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(54) **Flexible cooling element**

(57) The invention relates to an LED lamp construction comprising a housing (2) for retaining an LED lamp and at least one flexible conductor (3) for dissipating heat generated by the LED lamp to a cooling element, in which the flexible conductor comprises a solid-matter heat conductor. The invention also provides a method for cooling a heat source, in which the method comprises the following steps: a) connecting one or more flexible solid-matter heat conductors (3) to a heat source for dissipating heat, and b) connecting said one or more flexible heat conductors to one or more cooling elements for absorbing said heat. The invention also provides a flexible conductor, and the use thereof, for cooling a heat source, in which the conductor is a solid-matter heat conductor which connects the heat source to a cooling element.

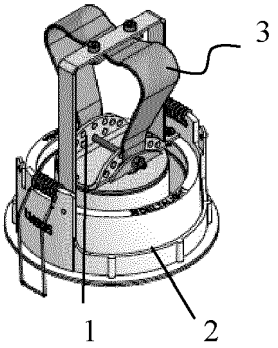

FIG. 4

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Description

[0001] The invention relates to cooling a heat source, for example an LED lamp.

[0002] LED lamps are highly efficient. For an LED lamp, it is essential that the heat is dissipated effectively. If this is not the case, the service life of the LED is shortened significantly. Good cooling is therefore required.

[0003] Until now, LED lamps have usually been cooled using cooling fins. The heat which is generated by the LED lamp is dissipated by cooling fins which are attached to the base of the LED lamp. US 2010/0212859 is an example thereof. A drawback in this case is the fact that this structure takes up a certain volume. This volume also has to be fitted and concealed in a structural element or a ceiling or wall, i.e. there has to be sufficient installation space. In addition, the size of the structure is limiting when directing the LED lamp at a specific angle.

[0004] Other known systems provide heat dissipation via air ducts or "heat pipes". US 7,144,135 describes an LED lamp provided with an air-cooling system in which the hot air can escape via a space around the lighting fixture of the LED lamp. US 7,547,124 describes an LED lamp provided with a pulsating heat pipe in combination with cooling fins. However, it is a drawback that such a cooling system takes up considerable space in the overall LED structure. Moreover, the heat dissipation is limited.

[0005] DE 102009020112 describes an LED headlight, for example for a surgeon, in which the LED is cooled by means of a coolant which is pumped through two flexible coolant lines between the headlight and a cooling element, comprising cooling fins or a fan which is situated at a distance. A drawback in this case is the use of a coolant and the requirement for an external cooling element to cool the coolant.

[0006] FR 2 889 291 describes an LED lamp construction which is suitable for a vehicle comprising a housing for retaining an LED lamp and a flexible conductor for dissipating the heat generated by the LED lamp to a cooling element.

[0007] It is an object of the invention to provide a highly efficient cooling system and heat dissipation for LED lamps, or other constructions comprising heat sources, in which the cooling elements take up a minimum amount of space and allow for a maximum degree of flexibility for directing the LED lamp. In this manner, the LED lamp requires a minimal amount of installation space. Another advantage is the fact that with insulated installation spaces (e.g. a space in an insulated ceiling), the heat of the LED module is transferred to the open side of the lighting fixture. With modules which are cooled in the conventional way, it is difficult to dissipate the heat in the insulated ceiling and, in addition, there is also a hazard that the insulation might catch fire.

[0008] In addition, the weight of the LED lamp overall is lower and less raw material is required.

[0009] This object of the invention is achieved by Claim 1. This object of the invention is furthermore achieved by the dependent claims.

[0010] The invention relates to an LED lamp construction comprising a housing for retaining an LED lamp and at least one flexible conductor for dissipating heat generated by the LED lamp to a cooling element, characterized in that the flexible conductor comprises a solid-matter heat conductor.

[0011] The object of the invention is achieved by providing dissipation of heat from the heat source, such as for example an LED lamp, by means of flexible heat conductors. The flexible heat conductor is brought into direct contact with, and preferably attached to, the heat source. In a particular embodiment, the flexible heat conductor is furthermore connected to the housing of the LED module, such as for example the lighting fixture. The lighting fixture is preferably in communication with the ambient air in a space. As a result thereof, heat is transferred from the LED lamp to the open ambient space.

[0012] In another embodiment, the heat transfer takes place via flexible heat conductors to a feature other than the housing, for example to an external cooling body, or to a structural element which forms part of the suspension means, installation or superstructure or is located in the vicinity of the LED lamp, such as for example a preferably metal profile for roof and ceiling structures, or verandas and/or sunshades. Said external cooling body may be arranged in a location which does not impede the installation of the LED lamp, and which ensures optimum cooling. Examples of external cooling bodies are cooling fins, air ducts, and fans. The term "external" is understood to mean that the cooling body is separate from the LED lamp construction.

[0013] Possible applications of the invention are all lighting fixtures in which the heat has to be dissipated as efficiently as possible, either to the housing or to an external cooling body, and with both installed and surface-mounted apparatus.

[0014] The flexible cooling element of the invention comprises good heat-conducting materials. The thermal conductivity or thermal conduction coefficient is preferably at least equal to that of steel or 50 W/m-K (at 293 K), preferably higher than 100, more preferably higher than 200. Examples of suitable materials for the flexible cooling element of the invention are (thermal conduction coefficient given in brackets): metals, such as preferably aluminium (237) and copper (390), but also gold (310) and silver (417), or bronze (190) and zinc (116), or optionally other materials, such as diamond (165) and graphite (160). The heat-conducting materials used with the invention can typically be classified as solid materials, in contrast with the liquid or gaseous materials. No coolant liquid or coolant gas is therefore used. Consequently, according to a preferred embodiment of the LED lamp construction according to the invention, the flexible conductor is made of metal, preferably aluminium or copper. In particular, the flexible conductor has a thermal conductivity of at least 50 W/m-k, preferably of at least 100 W/m-k and most preferably of at least 200 W/m-k.

[0015] Heat transfer preferably takes place by conduction between two solid media.

[0016] According to a particular embodiment of the LED lamp construction according to the invention, the flexible conductor comprises one or more wires or strips. The term "flexible" is understood to mean movable in all or many possible degrees of freedom, deformable, taking up a minimal amount of volume, adjustable or retractable. Examples of flexible embodiments are wires (round or flat), strips, chains, pliable materials, such as for example aluminium, mechanical joints, etc. A specific example is a litz wire, for example an 8 mm^2 silicone litz wire with a superstructure comprising 2056 conductors r = 0.035mm. In a preferred embodiment of the LED lamp construction, the flexible conductor comprises one or more mechanical joints. Mechanical joints may allow both rotation and translation, or a combination of both. In a particular embodiment, said mechanical joints comprise balls or pivots which allow rotation and/or translation.

[0017] The flexible cooling elements may assume different degrees of flexibility, so that they can assume any possible shape, e.g. bent, folded, turned, and rolled up. The shape is preferably adapted to the space which is available for the cooling system.

[0018] The invention thus provides a flexible conductor for cooling a heat source, characterized in that the conductor is a solid-matter heat conductor which connects the heat source to a cooling element. In this case, a characteristic feature is the fact that the cooling element is not attached to the heat source in a conventional manner and thus forms an integral part thereof, but that the cooling element typically is either an element which is present on the structure (housing, profile) and is not a cooling element as such, or is an external cooling body, in which case the term "external" means that the cooling body is situated at a distance from the heat source, with the distance being bridged by the flexible heat conductor.

[0019] In a particular embodiment, the flexible cooling element consists of thermally optimized or heat-conducting flexible mechanical joints, such as for example balls or pivots.

[0020] In a more particular embodiment, a heat source comprises one or more flexible cooling elements according to the invention.

[0021] In another embodiment, known cooling systems, such as cooling fins or cooling ducts, such as for example air ducts, are combined or supplemented by the flexible cooling elements of the invention. Thus, for example in a particular embodiment, it is also possible to fit the flexible cooling elements on the cooling fins in order thus to ensure improved heat transfer from the cooling fins. The walls or ends of air ducts may also be provided with flexible cooling elements of the invention in order to ensure further cooling or, for example, to minimize the fixed length of the air duct.

[0022] In yet another embodiment, one or more, optionally identical or different flexible cooling elements are fitted. The cooling elements may have different degrees of flexibility and/or be made of different heat-conducting materials, depending on the required degree of cooling and the available installation space and/or heat dissipation. If desired, different flexible cooling elements may assume different shapes. The flexible cooling elements may be fitted at different locations on the heat source, depending on the space or way of attachment and/or amount of heat.

[0023] In yet another embodiment, one or more flexible cooling elements of different heat sources are coupled to one another and conducted further via flexible cooling elements of any possible other cooling system. This is an application of, for example, a light source consisting of several LED lamps, in which the individual LED lamps are each cooled via a flexible cooling element, with the individual flexible cooling elements meet and further heat dissipation takes place via a central cooling system or flexible cooling element.

[0024] In a particular embodiment, the flexible heat conductor is guided or supported by the usual structural elements.

[0025] The flexible cooling elements of the invention are used in both low-power and high-power LED lamps.

[0026] The invention also provides a method for cooling a heat source, the method comprising the following steps: a) connecting one or more flexible solid-matter heat conductors to a heat source for dissipating heat, and b) connecting said one or more flexible heat conductors to one or more cooling elements for absorbing said heat. Preferably, said heat source comprises one or more LED lamps.

[0027] With a preferred method according to the invention, the cooling element comprises the housing of the heat source. In a particular embodiment of the method according to the invention, the cooling element comprises an external cooling body or another structural element.

[0028] The invention also provides a flexible conductor for cooling a heat source, characterized in that the conductor is a solid-matter heat conductor which connects the heat source to a cooling element. The flexible conductor according to the invention is in particular suitable for cooling the following heat sources: LED lamps, power transistors, MOSFET's, IGTB's, Switched-mode power supplies (SMPS) and Peltier elements.

[0029] The invention furthermore provides the use of a flexible conductor as described above for cooling a heat source.

[0030] The invention will now be explained in more detail by means of the following detailed description and drawings, in which:

- Figs. 1 to 5 show a number of views of an embodiment of an LED lamp construction according to the invention comprising a flexible cooling element connected to the lighting fixture;
- Fig. 6 shows a number of views of an LED lamp construction comprising a flexible cooling element connected to an external cooling element;

- Fig. 7 shows a compact installation of an LED lamp construction according to the invention;
- Fig. 8 shows a cross section of the illustration shown in Fig. 7.

[0031] A preferred embodiment of an LED lamp construction according to the invention, as illustrated in Figs. 1 to 5, comprises an LED lamp base (1) and lighting fixture (2). In the illustrated views, a flexible cooling element (3), in the form of a litz wire, connects the base (1) of the LED lamp and the lighting fixture (2). This results in a heat transfer from the LED lamp to the lighting fixture which is in communication with the ambient air and temperature. The flexible cooling element is optionally supported in this case.

[0032] Fig. 6 shows another embodiment according to the invention, in which a flexible cooling element (3) ensures heat dissipation from the base (1) of an LED lamp construction to an external cooling element (4), which is provided here with cooling fins. The flexible cooling element (3) is configured as a heat-conducting mechanical joint.

[0033] Figs. 7 and 8 illustrate an advantageous embodiment which shows that the flexibility of the heat-conducting cooling element (3) makes compact installation with a small ceiling height (5) possible. The flexible cooling element connects the base (1) to the lighting fixture (2), and is also connected to an external cooling body (4) for still more efficient heat transfer.

Claims

1. LED lamp construction comprising a housing (2) for retaining an LED lamp and at least one flexible conductor (3) for dissipating heat generated by the LED lamp to a cooling element, **characterized in that** the flexible conductor comprises a solid-matter heat conductor.

2. LED lamp construction according to Claim 1, **characterized in that** the flexible conductor (3) connects the base (1) of the LED lamp to the housing (2), a structural element and/or an external cooling body (4).

3. LED lamp construction according to Claim 2, **characterized in that** the external cooling body (4) consists of a cooling fin, air duct or fan.

4. LED lamp construction according to one of the preceding claims, **characterized in that** the flexible conductor (3) comprises a litz wire.

5. LED lamp construction according to one of the preceding claims, **characterized in that** the flexible conductor (3) has a thermal conductivity of at least 50 W/m -K, preferably of at least 100 W/m-K, most preferably of at least 200 W/m-K.

6. LED lamp construction according to one of the preceding claims, **characterized in that** the LED lamp construction is designed to be installed or surface-mounted.

7. LED lamp construction according to one of the preceding claims, **characterized in that** the flexible conductor (3) comprises one or more flexible heat conductors.

8. LED lamp construction according to Claim 7, **characterized in that** the one or more flexible heat conductors (3) are identical or different in terms of flexibility, material or shape.

9. LED lamp construction according to one of the preceding claims, **characterized in that** the construction comprises one or more LED lamps, each with its own housing (2) and/or a common housing.

10. Flexible conductor (3) for cooling a heat source, **characterized in that** the conductor is a solid-matter heat conductor which connects the heat source to a cooling element.

11. Flexible conductor (3) according to Claim 10, **characterized in that** the cooling element is either an external cooling body (4) or a structural element which forms part of the surroundings or is located in the vicinity of the heat source.

12. Flexible conductor (3) according to Claim 10 or 11, **characterized in that** the heat source comprises an LED lamp.

13. Method for cooling a heat source, the method comprising the following steps:

    a. connecting one or more flexible solid-matter heat conductors (3) to a heat source for dissipating heat, and
    b. connecting said one or more flexible heat conductors (3) to one or more cooling elements for absorbing said heat.

14. Method according to Claim 13, wherein the heat source comprises one or more LED lamps.

15. Use of a flexible conductor (3) from Claim 10 or 11 for cooling a heat source, such as for example one or more LED lamps.

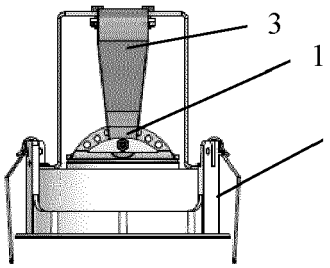

FIG. 1

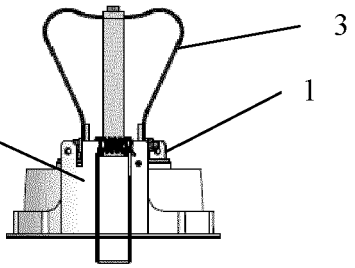

FIG. 2

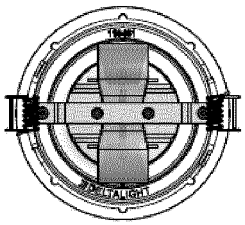

FIG. 3

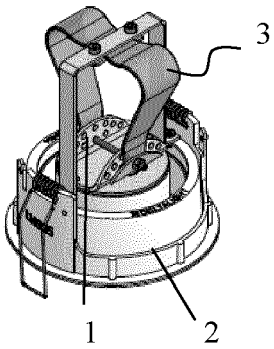

FIG. 4

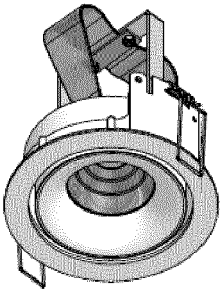

FIG. 5

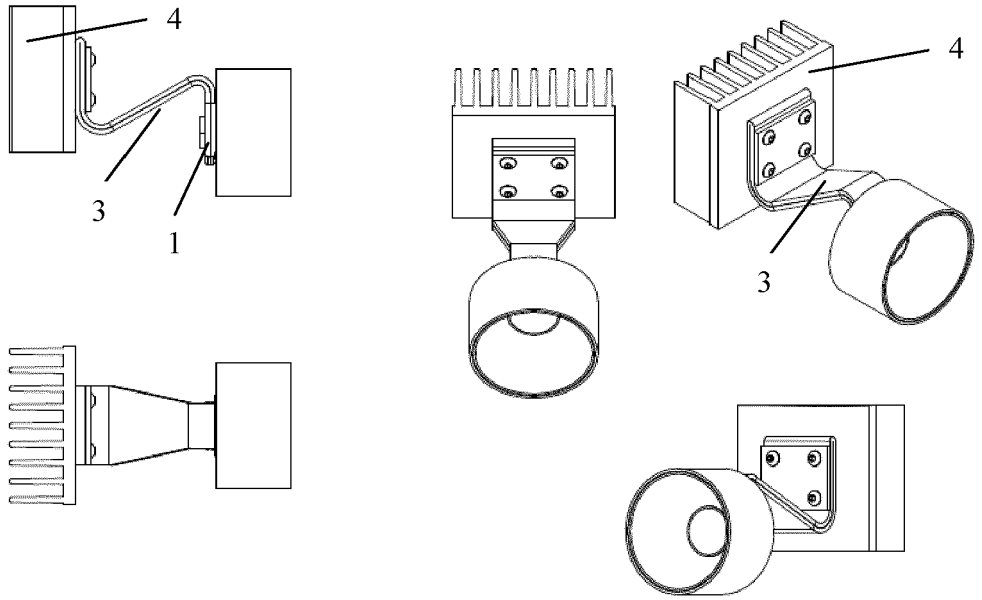

FIG. 6

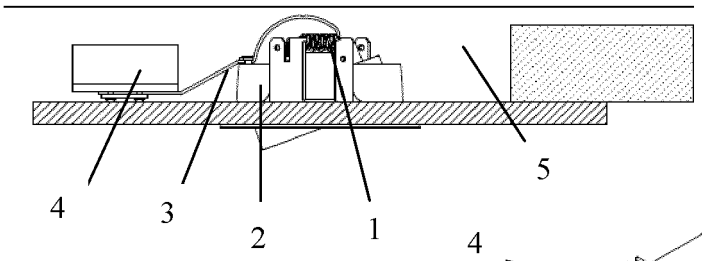

FIG. 8

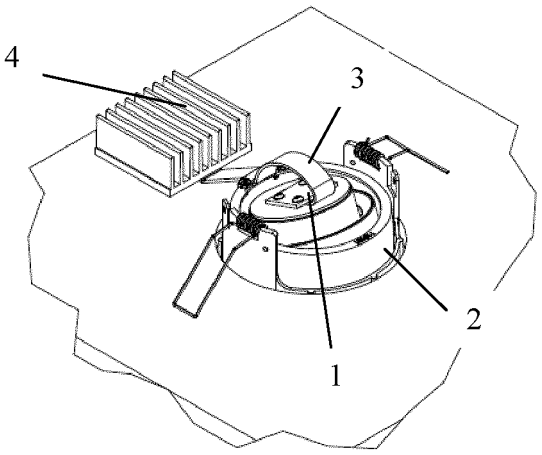

FIG. 7

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 20100212859 A **[0003]**
- US 7144135 B **[0004]**
- US 7547124 B **[0004]**
- DE 102009020112 **[0005]**
- FR 2889291 **[0006]**