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(54) **LIGHTING UNIT**

(57) A lighting unit including a first part (3) having a mounting structure (5) that is arranged for insertion into an aperture in a partition, such as a ceiling or wall; a second part (9) including at least one solid state lighting device (15) and a support arranged to support the at least one solid state lighting device, wherein the second part (9) is pivotable with respect to the first part (3); and a seal (21) arranged to seal the first part (3) to the second part (9). The seal (21) is arranged to deform to accommodate pivoting movement of the second part (9) with respect to the first part (3), wherein the seal (21) includes a membrane having an outer peripheral portion (91) that sealably engages to the first part (3), an inner peripheral portion (89) that sealably engages to the second part (9), a flexible connector portion (78) connecting the outer peripheral portion (91) to the inner peripheral portion (89), and a retaining member (94) arranged to hold the outer peripheral portion (91) in contact with the first part (3).

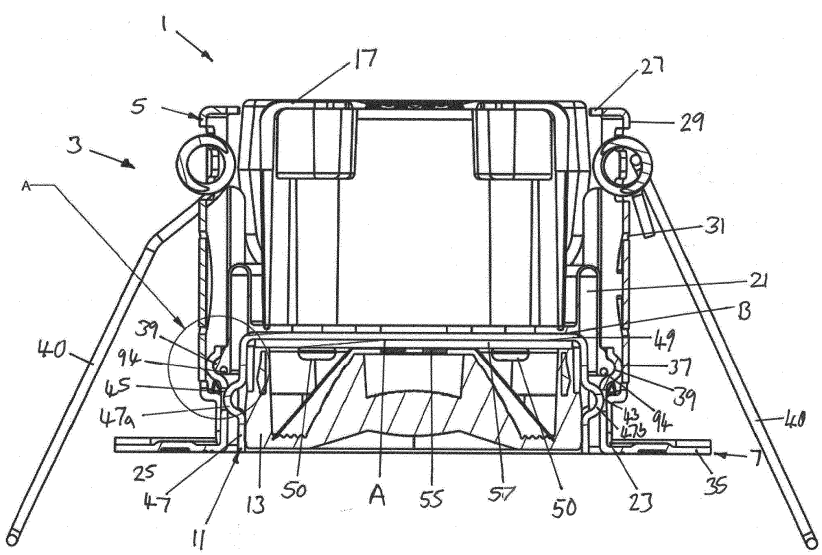

Fig. 2

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Description

[0001] The present invention relates to an adjustable lighting unit, for example an adjustable downlight that includes a solid state lighting device.

[0002] An adjustable downlight typically includes a static mounting structure, for example an outer casing that is mounted in an aperture in a ceiling and an internal structure that carries a light source that is pivotable with respect to the mounting structure. Pivoting the internal structure with respect to the mounting structure adjusts the angle at which light is emitted from the lighting unit. For example, the light source can be adjusted so that it is aligned with a vertical axis, or it can be adjusted such that the light source is inclined to the vertical axis.

[0003] The internal structure can be pivotally attached to the mounting structure by pivot members and can pivot about a single axis. Other lighting units have more than one degree of freedom.

[0004] With angularly adjustable lighting units there are several design challenges.

[0005] A first challenge is adapting adjustable lighting units for moist environments, such as bathrooms, kitchens, and outdoor applications. This is because there is a gap between the static mounting structure and the adjustable internal structure to enable the internal structure to pivot relative to the mounting structure. Moisture enters the lighting unit via the gap and can cause damage to electrical components, which overtime may cause the lighting unit to fail.

[0006] A known way to deal with this problem is to apply a steel can over the entire lighting unit, which is closed off at its upper end. The steel can acts as a moisture barrier and prevents moisture from entering the void above the ceiling. An example of this type of lighting unit is shown in Figure 1. The unit A includes a steel can B, heatsink C and solid state lighting unit having a lens unit D.

[0007] A second challenge is to meet the requirements of the applicable building regulations regarding fire resistance. Fire-rated lighting units of the type that fit into an aperture in a partition are designed to maintain the integrity of the partition in the event of a fire. Typically building regulations require ceilings to survive for a specified period of time when a fire occurs and the fire-rated lighting units play a very important role in achieving this rating. The holes that are cut through the partition to accommodate the lighting units provide pathways for the flames to access the floor above the ceiling. The lighting units close these pathways off and therefore in order for the ceiling to adequately defend the floor above, the lighting units must not fail within the specified rating period, such as 30 minutes, 60 minutes or 90 minutes.

[0008] Since adjustable lighting units have a gap between the internal structure and the mounting structure, this provides a potential weakness to fire resistance. In some arrangements, increasing the angle of inclination of the internal structure with respect to the mounting structure increases the size of the gap, and hence the vulnerability to fire. To mitigate this problem, many adjustable fire-rated lighting units include a large fire resistant can which is mounted over the entire lighting unit (see arrangement in Figure 1, where the steel can B acts as a moisture barrier and a fire resistant barrier). However the can is relatively large, which increases the weight and cost of the lighting unit. Alternatively, a fire resistant hood can be placed over the entire lighting unit. The hood is a separate component from the lighting unit and is applied during installation. The fire can and hood can significantly impede air flow around the light source, and in some instances, particularly with some solid state lighting units, can lead to overheating problems.

[0009] A third challenge for angularly adjustable lighting units arises when the light source comprises one or more solid state lighting devices. The performance and the useful life of some solid state lighting devices, particularly high powered or inefficient device, is significantly affected by heat generated in use by the LEDs. In order to obtain good performance, and a long life, it is necessary to remove heat from the LEDs as efficiently as possible, therefore good thermal management is required. However, this can be difficult to achieve when the light source is movable, there is a need to seal the lighting unit against moisture ingress, and/or there is a need to make the lighting unit fire resistant.

[0010] One way to deal with the overheating problem is to include several openings in the can B, typically in the end wall E, to enable heat to dissipate to the environment by convection. However this compromises the ability of the can B to act as a moisture barrier. Therefore there is a desire to provide a solid state lighting unit that is arranged to have good thermal management, is fire resistant and prevents moisture from entering the void in the ceiling.

[0011] A fourth challenge is to provide an adjustable lighting unit that is light weight, and easy to manufacture and assemble.

[0012] A known lighting unit is disclosed in GB2522419. The lighting unit includes a first part, having: a casing; and bezel. The lighting unit includes a second part, having: a fire resistant housing; a lens module; a solid state lighting device; a clamping member, and a driver unit for the solid state lighting device. The second part is pivotally attached to the first part. This enables the angular orientation of the solid state lighting device to be adjusted with respect to the first part, thereby adjusting the angle at which light is emitted from the lighting unit. The lighting unit also includes a seal that seals the first part to the second part. The seal prevents moisture passing through the lighting unit via the gap between the first and second parts. This lighting unit provides a solution to many of the problems described above. However the inventor has determined that a drawback with this type of lighting unit is that the moisture seal can pop out of its seating, which is typically in the form of a groove formed in the first part of the lighting unit, for example a groove formed in the bezel. The problem occurs most frequently when the fire resistant housing is fully tilted with respect to the first part of the lighting unit. Similarly, if an installer mishandles the light fitting during an installation process the moisture seal may become dislodged from its seating, which can compromise the IP rating. Accordingly there is a desire to address the seal dislodgement problem for this type of lighting unit. One proposed solution is simply to glue the moisture seal in place to maintain the waterproof seal. While this solution addresses the problems outlined above, it has been found to be time consuming, expensive, messy and can result in a high reject rate in production as the process requires a high degree of manual dexterity and skill. Therefore a different solution is desirable.

[0013] Accordingly the invention seeks to provide a lighting unit that mitigates at least one of the above-mentioned problems or provides an alternative solution thereto.

[0014] According to one aspect of the invention, there is provided a lighting unit according to claim 1. The invention provides a very simple, light weight, sealed, fire proof adjustable LED lighting unit. The retaining member holds the moisture seal in its seating against the first part of the lighting unit, meaning it cannot easily be dislodged, thereby maintaining the waterproof seal, during installation and in use. Furthermore, the arrangement improves the assembly process as the seal is much easier to fit into the lighting unit without requiring use of an adhesive. Therefore the assembly process is much cleaner and reliable, and leads to a near zero rejection rate.

[0015] According to another aspect of the invention, there is provided a lighting unit. The lighting unit can include a first part having a mounting structure that is arranged for insertion into an aperture in a partition. The lighting unit can include a second part including at least one solid state lighting device and a support for supporting the at least one solid state lighting device. The second part can be pivotable with respect to the first part. The lighting unit can include a seal arranged to seal the first part to the second part.

[0016] The seal is arranged to deform to accommodate pivoting movement of the second part with respect to the first part. The seal can include a membrane having an outer peripheral portion that sealably engages to the first part. The seal can include an inner peripheral portion that sealably engages to the second part. The seal can include a flexible connector portion connecting the outer peripheral portion to the inner peripheral portion. The seal can include a retaining member arranged to hold the outer peripheral portion in contact with the first part.

[0017] The retaining member can be annular. For example, the retaining member can be in the form of a retaining ring. This enables the retaining member to hold the seal against a circumferential surface.

[0018] The retaining member can be resiliently deformable. The retaining member can bias the outer peripheral portion into contact with the first part of the lighting unit. This helps the seal to be assembled into the lighting unit and helps to retain the seal in-situ.

[0019] The retaining member can include metal. For example, the retaining member can include steel, such as spring steel. The retaining member can include non-metals, such as plastics, for example nylon.

[0020] The retaining member can be in the form of a wire. For example, the retaining member can comprise a loop of wire. This provides a simple structure that is cheap and easy to manufacture. Typically, the loop can be annular.

[0021] The retaining member can have a circular transverse cross-section. The retaining member can have a rectangular transverse cross-section.

[0022] The seal can be annular. This enables the seal to seal against circumferential surfaces. The seal is substantially circular in plan view.

[0023] The seal can be resilient. This enables the seal to deform resiliently during use. It also enables the seal to be more easily inserted during the assembly process. The seal may include a resilient material such as silicone or rubber.

[0024] The membrane provides a thin walled structure that enables the seal to deform when the second part is pivoted with respect to the first part without compromising the seal between the first and second parts.

[0025] The connector portion of the membrane can include a hollow substantially ∩-shaped, or U-shaped, cross-section having an annular inner side wall and an annular outer side wall. The connector portion can extend into the gap between the first and second parts of the lighting unit. For example, the connector portion can extend between a clamping member and casing. The connector portion of the seal is not clamped and therefore is able to freely deform when the orientation of the second part is adjusted with respect to the first part. The ∩-shaped, or U-shaped, cross-section provides sufficient membrane material to enable the seal to deform easily, which reduces the load required in order to deform the membrane. This helps to increase the useful life of the seal.

[0026] The inner peripheral portion can include an inner lip. The inner lip can extend inwardly from the inner side wall. The inner lip can extend perpendicularly inwardly from the inner side wall, for example in a radial manner. The inner lip can be annular.

[0027] The outer peripheral portion can include an outer lip. The outer lip can extend outwardly from the outer side wall. The outer lip can extend perpendicularly outwardly from the outer side wall, for example in a radial manner. The outer lip can be annular.

[0028] The seal has a central axis and the inner peripheral portion can be offset from the outer peripheral portion in the axial direction. In some embodiments the inner peripheral portion can be offset from the outer peripheral portion in the axial direction by at least 3mm. In some embodiments the inner peripheral portion can be offset from the outer peripheral portion in the axial direction by less than or equal to 20mm, preferably less than or equal to 15mm and more preferably less than or equal to 10mm.

[0029] The seal can comprise a moulded component. The retaining member can be moulded into the seal.

[0030] The retaining member can be embedded in the seal. The retaining member can be embedded in the outer peripheral portion, for example in or adjacent to the annular outer lip. The retaining member can be completely embedded in the seal. Thus the seal material can fully enclose the retaining member. This helps to prevent the retaining member from rusting in moist environments.

[0031] The support can comprise a fire resistant member arranged to prevent fire penetration through the aperture in the partition. The fire resistant member can include material that melts at a temperature greater than or equal to 900C. The fire resistant member can include material that melts at a temperature greater than or equal to 950C, preferably greater than or equal to 1000C, more preferably greater than or equal to 1200C and more preferably still greater than or equal to 1300C. The fire resistant housing can include steel, and preferably is made entirely of steel. The fire resistant member can include other materials such as at least one of brass, ceramic and copper.

[0032] The support can be made from sheet material. The sheet material preferably has a thickness in the range 0.2mm to 3mm. This is a good balance between fire resistance and providing a light weight assembly. It has been found that providing a steel fire resistant member of a sufficient thickness provides the fire resistant quality, that is, it does not melt at temperatures below 900C.

[0033] The second part can include a clamping member. The support has a front side and a rear side, and the clamping member can be located on the rear side of the support.

[0034] The inner peripheral portion of the seal can be clamped between the clamping member and the support. For example, the inner lip can be clamped between the rear side of the support and an end face of the clamping member. The clamping member can attached to the support by at least one threaded member, which applies the clamping load to the seal. At least one hole can be formed through the support to accommodate the at least one threaded member. Preferably a plurality of holes are provided through the support and a plurality of threaded members attach the clamping member to the support.

[0035] The clamping member can comprise a heatsink. The heatsink can be mounted in thermal contact with the solid state lighting device such that at least some of the heat generated by the solid state lighting device can be transferred to the heatsink by conduction.

[0036] The support can be pivotally attached to the first part of the lighting unit. Since the solid state lighting device and clamping member are mounted on the support, they pivot with the support as a unit. The support-solid state lighting device-clamping member assembly is pivotally attached to the first part towards one end thereof, and preferably towards a lower end thereof, that is, towards the front of the lighting unit.

[0037] The support includes a front side and a rear side.

[0038] The solid state lighting device can be mounted on a front side of the support.

[0039] The clamping member can be mounted on a rear side of the support. The clamping member can comprise a plastic housing. The plastic housing can visually resemble a heatsink. Alternatively, the clamping member can comprise a heatsink. The heatsink can be mounted in thermal contact with the support. Heat generated by the solid state lighting device can be conducted through the support into the heatsink. A thermal paste and/or thermal pad can be located between the clamping member and the support in order to assist heat transfer by way of conduction. The heatsink is particularly suited to high power solid state lighting devices and to inefficient lighting devices.

[0040] The solid state lighting device can include at least one LED. The solid state lighting device can include a PCB.

[0041] The support can include at least one hole formed through the support from the front side to the rear side. At least part of the solid state lighting device can be mounted on a rear side of the support.

[0042] The PCB can be mounted on the rear side of the support. The clamping member can be mounted on the rear side of the PCB. The clamping member can comprise a plastic housing. The plastic housing can visually resemble a heatsink. Alternatively, the clamping member can comprise a heatsink. The heatsink can be mount in thermal contact with the PCB. Heat generated by the solid state lighting device can be conducted directly into the heatsink. A thermal paste and/or thermal pad can be located between the heatsink and PCB in order to assist heat transfer by way of conduction. Thus there is a substantially direct connection between the heatsink and the solid state lighting unit, which promotes good heat transfer by conduction.

[0043] The fire resistant member can comprise a fire resistant housing. The housing can include an end wall and at least one side wall.

[0044] The solid state lighting device can be mounted on a front side of the end wall of the housing. The clamping member can be located on the rear side of the end wall. Thus the solid state lighting device and the clamping member can be separated by the thickness of the end wall of the housing.

[0045] The solid state lighting device can be mounted on a rear side of the end wall of the housing. The at least one hole formed through the support can be formed through the end wall of the fire resistant housing. The solid state lighting device can be mounted in relation to the at least one hole such that light emitted from the solid state lighting device exits a front side of the lighting unit. The lighting device is positioned adjacent to, or at least partly within, the hole. For example, the lighting device can be arranged in relation to the hole in one of the following ways: the lighting device is located fully on the rear side of the support and light emitted from the lighting device passes through the hole; the lighting device is partly located in the hole but does not protrude therefrom; and the lighting device is at least partly located in the hole and protrudes therefrom on the front side of the support.

[0046] The support can include a plurality of holes formed therethrough. The solid state lighting device can include a plurality of LEDs, typically each LED having a respective hole. Each LED can be arranged in relation to its respective hole similarly to that described above. Any practicable number of holes can be included in the support that does not compromise its fire resistant ability. The support can have n holes for receiving LEDs, wherein n is typically in the range 1 to 20, and preferably n is in the range 1 to 10 holes. Advantageously the or each hole in the support has a diameter N, wherein N is less than or equal to around 10mm. Each hole is relatively small to maintain the fire resistant qualities of the member. The larger the or each hole the greater the propensity of flames to pass through the hole and damage things on the other side of the partition. Preferably each hole has a diameter N in the range 1mm to 8mm, and more preferably still within the range 1mm to 5mm.

[0047] The fire resistant housing is open at a front end. For substantially cylindrical housings, the housing has one side wall. For other shapes of housing, the housing includes a plurality of side walls, for example a substantially cuboid housing includes four side walls. The housing can have an outwardly extending flange at the front side of the housing.

[0048] The lighting unit can include a lens module. The lens module is located on a front side of the support, and preferably inside the fire resistant housing.

[0049] The first part of the lighting unit can include a casing. The casing at least partly houses the second part of the lighting unit. The casing can include at least one side wall. For a cylindrical casing having a single side wall, the side wall circumferentially surrounds the second part. The casing may of course take other shapes, for example may have a substantially rectangular cross-section, and include a plurality of side walls that together surround part of the periphery of the second part.

[0050] The casing can include first and second ends. Preferably the casing is open at the first and second ends. This provides a substantially tubular structure. The opening at the second end provides good ventilation for the clamping member.

[0051] The first part of the lighting unit can include a bezel. The bezel can be attached to the first end of the casing. The bezel is preferably fire resistant. The bezel can include material that melts at a temperature that is greater than or equal to 900C. For example, the bezel can include steel. The bezel can be made from sheet material, for example pressed steel. Preferably the sheet material has a thickness of at least 0.2mm. The thickness is typically less than 3 mm, and preferably less than 2mm.

[0052] The support can be pivotally attached to at least one of the casing and the bezel. In preferred embodiments the fire resistant housing is pivotally attached to the bezel, since this aids assembly of the lighting unit.

[0053] The collar connects the bezel to the casing. The support is pivotally attached to the collar. For embodiments including the fire resistant housing, at least one side wall of the housing can be pivotally attached to the bezel collar.

[0054] The bezel can include a collar and an outwardly extending flange. The collar can connect the bezel to the casing. For example, the collar can be arranged to fit into the first end of the casing. The support can be pivotally attached to the collar.

[0055] The outer peripheral portion of the seal can seal against at least one of the casing and the bezel. In a preferred embodiment the outer peripheral portion seals against the bezel collar. For example, the collar can include an annular groove that is arranged to receive the outer lip.

[0056] At least one of the bezel and the casing can include a groove. The outer peripheral portion can be seated in the groove. The groove can be located in an inner surface of the bezel and/or casing.

[0057] The lighting unit can be a downlight.

[0058] According to another aspect of the invention there is provided a method for preventing moisture from penetrating an aperture formed in a partition, including inserting a lighting device according to any configuration described herein into the aperture.

[0059] According to another aspect of the invention there is provided a method for preventing fire from penetrating through an aperture in a partition, including inserting a lighting device according to any configuration described herein, that includes a fire resistant member, into the aperture.

[0060] Embodiments of the invention will now be described by way of example only with reference to the drawings, wherein:

Figure 1 is a cross-sectional view diagrammatic view of a prior art device;

Figure 2 is a cross-sectional view of a lighting unit according to a first embodiment of the invention;

Figure 3 is a cross-sectional view of an enlarged part of Figure 2;

Figure 4 is an isometric view of a seal used in the first embodiment of the invention;

Figure 5 is a plan view from above of the seal of Figure 4;

Figure 6 is a cross-sectional view of the seal of Figure

4; and

Figure 7 is a cross-sectional view of lighting unit according to a second embodiment of the invention.

[0061] Figures 2 to 6 show a lighting unit 1 in accordance with a first embodiment of the invention. The lighting unit 1 is in the form of a downlight, which is typically mounted in an aperture in a ceiling, though of course can be mounted in other partitions such as a wall.

[0062] The lighting unit 1 includes a first part 3, having: a casing 5; and bezel 7.

[0063] The lighting unit 1 includes a second part 9, having: a fire resistant member in the form of a fire resistant housing 11; a lens module 13; a solid state lighting device 15; a clamping member 17, and optionally a driver unit (not shown) for the solid state lighting device 15. The second part 9 is pivotally attached to the first part 3 in the manner described below. This enables the angular orientation of the solid state lighting device 15 to be adjusted with respect to the first part 3, thereby adjusting the angle at which light is emitted from the lighting unit 1.

[0064] The lighting unit 1 also includes a seal 21 that seals the first part 3 to the second part 9. The seal 21 prevents moisture passing through the lighting unit via the gap between the first and second parts.

[0065] The casing 5 provides a mounting structure. It comprises a substantially cylindrical shell that includes a first opening 23 at a first end 25 and a second opening 27 at a second end 29. The first opening 23 is arranged to receive and engage the bezel 7. The second opening 27 is a vent and is provided to promote good air circulation around the clamping member to assist heat transfer to the environment by convection. The casing 5 also includes several apertures 31 formed through a side wall 33 of the casing for similar reasons to the second opening 27.

[0066] The bezel 7 includes a flange 35 and a collar 37, and is preferably made from steel. The flange 35 provides an initial barrier against fire leaking through the hole formed in the ceiling, for example in the situation where the installer has not cut a neat hole into the ceiling. The bezel 7 also provides an aesthetically pleasing finish to the front side of the lighting unit.

[0067] The collar 37 is connected to the casing 5. This can be achieved, for example by way of at least one of: an external screw thread formed on the collar 37 and an internal screw thread formed on the casing; screws; rivets; and a push-fit coupling for example that has interference fit. The collar 37 includes a circumferential groove 39 formed in its inner surface, which engages with the seal 21. First and second holes 43,45, or recesses, are formed in the collar 37. The first and second holes 43,45, or recesses, are formed diametrically opposite to one another, and enable the second part 9 to be pivotally connected to the first part 3.

[0068] The lighting unit 1 can optionally include spring loaded clips 40 that are pivotally mounted to, for example the casing 5, and are arranged to be manually pinched closed when inserting the lighting unit into the partition and to spring outwards when released by the installer to load the partition. The biasing force generated by the spring loaded clips is sufficient to retain the lighting unit within the partition.

[0069] The second part 9 comprises an assembly that is pivotable with respect to the first part 3 as a unit. The arrangement of the assembly is described below.

[0070] The fire resistant housing 11 supports the solid state lighting device 15. The fire resistant housing 11 resembles an open ended cylindrical box having a side wall 47 and an end wall 49. The housing 11 may of course take any convenient shape. The housing 11 has a front side 'A' that faces outwards from the casing 5 and a rear side 'B' that faces towards the casing 5. The housing 11 is made from a material having a melting point that is greater than or equal to 900°C, preferably greater than equal to 950°C, and more preferably greater than or equal to 1000°C. For example at least part of the housing, and preferably the entire housing, is made from metal such as steel. The housing 11 is preferably made from sheet material, such as sheet steel, and is formed by a pressing process. Typically the thickness of the sheet material, and hence the walls of the housing 47,49, is in the range 0.3 to 3mm, and preferably 0.3 to 2mm. Thus the housing 11 is arranged such that it does not melt at temperatures below 900°C. The housing 11 preferably comprises a single pressed component, however the housing can comprise a plurality of parts connected together. Each component part can be made from a different material.

[0071] The housing 11 includes two pivot members 47a,47b formed in the side wall 47. The pivot members 47a,47b are arranged to engage with the holes 43,45, or recesses, formed in the collar 37. The pivot members 47a,47b enable the second part 9 to pivot with respect to the first part. The pivot members 47a,47b can be formed integrally with the housing 11, for example can be pressed from the housing material. For a substantially cylindrical housing 11 having one side wall 47, the pivot members 47a,47b are arranged diametrically opposite to one another. Each pivot member 47a,47b extends radially outwardly from the side wall 47.

[0072] The solid state lighting device 15 includes at least one LED 55, and typically 1 to 10 LEDs 55 mounted on a printed circuit board (PCB) 57. The solid state lighting device 15 is preferably located within the fire resistant housing 11 on the front side 'A' thereof. Typically, the solid state lighting device 15 is mounted on the front side 'A' of the end wall 49 of the fire resistant housing 11. Thus the solid state lighting device 15 is supported by the housing 11 and is in thermal contact with the fire resistant housing 11. In use, heat generated by the solid state lighting device 15 is thermally conducted into the fire resistant housing 11. In the absence of a dedicated heatsink, the fire resistant housing 11 acts as a heatsink for the solid state lighting devices 15. This is possible for some efficient or low power solid state lighting devices 15.

[0073] The clamping member 17 is mounted on the rear side 'B' of the end wall 49. The clamping member 17 is provided to clamp the seal 21 to the second part of the lighting unit 9, and preferably to the rear side 'B' of the housing 11. The clamping member 17 can comprise a plastics member. The clamping member 17 can be fixed to the housing 11 by screws 50. The clamping member can comprise a plastics housing that visually resembles a heatsink, though this entirely optional.

[0074] The lens module 13 is mounted in the housing 11 on the front side 'A'. The lens module 13 can comprise a single lens or can include a plurality of lenses, typically one for each LED 55.

[0075] The lens module 13 preferably comprises a moulded component. Preferably the lens module 13 is made from a plastics material such as acrylic and is formed by injection moulding.

[0076] The lens module 13 closes the open side of the housing 11. The lens module 13 is sealed to the housing 11 thereby preventing moisture from entering the fire resistant housing 11.

[0077] The seal 21 provides a moisture barrier between the first and second parts 3,9, of the lighting unit and therefore prevents moisture from entering the void above the ceiling via the gap between the first and second parts 3,9. The seal 21 is flexible. It is made from a resilient material such as silicone or natural rubber, and is able to deform elastically.

[0078] The seal 21 comprises a flexible membrane having the shape shown in Figure 3, said shape being formed by a moulding process. The flexible membrane provides the seal 21 with a thin walled structure that enables the seal to deform, for example flex and/or stretch, when the second part 9 is pivoted with respect to the first part 3, without compromising the seal between the first and second parts 3,9.

[0079] The seal 21 is annular, and is substantially circular in plan view. The seal 21 includes a connector portion in the form of central portion 78. The central portion 78 has a hollow substantially ∩-shaped, or U-shaped, cross-section. The central portion 78 includes an annular inner side wall 79 and an annular outer side wall 81. At least a portion of the inner side wall 79 is substantially parallel with at least a portion of the outer side wall 81 in a non-deformed state. The ∩-shaped, or U-shaped, cross-section provides a flexible folded membrane structure, which reduces the load required in order to deform the membrane. The seal 21 is closed at a first side 83 and open at a second side 85. The closed side 83, inner side wall 79 and outer side wall 81 define an annular channel 87.

[0080] The seal 21 is located within the unit such that the closed side 83 is oriented upwards (∩-shaped), however it will be appreciated by the skilled person that the seal 21 can be inverted with respect to the first and second parts 3,9, thereby providing a substantially U-shaped arrangement.

[0081] The seal 21 includes an inner peripheral portion in the form of an annular inner lip 89. The inner lip 89 extends substantially radially inward from the end portion of the inner side wall 79, towards the end thereof. The inner lip 89 surrounds the solid state lighting unit 15, in one plane. The seal includes an outer peripheral portion in the form of an annular outer lip 91. The outer lip 91 extends substantially radially outwards from the outer side wall 81, towards the end thereof. The central portion 78 connects the inner lip 89 to the outer lip 91.

[0082] The inner peripheral portion includes holes 92 to accommodate screws 50.

[0083] The seal 21 includes a retaining member in the form of a retaining ring 94. The retaining ring 94 is moulded into the outer lip 91. The purpose of the retaining ring 94 is to hold the outer lip 91 in engagement with the first part 3 of the lighting unit, for example in engagement with groove 39. The retaining ring 94 also makes assembly of the lighting unit easier since it is not necessary to adhere the seal 21 in place, which is a messy process and leads to a significant number of rejections during the assembly process. The retaining ring 94 is preferably made from metal, such as steel. However, other materials such as plastics can be used, for example the retaining ring 94 can be made from nylon or similar materials. Preferably the retaining ring 94 is resilient, so that it can bias the outer lip 91 into engagement with the first part of the lighting unit 3, such as groove 39. For example, the retaining ring 94 can be made from spring steel. Typically, the retaining ring 94 comprises a loop of wire, for example a circular loop. The retaining ring typically has a circular transverse cross-section, however the transverse cross-section can have other shapes, such as rectangular.

[0084] The seal 21 has a central axis 93, and the inner lip 89 can be offset from the outer lip 91 in the axial direction. Typically inner lip 89 is offset OS from the outer lip 91 in the axial direction by around 5mm to 30mm, depending on the arrangement of the lighting unit.

[0085] The outer lip 91 is seated in the annular groove 39 formed in the bezel collar 37. The outer lip 91 is sized and shaped to form a seal with the groove 39 and hence the first part 3. The outer lip 91 is firmly attached to the groove 39 by the retaining ring 94. The function of the groove 39, and retaining ring 94, is to ensure that the seal 21 does not disassociate from the bezel 7 when the second part 9 is tilted with respect to the first part 3. The inner lip 89 is sized and shaped to be clamped between the clamping member 17 and the rear side 'B' of the end wall 49 of the fire resistant housing 11, thereby forming a seal with the second part 9. Since the inner lip 89 surrounds the solid state lighting unit 15, in one plane, clamping the inner lip 89 between the clamping member 17 and housing 11, helps to protect at least parts of the solid state lighting device 15 from moisture ingress.

[0086] The clamping load is provided by screws 50.

[0087] In use, the lighting unit is arranged such that a user is enable to adjust the angle of the second part 9 of the lighting unit by a limited amount, typically ± 20 degrees, without breaking the seal between the first and second parts 3,9. The seal 21 deforms, for example by stretching and/or flexing in the fully tilted positive orientation and fully tilted negative orientation respectively. Thus the seal 21 provides an effective moisture barrier regardless of the operational orientation of the second part 9 with the respect to the first part 3. Since the seal 21 is resilient it returns to its original shape when the lighting unit is adjusted so that the central axis of the second part 9 is substantially co-axial (or at least substantially parallel) with the central axis of the first part 3.

[0088] In the event of a fire, the fire barrier formed by the partition and the fire resistant housing 11 is not compromised for the period of its fire rating. For example, a ceiling may be rated in accordance with the test outlined in BS 476: Part 21: 1987, or BS EN 1363-1:2012. The material and thickness of the material for the fire resistant housing 11 is selected according to the rating of the ceiling. Typically the fire resistant housing 11 is designed to withstand temperatures of around 900°C and will not fail in fires having temperatures below its design threshold. For a lighting unit rated at 90 minutes, the fire resistant barrier must not melt in temperatures of around 1000C, according to the test. Thus the lighting unit according to the invention has the advantage that it meets current standards, while at the same time providing a simple structure that is relatively cheap to manufacture and relatively easy to install when compared with known fire resistant lighting units.

[0089] Figure 7 is a cross-sectional view of a lighting unit 201 in accordance with a second embodiment of the invention. The second embodiment is similar to the first embodiment in that the seal 221 includes a retaining ring 294 moulded into the outer lip 291 for ease of assembly and for maintaining the seal 221 in engagement with the first part 203 of the lighting unit. The arrangement of the second embodiment differs from the first embodiment in the positioning of the solid state lighting device 215 and the modifications necessary to the fire resistant member and clamping member 217 to accommodate this.

[0090] In the second embodiment of the invention the fire resistant member, which comprises a fire resistant housing 211, includes a set of holes 251 formed therethrough from the front side "A" to the rear side "B". The holes 251 are formed through the end wall 249. The solid state lighting device 215 is at least partly mounted on the rear side 'B' of the end wall 249 of the housing 211 and is arranged such that light emitted by the LEDs 255 passes through the first set of holes 251. The PCB 257 is mounted on the rear side 'B' of the end wall 249 and each LED 255 is positioned in and/or adjacent a respective hole 251. For example, each LED 255 is located fully outside of its respective hole 251 on the rear side 'B' of the housing, partially within its respective hole 251, or such that it at least partly protrudes out of its respective hole 251 into the front side 'A' of the housing. However at least a part of the solid state lighting device 215, typically a part including the PCB 257, is located on the rear side 'B' of the housing.

[0091] Each hole 251 is preferably sized such that it is just large enough to accommodate the light emitting part of the LED 255, and therefore typically has a diameter in the range 1 to 10mm depending on the size of the LED 255. Since the holes 251 are relatively small, and few in number, the ability of the housing to resist fire is not compromised.

[0092] The clamping member 217 can comprise a plastics housing similar to the first embodiment. Alternatively, the clamping member 217 can comprise a heatsink. The heatsink is at least partly made from a thermally conductive material, such as aluminium, for example can comprise an aluminium extrusion.

[0093] When the clamping member 217 comprises a heatsink, the heatsink is mounted on the rear side 259 of the PCB and is arranged such that there is good thermal contact between an end face 261 of the heatsink and the rear side 259 of the PCB. This may be assisted by using a thermal paste and/or a thermal pad to displace air pockets between them. Thus, during use, heat generated by the solid state lighting device 215 is transferred from the lighting device 215 to the heatsink by thermal conduction. Since the heatsink be mounted on the rear side 259 of the PCB the thermally conductive pathway is very short, with minimal thermal interfaces, and thus heat is removed from the solid state lighting device 215 very efficiently. This helps to ensure good performance for the LEDs 255 and a long service life.

[0094] It will be appreciated by the skilled person that modifications can be made to the above-mentioned embodiment that fall within the scope of the invention, for example the solid state lighting device does not strictly require a printed circuit board, for example the or each LED can be mounted directly onto the fire resistant housing. The lighting device can include any practicable number of LEDs.

[0095] The seal can be arranged to sealingly engage with the casing in addition to, or as an alternative to, the bezel.

[0096] The seal can include a plurality of folds formed in the membrane, for example a plurality of $\cap$-shaped and/or U-shaped cross-sectioned formations, to increase the flexibility of the seal and/or to account for larger lighting units.

[0097] The housing can have a different shape from a cylindrical housing, for example the open box like structure can be substantially cuboid having four side walls. The shape of the seal moulding is adjusted accordingly, for example may have a substantially rectangular form when viewed in plan. For a substantially cuboid housing having four side walls, the first pivot member is mounted on a first side wall, and the second pivot member is mounted on a second side wall, which is opposite to the first side wall. The pivot members are arranged co-axially. The members are preferably integrally formed in their respective side walls.

[0098] Materials other than steel can be used in the construction of the fire resistant housing that have a high melting point, for example brass, ceramic and/or copper.

[0099] Although the housing is preferably made from a single material in the form of a single component, a housing including a plurality of components and/or materials can be used.

[0100] The clamping member can comprise a heatsink, for example an aluminium heatsink, and preferably an extruded aluminium heatsink. The heatsink is in thermal contact with rear side 'B' of the end wall of the housing. In use, heat generated by the solid state lighting device is conducted into the heatsink via the fire resistant housing. The heatsink can be used for example with less efficient and/or higher powered solid state lighting devices. The heatsink is preferably in direct contact with the end wall of the housing. Thermal pastes and/or pads can be used at the thermal interfaces of components to promote thermal conduction. For example, a thermal pad and/or paste can be used between the heatsink and the end wall and between the solid state lighting device and the end wall. The term "direct contact" is used in the context of the specification to also include arrangements wherein there are thermal pads and/or pastes used to promote thermal conduction between adjacent components.

[0101] The fire resistant housing can be replaced by a fire resistant plate, for example having at least one hole formed through it for each LED.

[0102] In some embodiments the plate is not fire resistant. In this arrangement, the plate acts as a support for the solid state lighting device. For example, the plate can be made from non-fire resistant material such as aluminium and/or plastic.

[0103] In some embodiments the housing is not fire resistant. In this arrangement, the housing acts as a support for the solid state lighting device. For example, the housing can be made from non-fire resistant material such as aluminium and/or plastic.

Claims

1. A lighting unit, including:

   a first part having a mounting structure that is arranged for insertion into an aperture in a partition;
   a second part including at least one solid state lighting device and a support for supporting the at least one solid state lighting device, wherein the second part is pivotable with respect to the first part; and
   a seal arranged to seal the first part to the second part, said seal being arranged to deform to accommodate pivoting movement of the second part with respect to the first part, wherein the seal includes a membrane having an outer peripheral portion that sealably engages to the first part, an inner peripheral portion that sealably engages to the second part, a flexible connector portion connecting the outer peripheral portion to the inner peripheral portion, and a retaining member arranged to hold the outer peripheral portion in contact with the first part.

2. A lighting unit according to claim 1, wherein the retaining member is annular and/or the seal is annular.

3. A lighting unit according to any one of the preceding claims, wherein the retaining member is resiliently deformable, and the retaining member biases the outer peripheral portion into contact with the first part of the lighting unit.

4. A lighting unit according to any one of the preceding claims, wherein the retaining member includes metal, and preferably includes steel, such as spring steel.

5. A lighting unit according to any one of the preceding claims, wherein the retaining member is in the form of a wire.

6. A lighting unit according to any one of the preceding claims, wherein the seal is resilient.

7. A lighting unit according to any one of the preceding claims, wherein the connector portion of the membrane includes a hollow substantially ∩-shaped, or U-shaped, cross-section having an annular inner side wall and an annular outer side wall.

8. A lighting unit according to any one of the preceding claims, wherein the inner peripheral portion includes an annular inner lip, and preferably the inner lip extends inwardly from the inner side wall.

9. A lighting unit according to any one of the preceding claims, wherein the outer peripheral portion includes an annular outer lip, and preferably the outer lip is annular and extends outwardly from the outer side wall.

10. A lighting unit according to any one of the preceding claims, wherein the seal has a central axis, and the inner peripheral portion is offset from the outer peripheral portion in the axial direction.

11. A lighting unit according to any one of the preceding claims, wherein the seal is a moulded component, and preferably the retaining member is moulded into the seal.

12. A lighting unit according to any one of the preceding claims, wherein the retaining member is embedded in the seal.

13. A lighting unit according to any one of the preceding claims, wherein the second part includes a clamping member, the support has a front side and a rear side, and the clamping member is located on the rear side of the support, wherein the inner peripheral portion of the seal is clamped between the clamping member and the support.

14. A lighting unit according to claim 13, wherein the clamping member comprises a heatsink and the heatsink is mounted in thermal contact with the solid state lighting device such that at least some of the heat generated by the solid state lighting device is transferred to the heatsink by conduction.

15. A lighting unit according to any one of the preceding claims, wherein the support is pivotally attached to the first part, and preferably the first part includes at least one of a casing and a bezel, and the support is pivotally attached to at least one of the casing and the bezel.

16. A lighting unit according to any one of the preceding claims, wherein the solid state lighting device is mounted on a front side of the support.

17. A lighting unit according to any one of the preceding claims, wherein the support comprises a fire resistant housing including an end wall and at least one side wall, said fire resistant housing including material that melts at a temperature greater than or equal to 900C, and preferably the housing is made from sheet material having a thickness in the range 0.2mm to 3mm.

18. A method for preventing moisture from penetrating an aperture formed in a partition, including inserting a lighting device according to any one of the preceding claims into the aperture.

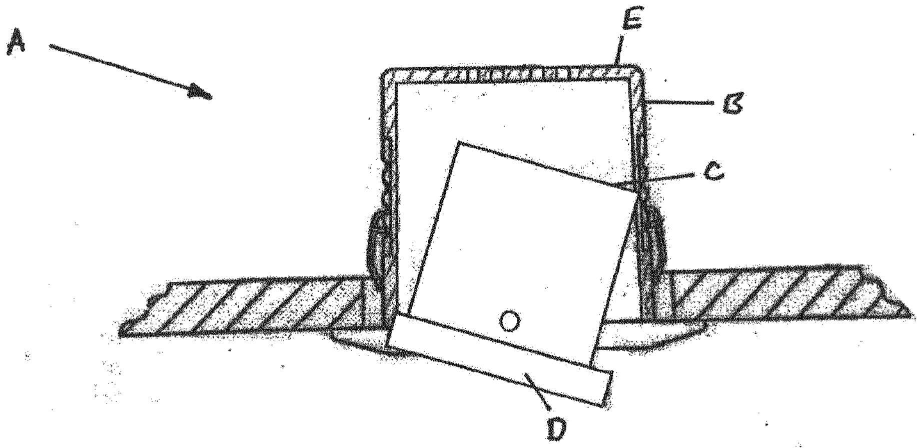
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Fig. 1

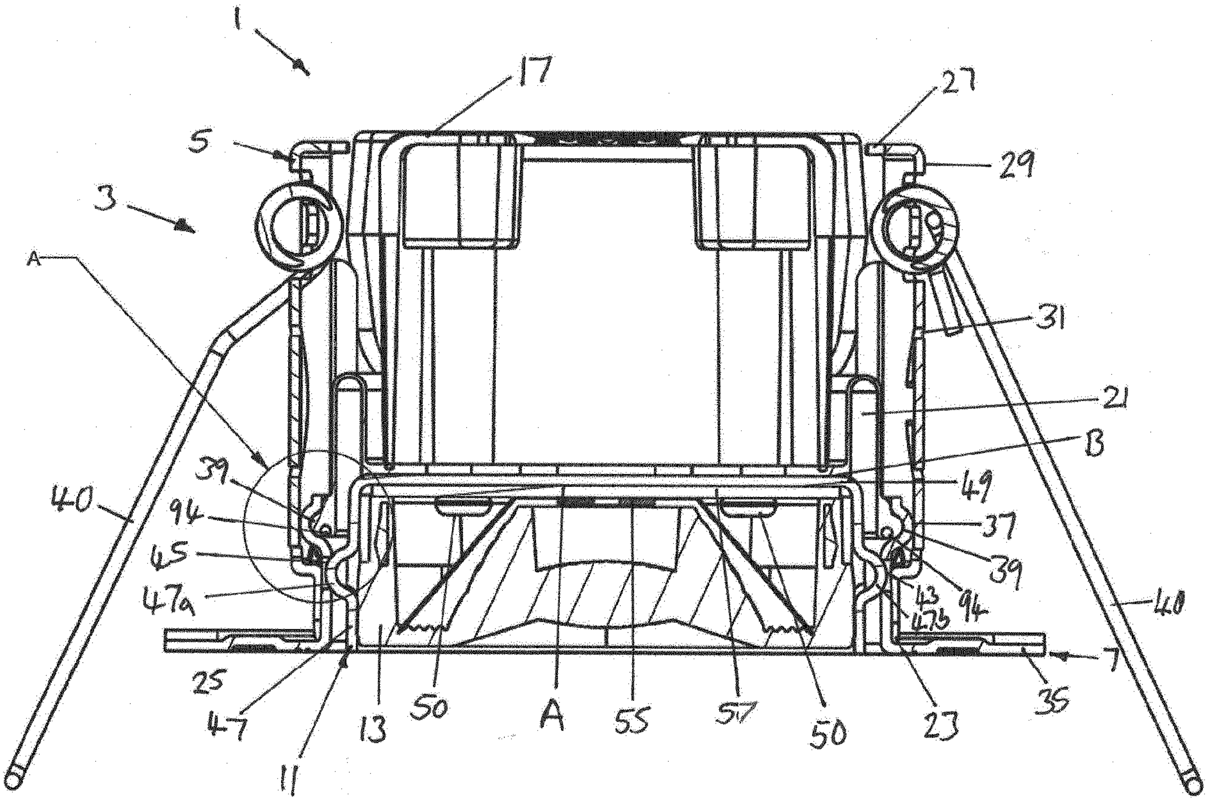
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Fig. 2

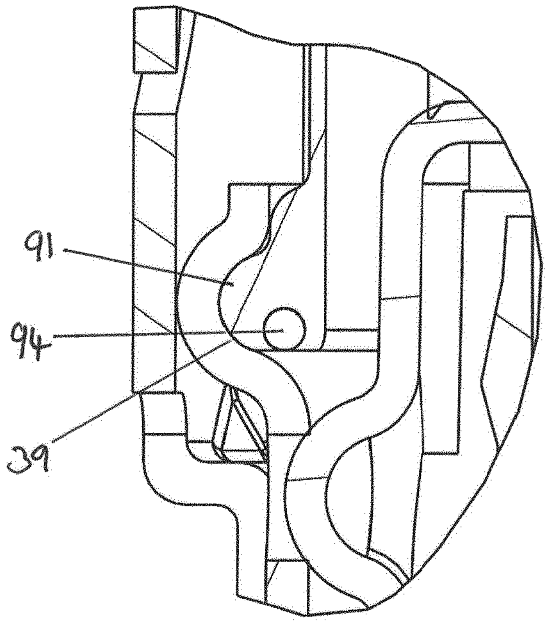

Fig. 3

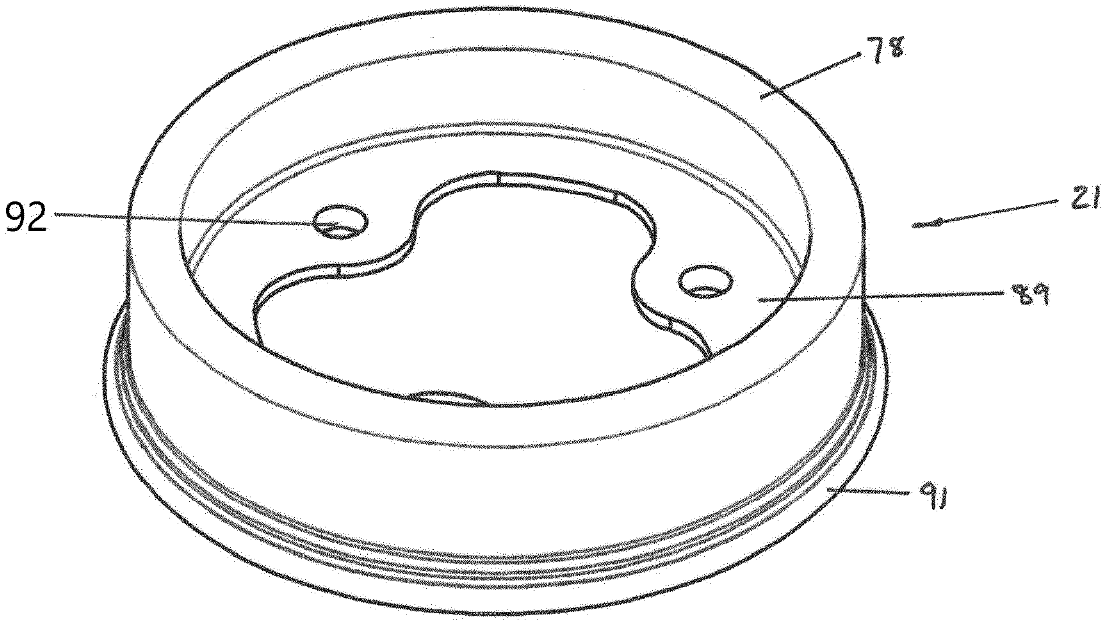

Fig. 4

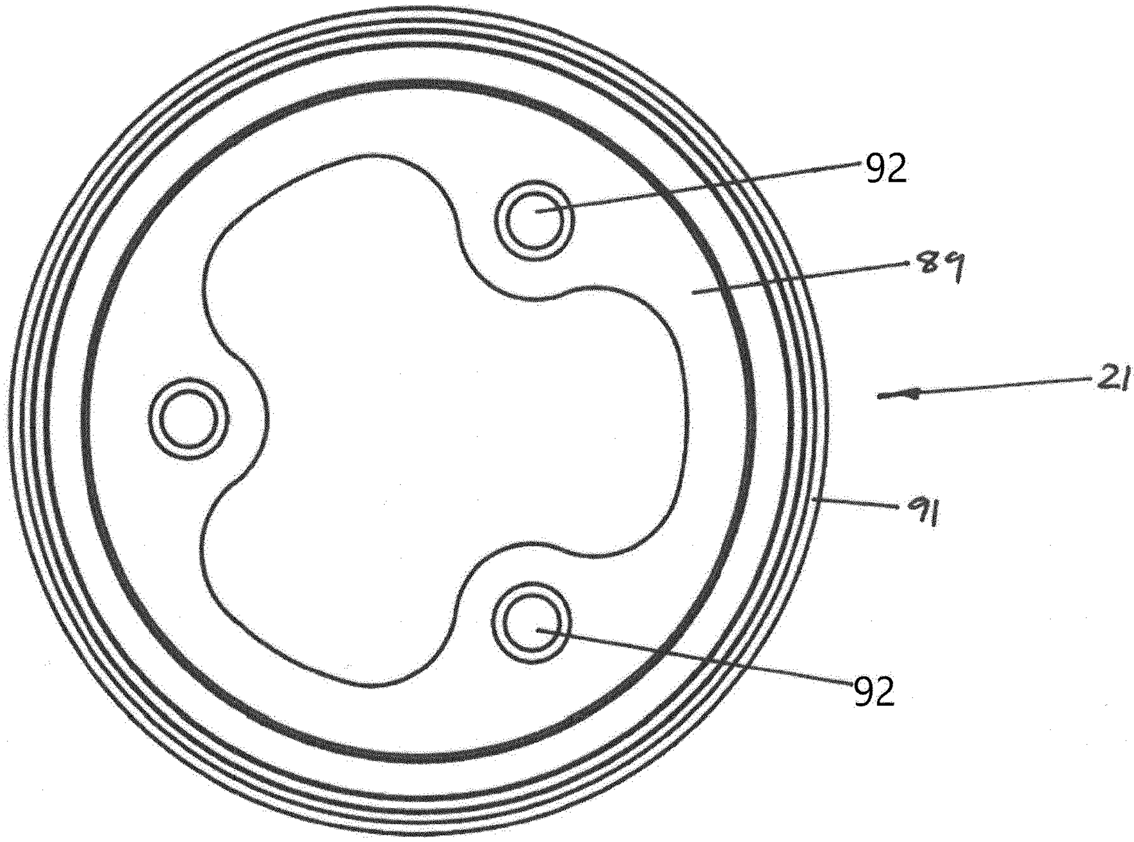

Fig. 5

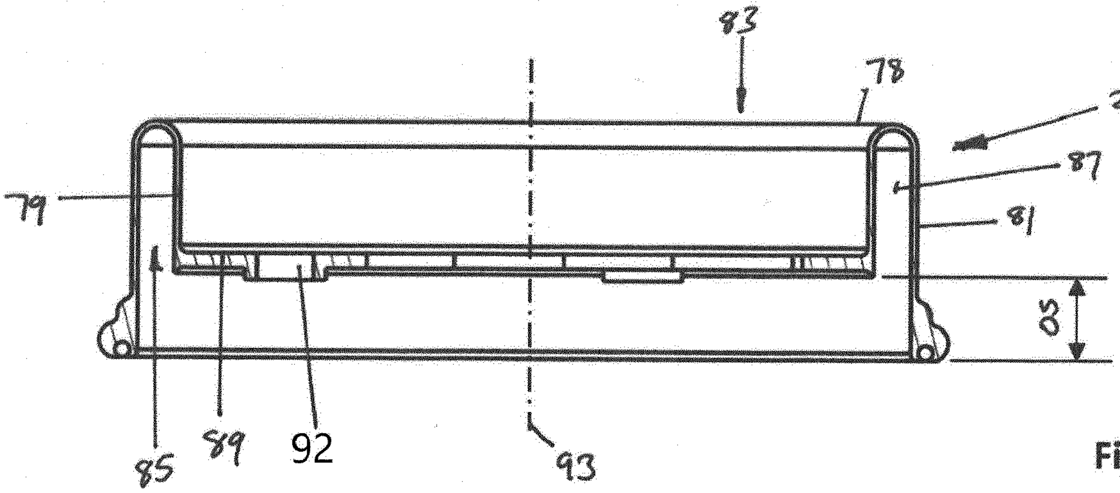

Fig. 6

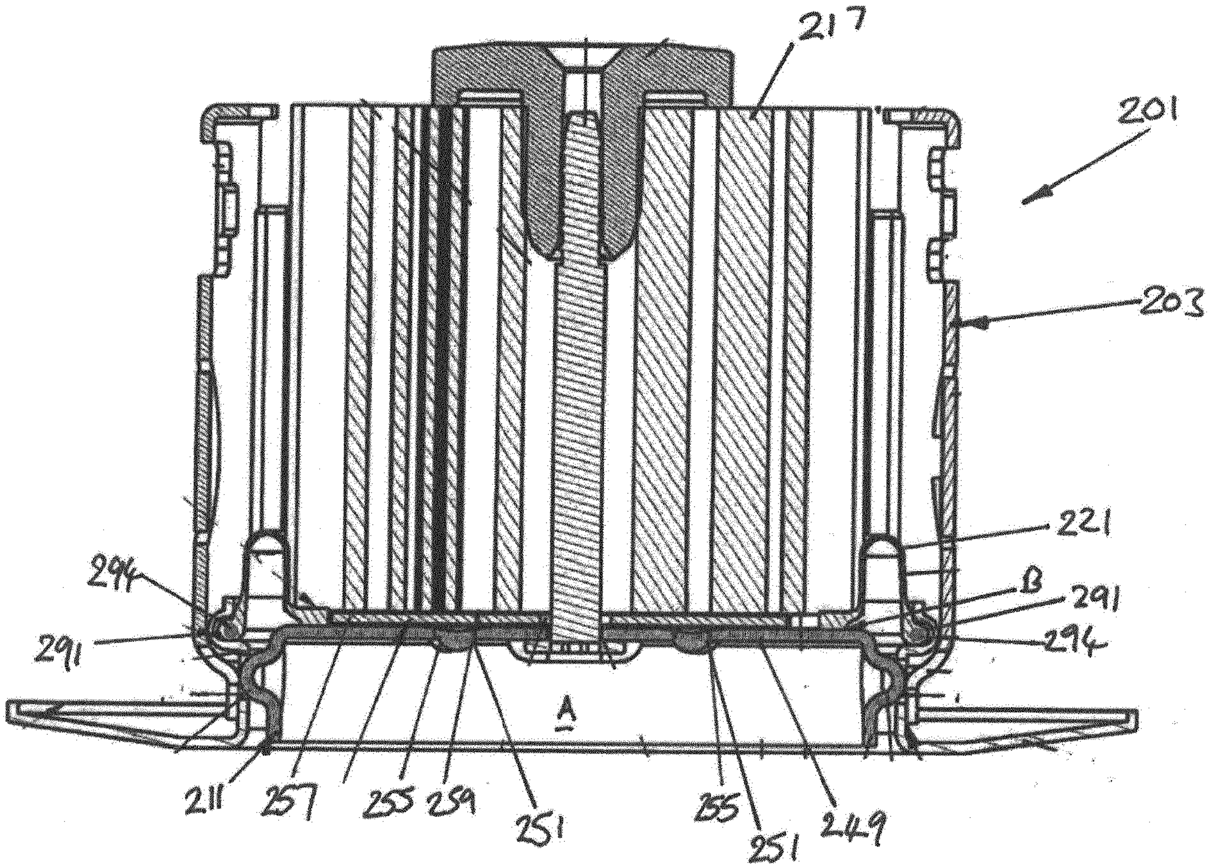
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Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
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