**Illumination Apparatus**

TECHNICAL FIELD

[0001] This invention relates to an illumination apparatus, and more particularly to an illumination apparatus comprising light emitting diodes.

[0002] The invention has been devised particularly, although not necessarily solely, as an apparatus operable for illumination of an adjacent or surrounding environment in the manner of floodlighting, although it can of course also be used on any other appropriate illumination purpose.

BACKGROUND ART

[0003] The following discussion of the background art is intended to facilitate an understanding of the present invention only. The discussion is not an acknowledgement or admission that any of the material referred to is or was part of the common general knowledge as at the priority date of the application.

[0004] The discussion is provided in the context of an apparatus for illumination of an adjacent or surrounding environment in the manner of floodlighting, such as for example, illumination of part of a sporting or recreation facility such as a tennis court. The invention may, however, have application to other lighting solutions, including for example street lights, as would be understood by a person skilled in the art.

[0005] Light emitting diodes (LEDs) are being increasingly used for illumination purposes, owing to their smaller size, lower energy consumption, efficiency, and longer service life than other conventional lighting devices.

[0006] In order to provide sufficient illumination, particularly in an application requiring illumination of an adjacent or surrounding environment, such as part of a sporting or recreation facility, it is necessary to provide a plurality of LEDs in one or more arrays. Each array typically comprises an LED module having a plurality of LEDs which, when operating, can generate a significant amount of heat which must be dissipated to maintain the efficiency and service life of the LED module. Accordingly, there is a need to dissipate the heat generated by the LEDs, and a heat sink is typically provided for this purpose.

[0007] In certain applications, such as in floodlighting, there is a need for directional control of light emitted by the LEDs.

[0008] Previous attempts to provide lighting apparatus using LEDs for floodlighting purposes have not proved to be altogether satisfactory, as the resultant lighting often did not provide a relatively even illumination of the target area and had a tendency to produce excessive glare which could dazzle persons in the vicinity.

[0009] Accordingly, there is a need for some directional control light emitted by the LEDs.

[0010] The production of an illumination apparatus having a plurality of LEDs to provide sufficient illumination, a heat sink for dissipation heat generated by the LED, and also directional control of light emitted by the LEDs can present challenges.

[0011] It is against this background, and the problems and difficulties associated therewith, that the present invention has been developed.

## SUMMARY OF INVENTION

[0012] According to a first aspect of the invention there is provided an illumination apparatus comprising a plurality of light emitting diodes (LEDs), a heat sink, and a reflector, the reflector defining a plurality of cavities in which the LEDs are accommodated, the heat sink comprising an elongate body providing a base portion and a heat dissipation portion of integral construction, the plurality of LEDs being mounted on the base portion whereby heat generated by the plurality of LEDs is absorbed by the base portion and transferred to the heat dissipation portion, wherein the heat dissipation portion comprises a cooling fin assembly for dissipating heat to surrounding air, the cooling fin assembly comprising at least one longitudinal fin disposed to one side of the base portion and a plurality of lateral fins extending from the longitudinal fin, the lateral fins being disposed on opposed longitudinal sides of the longitudinal fin, and wherein the reflector is mounted on the base portion and comprises a plurality of reflector portions defining said plurality of cavities in which the plurality of LEDs are accommodated, each reflector portion being configured to receive a respective one of the LEDs, each reflector portion comprising an aperture through which the respective LED extends into the cavity, each reflector portion defining an opening and the respective cavity extending to the opening, whereby light emitted by the respective LED passes through the opening for illumination purposes, each reflector portion comprising a wall structure defining side walls and an inner wall in opposed relation to the opening, the

aperture in the reflector portion through which the respective LED extend into the cavity being provided in the inner wall, the side walls and the inner wall providing reflective surfaces for intercepting light emitted from the respective LED and directing the light towards the opening, the side walls comprising first and second side walls disposed in opposed relation, the first and second walls being oblique to the opening and slanted at different angles with respect to the opening.

[0013] The plurality of LEDs may be provided by one or more LED modules. Each LED module may comprise the LEDs mounted on a printed circuit board (PCB).

[0014] Where there is more than one LED module, the LED modules may have a common heat sink. By way of example, the heat sink may be of elongate configuration and the various LED modules may be disposed along the elongate heat sink.

[0015] There may be two longitudinal fins disposed in spaced apart relation to define a gap therebetween. Cabling for supplying electrical power to the LEDs may be accommodated in the gap.

[0016] The longitudinal fin(s) may be integral with the base portion. The lateral fins may be integral with the respective longitudinal fin.

[0017] The heat sink may comprise an extrusion. The heat sink may be formed of any appropriable material, as would be understood by a person skilled in the art; for example, aluminium. The heat sink may comprise an aluminium extrusion.

[0018] The base portion may present a face on which the LEDs are mounted. Where the LEDs are provided by one or more LED modules, each LED module may be mounted on the face of the base portion. In particular, the PCB of the LED module may be affixed to the face of the base portion and the respective LEDs electrically connected to the PCB.

[0019] The reflector may be affixed to the base portion of the heat sink in any appropriate way; for example, by way of one of more mechanical fixings extending between the reflector and the heat sink, or by way of a bonding process.

[0020] The opening may be of rectangular configuration.

[0021] Where the opening is of rectangular configuration, there may be four side walls extending between the opening and the inner wall.

[0022] In one embodiment, all of the side walls and also the inner wall provide reflective surfaces; that is, each one of the side walls provides a reflective surface, and the inner wall also provides a reflective surface.

[0023] The arrangement in which the first and second walls are oblique to the opening and slanted at different angles with respect to the opening affords some directional control of light being emitted through the opening. In one embodiment, the reflective surface provided by each one of the side walls is oblique to the opening. This may be achieved by forming all of the side walls of a slanted configuration. The third and fourth side walls may be slanted at the same or at different angles. In one embodiment, third and fourth opposed side walls may be slanted at the same angle with respect to the opening.

[0024] The reflector may be of integral construction, whereby the reflector portions are connected one to another; that is, the reflector may comprise a single unit.

[0025] The single unit defining the reflector may comprise a plurality of the reflector portions arranged in one or more rows. Where there is a plurality of rows of reflector portions, the rows may be in side-by-side relation.

[0026] The reflector may be made from any suitable material; for example, the reflector may comprise aluminium plate.

[0027] The apparatus may further comprise a transparent cover for covering the plurality of LEDs. There may be one transparent cover associated with each LED module.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] Further features of the present invention are more fully described in the following description of several non-limiting embodiments thereof. This description is included solely for the purposes of exemplifying the present invention. It should not be understood as a restriction on the broad summary, disclosure or description of the invention as set out above. The description will be made with reference to the accompanying drawings in which:

Figure 1 is a perspective view of a fixture comprising a lighting assembly and a post for mounting the lighting assembly in an elevated (overhead) location for floodlighting a target area;

Figure 2 is a schematic exploded view of a first embodiment of an illumination apparatus, which embodiment forms part of the lighting assembly shown in Figure 1;

Figure 3 is a perspective view of the illumination apparatus of Figure 2;

Figure 4 is a view somewhat similar to Figure 3;

Figure 5 is an end view of the illumination apparatus;

Figure 6 is a view somewhat similar to Figure 4; showing an LED module of a partly assembled illumination apparatus and also a portion of an adjacent fully assembled illumination apparatus;

Figure 7 is a plan view of an LED module forming part of the illumination apparatus;

Figure 8 is a schematic end view of a heat sink forming part of the illumination apparatus;

Figure 9 is a perspective view of a reflector forming part of the illumination apparatus;

Figure 10 is a further perspective view of the reflector;

Figure 11 is a still further perspective view of the reflector, from one side and end thereof;

Figure 12 is a view similar to Figure 11, except that it is from the opposed side and end thereof;

Figure 13 is a schematic plan view of the reflector;

Figure 14 is a cross-section of the reflector as shown in Figure 13;

Figure 15 is an end view of the reflector as shown in Figure 13, and also schematically depicting the heat sink;

Figure 16 is a schematic view of certain parts of the illumination apparatus;

Figure 17 is a perspective view of a reflector forming part of a second embodiment of an illumination apparatus, from one side and end thereof;

Figure 18 is a view similar to Figure 17, except that it is from the opposed side and end thereof;

Figure 19 is a schematic plan view of the reflector of Figure 17;

Figure 20 is a cross-section of the reflector as shown in Figure 19; and

Figure 21 is an end view of the reflector as shown in Figure 19, and also schematically depicting the heat sink.

[0029] In the drawings like structures are referred to by like numerals throughout the several views. The drawings shown are not necessarily to scale, with emphasis instead generally being placed upon illustrating the principles of the present invention.

[0030] The figures depict several embodiments of the invention. The embodiments illustrate certain configurations; however, it is to be appreciated that the invention can take the form of many configurations, as would be obvious to a person skilled in the art, whilst still embodying the present invention. These configurations are to be considered within the scope of this invention.

DESCRIPTION OF EMBODIMENTS

[0031] Refining to Figures 1 to 16 of the drawings, there is shown a first embodiment of an illumination apparatus 10 according to the invention. In the arrangement shown, the illumination apparatus 10 forms part of a fixture 11 comprising a lighting assembly 13 and a post 15 for mounting the lighting assembly 13 in an elevated (overhead) location for floodlighting a target area. The target area is identified generally by reference numeral 14. Other forms of mounting the lighting assembly 13 are also contemplated, including mounting the lighting assembly on some other structure, such as for example on part of a building. Further, the lighting assembly 13 need not be limited to exterior lighting, as it may also be used for interior lighting within buildings. By way of example, the illumination apparatus 10 may be used for lighting of indoor sporting or recreational arenas.

[0032] The lighting assembly 13 comprises a housing 17 which accommodates a plurality of the illumination apparatus 10. In the arrangement shown, the lighting assembly 13 comprises an array 19 of lighting modules 20. In particular, the lighting modules 20 are arranged in several rows disposed one alongside another to provide a sufficient number within the lighting assembly 13 to emit light of the intensity required for floodlighting purposes.

[0033] Each lighting modules 20 comprises a respective illumination apparatus 10.

[0034] Each illumination apparatus 10 within the array 19 comprises a plurality of light emitting diodes (LEDs) 21, a heat sink 23, and a reflector 25, the reflector defining a plurality of cavities 27 in which the LEDs 21 are accommodated.

[0035] The LEDs 21 may be of any appropriate type suitable for the intended purpose. In this embodiment, the LEDs 21 comprise LEDs marketed under the trade mark *CREE XLamp XT-E LE.*

[0036] The various illumination apparatus 10 defining the lighting modules 20 within each row of the array 19 share a common heat sink 23, as will be explained in more detail later.

[0037] The LEDs 21 are provided by a plurality of LED modules 29. Each LED module 29 comprises the LEDs 21 mounted on a printed circuit board (PCB) 31.

[0038] In the arrangement shown, each LED module 29 corresponds to one of the lighting modules 20 within the array 19.

[0039] As mentioned above, the lighting modules 20 within each row of the array 19 share a common heat sink 23. With this arrangement, the lighting modules 20 within each row of the array 19 utilise the same heat sink 23, but are positioned at different locations on the heat sink, as will become apparent later. In particular, the common heat sink 23 is of elongate configuration and the various LED modules 29 are disposed along the elongate heat sink.

[0040] The common heat sink 23 comprises a base portion 31 and a heat dissipation portion 33. The LEDs 21 are mounted on the base portion 31, whereby heat generated by the LEDs can be absorbed by the base portion and transferred to the heat dissipation portion 33.

[0041] The heat dissipation portion 33 comprises a cooling fin assembly 35, whereby heat can be dissipated to air surrounding the fin assembly. The fin assembly 35 comprises a plurality of fins 37 disposed to one side of the base portion 31. More particularly, the fine assembly 35 comprises two longitudinal fins 41 disposed to one side of the base portion 31 and a plurality of lateral fins 43 extending from the longitudinal fins 41. The lateral fins 43 are disposed on opposed longitudinal sides of the two longitudinal fins 41. The two longitudinal fins 41 and associated lateral fins 43 are disposed in spaced-apart relation to define a gap 45 therebetween. The gap 45 facilitates air flow and can also accommodate cabling 47 for supplying electrical power to the PCB 31 to which the LEDs 21 are electrically connected in known manner.

[0042] In this embodiment, the base portion 31 and the heat dissipation portion 33 are of integral construction, although they need not necessarily be so. In the arrangement shown, the heat sink 23 comprises an extrusion. The heat sink 23 may comprise an aluminium extrusion.

[0043] The base portion 31 of the common heat sink 23 presents a face 51 on which the LEDs 21 are mounted. More particular, the various LED modules 29 sharing the common heat sink 23 are mounted on the face 51. Specifically, the PCB 31 of each LED module 29 is affixed to the face 51 and the respective LEDs 21 electrically connected to the PCB.

[0044] The reflector 25 is mounted on the base portion 31 of the heat sink 23. The reflector 25 may be affixed to the heat sink 23 in any appropriate way; for example, by way of one of more mechanical fixings extending between the reflector and the heat sink.

[0045] The reflector 25 comprise a plurality of reflector portions 61 defining the cavities 27 in which the LEDs 21 are accommodated. In this embodiment, each reflector portion 61 is configured to receive a respective one of the LEDs 21. In this way, the number of cavities 27 within each reflector 25 corresponds to the number of LEDs 21 within the associated the LED module 29.

[0046] Each reflector portion 61 comprises an aperture 63 through which the respective LED 21 can extend into the cavity 27 when reflector 25 is mounted on the base portion 31 of the heat sink 23.

[0047] Each reflector portion 61 defines an opening 65 to which the respective cavity 27 extends, whereby light emitted by the respective LED 21 can pass through the opening for illumination purposes.

[0048] In the arrangement shown, each opening 65 is of rectangular configuration.

[0049] Each reflector portion 61 comprises a wall structure 67 defining side walls 70, and also an inner wall 75 which is in opposed relation to the opening 65. With this arrangement, there are four side walls 70 extending between the opening 65 and the inner wall 75.

[0050] The four side walls 70 provide reflective surfaces 81 for intercepting light emitted from the respective LED 21 and directing it towards the opening 65. Similarly, the inner wall 75 also provides a reflective surface 83 for intercepting light emitted from the respective LED 21 and directing it towards the opening 65.

[0051] The reflective surfaces 81 provided by the side walls 70 are oblique to the opening 65, facilitating some directional control of light being emitted through the opening. This is achieved by forming the side walls 70 of a slanted configuration. The side walls 70 may be slanted at the same or at different angles. In the arrangement shown, the four side walls comprises first and second side walls 71, 72 disposed in opposed relation, and also third and fourth side walls 73, 74 disposed in opposed relation. The first and second opposed

side wall 71, 72 are slanted at different angles with respect to each other, as can be best seen in Figure 14. The third and fourth opposed side walls 73, 74 are slanted at the same angle with respect to each other, as can be best seen in Figures 13 and 15.

[0052] Directional control of light emitted from each reflector portion 61 may be refined by appropriate selection of the angles of the side walls 70.

[0053] Formations may be provided on the third and fourth opposed side walls 73, 74. The formations may further assist with directional control of light emitted from each reflector portion 61.

[0054] The aperture 63 in each reflector portion 61 through which the respective LED 21 can extend into the cavity 65 is provided in the inner wall 75.

[0055] The reflector 25 is of integral construction, whereby the reflector portions 61 are connected one to another to provide a single unit 90.

[0056] In the arrangement shown, the single unit 90 comprises a plurality of the reflector portions 61 arranged in two rows 91, 92 disposed in side-by-side relation. With this arrangement, the unit 90 comprises two opposed sides 95, 97, with the openings 65 being on side 95 and the apertures 63 being on the opposed side 97.

[0057] The reflector 25 may be made from any suitable material; for example, the reflector may comprise aluminium plate configures to provide the unit 90.

[0058] Each illumination apparatus 10 further comprise a transparent cover 101 for covering the respective LED module 29. The transparent cover 101 incorporates a peripheral flange 103 which is adapted to be affixed to the face 51 of the base portion 31 of the common heat sink 23, with an intervening seal 105 in position between the flange 103 and the face 51 of the heat sink.

[0059] In operation, the lighting assembly 13 is mounted in position, with the openings 65 of the cavities 27 in which the LEDs 21 are accommodated facing the direction in which light emitted from the LED modules 29 is to be directed. In circumstances where the lighting assembly 13 is to provide floodlighting to an adjacent area, the lighting assembly 13 is typically mounted in an elevated (overhead) location, with the openings 65 facing downwardly and in the direction towards the target area 14.

[0060] Because of the number of lighting modules 20 within the lighting assembly 13, the latter is able to emit light of the intensity required for floodlighting purposes. Further, the heat

sink 23 is capable of dissipating heat generated by the LEDs 21. Still further, the reflector 25 affords directional control of light emitted by the LEDs 21, thereby facilitating relatively even illumination of the target area 14 without producing glare which might otherwise dazzle persons in the vicinity.

[0061] The directional control may include horizontal and vertical light reflection to achieve the desired or optimum light distribution.

[0062] It is a feature of the embodiment that the lighting modules 20 within each row of the array 19 of the lighting assembly 13 share a common heat sink 23. This may be advantageous in terms of the ease and cost of production of the illumination apparatus 10 and the associated lighting modules 20. It may also facilitate mounting of the lighting modules 20 in the housing 17.

[0063] Referring now to Figures 17 to 21, there is shown a reflector for a second embodiment of an illumination apparatus according to the invention. The reflector shown in Figures 17 to 21 is similar in many respects to the reflector 25 of the first embodiment. Accordingly, similar reference numerals are used to denote similar parts. However, with the reflector shown in Figures 17 to 21, the angle of slant of the first side wall 71 of each reflector portion 61 has been varied. This provides one example of the manner in which the reflector 25 can be varied in order to achieve directional control of the reflected light.

[0064] The two embodiments distribute the reflected light differently, one providing a narrow light distribution than the other.

[0065] The reflectors 25 of the first and second embodiments are shown in side-by-side relation in Figures 11 and 17, and also in Figures 12 and 18, for ease of comparison.

[0066] It should be appreciated that the scope of the invention is not limited to the scope of the two embodiments described. Modifications and variations such as would be apparent to the skilled addressee are considered to fall within the scope of the present invention.

[0067] The present disclosure is provided to explain in an enabling fashion the best modes of making and using various embodiments in accordance with the present invention. The disclosure is further offered to enhance an understanding and appreciation for the invention principles and advantages thereof, rather than to limit in any manner the invention. While a preferred embodiment of the invention has been described and illustrated, it is clear that the invention is not so limited. Numerous modifications, changes, variations, substitutions, and equivalents will occur to those skilled in the art having the benefit of this disclosure without

departing from the spirit and scope of the present invention as defined by the following claims.

[0068] Reference to positional descriptions, such as "inner", "outer", "upper", "lower", "top" and "bottom", are to be taken in context of the embodiments depicted in the drawings, and are not to be taken as limiting the invention to the literal interpretation of the term but rather as would be understood by the skilled addressee.

[0069] Additionally, where the terms “system”, “device”, and “apparatus" are used in the context of the invention, they are to be understood as including reference to any group of functionally related or interacting, interrelated, interdependent or associated components or elements that may be located in proximity to, separate from, integrated with, or discrete from, each other.

[0070] Throughout this specification, unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

CLAIMS

1. An illumination apparatus comprising a plurality of light emitting diodes (LEDs), a heat sink, and a reflector, the reflector defining a plurality of cavities in which the LEDs are accommodated, the heat sink comprising an elongate body providing a base portion and a heat dissipation portion of integral construction, the plurality of LEDs being mounted on the base portion whereby heat generated by the plurality of LEDs is absorbed by the base portion and transferred to the heat dissipation portion, wherein the heat dissipation portion comprises a cooling fin assembly for dissipating heat to surrounding air, the cooling fin assembly comprising at least one longitudinal fin disposed to one side of the base portion and a plurality of lateral fins extending from the longitudinal fin, the lateral fins being disposed on opposed longitudinal sides of the longitudinal fin, and wherein the reflector is mounted on the base portion and comprises a plurality of reflector portions defining said plurality of cavities in which the plurality of LEDs are accommodated, each reflector portion being configured to receive a respective one of the LEDs, each reflector portion comprising an aperture through which the respective LED extends into the cavity, each reflector portion defining an opening and the respective cavity extending to the opening, whereby light emitted by the respective LED passes through the opening for illumination purposes, each reflector portion comprising a wall structure defining side walls and an inner wall in opposed relation to the opening, the aperture in the reflector portion through which the respective LED extend into the cavity being provided in the inner wall, the side walls and the inner wall providing reflective surfaces for intercepting light emitted from the respective LED and directing the light towards the opening, the side walls comprising first and second side walls disposed in opposed relation, the first and second walls being oblique to the opening and slanted at different angles with respect to the opening.

2. The illumination apparatus according to claim 1, wherein the plurality of LEDs are provided by one or more LED modules.

3. The illumination apparatus according to claim 2, wherein each LED module comprises two or more LEDs mounted on a printed circuit board (PCB).

4. The illumination apparatus according to claim 2 or 3, wherein the heat sink is common to a plurality of the LED modules.

5. The illumination apparatus according to claim 4, wherein the LED modules are disposed along the elongate body.

6. The illumination apparatus according to any one of the preceding claims, wherein the cooling fin assembly comprises two longitudinal fins and associated lateral fins disposed in spaced apart relation to define a gap therebetween.

7. The illumination apparatus according to any one of the preceding claims, wherein the heat sink comprises an extrusion.

8. The illumination apparatus according to any one of the preceding claims, wherein the base portion presents a face on which the plurality of LEDs are mounted.

9. The illumination apparatus according to claim 8 when dependent upon claim 2, wherein each LED module is mounted on the face of the base portion.

10. The illumination apparatus according to any one of the preceding claims, wherein the opening is of rectangular configuration.

11. The illumination apparatus according to any one of the preceding claims, wherein all of said walls provide reflective surfaces.

12. The illumination apparatus according to any one of the preceding claims, wherein the side walls further third and fourth side walls disposed in opposed relation.

13. The illumination apparatus according to claim 12, wherein the third and fourth opposed side walls are slanted at the same angle with respect to the opening.

14. The illumination apparatus according to any one of the preceding claims, wherein the reflector is of integral construction, whereby the reflector portions are connected one to another to provide a single unit.

15. The illumination apparatus according to claim 14, wherein the single unit defining the reflector comprises the plurality of the reflector portions arranged in one or more rows.

16. The illumination apparatus according to any one of the preceding claims, further comprising a transparent cover for covering the plurality of LEDs.

17. The illumination apparatus according to claim 16 when dependent upon claim 2, wherein there is one transparent cover associated with each LED module.