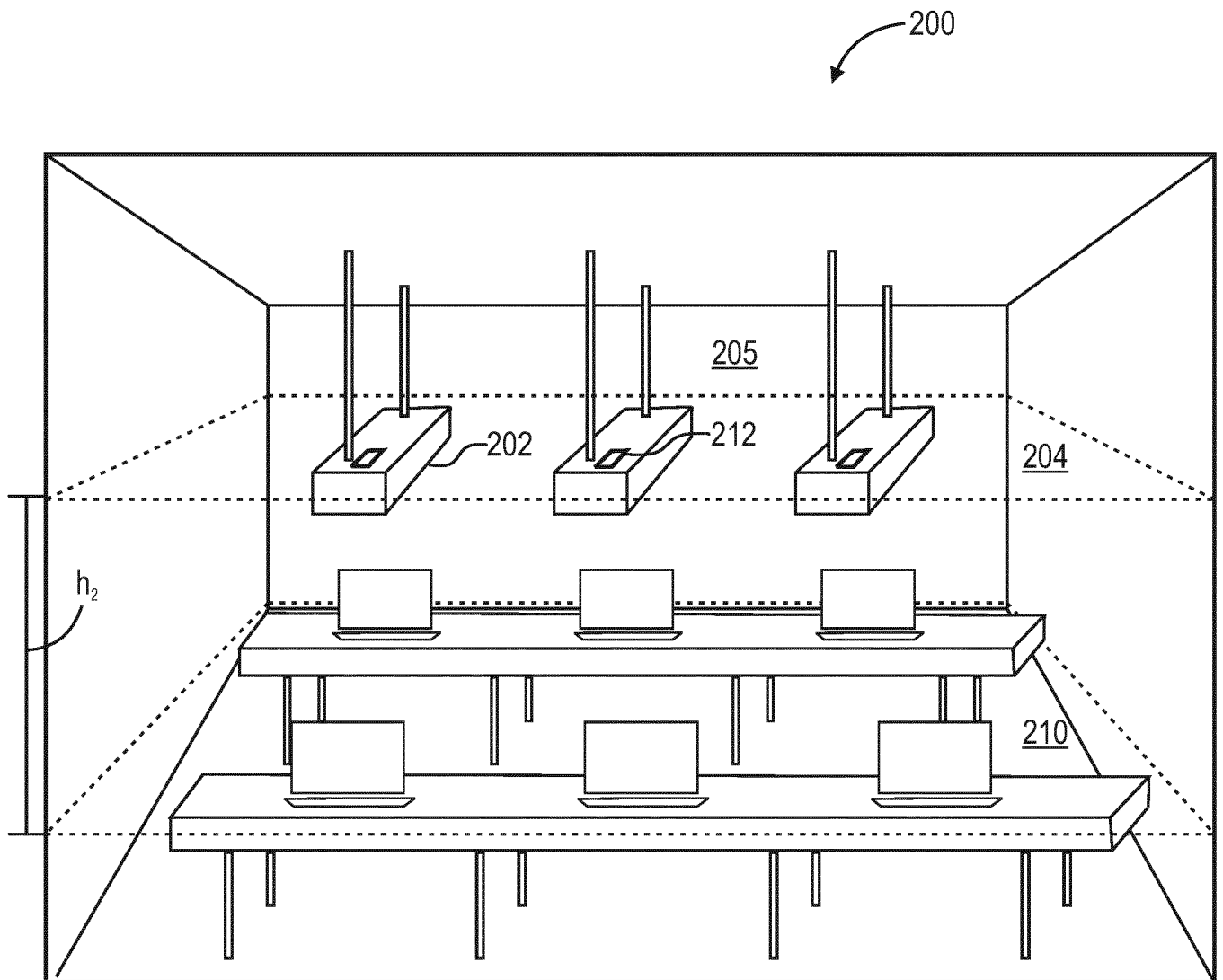


Fig. 2

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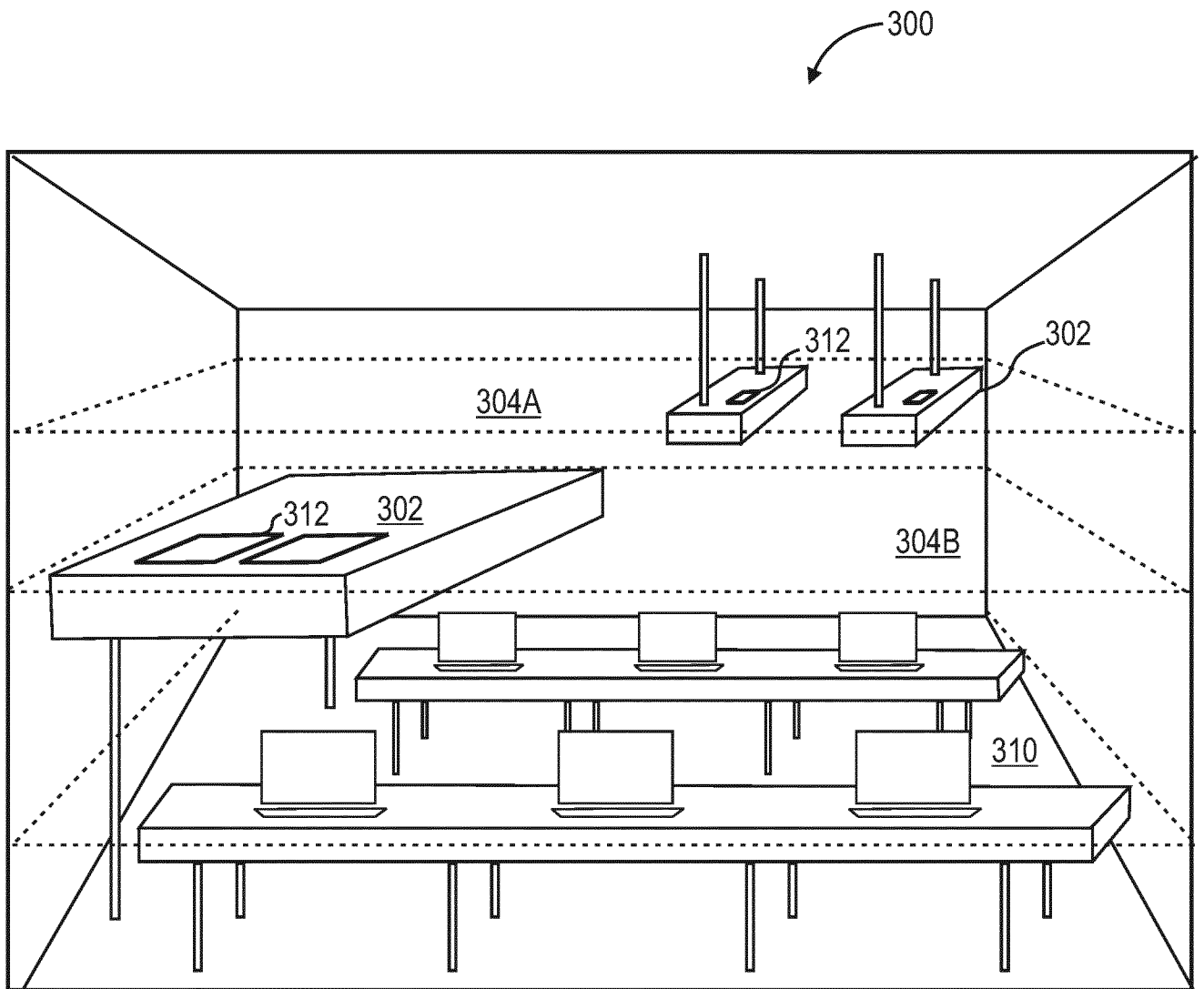


Fig. 3

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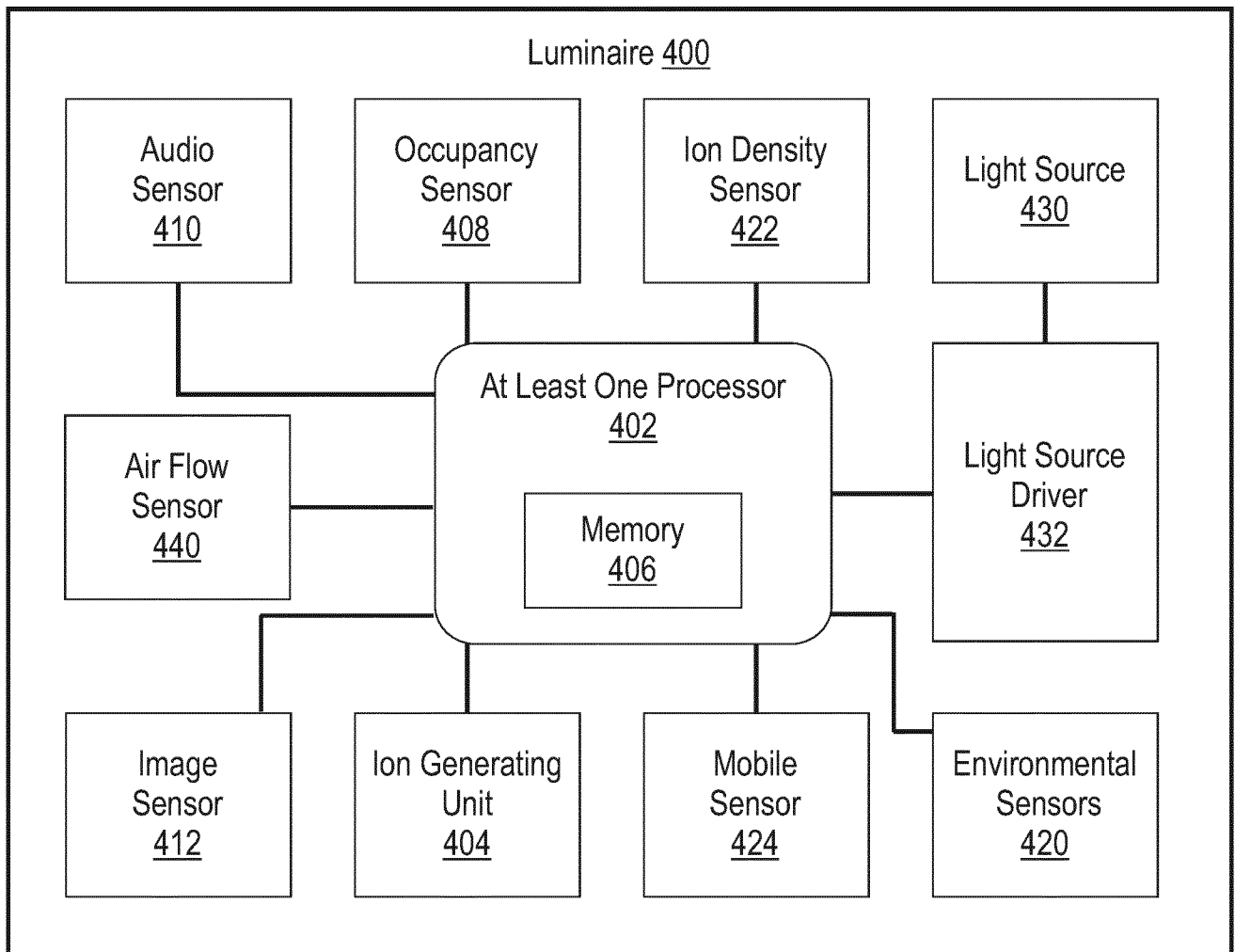


Fig. 4

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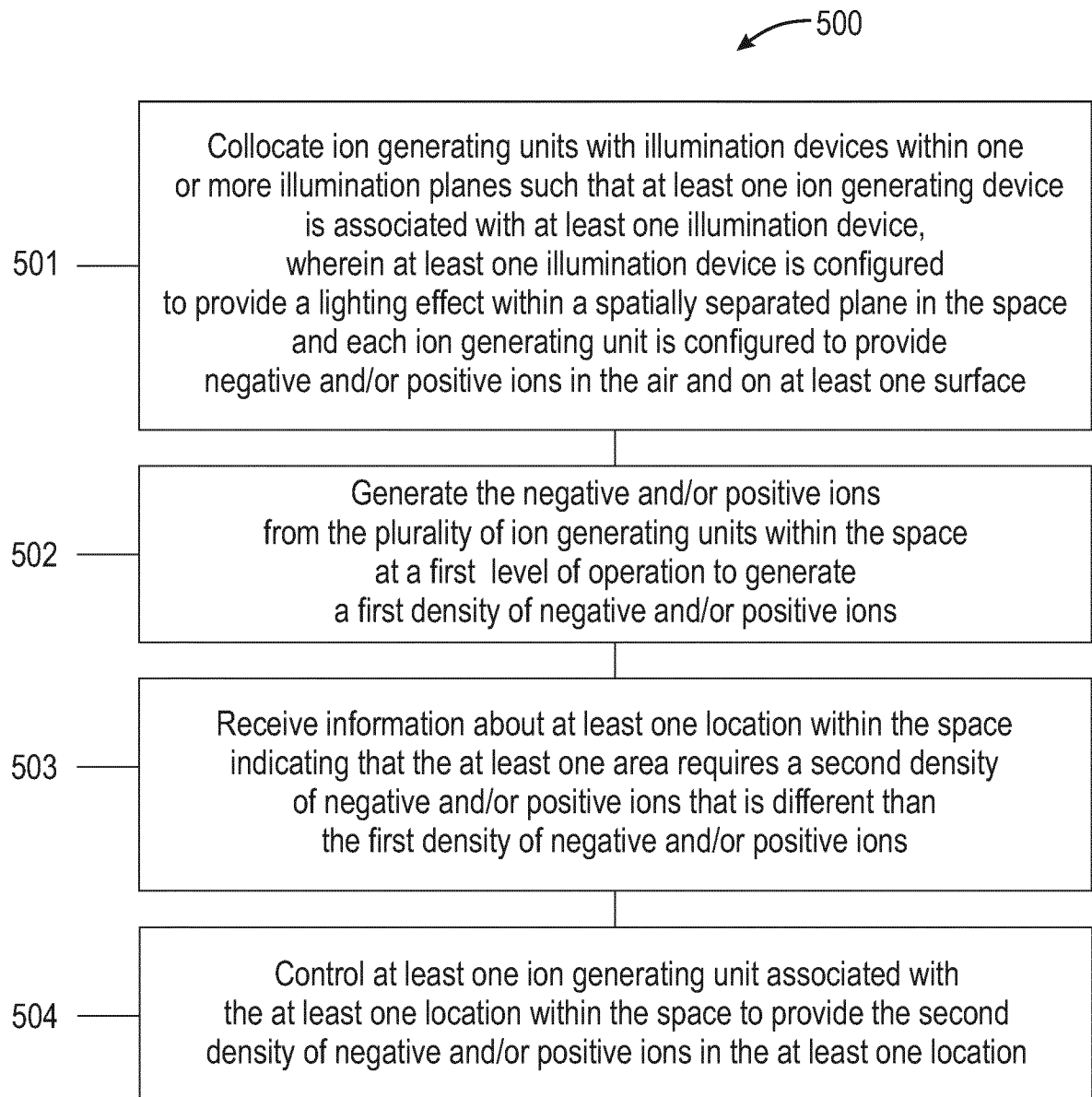


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2021/069015

A. CLASSIFICATION OF SUBJECT MATTER		
INV.	A61L9/22 F21V33/00	A61L2/14 F21S8/02
	A61L2/24 F21S8/06	F21S6/00 F21V23/04
	F21S8/00	
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) A61L F21V F21S		
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		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/005708 A1 (YUEN JOHN S [HK]) 12 January 2006 (2006-01-12) paragraphs [0005], [0006], [0020], [0025], [0026] figures	1,11
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Y		
	----- -/--	
☒ 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 8 October 2021		Date of mailing of the international search report 18/10/2021
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 Varga, Viktoria

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2021/069015

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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