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(54) **LUMINAIRE**

(57) The invention relates to a luminaire (1) for illuminating a room (R) and for controlling room acoustics in said room (R). The luminaire (1) comprises: a housing (2) with a cavity (3), a light source (4) arranged in the cavity (3), a rigid transparent cover (5) arranged such that at least part of the light emitted by the light source (4) can be emitted via the cover (5) into the room (R) to be illuminated, a support (6) arranged to support the cover (5), a fastener (7) arranged to fix the cover (5) to the support (6), and a flexible section (8) arranged between the support (6) and the cover (5) and/or between the cover (5) and at least part of the fastener (7) such that the flexible section (8) and the cover (5) are pressed together

when the cover (5) is fixed, by the fastener (7), to the support (6). The fastener (7) is arranged to be selectively adjustable between a first position in which the flexible section (8) and the cover (5) are pressed together such that the cover (5) is in a first fixed state in which the cover (5) has a first resonance frequency, and a second position in which the flexible section (8) and the cover (5) are pressed together such that the cover (5) is in a second fixed state in which the cover (5) has a second resonance frequency different from the first resonance frequency. Each of the first and second resonance frequencies is in a range of 300Hz or less.

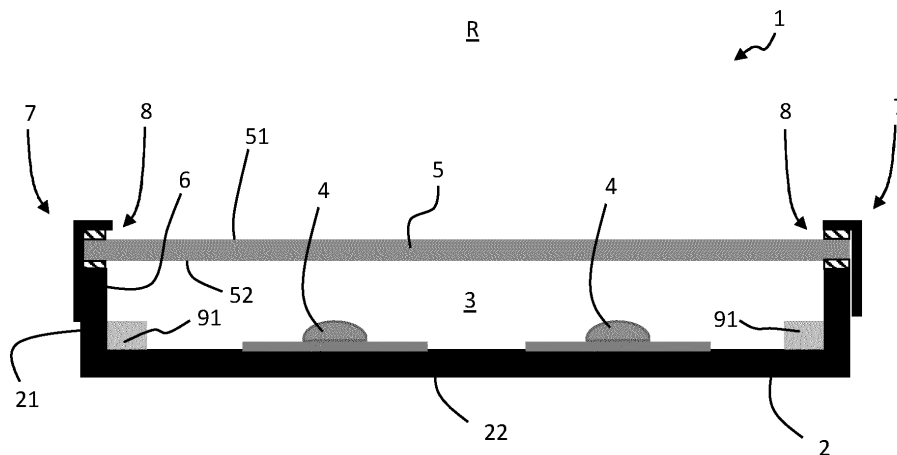


Fig. 1

Description

TECHNICAL FIELD OF THE INVENTION

[0001] The invention relates to a luminaire for illuminating a room and for controlling room acoustics in said room.

BACKGROUND OF THE INVENTION

[0002] The field of room acoustics concerns the control of sound in a room. The control of sound (which is a vibration that propagates as an acoustic wave) in a room can be addressed by specialized means that help to shape the room acoustics according to the intended use. As luminaires are typically built for a certain application, and normally are located in a plurality of or even all sections of a given room, sound waves may impinge one or more of such luminaires.

[0003] Typical solutions for room acoustic treatment are: acoustic absorption, e.g. by adding absorbing surface materials (felt, foam, etc.); acoustic diffusion, e.g. by using a certain shape (such as a half cylindrical shape for one dimensional diffusion).

[0004] Using special surface materials to aid absorption is normally limited to high frequencies, as absorber thickness in porous materials determines a lower frequency limit. This is typically above 300Hz, where modal spacing in rooms is already dense (Schroeder-Frequency). Single lower frequency modes cannot be addressed with porous absorbers the size of typical luminaires. Total absorption with porous absorbers is proportional to the surface fraction of the room covered with absorbers. As this fraction is normally small, total effect by such a treatment is low in a given room.

[0005] Diffusion can help reducing certain critical spots, even with low surface coverage. The diffusive properties of a surface have so far not been used beyond simple geometrical shapes such as cylinders. A multi-directional or omni-directional diffusion has not been realized yet on purpose.

[0006] Thus, it is an objective to provide an improved control of room acoustics which avoid the above-mentioned disadvantages. In particular, it is an objective to reduce sound energy in a room for certain room modes at low frequency, in particular where absorptive materials have little effect due to inefficient absorption at low frequencies. Further, an objective is to achieve strong total absorption in spite of low total surface coverage, in particular because of room mode absorption below Schroeder frequency. Further objects are a tunability of absorption to critical room modes and/or further reduction of critical mid- and high frequency noise beyond capabilities of absorptive surfaces.

SUMMARY OF THE INVENTION

[0007] The object of the present invention is achieved

by the solution provided in the enclosed independent claim. Advantageous implementations of the present invention are further defined in the dependent claims.

[0008] According to the invention, a luminaire is provided for illuminating a room and for controlling room acoustics in said room. The luminaire comprises: a housing with a cavity, a light source arranged in the cavity, a rigid transparent cover arranged such that at least part of the light emitted by the light source can be emitted via the cover into the room to be illuminated, a support arranged to support the cover, a fastener arranged to fix the cover to the support, and a flexible section arranged between the support and the cover and/or between the cover and at least part of the fastener such that the flexible section and the cover are pressed together when the cover is fixed, by the fastener, to the support. The fastener is arranged to be selectively adjustable between a first position in which the flexible section and the cover are pressed together such that the cover is in a first fixed state in which the cover has a first resonance frequency, and a second position in which the flexible section and the cover are pressed together such that the cover is in a second fixed state in which the cover has a second resonance frequency different from the first resonance frequency. Each of the first and second resonance frequencies is in a range of 300Hz or less.

[0009] Thus, the rigid transparent cover of the luminaire, and thus preferably an outer surface of the luminaire, is able to vibrate at acoustic frequencies, preferably at frequencies below Schroeder frequency of the room. The vibrating cover (and thus, e.g., a surface comprised by the cover) may form a mechanically coupled system with other parts of the luminaire, such as the luminaire interior (e.g. the cavity and/or a gas, such as air, in the cavity) or a bottom or back-surface of the luminaire, each of which may be part of the housing. Thereby, energy propagated by a sound wave can be effectively transformed into vibrational energy of the luminaire to be dissipated, e.g. by friction and/or by material and/or medium friction. For example, the vibrational energy may be dissipated by the luminaire itself (e.g., transformed into heat) and/or by a feature connected to the luminaire, such as by a gas (such as air) volume within a separated installation area (a ceiling, a wall, etc.) to which the luminaire is attached.

[0010] By the fastener of the luminaire, the resonance frequency (of the cover and thus preferably of the total vibrational system) can be easily tuned (e.g., mechanically) in order to control the acoustics of the room in a desired manner. In other words, the fastener enables to adjust the mounting tension of the cover (e.g., to a room mode which must be attenuated) and, thus, to adjust the resonance frequency of the cover. For example, local "loud" spots with a low frequency in a room can be effectively absorbed by the luminaire being adapted (or tuned), by the fastener, such that the cover has a resonance frequency by which the cover can effectively vibrate in response to the respective sound wave, thereby

transforming the energy propagated by the sound wave into vibrational energy to be dissipated and thus absorbed.

[0011] By the cover of the luminaire, wherein the cover may comprise one or more (front) optical elements or optics, the luminaire may represent, or may be used as, a low frequency resonant absorber. Thereby, sound waves that have a low frequency (such as 300Hz or less) and that propagate through a room can be effectively absorbed by using the luminaire or the luminaire in combination with a damper (absorber), e.g. provided at a back side of the luminaire. The luminaire body interior, such as the cavity, may be used as an acoustical cavity of a resonator such as a Helmholtz resonator. Further, the cavity provided by the housing of the luminaire opens the possibility of adding dampers (absorbers) inside the luminaire to dampen/tune the vibrational absorbing system. As such, the luminaire is particularly effective in controlling sound in the room to be illuminated. The housing of the luminaire, such as a (luminaire body) back surface, opens the possibility to be coupled to a resonant element so as to dissipate vibrational energy and tune the vibrational absorbing system.

[0012] By the luminaire, an absorber for absorbing sound waves with a low frequency can be provided that, in particular,

- is not or less visible (compared to classical absorbers such as absorbers which are only provided for absorbing sound waves),
- provides a low frequency absorption tuneable to room acoustic demands,
- provides a low frequency absorption strength not dependent on a total wall coverage (in contrast to resistive absorption), and
- provides a low frequency absorption in a compact design, because absorption of the sound waves does not require to be effected by an absorber material inside of the luminaire alone (rather, the cover forms part of an absorbing system).

[0013] In each of the first and second fixed states, the cover may have a plurality of (respective) resonance frequencies, wherein the lowest of these resonance frequencies (i.e. the fundamental frequency) represents the first resonance frequency and the second resonance frequency, respectively. In each of the first and second fixed states, the cover may have a lowest resonant mode with a resulting resonance frequency that represents the first resonance frequency and the second resonance frequency, respectively.

[0014] Each of the first and second (and preferably third) resonance frequencies may be a fundamental frequency.

[0015] The cover may be a plate or at least some parts of the cover may be formed as a plate. The cover may comprise an inner surface and/or an outer surface, each of which may be flat. The outer surface may form a light

emitting surface. Via the inner surface light may be coupled into the cover.

[0016] Each of the first and second resonance frequencies may be in a range of 20-300Hz, preferably in a range of 50-200 Hz. The first resonance frequency is preferably in a range of 125-175Hz, such as 150Hz. Additionally or alternatively, the second resonance frequency is preferably in a range of 60-100 Hz, such as 80Hz.

[0017] In an embodiment, the cover may comprise a material with a density in a range of 1-4 kg/l, a Young's Modulus in a range of 1-100 GPa, and/or a Poisson ratio in a range of 0,1-0,45, and/or the cover may have a thickness in a range of 3-6mm. Such a design of the cover achieves the advantage that the resonance frequency of the cover can be effected by the fastener in an easy manner.

[0018] The fastener may be arranged to press the flexible section against a back side of the cover facing the light source. Via the cover's back side light emitted by the light source may enter from the cavity into the cover. By such an arrangement, at least part of the flexible section may be sandwiched between the back side and the support so that adjusting the fastener may compress the flexible section.

[0019] Additionally or alternatively, the fastener may be arranged to press the flexible section against a front side of the cover facing away from the light source. Via the cover's front side light may be emitted out of the cover and thus out of the luminaire, e.g. into the room to be illuminated. The front side may represent the outer surface of the cover and/or of the luminaire. By such an arrangement of the fastener, at least part of the flexible section may be sandwiched between part of the fastener and the front side of the cover so that adjusting the fastener may compress the flexible section.

[0020] The fastener may comprise, or is, a clamp or a part of a clamp. This achieves the advantage of compactness and/or of conveniently adjusting the fastener between the at least first and second positions in order to effect the at least first and second fixed states, respectively. The part of the clamp may be arranged so as to extend at least partially on a side of (such as above) the front side of the cover. For example, the (part of the) clamp may represent an outer clamp (part).

[0021] The fastener may comprise a moveable part that is moveable relative to the housing in order to adjust the fastener between the first and second positions, i.e. to transfer (e.g. move) the fastener in each of the first and second positions. The moveable part may be arranged to move towards the cover and/or the support in order to press the flexible section and the cover together, such as to compress the flexible section between the support and the cover and/or between the cover and at least part of the fastener, such as the moveable part. The moveable part may be a moveable part of the clamp or the part of the clamp.

[0022] The support may be fixed to the housing, such as integrally formed with the housing. This provides in

particular the advantage of compactness. The support may be an inner clamp and/or a part of a clamp, such as another part of the above-mentioned clamp and/or a part that forms, together with the above-mentioned part of the clamp, the clamp. The support preferably forms part of a sidewall of the housing.

[0023] The fastener may comprise a section extending laterally with respect to the flexible section and transversely with respect to the cover. Thereby, the flexible section can be securely held in a direction at least along a direction parallel to the cover. The section may extend along a direction substantially perpendicular to the extension of the cover. The section may be connected to a further section that is arranged such that the flexible section can be compressed, by the fastener, between the further section and the cover, such as the front side of the cover.

[0024] The fastener may comprise a plurality of fasteners that are adjustable independently from one another. Thus, by the position of, and the fixation effected by, the fasteners, the resonance frequency of the cover can be affected. The fasteners may be (preferably evenly) distributed around the cover, e.g. along the side edges of the cover. The fasteners may be arranged to fix the cover to the support such that the cover is fixed at discrete sections (wherein each of the sections is, e.g., in the form of a dot, a point or a spot) between the cover and the support. The fastener may be arranged to fix the cover by one or more dot-like fixations.

[0025] The cover may comprise an outer region. The outer region may be in the form of a ring, such as a rectangular, a circular, or an oval ring. The outer region has different segments delimited by different side edges of the cover, respectively. The segments may be distributed along the outline of the cover. The fastener may comprise a fastener arranged to fix only one of the segments to the support. Additionally, or alternatively, the fastener may comprise a single fastener arranged to fix a plurality or all of the segments to the support, wherein the fastener preferably surrounds (i.e. extends around) the cover; in particular, the luminaire may comprise only one fastener for fixing the cover to the support. Thus, by adjusting a single fastener a plurality or all of the segments of the cover can be fixed to the support, e.g. such that the segments of the cover are uniformly fixed to the support. Additionally, or alternatively, the fastener may comprise a plurality of fasteners that are arranged to fix different segments to different sections of the support.

[0026] The luminaire may comprise a damper (absorber) arranged in the cavity of the housing. Accordingly, at least part of the vibrational energy of the vibrating cover may be transferred, directly and/or indirectly, to the damper in order to be dissipated (i.e. absorbed) by the damper. Direct transfer of the vibrational energy to the damper may be effected by the damper directly contacting or abutting the cover. Indirect transfer of the vibrational energy to the damper may be effected by a gas, such as air, within the cavity and/or by a structural ele-

ment, such as a wall (in particular, a sidewall and/or a bottom) of the housing. The damper may be provided such that it represents an internal absorption means of the luminaire.

[0027] The damper may extend from the cover, such as from its back side, to a bottom of the housing, wherein the light source is arranged on the bottom. The damper may contact both the cover and the bottom. In particular, the damper may be arranged such that the vibrating cover can compress the damper, whereby at least part of the vibrating energy of the vibrating cover is effectively dissipated, in particular also in a case where the cavity is not gas tight, i.e. where a gas, such as air, can leak from the cavity.

[0028] The damper may abut or contact a sidewall of the housing. Thus, in a case where vibration of the cover is transferred, e.g. via the support, to the sidewall, the so present vibrational energy of the sidewall can be effectively dissipated by the damper.

[0029] The damper may have a volume that is at least 5%, and preferably 50% or less, such as 5 to 20%, of the volume of the cavity.

[0030] The damper may comprise a porous material and/or rubber. Additionally or alternatively, the damper may comprise a material comprising glass fiber and/or plastic, such as plastic foam.

[0031] The luminaire may further comprise a section arranged to be in sliding friction with the cover as the cover vibrates. By the sliding friction, the vibrational energy can be effectively dissipated, i.e. transformed into heat. Accordingly, a very simple means for dissipating the vibrational energy of the cover (and thus for absorbing sound waves) is provided, in particular one that requires no dedicated damper (such as made of foam or rubber). The housing and/or the fastener may comprise the section. This achieves the advantage of a compact luminaire absorbing sound waves.

[0032] The cavity may be sealed in a gastight manner, such as an airtight manner. Thus, a gas, such as air, within the cavity can transfer the vibrational energy of the cover towards another part (e.g. of the luminaire, such as of the housing, and/or of a feature connected to the luminaire, such as the ceiling) where it is then dissipated and/or can act as a dissipating means (such as by the molecules of the gas moving in response to the vibrating cover and thereby transforming the vibrational energy into heat). In particular, the gastight cavity can effect that the luminaire has no gas (such as air) leakage, so that the cover (e.g., a panel) and the gas in the luminaire can form a mechanically coupled vibrational system.

[0033] The housing may comprise a bottom on which the light source is arranged, wherein the bottom comprises a weakened area, wherein the weakened area is preferably formed by a recess (in the bottom). The weakened area may act as an interface via which vibrational energy can be transferred away from the luminaire, e.g. in order to be dissipated. The weakened area may comprise a thickness smaller than a thickness of other parts of the

bottom, so that the weakened area can be easily set into vibration. Preferably, the bottom is rigid and/or a back-panel.

[0034] Additionally or alternatively, the bottom may comprise a through opening, wherein the through opening is preferably sized so as to provide a Helmholtz Resonator with a resonance frequency in the range of 20-300Hz. The cavity of the Helmholtz resonator may be the cavity of housing. The narrow neck or tube of the Helmholtz resonator may be the through opening. Accordingly, when sound waves enter the neck, they cause the gas (such as air) inside the cavity to vibrate at a specific resonance frequency, which is determined by the volume of the cavity and the length and diameter of the neck. In particular, the gas (such as air) mass in the cavity can form a mechanically coupled vibrational system with the through opening. The through opening may be designed as a port, such as a tuned port. As the cover vibrates, the gas within the cavity may be moved in such a way (e.g. leak via the through opening) that vibration energy of the cover is dissipated, such as by the moving gas acting on a damper (absorber) and/or by the friction of the gas (e.g. within the gas, i.e. molecules of the gas moving relative to one another, and/or of the gas being in friction with a structure such as a wall of the housing).

[0035] The cover, such as the front side of the cover, may comprise a structure designed to diffuse acoustic (sound) waves. By such a structure the cover enables diffusion of mid- and high frequency sound in more than one direction, thereby improving the room acoustics in a particularly well fashion. In particular, by the cover comprising such a structure unwanted acoustic energy can be actively diffused in different directions. Thus, local reduction of acoustic energy maxima can be achieved in a particularly advantageous manner. The structure may comprise one or more optical elements (such as lenses or other front optics). Thus, no extra diffusive surface in addition to the transparent cover is required. Also, the diffusive effect is not dependent on total wall coverage, but can be locally effective at "loud" spots. The structure preferably acts as a pseudo-random diffuser. The structure, or the pseudo-random diffuser, preferably comprises different areas of different heights and/or depths. The structure may be two-dimensional (e.g. when viewed in a sectional view).

BRIEF DESCRIPTION OF THE DRAWINGS

[0036] The invention will be explained in the followings together with the figures.

- Fig. 1 shows a schematic cross-sectional view of a luminaire according to an embodiment;
- Fig. 2A shows a schematic detail of Fig. 1 in which the cover is in a first fixed state;
- Fig. 2B shows a schematic detail of Fig. 1 in which

the cover is in a second fixed state;

- Fig. 2C shows a schematic detail of Fig. 1 in which the cover is in a third fixed state;
- Fig. 3 shows a schematic cross-sectional view of a luminaire according to an embodiment;
- Fig. 4 shows a schematic cross-sectional view of a luminaire according to an embodiment;
- Fig. 5 shows a schematic top view of the cover of the luminaire shown in Fig. 4; and
- Fig. 6 shows a schematic cross-sectional view of a luminaire according to an embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0037] Fig. 1 shows a luminaire 1 for illuminating a room R and for controlling room acoustics in the room R. For example, in the room R a sound (or acoustic) source may be provided, wherein it is desired that the sound waves emitted by the sound source are controlled in a desired manner. Controlling the sound waves may comprise reflecting, deflecting, diffusing and/or absorbing the sound waves. For example, it may be desired that sound waves are absorbed at specific sections (or spots) in the room R so as to achieve a desired room acoustic. The luminaire 1 may be arranged at such sections.

[0038] The luminaire 1 comprises a housing 2 with a cavity 3. The cavity 3 may be (used as) an acoustical cavity. In particular, the cavity 3 may be designed to dampen and/or tune vibrational and/or absorbing features of the luminaire 1. The housing 2 may comprise a sidewall 21. The sidewall 21 may be arranged to delimit (e.g., laterally) the cavity 3. The cavity 3 may have a depth (or height) that corresponds to the height of the sidewall 21. The depth of the cavity 3 may be in a range of 0.03m-0.3m, such as 0.087m. The housing 2 may comprise a bottom 22. The bottom 22 may be arranged to delimit the cavity 3 (e.g. from below). The sidewall 21 may be arranged on and/or may extend (away) from the bottom 22, preferably along a direction transversely (such as perpendicularly) relative to the bottom 22. The bottom 22 may have the form of a plate.

[0039] The housing 2 is not limited to a specific shape. The housing 2 may have a cross-section with a shape that is polygonal, such as rectangular. The shape may be also formed differently, such as round and/or oval. The shape is preferably provided so as to delimit the cavity 3.

[0040] The luminaire 1 comprises a light source 4 (such as an LED) arranged in the cavity 3. The light source 4 may comprise a plurality of light sources 4, such as two or more light sources 4. The light source 4 may be arranged on the bottom 22 and/or laterally with respect to

the sidewall 21. The sidewall 21 may extend higher than the light source 4.

[0041] The luminaire 1 comprises a rigid transparent cover 5. The cover 5 is arranged such that at least part of the light emitted by the light source 4 can be emitted via the cover 5 into the room R to be illuminated by the luminaire 1. The cavity 3 may comprise an opening, e.g. defined by the sidewall 21, wherein light of the light source 4 can be emitted via the opening out of the cavity 3. The cover 5 may be arranged such this emitted light, i.e. the light exiting the cavity 3 via said opening, can be emitted into the cover 5.

[0042] To support the cover 5, the luminaire 1 comprises a support 6. The support 6 may be, or may be part of, an inner clamp. The cover 5 may be supported (and/or attached) directly or indirectly by the support 6. The support 6 may be part of the housing 2 (or vice versa). The support 6 may be provided on, or may form part of, the sidewall 21, such as a distal end of the sidewall 21. The support 6 may extend transversely (such as perpendicularly) relative to the sidewall 21 or at least part of the sidewall 21. At least part of the support 6 may extend parallel to the cover 5. The support 6 may be arranged such that it defines or delimits the cavity's 3 opening via which light can exit the cavity 3.

[0043] The luminaire 1 further comprises a fastener 7 arranged to fix the cover 5. The cover 5 may comprise at least a thin side (which is defined by a or the thickness of the cover 5) and/or a flat side, wherein the fastener 7 is arranged to fix the flat side of the cover 5 to the support 6. The fastener 7 may be arranged such that the cover 5 (i.e. part of the cover 5) is sandwiched between the support 6 and at least part of the fastener 7, such as a part 72 (of the fastener 7) that preferably extends parallel to at least part of the cover 5, such as to a flat region or flat side of the cover 5. The fastener 7 may be arranged to fix the cover 5 locally and/or may be arranged to fix an outer lateral region of the cover 5 to the support 6, wherein this region is preferably delimited on one side by a side edge of the cover 5. The fastener 7 may be designed to, or may comprise a plurality of (such as two, as shown in, e.g., Fig. 1, or more) fasteners 7 arranged to, fix a plurality of (such as all) outer lateral regions of the cover 5 to the support(s) 6 or to different sections of the support 6, respectively.

[0044] The outer lateral region of the cover 5 may be a segment of an outer region of the cover 5, wherein the outer region may be in the form of a ring, such as a rectangular, a circular, or an oval ring. Thus, the outer region may have different segments delimited by different side edges of the cover 5, respectively.

[0045] The (plurality of) fasteners 7 may be adjustable independently from one another. Each of the fasteners 7 may be arranged to fix only a respective one of the segments to the support 6. Accordingly, different outer lateral regions, such as different side edges, can be fixed in different ways, respectively. Each of the fasteners 7 may be arranged such that it does not extend uninter-

rupted around the cover 5. In other words, the fasteners 7 may be arranged segmentally around the cover 5, e.g. with a spacing between adjacent fasteners 7. Additionally, or alternatively, the fasteners 7 may comprise a single fastener 7 arranged to fix a plurality of the segments to the support 6. Alternatively, the fastener 7 may not comprise a plurality of fasteners 7. Accordingly, the fastener 7 may comprise a single fastener 7 that is arranged to fix all segments to the support 6 and/or that surrounds (i.e. extends around) the cover 5. As such, the fastener 7 may extend around the cover 5 uninterrupted, e.g. in the form of a (rectangular, circular, oval, etc.) ring.

[0046] The luminaire 1 further comprises a flexible section 8. The terms "flexible" and "rigid" imply different grades of flexibility so that a "flexible" object is more flexible than a "rigid" object. Accordingly, the flexible section 8 is more flexible than the rigid cover 5. This means that the section 8 is in particular more elastically deformable than the cover 5. For example, the stiffness and/or Young's Modulus of the flexible section 8 is/are smaller than the stiffness and/or Young's Modulus of the cover 5.

[0047] As shown in Figs. 2A-2C, the flexible section 8 (81, 82) is arranged between the support 6 and the cover 5 as well as between the cover 5 and at least part of the fastener 7, such as the part 72. The flexible section 8 may comprise a first part 81 and a second part 82. The first part 81 may be arranged between the part 72 of the fastener 7 and the cover 5, such as a front side 51 of the cover 5. The front side 51 is to be understood as the side of the cover 5 out of which light emitted by the light source 4 and coupled into the cover 5 can be coupled out of the cover 5. The second part 82 may be arranged between the cover 5, such as a back side 52 of the cover 5, and the support 6. The back side 52 is to be understood as the side of the cover 5 into which light emitted by the light source 4 can be coupled into the cover 5. The first and second parts 81, 82 may be two separate parts or may be integrally formed with one another, such as by forming a C-shape in a cross-sectional view, wherein the C-shape engages the cover 5.

[0048] As also shown in Figs. 2A-2C, the flexible section 8 is arranged such that by the fastener 7 fastening the cover 5 to the support 6, the flexible section 8 and the cover 5 are pressed together. Thereby, at least part of the flexible section 8 may be compressed, such as the first part 81 and/or the second part 82. In particular, by the fastener 7 fastening the cover 5 to the support 6, the flexible section 8 (e.g. the first part 81) may be pressed against the front side 51 of the cover 5 and/or the flexible section 8 (e.g. the second part 82) may be pressed against the back side 52 of the cover 5. The first part 81 may be compressed between the part 72 and the cover 5, and/or the second part 82 may be compressed between the cover 5 and the support 6.

[0049] The fastener 7 is arranged to be selectively adjustable between at least two positions (i.e., first and second positions) and preferably can be selectively adjusted into three positions (i.e., into a further position which is

thus a third position). These three positions are exemplified by Figs. 2A-2C, respectively. By the fastener 7 being adjustable between the at least two positions, different fixed states (such as at least a semi-fixed or partially fixed state and a fully-fixed state) of the cover 5 can be effected. In the different fixed states, different degrees of freedom of the cover 5, respectively, relative to the support 6 can be effected. In other words, the fastener 7 enables to adjust the pressure between the fastener 7 (such as the outer clamp) and the support 6 (such as the inner clamp) in order to effect at least two, preferably three fixed states which relate to different degrees of freedom of the cover 5, respectively (such as "open", Fig. 2A, "hinge", Fig. 2B, and "fixed", Fig. 2C).

[0050] In the first position, which is shown in Fig. 2A ("open"), the fastener 7 is arranged such that the flexible section 8 and the cover 5 are pressed together such that the cover 5 is in a first fixed state. In this state the cover 5 is fixed such that the cover 5 has a degree of freedom as indicated by the arrows. For example, the degree of freedom in this fixed state is such that the cover 5 can oscillate upwards and downwards (along a direction parallel to the Z-direction in Fig. 2A) and such that at least part of the cover 5 can oscillate (bend) about a pivot (e.g. a pivot axis perpendicular to the drawing page of Fig. 2A). The pivot may be an (side) edge of the cover 5 and/or may be arranged between the fastener 7 and the support 6. In particular, the cover 5 can move (up and down, etc.) within limits defined by the fastener 7 and the support 6.

[0051] In the first fixed state the cover 5 can thus vibrate in response to a sound wave. In particular, the fastener 7 effects that the flexible section 8 is in such a compressed state that the resulting restoring force acts to fix the cover 5 to the support 6. In the first fixed state the cover 5 has a first resonance frequency of 300Hz or less, preferably in a range of 50-200 Hz, more preferably in a range of 125-175Hz, such as 173Hz; the resonance frequency of the cover can be determined by modal analysis of the cover. Hence, vibrational energy propagated by sound waves with a small frequency (such as 300Hz or less, preferably in a range of 50-200 Hz, more preferably in a range of 125-175Hz, such as 173Hz) can be transferred to vibrational energy of the cover 5 in a particularly well manner. This is in particular because the frequency of sound wave(s) to be eliminated is equal or close to the resonance frequency of the cover 5, so that the cover 5 can vibrate (oscillate) with a particularly high amplitude in response to the respective sound wave.

[0052] In the second position, which is shown in Fig. 2B ("hinge"), the fastener 7 is arranged such that the flexible section 8 and the cover 5 are pressed together such that the cover 5 is in a second fixed state. In this state the cover 5 may be fixed such that the cover 5 has a degree of freedom that is smaller than the degree of freedom provided by the first fixed state; the degree of freedom of the cover 5 in the second fixed state may be as indicated by the arrow in Fig. 2B. For example, the degree of freedom in this fixed state is such that the cover

5 cannot oscillate linearly, such as upwards and downwards along a direction parallel to the Z-direction in Fig. 2A, but such that at least part of the cover 5 can oscillate (bend or rotate) about a (or the) pivot (e.g. a pivot axis perpendicular to the drawing page of Fig. 2B).

[0053] In the second fixed state the cover 5 thus can vibrate in response to a sound wave. In particular, the fastener 7 effects that the flexible section 8 is in such a compressed state that the resulting restoring force acts to fix the cover 5 to the support 6. In the second fixed state the cover 5 has a second resonance frequency that is different from the first resonance frequency and that is 300Hz or less, preferably in a range of 60-100 Hz, such as 80Hz or 118Hz. Thereby, vibrational energy propagated by sound waves with a small frequency (such as 300Hz or less, preferably in a range of 60-100Hz, such as 80Hz or 118Hz) can be transferred to vibrational energy of the cover 5 in a particularly well manner.

[0054] The invention is not limited to the fastener 7 being adjustable between the above-mentioned two positions. The fastener 7 may be arranged so as to be adjustable to be also in a third position and, thus, to effect a third fixed state of the cover 5, e.g. as shown in Fig. 2C. In the third fixed state the cover 5 has a third resonance frequency that is 300Hz or less (preferably in a range of 50-200 Hz, more preferably in a range of 125-175Hz) and different from the first and second resonance frequencies, such as smaller or greater than the first resonance frequency and/or smaller or greater than the second resonance frequency.

[0055] In the third position of the fastener 7 the fastener 7 is thus arranged such that the flexible section 8 and the cover 5 are pressed together such that the cover 5 is in the third fixed state ("fixed"). In this state the cover 5 may be fixed such that the cover 5 has a degree of freedom which is smaller than the degrees of freedom of the cover 5 in the first and second fixed states, respectively. For example, the degree of freedom in the third fixed state is such that the cover 5 cannot oscillate upwards and downwards (along a direction parallel to the Z-direction in Fig. 2A) and such that the cover 5, in response to a given periodic force acting on the cover 5, cannot oscillate (rotate) about a (or the) pivot, or at least less than in the second position (e.g. a pivot axis perpendicular to the drawing page of Fig. 2A). In an embodiment, in the third fixed state motion (such as linear motion) and vibration of the whole cover 5 is only possible by flexure of the cover 5 around the fixed edge in the fastener 7 and/or the cover 5 may have substantially no degree of freedom, i.e. cannot move linearly (up and down) and does not include any part that can rotate or bend about a pivot, which may be arranged in the fastener 7 or between part of the fastener 7 and the support 6.

[0056] For example, the luminaire 1 may comprise four fasteners 7 and four flexible sections 8 for fixing four outer lateral regions (comprising a respective (side) edge) of the cover 5, respectively, so that the following configurations with respective resonance frequencies of the cov-

er 5 may be possible:

- four outer lateral regions of the cover 5 in the fixed state "fixed": 150Hz;
- four outer lateral regions of the cover 5 in the fixed state "hinged": 80Hz;
- two outer lateral regions of the cover 5 in the fixed state "fixed" and two outer lateral regions of the cover 5 in the fixed state "hinged": 118Hz;
- four outer lateral regions of the cover 5 in the fixed state "open" or "free": 173Hz.

[0057] The fastener 7 may be designed in many different ways in order to be adjustable between the at least two positions, i.e. to be transferred (e.g. moved) into each of the at least two, preferably three positions. For example, the fastener 7 may be a clamp, or part of a clamp, in particular arranged such that the cover 5 and the flexible section 8 can be clamped by the fastener 7 and/or between the fastener 7 and the support 6. The fastener 7 may comprise a moveable part (such as an outer clamp and/or a frame) that is moveable relative to the housing 2 and/or the support 6. The moveable part may comprise the part 72. The moveable part may be arranged to move linearly, such as along a direction transversely, such as perpendicularly, relative to the cover 5 (e.g. parallel to the Z-direction in Fig. 2A). By moving the moveable part, the fastener 7 may be adjusted between the different positions, i.e. may be transitioned into each of the at least two positions. The moveable part may be guided by a guide and/or may be moveable in a stepless and/or incremental manner.

[0058] The fastener 7 may comprise a section 71 extending laterally with respect to the flexible mounting 8 and transversely with respect to the cover 5, e.g. with respect to the flat side and/or a flat region of the cover 5. The section 71 may extend transversely relative to the part 72 and/or may form together with the part 72 a substantially L-shape, when viewed in a sectional view. By the section 71, the flexible section 8 can be held along a lateral direction. That is, by the section 71 it can be prevented that the flexible section 8 detaches from the cover 5 along a lateral direction, e.g. along a left direction in Figs. 2A-2C. The section 71 may be part of the moveable part of the fastener 7. Accordingly, at least the section 71 and the part 72 may form the moveable part of the fastener 7. The section 71 may extend parallel to the sidewall 21.

[0059] As described above, the fastener 7 can be adjusted such that energy of a sound wave propagating in the room R and reaching the cover 5 can be transferred, at least partly, to the cover 5 which thus vibrates. To absorb at least part of the energy of the vibrating cover 5, the luminaire 1 may comprise a damper 91 arranged in the cavity 3. As shown in Fig. 1, the damper 91 may be arranged on the bottom 22 and/or may be arranged so as to abut and/or contact the sidewall 21. For example, at least a part of the vibration of the cover 5 may be

transferred (e.g. via the support 6) to the sidewall 21. The damper 91 abutting and/or contacting the sidewall 21 may then transform the kinetic energy of the vibrating sidewall 21 into dissipated energy, such as heat. The damper 91 may comprise a plurality of dampers 91. Each of the dampers 91 may abut and/or contact a respective sidewall 21. For each fastener 7, which fixes the cover 5 to a respective support 6, a respective damper 91 may be provided. The damper 91 may have a (total) volume that is at least 5%, and preferably 50% or less, such as 5 to 20%, of the volume of the cavity 3.

[0060] Additionally or alternatively, the cavity 3 may be sealed in a gastight (e.g. airtight) manner. Thereby, the air or any other gas inside of the cavity 3 may also act as a damper and/or as a means for transferring at least part of the vibrational energy, e.g. to the damper 91. The (optional) gastight sealing thus prevents that the gas (such as air or any other gas) can leak from the cavity 3. Thereby, motion of the cover 5 can be transferred to the gas in such a way that molecules in the gas move relative to one another (thereby dissipating at least part of the kinetic energy into heat) and/or that via the gas at least part of the kinetic energy of the cover 5 is transferred to another part, such as a part of the luminaire 1, e.g. the damper 91 and/or the bottom 22.

[0061] Additionally or alternatively, the luminaire 1 may comprise a section arranged to be in sliding friction with the cover 5 as the cover 5 vibrates. Thereby, the sliding friction effects that at least part of the kinetic energy of the vibrating cover 5 is transformed into heat.

[0062] Accordingly, at least part of the energy of the sound wave is transferred to the cover 5 and then, by the sliding friction, absorbed. The section may be stationary as the cover 5 vibrates. The section may be part of the housing 2, such as of the sidewall. Additionally or alternatively, the section 71 of the fastener may comprise at least part of the section that can be in sliding friction with the vibrating cover 5. The cover 5 may be in sliding friction with said section via the thin side of the cover 5 and/or via an (side) edge of the cover 5.

[0063] As shown in Fig. 3, the bottom 22 may comprise features that are "vibration tuned", which means in particular that they are designed to aid or support in dissipating vibration energy of the luminaire 1, such as of the cover 5 and/or of the sidewall 21. For example, the bottom 22 may comprise a weakened area 23. The weakened area 23 may be formed by a recess provided in the bottom 22. The bottom 22 may have a thickness that is smaller in a region of the weakened area 23 than in a region on which the light source 4 is arranged. Vibrational energy transferred to the weakened area 23 may effect that the weakened area 23 vibrates with a particularly high amplitude, so that by the weakened area 23 vibration energy can be dissipated effectively. For example, as the weakened area 23 vibrates, the weakened area 23 may be in sliding friction with a part that is part or no part of the luminaire 1, such as with an attachment section (e.g., a part behind the luminaire 1, such as a ceiling) to which

the luminaire 1 is attached.

[0064] Additionally or alternatively, the bottom 22 may comprise a through opening 24. Thus, vibrational energy may be transmitted via the through opening 24 to an area (such as an attachment section (such as a part behind the luminaire 1, a ceiling, etc.) to which the luminaire 1 is attached). The through opening 24 may be sized so as to provide a Helmholtz Resonator, e.g. with a resonance frequency in the range from 20-300Hz. For example, the width (e.g. diameter) and/or the depth of the through opening 24 may be chosen such that the Helmholtz Resonator is provided.

[0065] As shown in Fig. 3, the flexible section 8 is not limited to comprise the part 81 between the cover 5 and part of the fastener 7. Accordingly, in the embodiment shown in Fig. 3, the fastener 7, such as the part 72, contacts the cover 5 not via the flexible section 8 but differently, such as directly or indirectly via an element not comprised by the flexible section 8. In particular, the flexible section 8 may be compressed only in the region of the part 82. For example, the flexible section 8 consists of the part 82.

[0066] As shown in Fig. 4, the luminaire 1 may comprise (e.g. in addition to, or as an alternative for, the damper 91) a damper 92 that extends from the cover 5, such as from its back side 52, to the bottom 22 of the housing 20. Accordingly, the damper 92 is arranged such that it can be clamped and/or compressed between the cover 5 and the bottom 22. For example, as the cover 5 vibrates in response to a sound wave, the damper 92 may be compressed by the cover 5 moving towards the light source 4 and/or the bottom 22. Thereby, the damper 92 absorbs at least part of the vibrational energy of the cover 5, e.g. by transforming the vibrational energy into heat.

[0067] The damper 92 may be arranged to contact the cover 5, such as its back side 51, and/or the bottom 22, such as a surface on which the light source 4 is arranged. The damper 92 may have an elongated form and/or the form of a pillar or column. The damper 92 may be arranged between adjacent light sources 4. The damper 92 may include a function that goes beyond the damper's function of absorbing energy. For example, the damper 92 may be a light guide arranged to guide light to an interface (such as a sensor and/or a control interface) arranged in the cavity 3 and/or on the bottom 22. In particular, the damper 92 may be designed to guide light in the visible range and/or in the IR range. For example, the damper 92 may comprise two opposite ends 921, 922, wherein a first end 921 is in contact with the cover 5 and a second end 922 is provided such that light coupled out of this end is emitted to the interface. The end 922 may be in contact with the interface.

[0068] A plurality of the damper 92 may be arranged within the cavity 3. The damper 92 may have a (total) volume that is at least 5%, and preferably 50% or less, such as 5 to 20%, of the volume of the cavity 3.

[0069] As shown in Figs. 4 and 5, the cover 5 may have a (acoustic diffusive while optically transparent) structure

designed to diffuse acoustic or sound waves. The structure may be arranged on the front side 51 of the cover 5. The structure may comprise a plurality of (diffusive) areas (e.g. protrusions and/or recesses) which may be arranged in a specific pattern, such as in the form of a grid and/or matrix pattern (e.g., in the form of at least 7 rows and/or at least 7 columns (such as at least 7×7) and/or quadratic or tiled quadratic). The structure, or areas (sub-structures), may comprise one or more protrusions 53 that protrude from the front side 51. At least some of the one or more protrusions 53 may be formed as an optical element such as a lens and/or a lens section. The pattern and/or respective dimensions of the areas (such as protrusions 53) may be provided ("tailored") so as to achieve a specific (chosen) behavior in order to control room acoustics in the room R. In particular, the structure for diffusing the acoustic waves does not impair the transparency of the cover 5. The structure for diffusing acoustic waves may provide local optical characteristics such as optical emission shaping.

[0070] The areas of the diffusive structure may have different extensions, such as different heights and/or different depths. For example, if the areas comprise a plurality of protrusions (or recesses) 53, the protrusions (or recesses) 53 may have heights (or depths) as indicated in Fig. 5. In particular, the diffusive structure may be a pseudo-random diffuser. As such, a pseudorandom sequence of numbers may be produced, wherein these numbers then correspond to the extensions (such as heights and/or depths) of the different areas, respectively. For example, maximum length sequence (MLS) and/or Quadratic Residue may be used as a basis for deriving the pseudorandom sequence(s).

[0071] The (diffusive) structure of the cover 5 may be adapted to diffuse sound waves with a frequency in a range of, in particular, 0.5-20kHz, preferably 1-10kHz.

[0072] As shown in Fig. 6, the cover 5 with the diffusive structure 53 may be also provided in combination with the embodiment that comprises the damper 91.

[0073] The cover 5 is not limited to a specific material. Preferably, the cover 5 comprises a material with

- a density in a range of 1-4 kg/l, such as 1.2 kg/l,
- a Young's Modulus in a range of 1-100 GPa, such as 2.9 GPa, and/or
- a Poisson ratio in a range of 0,1-0,45, such as 0.35.

[0074] These material properties have been found particularly advantageous for effecting a resonance frequency of the cover 5 in such a way that the cover 5 can vibrate in response to sound waves having a small frequency, thereby particularly well transforming the energy of the sound waves into vibrational energy of the cover 5.

[0075] Additionally or alternatively, the cover 5 may have a constant thickness and/or a thickness in a range of 3-6mm. The cover 5 may have a length in a range of 0.3-1.5m. Preferably, the cover 5 has a width of 595mm +/-10mm, and/or of 1.2m +/- 10mm, and/or a length of

595mm +/- 10mm, and/or of 0.3m +/-10mm. The cover 5 may have (in a top view) a rectangular shape or any other polygonal shape (quadratic, etc.) or a round or oval shape.

[0076] The cover 5 may comprise a plastic material such as PMMA.

[0077] The damper 91 is not limited to a specific material. The damper 91 may comprise a material suitable for absorbing sound. Preferably, the damper 91 comprises a porous material and/or has a spongy structure. Additionally or alternatively, the damper 91 may comprise an elastic material such as rubber (e.g. synthetic rubber). The damper 92 is not limited to a specific material. The damper 92 may comprise a material suitable for absorbing sound. Preferably, the damper 92 comprises a porous material and/or has a spongy structure. Additionally or alternatively, the damper 92 may comprise an elastic material such as rubber (e.g. synthetic rubber). The damper 92 may comprise a material such that light can be guided via the damper 92 within the cavity, e.g. such a material that at the interface between the material and the gas (e.g. air) within the cavity 3 can be totally reflected within the damper 92.

[0078] The position(s) of the damper 91 and/or damper 92 may be in regions within the cavity 3 where gas (air) flow speed is highest during mechanical vibration of the cover 5.

[0079] The housing 2 is not limited to a specific material. Preferably, the bottom (back-plane) 22 of the housing 2 is designed in such a way that the bottom 22 has a resonance frequency in a range of 20-300Hz, a material density of >2kg/l, and/or a Young's Modulus (Loss Modulus) of > 100MPa. The housing 2 may be made of a material that comprises a metal and/or a plastic material.

[0080] Preferably, the flexible section 8 comprises, or consists of, an elastic material, such as rubber.

[0081] The luminaire 1 may be used in a variety of different applications. For example, the luminaire 1 may be attachable to a ceiling, such as into a cavity of a ceiling. The luminaire 1 may be part of a suspended luminaire. The luminaire 1 may be a linear luminaire, such as an elongate luminaire having a length that is at least twice or at least three times the width of the luminaire. As such, the luminaire may have a long axis and a short axis. Diffusive properties, i.e. properties able to diffuse sound waves, may be arranged along the short axis and/or along the long axis.

[0082] All features described above or features shown in the figures can be combined with each other in any advantageous manner within the scope of the invention.

Claims

1. A luminaire (1) for illuminating a room (R) and for controlling room acoustics in said room (R), wherein the luminaire (1) comprises:

- a housing (2) with a cavity (3),
- a light source (4) arranged in the cavity (3),
- a rigid transparent cover (5) arranged such that at least part of the light emitted by the light source (4) can be emitted via the cover (5) into the room (R) to be illuminated,
- a support (6) arranged to support the cover (5),
- a fastener (7) arranged to fix the cover (5) to the support (6), and
- a flexible section (8) arranged between the support (6) and the cover (5) and/or between the cover (5) and at least part of the fastener (7) such that the flexible section (8) and the cover (5) are pressed together when the cover (5) is fixed, by the fastener (7), to the support (6), wherein the fastener (7) is arranged to be selectively adjustable between
 - a first position in which the flexible section (8) and the cover (5) are pressed together such that the cover (5) is in a first fixed state in which the cover (5) has a first resonance frequency, and
 - a second position in which the flexible section (8) and the cover (5) are pressed together such that the cover (5) is in a second fixed state in which the cover (5) has a second resonance frequency different from the first resonance frequency,
 wherein each of the first and second resonance frequencies is in a range of 300Hz or less.

2. The luminaire (1) according to claim 1, wherein each of the first and second resonance frequencies is in a range of 20-300Hz, preferably in a range of 50-200 Hz, wherein the first resonance frequency is preferably in a range of 125-175Hz, such as 150Hz, and/or wherein the second resonance frequency is preferably in a range of 60-100 Hz, such as 80Hz.
3. The luminaire (1) according to claim 1 or 2, wherein the cover (5) comprises a material with a density in a range of 1-4 kg/l, a Young's Modulus in a range of 1-100 GPa, and/or a Poisson ratio in a range of 0,1-0,45, and/or wherein the cover (5) has a thickness in a range of 3-6mm.
4. The luminaire (1) according to any one of the preceding claims, wherein the fastener (7) is arranged to press the flexible section (8) against a back side (52) of the cover (5) facing the light source (4) and/or against a front side (51) of the cover (5) facing away from the light source (4).
5. The luminaire (1) according to any one of the preceding claims, wherein the fastener (7) comprises, or is, a clamp or a part of a clamp, and/or wherein the fastener (7) comprises a moveable part (71, 72) that is moveable relative to the housing (2) in order to adjust the fastener (7) between the first and sec-

ond positions and/or wherein the support (6) is fixed to the housing (2), such as integrally formed with the housing (2), wherein the support (6) preferably forms part of a sidewall (21) of the housing (2).

6. The luminaire (1) according to any one of the preceding claims, wherein the fastener (7) comprises a section (71) extending laterally with respect to the flexible section (8) and transversely with respect to the cover (5).
7. The luminaire (1) according to any one of the preceding claims, wherein the fastener (7) comprises a plurality of fasteners (7) that are adjustable independently from one another and/or that are distributed around the cover (5), and/or wherein the cover (5) comprises an outer region with different segments delimited by different side edges of the cover (5), respectively, wherein the fastener (7) comprises:
 - a fastener (7) arranged to fix only one of the segments to the support (6), and/or
 - a single fastener (7) arranged to fix a plurality or all of the segments to the support (6), wherein the fastener preferably surrounds the cover (5), and/or
 - a plurality of fasteners (7) that are arranged to fix different segments to different sections of the support (6).
8. The luminaire (1) according to any one of the preceding claims, further comprising a damper (91, 92) arranged in the cavity (3) of the housing (2), wherein the damper (91, 92) preferably comprises a porous material and/or rubber.
9. The luminaire (1) according to claim 8, wherein the damper (92) extends from the cover (5), such as from its back side (52), to a bottom (22) of the housing (2), wherein the light source (4) is arranged on the bottom (22).
10. The luminaire (1) according to claim 8 or 9, wherein the damper (91) abuts or contacts a sidewall (21) of the housing (2).
11. The luminaire (1) according to any one of claims 8 to 10, wherein the damper (91, 92) has a volume that is at least 5%, and preferably 50% or less, such as 5 to 20%, of the volume of the cavity (3).
12. The luminaire (1) according to any one of the preceding claims, further comprising a section (71) arranged to be in sliding friction with the cover (5) as the cover (5) vibrates, wherein preferably the housing (2) and/or the fastener (7) comprises the section (71).

13. The luminaire (1) according to any one of the preceding claims, wherein the cavity (3) is sealed in a gastight manner, such as an airtight manner.

14. The luminaire (1) according to any one of claims 1 to 12, wherein the housing (2) comprises a bottom (22) on which the light source (4) is arranged, wherein the bottom (22) comprises a weakened area (23), preferably formed by a recess, and/or a through opening (24), wherein the through opening (24) is preferably sized so as to provide a Helmholtz Resonator with a resonance frequency in the range of 20-300Hz.
15. The luminaire (1) according to any one of the preceding claims, wherein the cover (5), such as the front side (51) of the cover (5), comprises a structure (53) designed to diffuse acoustic waves, wherein the structure preferably acts as a pseudo-random diffuser and/or preferably comprises different areas (53) of different heights and/or depths, wherein the areas (53) are preferably arranged according to a grid and/or matrix.

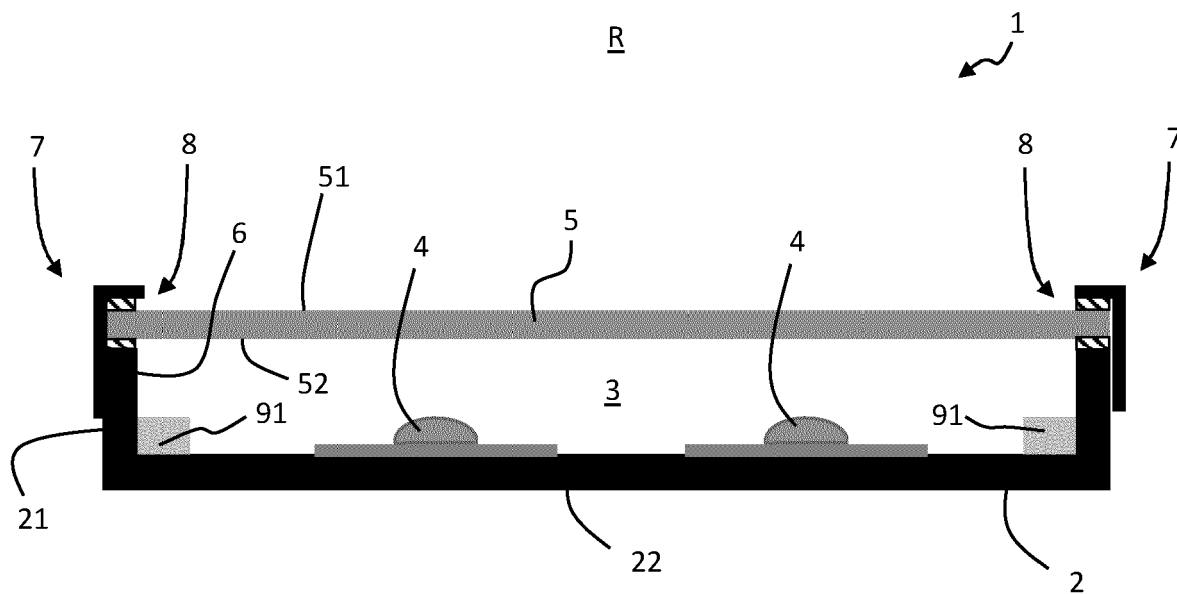


Fig. 1

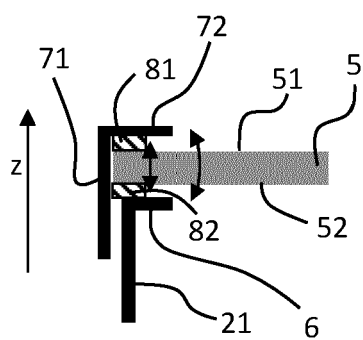


Fig. 2A

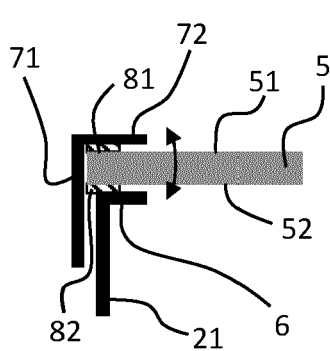


Fig. 2B

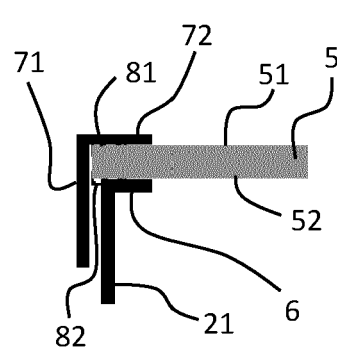


Fig. 2C

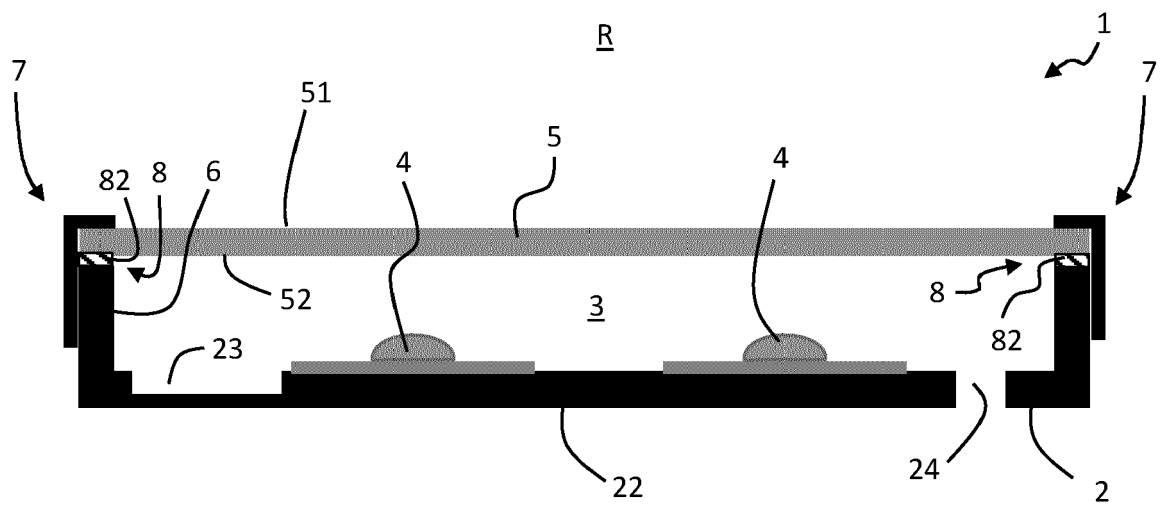


Fig. 3

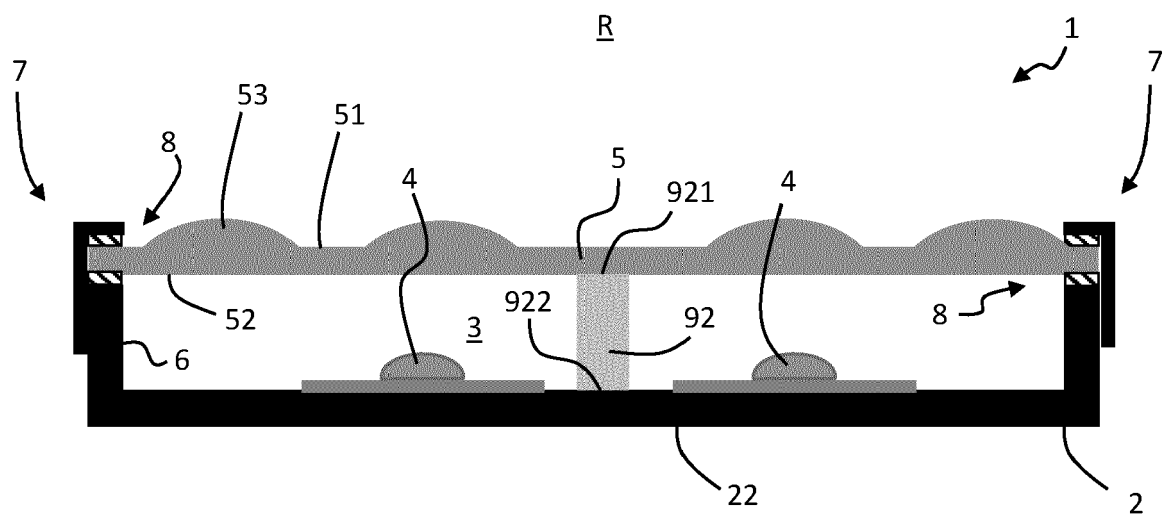


Fig. 4

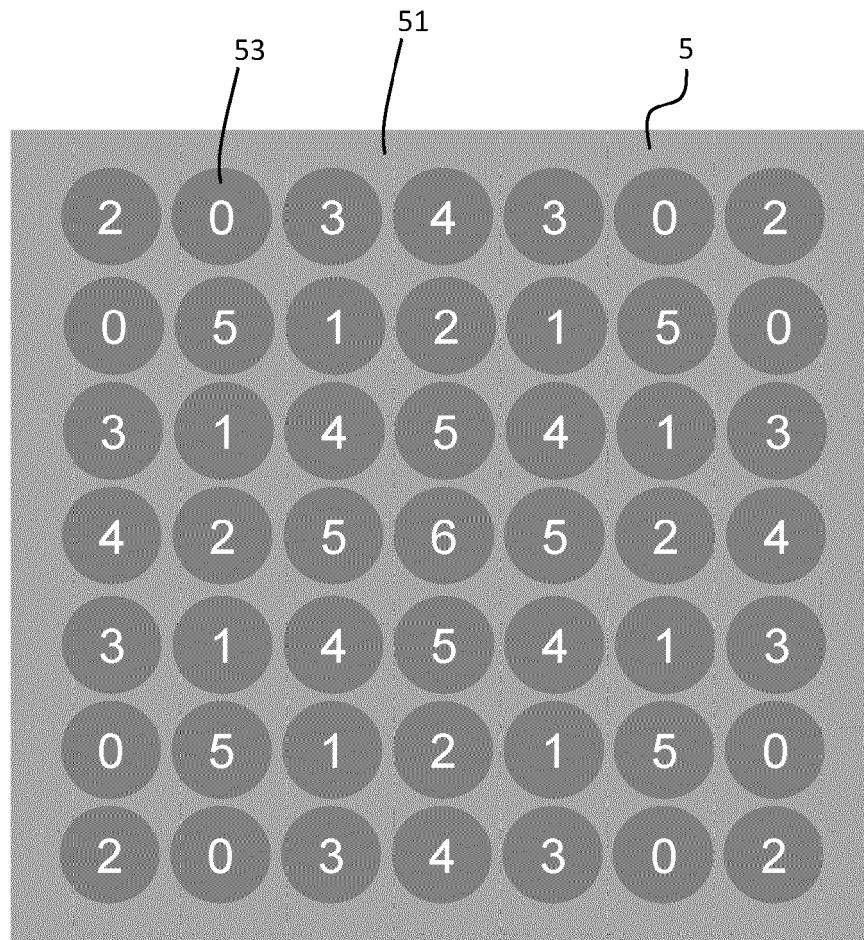


Fig. 5

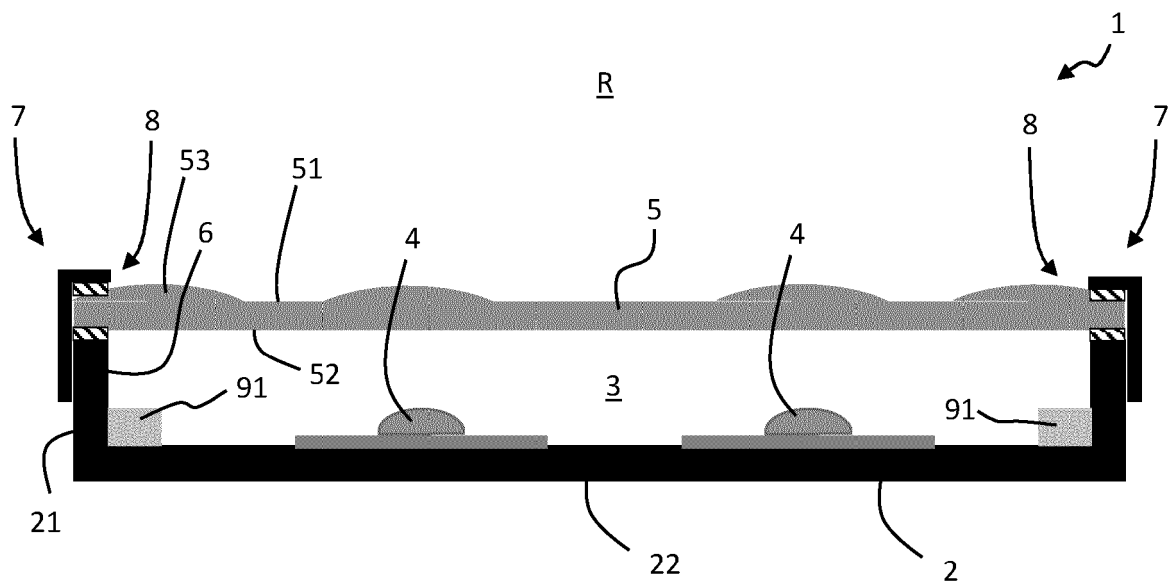


Fig. 6



EUROPEAN SEARCH REPORT

Application Number

EP 23 16 7651

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2019/295519 A1 (KRASS ROBERT M [US] ET AL) 26 September 2019 (2019-09-26) * paragraphs [0034] - [0061]; figures 1-8 * * paragraphs [0068] - [0074]; figure 10 * -----	1-15	INV. F21V3/00 F21V17/02 G10K11/16
A	EP 3 650 749 A1 (OSRAM GMBH [DE]; OSRAM SPA [IT]) 13 May 2020 (2020-05-13) * paragraphs [0031] - [0085]; figure 2 * -----	1-15	ADD. F21Y115/10 F21V31/005
A	US 2016/365079 A1 (SCHERRER JEAN-MARC [FR]) 15 December 2016 (2016-12-15) * the whole document * -----	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			F21V G10K F21Y
The present search report has been drawn up for all claims			

1

EPO FORM 1503 03:82 (P04C01)

Place of search	Date of completion of the search	Examiner
The Hague	21 September 2023	Thibaut, Arthur
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document		

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 23 16 7651

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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21-09-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2019295519 A1	26-09-2019	NONE	
EP 3650749 A1	13-05-2020	NONE	
US 2016365079 A1	15-12-2016	AU 2015225964 A1	25-08-2016
		BR 112016019867 A2	15-08-2017
		CA 2941314 A1	11-09-2015
		CN 106103858 A	09-11-2016
		DK 3114678 T3	20-12-2021
		EP 3114678 A1	11-01-2017
		FR 3018384 A1	11-09-2015
		US 2016365079 A1	15-12-2016
		WO 2015132521 A1	11-09-2015