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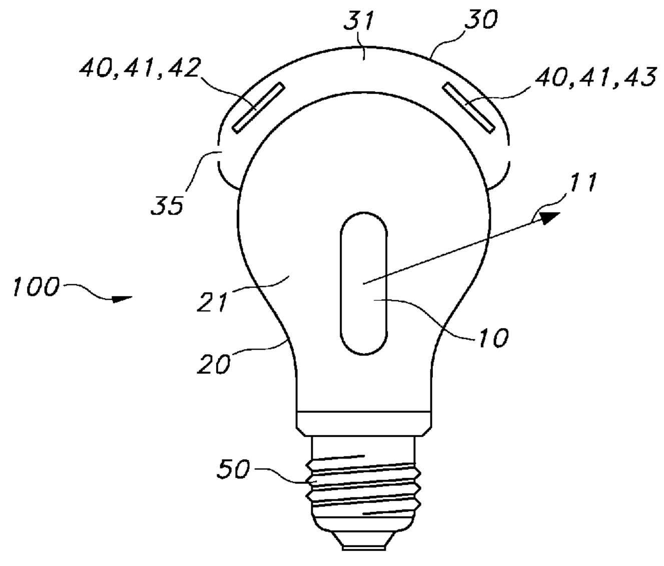

FIG. 1A

(57) Abstract: The invention provides a lamp comprising a light source, an envelope, a housing, an ionizer, a lamp base, a first optical element, and a second optical element; wherein the light source is configured to generate light source light; wherein the envelope at least partly defines an envelope space, wherein the envelope at least partially encloses the light source, wherein at least part of the envelope is optically transmissive for the light source light; wherein the ionizer is configured to ionize air; wherein the housing at least partly defines a housing space, wherein the housing is associated with the envelope, wherein the housing at least partially encloses the ionizer; wherein the first optical element is configured between the envelope space and the housing space, wherein the first optical element is configured to reflect at least part of the light source light; wherein the second optical element is configured as part of the housing or is configured on part of the housing; wherein the second optical element is configured to one or more of absorb or reflect at least part of light in the visible wavelength range; and wherein the lamp base and the housing are arranged at opposite sides of the envelope.

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LAMP COMPRISING AN IONIZER

FIELD OF THE INVENTION

The invention relates to a lamp comprising an ionizer. Further, the invention relates to a housing comprising an ionizer. Yet further, the invention relates to a method for treating a gas, such as air.

BACKGROUND OF THE INVENTION

LED lamps comprising ionizers are known in the art. For instance, EP1208854A1 describes an air cleaning device which includes a bulb-shaped casing provided at one end with a base and at the other end with an outlet. The casing accommodates an AC/DC converter for converting an alternating current from the base into a direct current, a boosting transformer for boosting the direct current, and a negative ion generator or ozone generator connected to the boosting transformer. Application of high voltage from the boosting transformer to the negative ion generator or ozone generator induces electrical discharge to generate negative ions alone or both negative ions and ozone and release the negative ions alone or both the negative ions and the ozone from the outlet.

KR101787373B1 discloses a LED lighting lamp having a sterilization function, using a UV lamp generating ultraviolet rays on the sterilization net of a housing inside the lamp, and generating ions by means of photocatalytic oxidation via a coating layer on the sterilization net. Air is passed through the housing inside the lamp using a fan. Light emitting diodes are positioned on a substrate inside the housing to provide a lighting function. The housing is light transmissive.

CN206207583U discloses a negative ion air purifier, having an air purifier main body, a pollutant collector, an indicator light, an air quality monitor and a controller. The main body of the air purifier includes a housing, and a negative ion generating device is arranged in the housing. The controller, the indicator light and the negative ion generating device are arranged on the housing. The controller is connected with the pollutant collector, the indicator light and the air quality monitor. The controller controls the on/off, brightness, light intensity, flashing frequency or light color of the indicator light according to the air quality parameters monitored by the air quality monitor.

KR200414806Y1 discloses a lamp provided with an anion generator, having a lamp base having a rectangular heat dissipation groove, a lamp cover coupled to the lamp base, a power supply unit built into the lamp base and a circuit unit constituting the LED lamp.

SUMMARY OF THE INVENTION

It appears desirable to protect people from the spread of bacteria and viruses such as influenza or against the outbreak of novel (corona) viruses like COVID-19, SARS and MERS. A method for disinfection may be the use of air ionizers. Microorganisms may be killed by positive ions and/or negative ions in air. Therefore, ionization is a technology that may bring benefits in containing and reducing the spread of viruses in air and on surfaces. Additionally, ionizers may be used for reducing particles in the air, removing pollen and/or removing VOC's (volatile organic compounds). Existing ionization systems may include floor standing purifiers utilizing a fan, such systems may be an obstacle in the room and the fan may produce a discomforting noise. Such ionization systems may not easily be implemented in existing infrastructure, such as in existing buildings like homes, offices, hospitality areas, etc. and/or may not easily be able to serve larger spaces. This may again increase the risk of contamination. Further, incorporation in HVAC systems may not lead to desirable effects and appears to be relatively complex.

Hence, it is an aspect of the invention to provide an alternative system for disinfection, for instance in homes, office spaces or retail shops, which preferably further at least partly obviates one or more of above-described drawbacks. The present invention may have as object to overcome or ameliorate at least one of the disadvantages of the prior art, or to provide a useful alternative.

It appears desirable to produce lamps comprising ionizers that may in operational mode have the same look and feel as existing lamps. In this way, areas of interest may be disinfected while disinfection systems may remain unnoticed. Amongst others, it is herein proposed in embodiments to apply a housing comprising an ionizing module, that can be connected to a lamp envelope (i.e. basically in embodiments a retrofit approach). The lamp and/or housing may in embodiments fit the design of lamps without disinfection system (to be unobtrusive) or can in embodiments look differently.

Hence, in a first aspect the invention provides a (reflector) lamp, wherein the lamp may comprise one or more of (i) a light source, (ii) an envelope, (iii) a housing, (iv) an ionizer, and (v) a base (or "lamp base"). The lamp further comprises a first optical element.

The lamp further comprises a second optical element. The light source is configured to generate light source light. The envelope defines an envelope space, wherein the envelope at least partially encloses the light source. Especially, at least part of the envelope is optically transmissive for the light source light. The ionizer is configured to ionize gas, such as air, and the ionizer comprises one or more of needles and brushes functioning as ion emitters. The housing may at least partly define a housing space. In embodiments, the housing may be associated with the envelope. In specific embodiments, the housing may at least partially enclose the ionizer. The first optical element is configured between the envelope space and the housing space. The first optical element is configured to reflect at least part of the light source light. The second optical element may in embodiments be configured as at least part of the housing. In alternative embodiments, the second optical element may be configured on at least part of the housing. Especially, the second optical element is configured to reflect at least part of light in the visible wavelength range, wherein the reflectivity of the second optical element is in the range of 70-100% for light having a wavelength selected from the visible wavelength range. Additionally or alternatively, the second optical element may be configured to absorb at least part of light in the visible wavelength range. The base and the housing are arranged at opposite sides of the envelope. Therefore, in specific embodiments the invention provides a lamp comprising a light source, an envelope, a housing, an ionizer, a (lamp) base, a first optical element, and a second optical element; wherein the light source is configured to generate light source light; wherein the envelope at least partly defines an envelope space, wherein the envelope at least partially encloses the light source, wherein at least part of the envelope is optically transmissive for the light source light; wherein the ionizer is configured to ionize gas, such as air; wherein the housing at least partly defines a housing space, wherein the housing is associated with the envelope, wherein the housing at least partially encloses the ionizer; wherein the first optical element is configured between the envelope space and the housing space, wherein the first optical element is configured to reflect at least part of the light source light; wherein the second optical element is configured as part of the housing or is configured on part of the housing; wherein the second optical element is configured to one or more of (i) absorb and (ii) reflect at least part of light in the visible wavelength range; and wherein the lamp base and the housing are arranged at opposite sides of the envelope.

Such a lamp for disinfection may be easy to install in existing buildings as it may be implemented in an existing light housing or luminaire. The lamp may further provide a large flexibility in the positioning of ionizers. In embodiments, the lamp may have a similar look and feel as regular lamps. Additionally or alternatively, the lamp may have a similar look and feel as reflector lamps. In this way, a disinfection system may be unobtrusive whilst being operational. As lamps comprising an ionizer may have a similar appearance to lamps without an ionizer, incorporating disinfection measures may no longer be held back by aesthetical reasons. The invention further allows providing a retrofit lamp having its lighting function as well as a further function, such as air treatment and/or disinfection. Further, the first optical element may increase the efficiency of the light source. Additionally or alternatively, the second optical element may increase the efficiency of the light source. Moreover, the second optical element may e.g. prevent glare. Also, one or more of the first optical element and second optical element may improve aesthetical appearance when the lamp is used in a luminaire (e.g. lampshade). For an ionizer device it may be advantageous to be located at a ceiling or otherwise over a floor, such as suspended from a roof, e.g. in a pendant lamp etc. In this way, the amount of obstruction by other elements, like chairs, desks, cupboards, cubicle walls, etc., may be minimized and large areas may be treated (with one or more units).

As indicated above, the invention provides a lamp which may in embodiments comprise a reflector lamp. The lamp may especially comprise the light source. The light source may in embodiments configured to generate light source light. In specific embodiments, the light source light may comprise one or more wavelengths in the visible wavelength range. Hence, the light source light may comprise one or more wavelengths in the range of 380-780 nm. Especially, the light source may be configured to generate visible light, such as in embodiments white light.

Especially, the lamp may be configured to generate lamp light. In embodiments, the lamp light may essentially consist of the light source light that escapes from the envelope. Hence, the lamp light may comprise at least part of the light source light.

In embodiments, the envelope may define an envelope space. Especially, in embodiments, the envelope may partially enclose the light source. In alternative embodiments, the envelope may fully enclose the light source. Hence, the light source may (at least partially) be arranged in the envelope space. The envelope space may in embodiments comprise a gas. In embodiments, part of the envelope may be optically transmissive for the light source light. In specific embodiments, the entire envelope may be optically transmissive for the light source light.

The envelope may comprise a light transmissive (envelope) material. The envelope is especially light transmissive for the light source light, like translucent or transparent. In specific embodiments, the envelope comprises light transparent material.

The light transmissive material may comprise one or more materials selected from the group consisting of a transmissive organic material, such as selected from the group consisting of PE (polyethylene), PP (polypropylene), PEN (polyethylene napthalate), PC (polycarbonate), polyurethanes (PU), polymethylacrylate (PMA), polymethylmethacrylate (PMMA) (Plexiglas or Perspex), polymethacrylimide (PMI), polymethylmethacrylimide (PMMI), styrene acrylonitrile resin (SAN), cellulose acetate butyrate (CAB), silicone, polyvinylchloride (PVC), polyethylene terephthalate (PET), including in an embodiment (PETG) (glycol modified polyethylene terephthalate), PDMS (polydimethylsiloxane), and COC (cyclo olefin copolymer). Especially, the light transmissive material may comprise an aromatic polyester, or a copolymer thereof, such as e.g. one or more of polycarbonate (PC), poly (methyl)methacrylate (P(M)MA), polyglycolide or polyglycolic acid (PGA), polylactic acid (PLA), polycaprolactone (PCL), polyethylene adipate (PEA), polyhydroxy alkanoate (PHA), polyhydroxy butyrate (PHB), poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV), polyethylene terephthalate (PET), polybutylene terephthalate (PBT), polytrimethylene terephthalate (PTT), polyethylene naphthalate (PEN). Especially, the light transmissive material may comprise polyethylene terephthalate (PET). Hence, the light transmissive material may especially be a polymeric light transmissive material.

However, in another embodiment the light transmissive material may comprise an inorganic material. Especially, the inorganic light transmissive material may be selected from the group consisting of glasses, (fused) quartz, transmissive ceramic materials, and silicones. Also hybrid materials, comprising both inorganic and organic parts may be applied. Especially, the light transmissive material comprises one or more of PMMA, transparent PC, or glass.

The lamp may in embodiments further comprise an ionizer. Especially, the ionizer may be configured to ionize gas. In specific embodiments, the ionizer may be configured to ionize air. Further embodiments will be described especially using air as embodiment of a gas. In embodiments, the ionizer may produce ionized air. As will be further elucidated below, this may be done with or without a fan or other type of air blower. Hence, the phrase “producing ionized air”, and similar phrase, may especially indicate that air in the housing is ionized, which thus leads to the production of ionized air. Especially, the ionized air may in embodiments comprise one or more of NO_2^-, NO_3^-, CO_3^-, HCO_3^-, $O_2^{\cdot -}$, O_3^-,

O^-, OH^-, NO_3^-, and CO_4^-. In embodiments, other ions may also be present. In this way, ions may be spread in the space wherein the lamp comprising the ionizer is configured. By ionizing air, the ionized air may be used to disinfect surfaces. Further, air may be treated in this way, and may be purified. For instance, particles may be removed from air using the ionizer. Hence, the lamp of the invention may have one or more of an air treatment function and a disinfection function.

Microorganisms may be killed by positively charged particles and/or negatively charged particles in air.

In embodiments, the ionized air may be used for disinfection of one or more of (i) bacteria, (ii) viruses, and (iii) spores. Other terms for air ionization that may be used are “plasma cluster ionization” or “needle point bi-polar ionization (NPBI)”, which are considered to be equivalent to air ionization. In embodiments, the ionizer device may produce negative ions. In embodiments the ionizer device may produce positive ions. In embodiments, the ionizer device may produce positive and negative ions, such as at different positions and/or guided in different directions. In embodiments, the ionizer may comprise one or more ionization elements. Especially, the ionizer may comprise a plurality of ionization elements.

In embodiments, the ionizer (especially the ionization elements) may comprise one or more of needles and brushes functioning as ion emitters. In embodiments, the ionizer my comprise one or more of needles and brushes electrically coupled to electronics of the lamp for electrical powering. In embodiments, the ion emitters may comprise one or more of tungsten, titanium, steel, and carbon, such as needles or brushes comprising one or more of tungsten, titanium, steel, and carbon. In embodiments, ions may be generated on the basis of the corona effect.

The term “ionizer” may also refer to a plurality of ionizers. The term ionizer may e.g. refer to an air ionizer.

The lamp may in embodiments further comprise a housing, wherein the housing may define a housing space. In embodiments, the housing may (at least) partially enclose the ionizer. In operational mode, the housing may be associated with the envelope. In embodiments, the housing unit may be configured detachable to the envelope. In this way, it may be relatively easy to perform maintenance or to replace the ionizers (along with their housing) at their end of lives.

In embodiments, the housing and envelope may be formed into a monolithic body, such as by welding or melting, and are thereby associated to each other. In alternative embodiments, the housing and the envelope may be associated to each other by gluing the housing and the envelope to each other. Hence, a glue or other adhesive means may be applied. Additionally or alternatively, the housing and envelope may be clamped to each other with clamping elements. Additionally or alternatively, the housing and envelope may be associated to each other *via* a screw element. For instance, the housing may be screwed to the envelope. Optionally, (further) fixation can be done with an additional clamp or (other) barb element. Also male-female connections may be applied, with optionally a (further) fixation with an additional clamp or (other) barb element. Additionally or alternatively, the housing and envelope may be associated to each other *via* (permanent) magnets. The housing and the envelope may in embodiments be made of the same material such as glass, ceramic or a polymer material. Alternatively, the housing and the envelope may in embodiments be made of different materials.

In embodiments, the housing may comprise a fan. Such fan may produce an air flow in a target direction which may transport ions produced by the ionizer in the target direction. The term “fan” may refer to any device that can generate a flow, with or without rotating blades. Further, the term “fan” may also refer to a plurality of (individually controllable) fans.

In alternative embodiments, the housing may not comprise a fan. In this case, ions produced by the ionizer may diffuse out of the housing. Alternatively, the ions produced by the ionizer may be transported by air flow that is already present (in a space), e.g. caused by heating, ventilation air conditioning (HVAC) systems. In such embodiments, ions that may propagate away from the ionizer may be entrained by an air flow that is already present in a space. Note that in case of embodiments of the housing with a fan, also the air flow already present may influence, such as assist, in distributing the ionized air (in the space).

In embodiments, the lamp may further comprise a first optical element. In specific embodiments, the first optical element may comprise a first reflective element. The first optical element may in embodiments be configured to reflect at least part of the light source light. Part of the light source light may in embodiments refer to part of a total intensity of the light source light. Additionally or alternatively, part of the light source light may in embodiments refer to one or more of the wavelengths comprised by the light source light. Especially, the first optical element may in specific embodiments be configured to reflect all wavelengths of the light source light. In this way, a larger part of the light source light may exit the lamp. In embodiments, the first optical element may be configured between the envelope space and the housing space. Hence, especially the first optical element is a reflector for the light source light. Therefore, a part of the light source light may escape directly via the light transmissive envelope, and part of the light source light may escape via the light transmissive envelope after reflection at the first optical element. Embodiments of the first optical element will be discussed in more detail below.

In embodiments, the lamp may further comprise a second optical element. The second optical element may in embodiments be configured as part of the housing. Additionally or alternatively, the second optical element may in embodiments be configured on part of the housing. In embodiments, the second optical element may be at least configured to reflect at least part of light in the visible wavelength range. The second optical element may in embodiments comprise a reflective layer or a reflective coating. In embodiments, the second optical element may be configured on an outer surface of the housing. Additionally or alternatively, the second optical element may be configured on an inner surface of the housing. In specific embodiments, the second optical element may comprise a (second) light reflective element. In this way, an at least partly reflective housing may be provided. In embodiments, the second optical element may be configured to reflect at least part of light in the visible wavelength range. Additionally or alternatively, the second optical element may be configured to reflect one or more wavelengths in the range of 380-780 nm. Especially, the second optical element may in embodiments be reflective for all wavelengths in the range of 380-780 nm. Especially, the reflectivity of the second optical element may in embodiments be relatively constant for all wavelengths in the range of 380-780 nm, such as in the range of 70-100% for all wavelengths in the range of 380-780 nm. Hence, in specific embodiments, the gas comprises air, the housing comprises a housing opening configured to provide access of air to the ionizer; and the second optical element is at least configured to reflect at least part of light in the visible wavelength range. Embodiments of reflectivity will be discussed in more detail below.

A reflective element may be a specular reflective material, such as an aluminum mirror. The reflective material may also be diffuse reflective material, such as a coating of a particulate white material. Suitable reflective material for reflection in the visible may be selected from the group consisting of TiO_2, $BaSO_4$, MgO, Al_2O_3, and Teflon.

In specific embodiments, the second optical element may be metallic, especially the second optical element may comprise a metal, more especially, the second optical element may be specular reflective. In specific embodiments, the second optical element may comprise a metallic reflector. Hence, especially the second optical element may be specular reflective.

Additionally or alternatively, the second optical element may in embodiments comprise a light absorbing material. In this way, an at least partly absorbing housing may be provided. In embodiments, the second optical element may be configured to absorb at least part of light in the visible wavelength range. Additionally or alternatively, the second optical element may be configured to absorb one or more wavelengths in the range of 380-780 nm. Especially, the second optical element may in embodiments be absorbing for all wavelengths in the range of 380-780 nm. In this way, the second optical element may thereby provide an at least partly (light) absorbing housing.

As indicated above, in specific embodiments the second optical element may be specular reflective.

In embodiments, the lamp may further comprise a base. The lamp base may in embodiments especially provide a mechanical and/or electrical interface with a lamp socket. Especially, the base and the housing may in embodiments be arranged at opposite sides of the envelope. The (lamp) base may in embodiments comprise an Edison screw cap, e.g. an E14 or E27. Alternatively, the base may comprise a bayonet mount, e.g. an GU5.3 or GU10. However, alternative connections may in embodiments also be applied. The base may especially be configured for functional coupling to a socket. Instead of the term “base” also the term “lamp base” may be applied. In embodiments, the lamp base may be configured for providing a mechanical and/or electrical interface (from the lamp with a lamp holder and/or a source of electrical energy, like mains).

Here, the phrases “a wavelength in the visible wavelength range” “the wavelength” or “one or more wavelengths”, and similar phrases, may especially indicate one wavelength or multiple wavelengths. Hence, the terms “a wavelength” or “the wavelength” in phrases like “transparent for a wavelength” or “transmissive for the wavelength”, or “reflective for the wavelength”, and similar phrases, may especially refer to a plurality of wavelengths, such as a wavelength range of at least 100 nm, especially a wavelength range of at least 250 nm, such as a wavelength range of at least 300 nm (within the range of 380-780 nm).

Especially, in embodiments a light transmissive material has a light transmission in the range of 50-100 %, especially in the range of 70-100%, for light having a wavelength selected from the visible wavelength range. Herein, the term “visible light” especially relates to light having a wavelength selected from the range of 380-780 nm.

Hence, for instance, the shell may be transparent for wavelengths in a wavelength range of at least 100 nm (within the visible wavelength range). Hence, at any wavelength in the range, the shell may be transparent. For instance, at any wavelength in the range, the transmission may be at least 50%.

Especially, a light absorbing material has a light absorbance in the range of 50-100 %, especially in the range of 70-100%, for light having a wavelength selected from the visible wavelength range. As can be derived from the above, this may apply for a wavelength range of at least 100 nm, especially a wavelength range of at least 250 nm, such as a wavelength range of at least 300 nm (within the range of 380-780 nm).

Especially, a light reflective material has a light reflectivity in the range of 50-100 %, especially in the range of 70-100%, for light having a wavelength selected from the visible wavelength range. As can be derived from the above, this may apply for a wavelength range of at least 100 nm, especially a wavelength range of at least 250 nm, such as a wavelength range of at least 300 nm (within the range of 380-780 nm).

Note that a material may be reflective for one or more first wavelengths and absorb one or more second wavelengths, which may be the case with colored material. Herein, the term “light absorbing material” especially refers to a colored material or to a black material. The term “light reflective material may herein especially refer to a white material or metallic reflective material, i.e. materials which have a relatively high reflection, such as at least 70%, over a relatively high wavelength range, such as at least 100 nm, even more especially at least 250 nm, such as at least 300 nm, within the range of 380-780 nm.

The transmission T (or light permeability) can be determined by providing light at a specific wavelength with a first intensity I_1 to the light transmissive material under perpendicular radiation and relating the intensity of the light I_2 at that wavelength measured after transmission through the material, to the first intensity of the light provided at that specific wavelength to the material, thus $T=I_2/I_1$. Likewise, the reflectivity R can be determined by relating the intensity of the light I_3 at that wavelength measured after reflection by the material, to the first intensity of the light I_1 provided at that specific wavelength to the material. Thus $R= I_3/I_1$. The absorbance A may in embodiments be defined as $A=1-(T+R)$ (see also E-208 and E-406 of the CRC Handbook of Chemistry and Physics, 69th edition, 1088-1989).

In specific embodiments, a material may be considered transmissive when the transmission of the radiation at a wavelength or in a wavelength range is larger than the reflectivity and absorbance (at that wavelength or in that wavelength range), thus when $T>R$ and $T>A$, especially wherein $T/R\geq1.2$ and $T/A\geq1.2$. In specific embodiments, a material may be considered reflective when the reflectivity of the radiation at a wavelength or in a wavelength range is larger than the transmission and absorbance (at that wavelength or in that wavelength range), thus when R>T and R>A, especially wherein R/T≥1.2 and R/A≥1.2. In specific embodiments, a material may be considered absorbing when the absorbance of the radiation at a wavelength or in a wavelength range is larger than the transmission and reflectivity (at that wavelength or in that wavelength range), thus when A>T and A>R, especially wherein A/T≥1.2 and A/R≥1.2. Here, T, R, and A refer to percentages.

In specific embodiments, a material may be considered transmissive when the transmission of the radiation at a wavelength or in a wavelength range, especially at a wavelength or in a wavelength range of radiation generated by a source of radiation as herein described, through a 1 mm thick layer of the material, especially even through a 5 mm thick layer of the material, under perpendicular irradiation with said radiation is at least about 20%, such as at least 40%, like at least 60%, such as especially at least 80%, such as at least about 85%, such as even at least about 90%.

The light transmissive material has light guiding or wave guiding properties. Hence, the light transmissive material is herein also indicated as waveguide material or light guide material. The light transmissive material will in general have (some) transmission of one or more of (N)UV, visible and (N)IR radiation, such as in embodiments at least visible light, in a direction perpendicular to the length of the light transmissive material.

The transmission of the light transmissive material (as such) for one or more luminescence wavelengths may be at least 80%/cm, such as at least 90%/cm, even more especially at least 95%/cm, such as at least 98%/cm, such as at least 99%/cm. This implies that e.g. a 1 cm^3 cubic shaped piece of light transmissive material, under perpendicular irradiation of radiation having a selected luminescence wavelength (such as a wavelength corresponding to an emission maximum of the luminescence of the luminescent material of the light transmissive material), will have a transmission of at least 95%.

Herein, values for transmission especially refer to transmission without taking into account Fresnel losses at interfaces (with e.g. air). Hence, the term "transmission" especially refers to the internal transmission. The internal transmission may e.g. be determined by measuring the transmission of two or more bodies having a different width over which the transmission is measured. Then, based on such measurements the contribution of Fresnel reflection losses and (consequently) the internal transmission can be determined. Hence, especially, the values for transmission indicated herein, disregard Fresnel losses.

In embodiments, an anti-reflection coating may be applied to the luminescent body, such as to suppress Fresnel reflection losses (during the light incoupling process).

In addition to a high transmission for the wavelength(s) of interest, also the scattering for the wavelength(s) may especially be low. Hence, the mean free path for the wavelength of interest only taking into account scattering effects (thus not taking into account possible absorption) may be at least 0.5 times the length of the body, such as at least the length of the body, like at least twice the length of the body. For instance, in embodiments the mean free path only taking into account scattering effects may be at least 5 mm, such as at least 10 mm. The wavelength of interest may especially be the wavelength at maximum emission of the luminescence of the luminescent material. The term “mean free path” is especially the average distance a ray will travel before experiencing a scattering event that will change its propagation direction.

In embodiments, the element comprising the light transmissive material may essentially consist of the light transmissive material. In specific embodiments, the element comprising the light transmissive material may be a light transparent element. Especially, the light transmittance is similar for all wavelengths in the visible wavelength range.

Especially, the light transmissive element, such as the light transparent element, may in embodiments have an absorption length and/or a scatter length of at least the length (or thickness) of the light transmissive element, such as at least twice the length of the light transmissive element. The absorption length may be defined as the length over which the intensity of the light along a propagation direction due to absorption drops with 1/e. Likewise, the scatter length may be defined as the length along a propagation direction along which light is lost due to scattering and drops thereby with a factor 1/e. Here, the length may thus especially refer to the distance between a first face and a second face of the light transmissive element, with the light transmissive material configured between the first face and second face.

Herein, when an element is indicated to be transmissive this may in embodiments imply that at one or more wavelengths the part of the radiation that is transmitted may be larger than the part of the radiation that is reflected or absorbed. Herein, when an element is indicated to be reflective this may in embodiments imply that at one or more wavelengths the part of the radiation that is reflected may be larger than the part of the radiation that is transmitted or absorbed.

In embodiments, the housing may comprise a housing opening. The housing opening may be configured to provide access of air to the ionizer. Hence, in specific embodiments, the housing comprises a housing opening configured to provide access of air to the ionizer; and the second optical element may at least be configured to reflect at least part of light in the visible wavelength range. Especially, the housing opening may be configured to provide access of air to the one or more ionization elements. The housing may in embodiments comprise a plurality of housing openings. In this way, ionized air may move out of the housing more easily and or faster. This may increase an efficiency of the ionizer. The housing may in embodiments comprise a plurality of ionization elements. In specific embodiments, the ionizer may comprise a plurality of ionization elements and the housing may comprise a plurality of openings.

The lamp of the invention may have a longitudinal axis (A). In embodiments, the ionizer may be configured such that the ionizer may not be observable by an observer (O) observing the lamp along the longitudinal axis (A) from the side of the housing. Additionally or alternatively, in embodiments, the (single or plurality of) housing opening(s) may be configured such that the housing opening(s) may not be observable by an observer (O) observing the lamp along the longitudinal axis (A) from the side of the housing. In this way, the lamp of the invention may look similar to reflector lamps that do not comprise an ionizer. Especially, one or more of the ionizer and the housing opening(s) may in embodiments not be observable by an observer when the lamp is in an operational mode, such as e.g. positioned as a downlight.

The housing may comprise a housing outer surface. The housing outer surface may comprise a first section and optionally a second section. Especially, the first section may in embodiments at least partly face away from the envelope. Additionally or alternatively, the first section may in embodiments be defined by a section of the housing outer surface that is not in contact with any one of (i) the first optical element, (ii) the envelope, and (iii) the envelope space. The second section may in embodiments be defined as the contact section. The second section may in embodiments especially comprise part of the housing outer surface that is in contact with one or more of (i) the first optical element, (ii) the envelope, and (iii) the envelope space.

In embodiments, the housing may only comprise a first section as defined above. Alternatively, in embodiments the housing may comprise a first section and a second section. In embodiments, at least 50%, such as at least 65%, especially at least 80% of an area of the first section may be covered or defined by the second optical element. Hence, in specific embodiments, the housing may have a housing outer surface, wherein the housing outer surface may comprise a first section at least partly facing away from the envelope, wherein at least 80% of an area of the first section may be covered or defined by the second optical element; and wherein the second optical element may comprise a metallic reflector.

The housing opening(s) may especially be located on the housing outer surface. In embodiments, one or more housing openings may be located on the first section. In this way, the housing space may be fluidly connected with an exterior of the lamp.

In embodiments, the housing may have a curved shape. Especially, the first section may in embodiments have a curved shape, e.g. a shape similar to a shape of a light bulb.

In specific embodiments the envelope may have a piriform-like shape. Additionally or alternatively, in embodiments a combination of the envelope and the housing may have a piriform-like shape. One or more of (i) the envelope and (ii) the combination of the envelope and the housing, may in embodiments have the cross-sectional shape rather similar to a conventional light bulb or to a pear. Hence, the envelope (with or without the housing) is herein also indicated as having in embodiments a piriform-like shape with a piriform-like shaped cross-section. The term “piriform-like shape” especially refers to a cross-sectional shape (along the longitudinal axis (A)). In other embodiments, the envelope may have a circular shape. Additionally or alternatively, in embodiments a combination of the envelope and the housing may have a circular shape.

In a cross-section perpendicular to the longitudinal axis (A), the envelope may be substantially circular and may have a first maximum diameter D1. In a cross-section perpendicular to the longitudinal axis (A), the housing may be substantially circular and may have a second maximum diameter D2. In embodiments $0.5 \leq D2/D1 \leq 2$, such as $0.65 \leq D2/D1 \leq 1.5$, especially $0.75 \leq D2/D1 \leq 1.5$, more especially $0.75 \leq D2/D1 \leq 1.25$. In this way, the thicknesses or widths of the housing and the envelope will not differ too much. As indicated above, in embodiments the combination of the envelope and the housing may comprise a piriform-like shape.

The envelope may comprise an envelope outer surface. Additionally, the envelope may comprise an envelope inner surface. In embodiments, the first optical element may comprise a reflective layer configured on part of the envelope outer surface. Additionally or alternatively, the first optical element may in embodiments comprise a reflective layer configured on part of the envelope inner surface. In embodiments, the housing may comprise the second section (the contact section), wherein the first optical element may comprise a reflective layer configured on part of the housing contact section. In embodiments, the housing may comprise the second section, wherein the first optical element may comprise a reflective layer configured on an inner surface of the housing. In alternative embodiments, the first optical element may be arranged as a physical separation between the envelope space and the housing space. Hence, in specific embodiments, the first optical element may be arranged as one of (i) a physical separation between the envelope space and the housing space, (ii) on an inner surface of the envelope, (iii) on an outer surface of the envelope, (iv) on an outer surface of a contact section of the housing, and (v) on an inner surface of a contact section of the housing, wherein the contact section of the housing is part of the housing that is in contact with one or more of (i) the first optical element, (ii) the envelope, and (iii) the envelope space. Especially, in embodiments, the first optical element may be a coating. Hence, the first optical element may in embodiments be one or more of a coating on (i) an inner surface of the envelope, (ii) an outer surface of the envelope, (iii) an outer surface of a contact section of the housing, and (iv) an inner surface of a contact section of the housing.

The lamp may in embodiments further comprise electronics. Yet further, in embodiments the lamp may comprise one or more electrically conductive tracks. In embodiments, the ionizer may be functionally coupled to the electronics via one or more of the one or more electrically conductive tracks. In embodiments, a first track part of one or more of the one or more electrically conductive tracks may be configured at an envelope outer surface of the envelope. Additionally or alternatively, a second track part of one or more of the one or more electrically conductive tracks may be configured at an envelope inner surface of the envelope. Additionally or alternatively, a third track part of one or more of the one or more electrically conductive tracks may be configured through the envelope space. In embodiments, the conductive tracks may only comprise the first track part. In alternative embodiments, the conductive tracks may only comprise the second track part. In alternative embodiments, the electronics may only comprise the third track part. In yet alternative embodiments, the conductive tracks may comprise both the first track part and the second track part. In yet alternative embodiments, the conductive tracks may comprise both the first track part and the third track part. In yet alternative embodiments, the conductive tracks may comprise both the second track part and the third track part. In yet alternative embodiments, the conductive tracks may comprise the first track part and the second track part and the third track part. The first track part may be relatively easy to produce. The second track part may be less fragile compared to the first track part. The third track part may be less obtrusive compared to the first track part and second track part. In specific embodiments, the one or more of the track parts may be configured electrically insulated via, e.g., a glass layer. Especially, the first track part may in embodiments be configured electrically insulated. Hence, in specific embodiments, the lamp may comprise electronics and one or more electrically conductive tracks, wherein the ionizer may be functionally coupled to the electronics via one or more of the one or more electrically conductive tracks, wherein a first track part of one or more of the one or more electrically conductive tracks may be configured at an envelope outer surface of the envelope, wherein the first track part may be configured electrically insulated. In this way, the ionizer may be electrically coupled to an electrical power source of the lamp.

In embodiments, one or more of (i) the physical separation as defined above, (ii) the envelope and (iii) the second (contact) section of the housing, may comprise a through-hole. Especially, in embodiments the electronics and the ionizer may be electrically coupled via one or more electrically conductive tracks that connect the envelope space and the housing space via the through-hole. Especially, however, in embodiments there may be no fluidic contact between the envelope space and the housing space.

The lamp may in embodiments further comprise an electrical power system. The electrical power system may in embodiments be configured to provide electrical energy to the ionizer. In embodiments, the electrical power system may be at least partly comprised by one or more of the base, the envelope, and the housing. In specific embodiments, the electrical power system may be one or more of (i) induction-based and (ii) photovoltaic cell based. Especially, the photovoltaic cell may in embodiments be configured to convert part of the light source light into electrical energy. The photovoltaic cell may in embodiments be configured in the envelope space. In this way, part of the light source light may directly irradiate the photovoltaic cell. For transferring the electrical energy to the ionizer, one or more electrically conductive tracks may in embodiments connect the photovoltaic cell and the ionizer via a through-hole as described above. Additionally or alternatively, the photovoltaic cell may in embodiments be configured in the housing space. In this way, part of the light source light may in embodiments enter the housing space and irradiate the photovoltaic cell. Especially, in such embodiments (all) components between the light source and the photovoltaic cell may be transmissive for at least part of the light source light. In specific embodiments, the electrical power system may further comprise a battery. The battery may in embodiments be electrically connected to the photovoltaic cell and the ionizer. In specific embodiments, the electrical power system may further comprise one or more electrical components, wherein the electrical components may convert electrical energy into a suitable electrical energy for the ionizer, e.g. current and/or voltage. Hence, in specific embodiments, the lamp may comprise an electrical power system configured to provide electrical energy to the ionizer, wherein the electrical power system may be at least partly comprised by one or more of the envelope and the housing, wherein the electrical power system is one or more of (i) induction-based and (ii) photovoltaic cell based, wherein the photovoltaic cell is configured to convert part of the light source light into electrical energy.

In embodiments wherein the electrical power system comprises an induction-based power system, the power system may be considered wireless, although electrically conductive tracks may be arranged in the envelope space. In embodiments wherein the electrical power system comprises a photovoltaic cell, the photovoltaic cell may be arranged in the housing space. In this way, no electrical connection between the envelope (space) and housing space may be necessary as the power system and the ionizer may be arranged in the same compartment. Hence, in operational mode, no electrically conductive tracks may be visible for an observer. Especially, the photovoltaic cell may be configured to receive at least part of the light source light.

As indicated above, in embodiments the ionizer may comprise one or more ionization elements. Especially, the ionizer may in embodiments comprise a plurality of ionization elements. The (plurality of) ionization element(s) may in embodiments comprise a (plurality of) negative ionization element(s) configured to provide negative ions. Additionally or alternatively, the (plurality of) ionization element(s) may in embodiments comprise a (plurality of) positive ionization element(s) configured to provide positive ions. In specific embodiments the negative ionization element(s) and the positive ionization element(s) may be configured to provide the negative ions *via* different housing openings than the positive ions. Especially, in embodiments, the negative ionization element(s) and the positive ionization element(s) may be configured to provide the negative ions and the positive ions at opposite sites. In this way, the efficiency of the ionizer may be increased. Hence, in specific embodiments, the lamp may comprise a plurality of ionization elements, wherein the plurality of ionization elements may comprise a negative ionization element configured to provide negative ions, and a positive ionization element configured to provide positive ions.

In a further aspect the invention provides a housing comprising an ionizer, wherein the ionizer is configured to ionize air. In embodiments, the housing may comprise a contact surface, wherein the contact surface may be configured to be arranged on an envelope of a lamp, especially a (retrofit) light bulb. The contact surface may in embodiments comprise a concave contact surface. Hence, in specific embodiments, the invention provides a housing comprising an ionizer, wherein the housing at least partially encloses the ionizer, wherein the ionizer is configured to ionize air, wherein the housing comprises a contact surface, wherein the contact surface is configured to be arranged on an envelope of a lamp.

In this way, an ionizer may be placed on a (retrofit) light bulb. Further, it may be relatively easy to perform maintenance or to replace the ionizers (along with their housing) at their end of lives. The housing and envelope may be associated to each other as indicated above.

The housing may in embodiments further comprise a first optical element. In embodiments, the first optical element may be reflective for light having one or more wavelengths selected from the range of 380 – 780 nm. Additionally or alternatively, the second optical element may in embodiments be absorbing for light having one or more wavelengths selected from the range of 380 – 780 nm. Especially, the first optical element may in embodiments be configured as at least part of the (concave) contact surface.

In embodiments, the housing may further comprise a housing outer surface wherein the housing outer surface comprises a first section. In embodiments at least 50%, such as at least 65%, especially at least 80% of the first section may be covered or defined by the second optical element. In specific embodiments, the second optical element may comprise a metallic reflector.

The embodiments described above in relation to the lamp of the present invention, may also apply for the housing of the invention.

The terms “upstream” and “downstream” relate to an arrangement of items or features relative to the propagation of the light from a light generating means (here the especially the light source), wherein relative to a first position within a beam of light from the light generating means, a second position in the beam of light closer to the light generating means is “upstream”, and a third position within the beam of light further away from the light generating means is “downstream”.

In embodiments, the lamp as described herein may comprise a control system. In other embodiments, the lamp as described herein may be functionally coupled to a control system.

The control system may be configured to control one or more optical properties of the lamp light, such as one or more of the intensity, the spectral power distribution, the color point, the correlated color temperature. Control of the lamp light may be done by controlling the light source light. Especially, the lamp may comprise a plurality of light sources, such as a plurality of LEDs.

The control system may be configured to control the ionizer. For instance, this may imply controlling a potential difference, controlling a potential to one or more electrodes, controlling time behavior of the potential difference or potential to one or more of the electrodes, etc. Would a blower be available, then the control system may also control the blower.

The term “controlling” and similar terms especially refer at least to determining the behavior or supervising the running of an element. Hence, herein “controlling” and similar terms may e.g. refer to imposing behavior to the element (determining the behavior or supervising the running of an element), etc., such as e.g. measuring, displaying, actuating, opening, shifting, changing temperature, etc.. Beyond that, the term “controlling” and similar terms may additionally include monitoring. Hence, the term “controlling” and similar terms may include imposing behavior on an element and also imposing behavior on an element and monitoring the element. The controlling of the element can be done with a control system, which may also be indicated as “controller”. The control system and the element may thus at least temporarily, or permanently, functionally be coupled. The element may comprise the control system. In embodiments, the control system and element may not be physically coupled. Control can be done via wired and/or wireless control. The term “control system” may also refer to a plurality of different control systems, which especially are functionally coupled, and of which e.g. one control system may be a master control system and one or more others may be slave control systems. A control system may comprise or may be functionally coupled to a user interface.

The control system may also be configured to receive and execute instructions from a remote control. In embodiments, the control system may be controlled via an app on a device, such as a portable device, like a smartphone or iPhone, a tablet, etc.. The device is thus not necessarily coupled to the lighting system, but may be (temporarily) functionally coupled to the lighting system.

Hence, in embodiments the control system may (also) be configured to be controlled by an app on a remote device. In such embodiments the control system of the lighting system may be a slave control system or control in a slave mode. For instance, the lighting system may be identifiable with a code, especially a unique code for the respective lighting system. The control system of the lighting system may be configured to be controlled by an external control system which has access to the lighting system on the basis of knowledge (input by a user interface of with an optical sensor (e.g. QR code reader) of the (unique) code. The lighting system may also comprise means for communicating with other systems or devices, such as on the basis of Bluetooth, Wifi, ZigBee, BLE or WiMax, or another wireless technology.

The system, or apparatus, or device may execute an action in a “mode” or “operation mode” or “operational mode” or “mode of operation” or “control mode”. Likewise, in a method an action or stage, or step may be executed in a “mode” or operation mode” or “operational mode” or “mode of operation” or “control mode”. The term “mode” may also be indicated as “controlling mode”. This does not exclude that the system, or apparatus, or device may also be adapted for providing another controlling mode, or a plurality of other controlling modes. Likewise, this may not exclude that before executing the mode and/or after executing the mode one or more other modes may be executed.

However, in embodiments a control system may be available, that is adapted to provide at least the controlling mode. Would other modes be available, the choice of such modes may especially be executed via a user interface, though other options, like executing a mode in dependence of a sensor signal or a (time) scheme, may also be possible. The operation mode may in embodiments also refer to a system, or apparatus, or device, that can only operate in a single operation mode (i.e. “on”, without further tunability).

Hence, in embodiments, the control system may control in dependence of one or more of an input signal of a user interface, a sensor signal (of a sensor), and a timer. The term “timer” may refer to a clock and/or a predetermined time scheme.

Therefore, in specific embodiments the control system may control the lamp light in dependence of one or more of an input signal of a user interface, a sensor signal (of a sensor), and a timer. The term “timer” may refer to a clock and/or a predetermined time scheme.

Yet, in specific embodiment the control system may control the ionizer in dependence of one or more of an input signal of a user interface, a sensor signal (of a sensor), and a timer. The term “timer” may refer to a clock and/or a predetermined time scheme.

Yet, in specific embodiment the control system may control the optional blower in dependence of one or more of an input signal of a user interface, a sensor signal (of a sensor), and a timer. The term “timer” may refer to a clock and/or a predetermined time scheme.

The optional sensor may be comprised by the lamp or may be functionally coupled to the control system. In embodiments, the sensor may comprise one or more sensors selected from the group comprising: a movement sensor, a presence sensor, a distance sensor, an ion sensor, a gas sensor, a volatile organic compound sensor, a pathogen sensor, an airflow sensor, a sound sensor, and a communication receiver. The ion sensor may comprise a positive ion sensor. Additionally or alternatively, the ion sensor may comprise a negative ion sensor. The pathogen sensor may comprise a sensor for one or more of bacteria, viruses, and spores. Alternatively or additionally, the sensor may comprise a temperature sensor. Further, alternatively or additionally, the sensor may comprise a humidity sensor.

The lamp may be part of or may be applied in e.g. office lighting systems, household application systems, shop lighting systems, home lighting systems, accent lighting systems, spot lighting systems, theater lighting systems, fiber-optics application systems, projection systems, self-lit display systems, pixelated display systems, segmented display systems, warning sign systems, medical lighting application systems, indicator sign systems, decorative lighting systems, portable systems, automotive applications, green house lighting systems, horticulture lighting, or LCD backlighting.

As indicated above, the lamp may be used as back-lighting unit in an LCD display device. Hence, the invention provides also an LCD display device comprising the lighting unit as defined herein, configured as backlighting unit. The invention also provides in a further aspect a liquid crystal display device comprising a back-lighting unit, wherein the back-lighting unit comprises one or more lighting devices as defined herein.

Preferably, the light source is a light source that during operation emits (light source light) at least light at a wavelength selected from the range of 380-780 nm.

In a specific embodiment, the light source comprises a solid-state LED light source (such as a LED or laser diode). In yet other embodiments, the light source may comprise a superluminescent diode.

The term “light source” may also relate to a plurality of light sources, such as 2-20 (solid state) LED light sources. Hence, the term LED may also refer to a plurality of LEDs.

The term white light, and similar terms, herein, is known to the person skilled in the art. It especially relates to light having a correlated color temperature (CCT) between about 1800 K and 20000 K, like at least about 2000 K, especially in the range of 2700-20000 K, for general lighting especially in the range of about 2000-6700 K, such as 2700-6500 K, and for backlighting purposes especially in the range of about 6500 K and 20000 K, and especially within about 15 SDCM (standard deviation of color matching) from the BBL (black body locus), especially within about 10 SDCM from the BBL, even more especially within about 5 SDCM from the BBL.

Yet further, in an aspect the invention provides a method for treating a gas, wherein the method comprises operating the ionizer of the lamp as defined herein in the presence of the gas. Especially, in embodiments the gas may comprises air. For instance, the lamp can be used in a home, in an office, a hospitality area, or any other (indoor) space.

The term “space” may for instance relate to a (part of) hospitality area, such as a restaurant, a hotel, a clinic, or a hospital, etc.. The term “space” may also relate to (a part of) an office, a department store, a warehouse, a cinema, a church, a theatre, a library, etc. However, the term “space” also relate to (a part of) a working space in a vehicle, such as a cabin of a truck, a cabin of an air plane, a cabin of a vessel (ship), a cabin of a car, a cabin of a crane, a cabin of an engineering vehicle like a tractor, etc.. The term “space” may also relate to (a part of) a working space, such as an office, a (production) plant, a power plant (like a nuclear power plant, a gas power plant, a coal power plant, etc.), etc. For instance, the term “space” may also relate to a control room, a security room, etc.. Especially, the term “space” may herein refer to an indoor space.

The lamp may provide an ionized gas, such as ionized air, when the ionizer (of the lamp) is operated. In embodiments, the method may comprise exposing a gas, especially air, to ionized air from the system. Hence, in specific embodiments, the method for treating air may comprise exposing air to ionized air from the system. In this way, the method may provide one or more of disinfection of pathogens, removal of particles and dust, and removal of odors. Especially, the treatment of the air may comprise disinfection of (the) air.

While treating gas, such as air, the lamp may also provide (visible) radiation.

The invention also provides a method for treating at least part of a space by operating the ionizer of the lamp as defined herein in the presence of the gas, such as air, within that space.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying schematic drawings in which corresponding reference symbols indicate corresponding parts, and in which:

Figs. 1A – 1C schematically depict embodiments of the invention;

Fig. 2 schematically depicts embodiments of the first optical element;

Figs. 3A – 3D schematically depict some further embodiments of the invention; and

Fig. 4 schematically depicts some further aspects of the invention.

The schematic drawings are not necessarily on scale.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Fig. 1 schematically depicts embodiments of a lamp 100 comprising a light source 10, an envelope 20, a housing 30, an ionizer 40, a lamp base 50 (or base 50), a first optical element 161, and a second optical element 162. The light source 10 may be configured to generate light source light 11. The envelope 20 may at least partly define an envelope space 21, wherein the envelope 20 at least partially encloses the light source 10. Especially, at least part of the envelope 20 may be optically transmissive for the light source light 11. The ionizer 40 may be configured to ionize gas. In specific embodiments, the ionizer 40 may be configured to ionize air. The housing 30 may at least partly define a housing space 31, wherein the housing 30 may be associated with the envelope 20, wherein the housing 30 may at least partially enclose the ionizer 40. In the depicted embodiments, the housing 30 comprises one housing opening 35 or a plurality of housing openings 35 configured to provide access of air to the ionizer 40. In the depicted embodiments, the housing 30 has a curved shape. The first optical element 161 may be configured between the envelope space 21 and the housing space 31, wherein the first optical element 161 may be configured to reflect at least part of the light source light 11. The base 50 and the housing 30 may be arranged at opposite sides of the envelope 20. In the depicted embodiments, the envelope 20, or a combination of the envelope 20 and the housing 30, have a piriform-like shape.

Light source light 11 escaped from the lamp (i.e. via the (optically transmissive) envelope 20), may also be indicated as lamp light.

Fig. 1A schematically depicts an embodiment wherein the ionizer 40 comprises a plurality of ionization elements 41. The ionization elements 41 may be selected from the group of an ionization brush and an ionization needle. Especially, in the depicted embodiment the lamp 100 comprises a plurality of ionization elements 41, wherein the plurality of ionization elements 41 comprises (one or more of) a negative ionization element 42 configured to provide negative ions, and (one or more of) a positive ionization element 43 configured to provide positive ions. In the depicted embodiment, the housing 30 comprises a plurality of housing openings 35. The housing openings 35 are configured to provide access of air to the one or more ionization elements 41.

With applying the lamp 100, especially the ionizer 40, a method for treating a gas, wherein the method comprises operating the ionizer of the lamp as defined herein in the presence of the gas, may be executed. Especially, in embodiments the gas may comprises air. For instance, the lamp can be used in a home, in an office, a hospitality area, or any other (indoor) space.

Fig. 1B schematically depicts a front view of embodiments wherein the second optical element 162 is configured on part of the housing 30. Alternatively, the second optical element may be configured as part of the housing 30. In specific embodiments, the second optical element 162 may be configured to reflect at least part of light in the visible wavelength range, thereby providing an at least partly reflective housing 30. Additionally or alternatively, the second optical element 162 may be configured to absorb at least part of light in the visible wavelength range, thereby providing an at least partly absorbing housing 30. Especially, in the depicted embodiments, the housing 30 has a housing outer surface 32, wherein the housing outer surface 32 comprises a first section 132. The first section especially may be at least partly facing away from the envelope. Additionally or alternatively, the first section may in embodiments be defined by a section of the housing outer surface that is not in contact with any one of (i) the first optical element, (ii) the envelope, and (iii) the envelope space. Especially, in embodiments at least 50%, such as at least 65%, like at least 80% of an area of the first section 132 may be covered or defined by the second optical element 162. In specific embodiments, the second optical element 162 may comprise a metallic reflector. In the depicted embodiments, the housing 30 comprises (I) a plurality of housing openings 35 or (II) one housing opening 35.

Fig. 1C schematically depicts an embodiment wherein the lamp 100 has a longitudinal axis (A), wherein the ionizer 40 is configured such that the ionizer 40 is not observable by an observer (O) observing the lamp 100 along the longitudinal axis (A) from the side of the housing 30. In the depicted embodiment, the housing opening 35 is configured such that the housing opening 35 is not observable by the observer (O) observing the lamp 100 along the longitudinal axis (A) from the side of the housing 30. In the depicted embodiment, the envelope 20 has a first maximum diameter D1, and the housing 30 has a second maximum diameter D2, wherein $0.5 \leq D2/D1 \leq 2$, such as $0.65 \leq D2/D1 \leq 1.5$, especially $0.75 \leq D2/D1 \leq 1.5$, more especially $0.75 \leq D2/D1 \leq 1.25$.

Fig. 2 schematically depicts examples of positions of the first optical element. The first optical element 161 may be arranged as one of (i) a physical separation 25 between the envelope space 21 and the housing space 31, (ii) on an inner surface of the envelope, (iii) on an outer surface of the envelope 22, (iv) on an outer surface of a contact section of the housing, and (v) on an inner surface of a contact section of the housing. Especially, the contact section of the housing is in embodiments part of the housing that is in contact with the envelope. Alternative embodiments may also be possible.

Fig. 3 schematically depicts embodiments of a lamp 100 comprising electronics 70 and one or more electrically conductive tracks 80. Especially, the ionizer 40 may in embodiments be electrically coupled to the electronics 70 via one or more of the one or more electrically conductive tracks 80. The depicted embodiments further comprise an electrical power system 90 configured to provide electrical energy to the ionizer 40. The electrical power system 90 is at least partly comprised by one or more of the envelope 20 and the housing 30. In embodiments wherein the electrical power system 90 is arranged in the envelope space 21, the electrical power system 90 may in embodiments provide power the light source 10 and the ionizer 40. Alternatively, in embodiments the power system 90 in the envelope space 21 may provide power only to the light source 10. In this case, in embodiments a second power system 90 may be arranged in the housing space 31 to provide power to the ionizer 40.

Fig. 3A schematically depicts an embodiment wherein the envelope 20 comprises an envelope outer surface 22. In the depicted embodiment, the first optical element 161 is configured on part of the envelope outer surface 22. Especially, the first optical element may comprise a reflective layer 61. In the depicted embodiment, a first track part 81 of one or more of the one or more electrically conductive tracks 80 is configured at an envelope outer surface 22 of the envelope 20. Especially, the first track part 81 may be configured electrically insulated.

The embodiment depicted in Fig. 3B comprises an induction-based electrical power system 90.

Fig. 3C schematically depicts a photovoltaic cell 95 based power system 90. In the depicted embodiment, the photovoltaic cell is arranged in the housing space 31. Especially, at least part of the first optical element 161 may be transmissive for the light source light. Especially, the photovoltaic cell 95 may in embodiments be configured to convert part of the light source light 11 into electrical energy.

Fig. 3D schematically depicts a photovoltaic cell 95 based power system 90. In the depicted embodiment, the photovoltaic cell is arranged in the envelope space 21. In the depicted embodiment, the envelope and the housing comprise a through-hole 26. In embodiments, one or more of (i) the physical separation as defined above, (ii) the envelope and (iii) the second (contact) section of the housing, may comprise a through-hole 26. Especially, in embodiments the electronics 70 (such as the photovoltaic cell) and the ionizer 40 may be electrically coupled via one or more electrically conductive tracks 80 that connect the envelope space 21 and the housing space 31 via the through-hole 26 Especially, there may be no fluidic contact between the envelope space 21 and the housing space 31. Especially, the photovoltaic cell 95 may in embodiments be configured to convert part of the light source light 11 into electrical energy.

Fig. 4 schematically depicts embodiments of the housing 30. The housing 30 may comprise an ionizer 40, wherein the housing 30 at least partially encloses the ionizer 40. Especially, the ionizer 40 is configured to ionize air. In embodiments, the housing 30 may comprise a concave contact surface 33 (I). In embodiments, the housing 30 may comprise a flat contact surface 33 (II). Especially, the contact surface 33 may be configured to be arranged on an envelope 20 of a lamp 100. In the depicted embodiments, the housing 30 comprises a first optical element 161, wherein the first optical element 161 is reflective for light having one or more wavelengths selected from the range of 380 – 780 nm. Especially, the first optical element 161 may be configured as at least part of the contact surface 33. Especially, the housing 30 comprises a housing outer surface 32 wherein the housing outer surface 32 comprises a first section 132, wherein in embodiments at least 80% of the first section 132 may be covered or defined by the second optical element 162. In specific embodiments, the second optical element 162 may comprise a metallic reflector.

The term “plurality” refers to two or more. Furthermore, the terms “a plurality of” and “a number of” may be used interchangeably.

The terms “substantially” or “essentially” herein, and similar terms, will be understood by the person skilled in the art. The terms “substantially” or “essentially” may also include embodiments with “entirely”, “completely”, “all”, etc. Hence, in embodiments the adjective substantially or essentially may also be removed. Where applicable, the term “substantially” or the term “essentially” may also relate to 90% or higher, such as 95% or higher, especially 99% or higher, even more especially 99.5% or higher, including 100%. Moreover, the terms ”about” and “approximately” may also relate to 90% or higher, such as 95% or higher, especially 99% or higher, even more especially 99.5% or higher, including 100%. For numerical values it is to be understood that the terms “substantially”, “essentially”, “about”, and “approximately” may also relate to the range of 90% - 110%, such as 95%-105%, especially 99%-101% of the values(s) it refers to.

The term “comprise” also includes embodiments wherein the term “comprises” means “consists of”.

The term “and/or” especially relates to one or more of the items mentioned before and after “and/or”. For instance, a phrase “item 1 and/or item 2” and similar phrases may relate to one or more of item 1 and item 2. The term "comprising" may in an embodiment refer to "consisting of" but may in another embodiment also refer to "containing at least the defined species and optionally one or more other species".

Furthermore, the terms first, second, third and the like in the description and in the claims, are used for distinguishing between similar elements and not necessarily for describing a sequential or chronological order. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other sequences than described or illustrated herein.

The devices, apparatus, or systems may herein amongst others be described during operation. As will be clear to the person skilled in the art, the invention is not limited to methods of operation, or devices, apparatus, or systems in operation.

The term “further embodiment” and similar terms may refer to an embodiment comprising the features of the previously discussed embodiment, but may also refer to an alternative embodiment.

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims.

In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim.

Use of the verb "to comprise" and its conjugations does not exclude the presence of elements or steps other than those stated in a claim. Unless the context clearly requires otherwise, throughout the description and the claims, the words “comprise”, “comprising”, “include”, “including”, “contain”, “containing” and the like are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense; that is to say, in the sense of “including, but not limited to”.

The article "a" or "an" preceding an element does not exclude the presence of a plurality of such elements.

The invention may be implemented by means of hardware comprising several distinct elements, and by means of a suitably programmed computer. In a device claim, or an apparatus claim, or a system claim, enumerating several means, several of these means may be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

The invention also provides a control system that may control the device, apparatus, or system, or that may execute the herein described method or process. Yet further, the invention also provides a computer program product, when running on a computer which is functionally coupled to or comprised by the device, apparatus, or system, controls one or more controllable elements of such device, apparatus, or system. Hence, in embodiments the lamp as described herein may comprise a control system. In other embodiments, the lamp as described herein may be functionally coupled to a control system.

The invention further applies to a device, apparatus, or system comprising one or more of the characterizing features described in the description and/or shown in the attached drawings. The invention further pertains to a method or process comprising one or more of the characterizing features described in the description and/or shown in the attached drawings. Moreover, if a method or an embodiment of the method is described being executed in a device, apparatus, or system, it will be understood that the device, apparatus, or system is suitable for or configured for (executing) the method or the embodiment of the method, respectively.

The various aspects discussed in this patent can be combined in order to provide additional advantages. Further, the person skilled in the art will understand that embodiments can be combined, and that also more than two embodiments can be combined. Furthermore, some of the features can form the basis for one or more divisional applications.

Amongst others, the invention describes a (reflector) lamp comprising an ionizer and a base for connecting the lamp to a socket of a luminaire. In embodiments, the lamp may comprise an envelope enclosing the (LED) light source. The lamp may further comprise in embodiments a (cupped) housing arranged on top of the envelope. In embodiments, an ionizer may be integrated into the housing for providing ionized air. In this way, in embodiments the non-emitting part of the light source may be used to implement the ionizer instead of integrating it in the light emitting part and axial irradiance may be reduced. The surface of the (cupped) housing facing the outer surface of the envelope may in embodiments be highly reflective to reflect light source light for improved efficiency and/or light distribution. Additionally or alternatively, the inner or outer surface of the envelope facing the (cupped) housing may in embodiments be highly reflective to reflect light source light. The surface of the (cupped) housing which is not facing the outer surface of the envelope may in embodiments also be reflective to mimic a ‘standard’ silver cupped LED lamp. The power system may in embodiments be arranged in the base. The power system may in embodiments be electrically connected to the LED light source *via* electronics through the stem and connected to the ionizer *via* an electrically conductive track e.g. on the outer surface of the envelope. Additionally or alternatively, in embodiments, the envelope may comprise a through-hole to the housing, to power the ionizer. The cupped housing may in embodiments comprise additional electronics to transfer the current of the power system to a suitable electrical power for the ionizer. The outer shape of the (cupped) housing may in embodiments be like the shape of an envelope at that position. Especially, in embodiments the envelope and housing may provide a smooth transition. In embodiments, the compartment containing the ionizer may be fixed to the light source or may de-connectable to be replaced with a different or new ionizer unit.

CLAIMS:

1. A lamp (100) comprising a light source (10), an envelope (20), a housing (30), an ionizer (40), a lamp base (50), a first optical element (161), and a second optical element (162); wherein:

- the light source (10) is configured to generate light source light (11);
- the envelope (20) at least partly defines an envelope space (21), wherein the envelope (20) at least partially encloses the light source (10), wherein at least part of the envelope (20) is optically transmissive for the light source light (11);
- the ionizer (40) is configured to ionize gas and the ionizer comprising one or more of needles and brushes functioning as ion emitters;
- the housing (30) at least partly defines a housing space (31), wherein the housing (30) is associated with the envelope (20), wherein the housing (30) at least partially encloses the ionizer (40);
- the first optical element (161) is configured between the envelope space (21) and the housing space (31), wherein the first optical element (161) is configured to reflect at least part of the light source light (11);
- the second optical element (162) is configured as at least part of the housing (30) or is configured on at least part of the housing (30), wherein the second optical element (162) is configured to reflect at least part of light in the visible wavelength range, wherein the reflectivity of the second optical element is in the range of 70-100% for light having a wavelength selected from the visible wavelength range; and
- the lamp base (50) and the housing (30) are arranged at opposite sides of the envelope (20).

2. The lamp (100) according to claim 1, wherein the gas comprises air, wherein the housing (30) comprises a housing opening (35) configured to provide access of air to the ionizer (40); and wherein the second optical element (162) is at least configured to reflect at least part of light in the visible wavelength range.

3. The lamp (100) according any one of the preceding claims, wherein the lamp (100) has a longitudinal axis (A), wherein the ionizer (40) is configured such that the ionizer (40) is not observable by an observer (O) observing the lamp (100) along the longitudinal axis (A) from the side of the housing (30).

4. The lamp (100) according to claims 2 and 3, wherein the housing opening (35) is configured such that the housing opening (35) is not observable by the observer (O) observing the lamp (100) along the longitudinal axis (A) from the side of the housing (30).

5. The lamp (100) according any one of the preceding claims, wherein the housing (30) has a curved shape.

6 The lamp (100) according any one of the preceding claims, wherein the housing (30) has a housing outer surface (32), wherein the housing outer surface (32) comprises a first section (132) at least partly facing away from the envelope, wherein at least 80% of an area of the first section (132) is covered or defined by the second optical element (162); and wherein the second optical element (162) comprises a metallic reflector.

7. The lamp (100) according any one of the preceding claims, wherein the envelope (20) has a first maximum diameter D1, wherein the housing (30) has a second maximum diameter D2, wherein $0.75 \leq D2/D1 \leq 1.25$.

8. The lamp (100) according to any one of the preceding claims, wherein the envelope (20), or a combination of the envelope (20) and the housing (30), have a piriform-like shape.

9. The lamp (100) according to any one of the preceding claims, wherein the envelope (20) comprises an envelope outer surface (22), wherein the first optical element (161) comprises a reflective layer (61) configured on part of the envelope outer surface (22).

10. The lamp (100) according to any one of the preceding claims, wherein the lamp (100) comprises electronics (70) and one or more electrically conductive tracks (80), wherein the ionizer (40) is electrically coupled to the electronics (70) via one or more of the one or more electrically conductive tracks (80), wherein a first track part (81) of one or more

of the one or more electrically conductive tracks (80) is configured at an envelope outer surface (22) of the envelope (20), wherein the first track part (81) is configured electrically insulated.

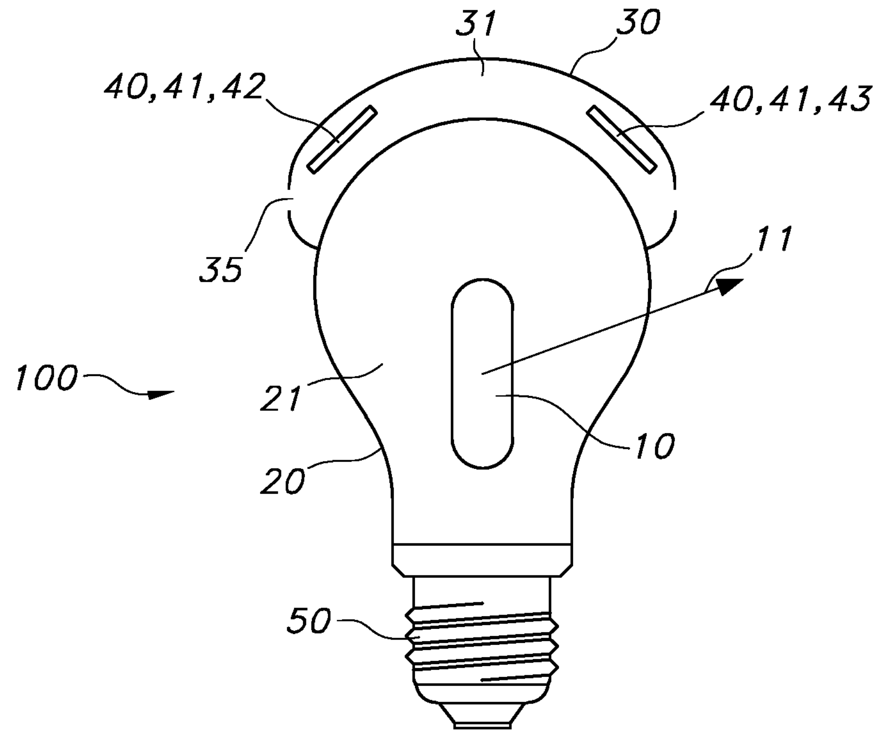
11. The lamp (100) according to any one of the preceding claims, comprises an electrical power system (90) configured to provide electrical energy to the ionizer (40), wherein the electrical power system (90) is at least partly comprised by one or more of the envelope (20) and the housing (30), wherein the electrical power system (90) is one or more of (i) induction-based and (ii) photovoltaic cell based, wherein the photovoltaic cell (95) is configured to convert part of the light source light (11) into electrical energy.

12. The lamp (100) according to any one of the preceding claims, wherein the lamp (100) comprises a plurality of ionization elements (41), wherein the plurality of ionization elements (41) comprises a negative ionization element (42) configured to provide negative ions, and a positive ionization element (43) configured to provide positive ions.

13. The lamp (100) according to any one the claims 1 – 11, wherein the ionizer (40) is configured to produce negative ions.

14. The lamp (100) according to any of the preceding claims, wherein the light source light comprises one or more wavelengths in the visible wavelength range and wherein the first optical element (161) having a light reflectivity in the range of 70 - 100% for light having a wavelength selected from the visible wavelength range.

15. A method for treating a gas, wherein the method comprises operating the ionizer (40) of the lamp (100) according to any one of the preceding claims 1-12 in the presence of the gas.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30
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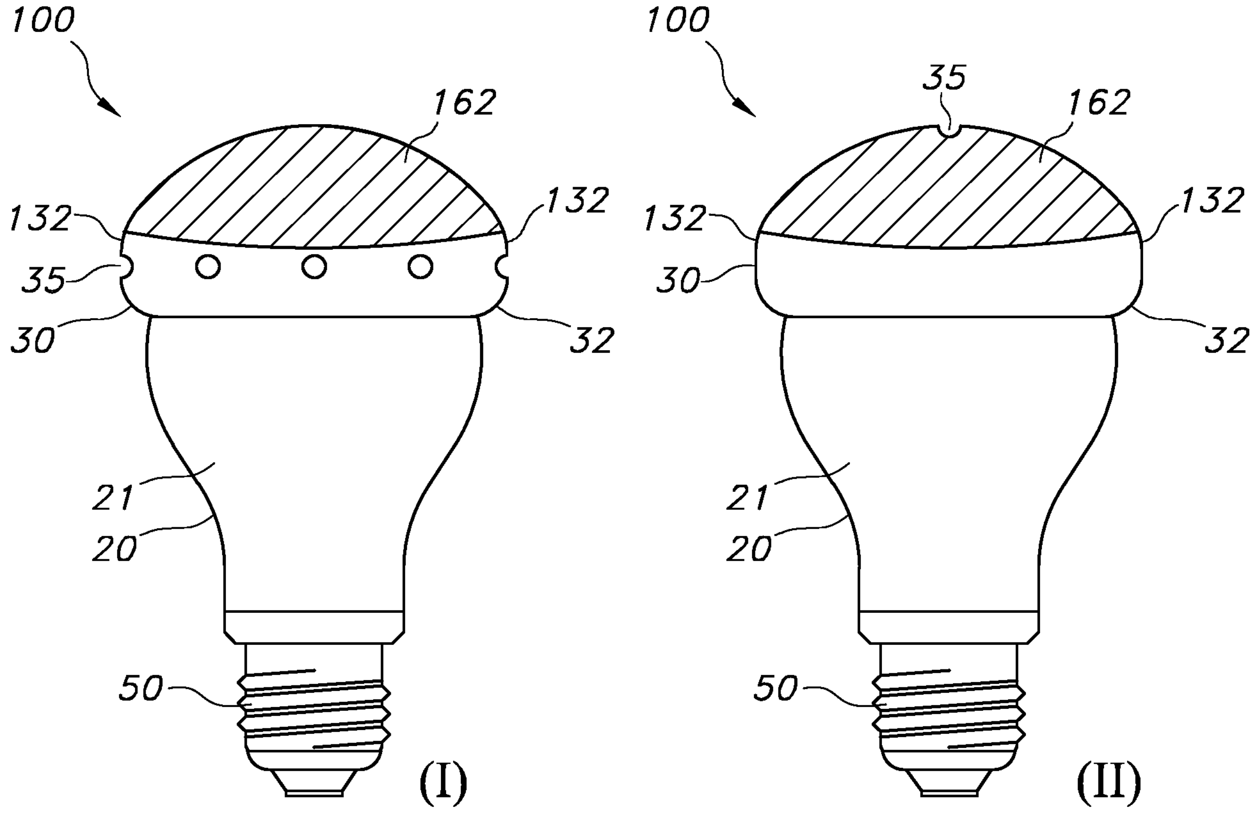
40,41,43
35
11
100
21
10
20
50

FIG. 1A


100
162
132
132
35
30
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(I)
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162
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20
50
(II)

FIG. 1B

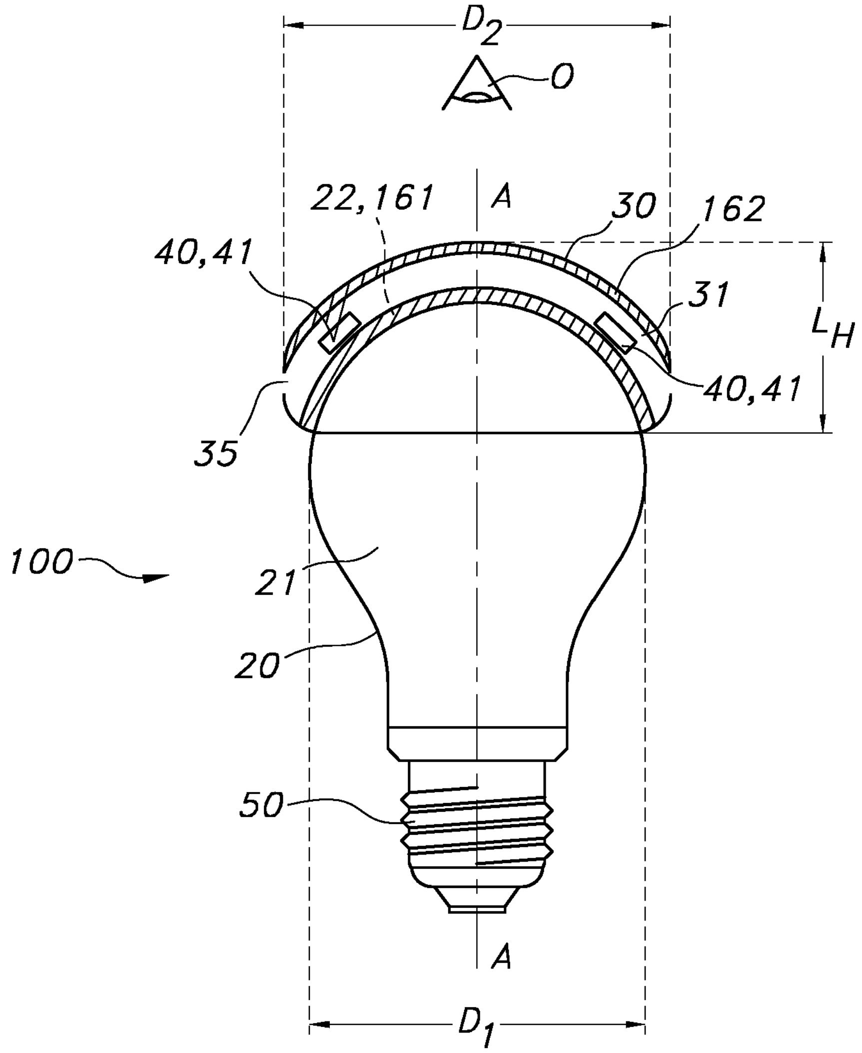
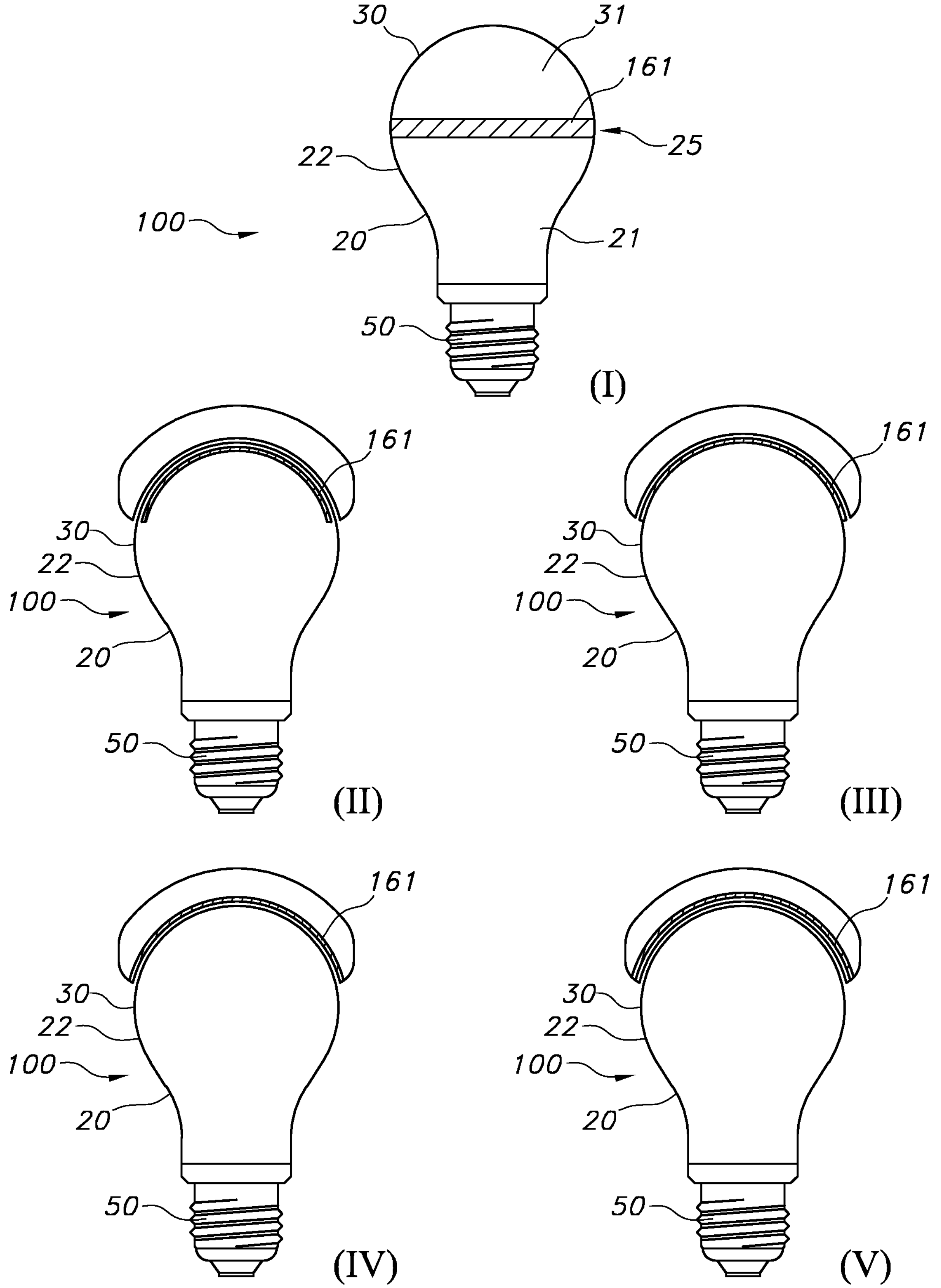


FIG. 1C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100
20
50
(III)
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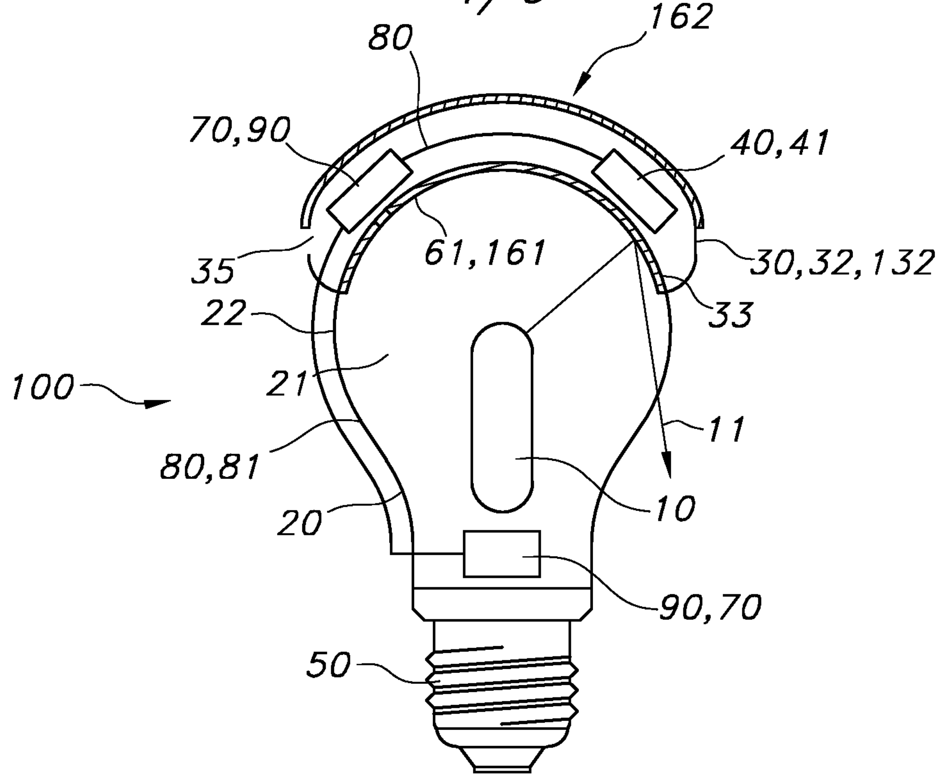
50
(IV)
161
30
22
100
20
50
(V)

FIG. 2


162
80
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90,70
50

FIG. 3A

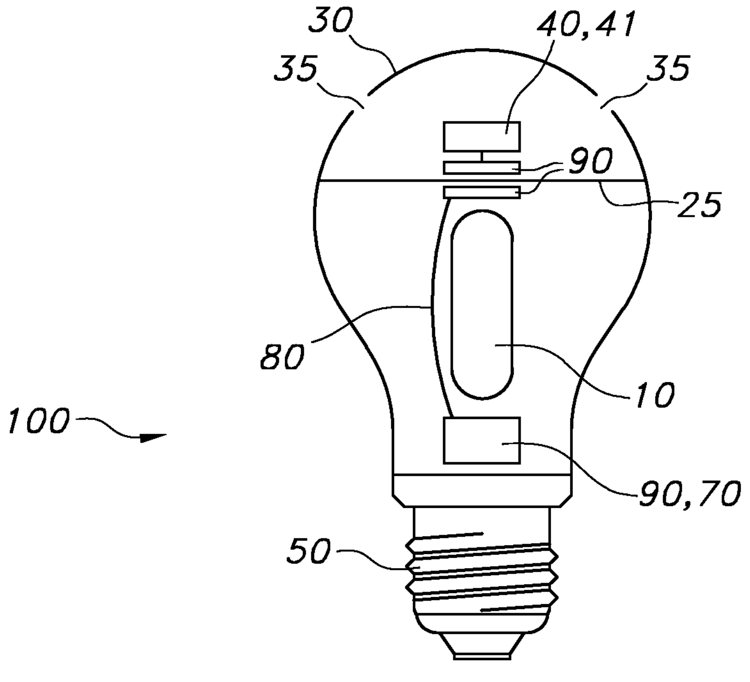
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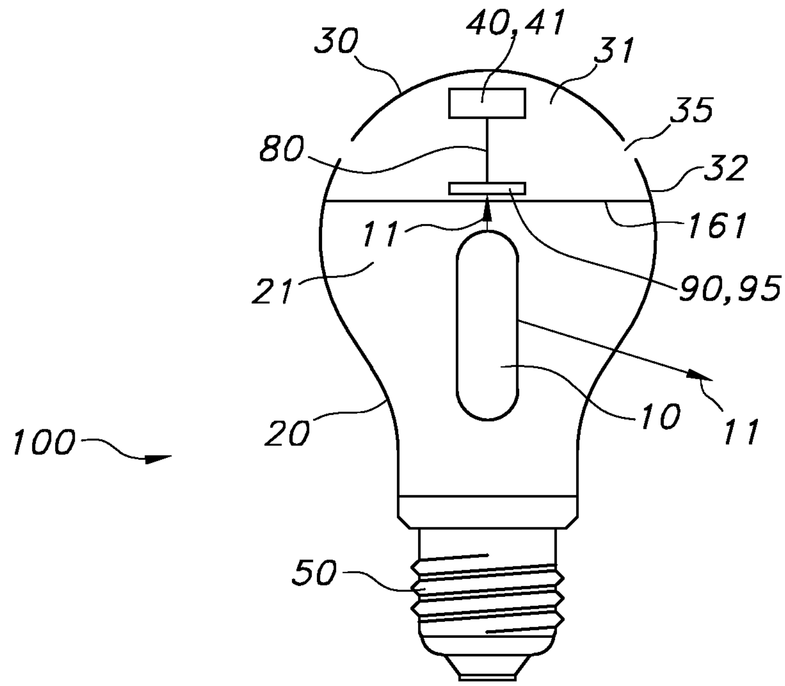
FIG. 3B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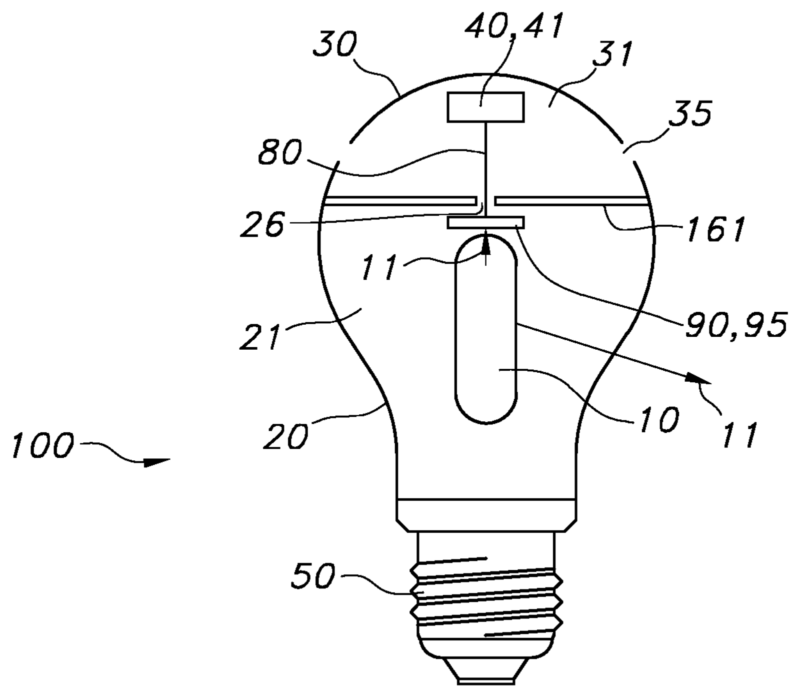
50

FIG. 3C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100
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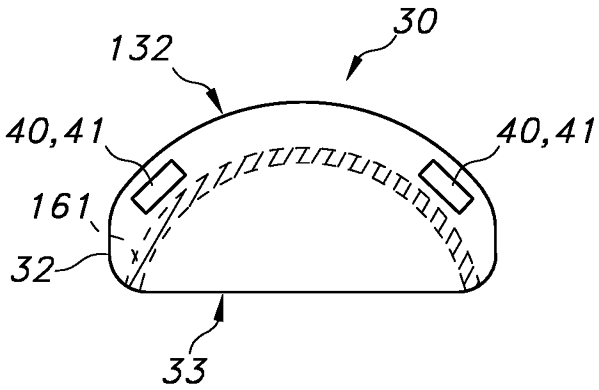
10
11
50

FIG. 3D



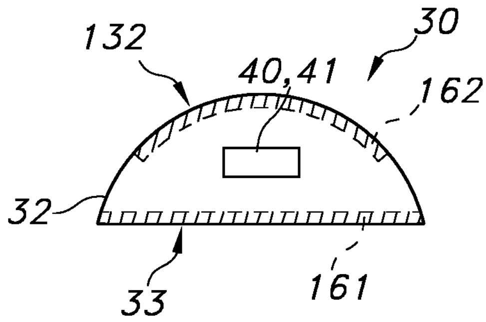


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2021/087659

A. CLASSIFICATION OF SUBJECT MATTER
INV. F21K9/232 A61L9/22 H01T23/00 F21V33/00
ADD. F21K9/66 F21Y115/10

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 H05C F21V F21K H01T F24F B01D

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.
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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"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

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"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	Date of mailing of the international search report
30 March 2022	14/04/2022

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Gangl, Martin

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2021/087659

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

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