

Light source

Cross-Reference to Related Applications

The present application claims priority from Australian Provisional Patent
5 Application No 2005907027 filed on 14 December 2005, the content of which is
incorporated herein by reference.

Introduction

The present invention relates generally to the field of emergency lighting and in
10 particular the invention provides a new illuminated emergency sign design and type of
light source for use in such signs.

Background to the Invention

Illuminated emergency signs such as exit signs are traditionally lit by light
15 sources such as fluorescent lamps, which may be used alone or in pairs depending on
the application. Fluorescent lamps have a good life expectancy, particularly when
compared to other type of lamps in everyday usage such as incandescent lamps, but
their life expectancy is much less than that of a LED.

Some manufacturers have replaced gas discharge lamps with LEDs in their
20 illuminated emergency signs, employing a number of low-wattage LEDs, usually
distributed along an edge of the sign. The use of a number of LEDs in distributed
locations helps to provide even illumination of the sign while allowing the use of
commonly available and inexpensive low power LEDs. However, the use of multiple
LEDs adds to manufacturing complexity and makes maintenance more difficult in the
25 case of failure of an LED.

In the case of edge lit signs where the sign body acts as a light pipe, employing
total internal reflection to distribute light evenly across the display surface of the sign,
the use of a single LED has been proposed as a source of illumination, but this has not
been considered feasible for conventional sign panels which depend on rear
30 illumination, where light is projected onto the rear surface of a sign and is transmitted
directly through the sign. Also, in the past LEDs have suffered significant output
degradation over their life and have not been considered suitable for this application.
Some newer power LEDs do not degrade to the same extent and are considered suitable
for this application.

Summary of the Invention

According to a first aspect a lens is provided having a shape which is arranged to project light from a single compact source approximating a point source, onto an inward facing surface of a sign panel, where the source is mounted adjacent to one edge of the sign panel, the lens having a primary axis and a lateral axis perpendicular to the primary axis, whereby the lens is intended to be mounted with the primary axis passing through a central plane of the sign assembly in a first direction of the sign assembly and the lateral axis is intended to pass through the central plane of the sign assembly in a second lateral direction of the sign assembly, the lens comprising a beam forming portion, having an axis co-incident with the primary axis of the lens, a deflecting portion to deflect light from an axial direction of the beam forming portion towards a substantially lateral direction, and scattering portions extending laterally outwardly of the deflecting portions with respect to the axis of the beam forming portion.

In one embodiment the lens is a hollow reflective lens in which the beam forming portion is a parabolic reflector, the deflecting portion is a wedge shaped reflector located on an axis of the parabolic reflector with its apex directed at the parabolic reflector, and the scattering portion comprises pairs of wings extending laterally from two sides of the deflector, each of the pairs of wings having reflective inwardly facing scattering surfaces facing one another about the lateral axis.

Preferably also the scattering surfaces include lateral steps extending from a point or points adjacent an inner end of the respective wing. This embodiment of the lens is preferably moulded from plastics material in two identical shell halves which snap together about the plane defined by the primary and lateral axes. The shell halves are preferably made of ABS plastic and vacuum metallised.

In another embodiment the lens comprises a solid lens body relying on total internal reflection at outer surfaces of the body, in which the beam forming portion is a solid parabolic element into which light is projected from the source, via walls of a source aperture in which the source is located, the deflecting portion is a wedge shaped notch in a lower portion of the lens, forming a wedge shaped internally reflective surfaces located on an axis of the parabolic reflector with the apex of the wedge shape directed at the parabolic reflector, and the scattering portion comprises wings extending laterally from two sides of the notch, each of the wings having internally reflective surfaces facing one another about the lateral axis and scattering end surfaces to scatter the light reflected internally and light passing through the scattering surfaces.

Preferably the facing surfaces include lateral steps extending from a point or points adjacent an inner end of the respective wing. Further scattering surfaces are

preferably provided in lateral planes adjacent to and angled with respect to the first axis such that they converge away from the beam forming portion. The lens is preferably moulded from plastics material in one piece. This embodiment of the lens is also preferably made of acrylic or polycarbonate plastic material.

- 5 According to a second aspect, a light source for a sign is provided comprising a Light Emitting Diode (LED), and a lens element having a shape which projects light from the LED onto a surface of a translucent panel, whereby the intensity of illumination of the surface by the LED enables light to be emitted from an opposite surface of the translucent panel at a level of at least 2 cd/m^2 and preferably 8 cd/m^2
- 10 over an area of the opposite surface of at least in the order of 0.02 m^2 and typically in the order of 0.05 m^2 or more. The emitted light from the opposite surface of the panel will generally exhibit a luminance ratio of at least 4:1 between background areas of the translucent panel and graphic (foreground) areas carrying a translucent graphic. Preferably the luminance ratio is a ratio of 5:1 or more. Preferably also light will be
- 15 emitted from the outer surface of the translucent panel at a level of at least 40 cd/m^2 over the panel foreground area.

The lens is provided with an aperture such that the lens fits over the LED and substantially the entire light output of the LED is projected into and distributed by the lens.

- 20 By using a single LED in an Emergency Sign, energy consumption can be reduced and the period of time required between lamp changes can be increased. By using LEDs it is possible to extend the average life expectancy of a light source to a period approaching the expected operational life of the fixture.

- According to a third aspect, a sign assembly is provided comprising a sign body
- 25 having a substantially hollow light box at least one transparent sign panel mounted over an opening in the light box, and a light source mounted internally of the light box and located to project light onto an internal facing surface of the sign panel to evenly illuminate a sign image on the sign panel by projecting light through the sign panel. The light source comprises a Light Emitting Diode (LED), and a lens element having a
- 30 shape which concentrates light from the LED onto the inward facing surface of the sign panel, whereby the intensity of illumination on the internal surface of the sign panel provided by the LED enables light to be emitted from the outer surface of the sign panel at a level of at least 2 cd/m^2 over the effective sign surface.

- The internal surfaces of the light box are gloss white and co-operate with the
- 35 lens to provide even illumination of the sign panel surfaces. The walls of the light box

reflect the light that is scattered sideways by the lens to further even out the illumination of the sign panel surfaces.

The emitted light from the sign surface will generally exhibit a luminance ratio of at least 4:1 between graphic (foreground) and background areas of the sign panel and preferably a ratio of 5:1 or more. Preferably also light will be emitted from the outer surface of the sign panel at a level of at least 8 cd/m² over the effective sign area in the background areas (generally green) of the sign and at least 4 times this level in the foreground (generally white) areas of the sign. The lens is provided with an opening in one side such that the lens fits over the LED and substantially the entire light output of the LED is projected into and through the lens. In a particularly preferred embodiment, two sign panels are provided over openings on opposite sides of the light box and the two sign panels are each illuminated by the light source.

LEDs also demonstrate a significant power advantage as typically the power consumption saving using a single LED could be as great as 10 times (1W for an LED source versus 10W for a gas discharge source). Such a saving is significant given that the device is illuminated 24 hours per day 365 days per year over a 5 to 10 year lifespan. LED devices capable of being driven at greater than one watt are also possible and in one embodiment a LED rated at 3W is proposed to be driven at 2.5 W in emergency mode.

Brief description of the Drawings

Embodiments of the invention will now be described, by way of example with reference to the accompanying drawings in which: -

Fig. 1 is a perspective view of a sign fitting of a type suited to the present light source;

Fig. 2 is an exploded view of the sign fitting of Fig. 1;

Fig. 3 is a schematic front view of a sign fitting of the type shown in Figs. 1 and 2, incorporating the present LED light source of showing light distribution;

Fig. 4 is a schematic side view of the illuminated sign fitting of Fig. 3;

Fig. 5 is a schematic top view of the illuminated sign fitting of Fig. 3;

Fig. 6 is a perspective view of a first embodiment of the lens of the illumination source of Figs. 1 to 4;

Fig 7 is a top view of the lens of Fig. 5;

Fig 8 is a front view of the lens of Fig. 5;

Fig 9 is a bottom view of the lens of Fig. 5;

Fig 10 is an end view of the lens of Fig. 5;

Fig 11 is a perspective view of the lens of Fig. 5 from a high view point;

Fig 12 is a perspective view of the lens of Fig. 5 from a low view point;

Fig. 13 is a perspective view of a second embodiment of the lens of the illumination source of Figs. 1 to 4;

5 Fig 14 is a top view of the lens of Fig. 13;

Fig 15 is a front view of the lens of Fig. 13;

Fig 16 is a bottom view of the lens of Fig. 13;

Fig 17 is an end view of the lens of Fig. 13;

Fig 18 is a perspective view of the lens of Fig. 13 from a low view point;

10 Fig 19 is a perspective view of the lens of Fig. 13 from a high view point;

Fig 20 (a) to (d) are respectively Perspective, top, side and end views of a lens designed to fit in the bottom of the sign fittings of figures 1 to 4 to provide an emergency lighting function;

Fig. 21 is a perspective view, from below of a possible heat sink and LED
15 assembly for use in embodiments of the sign assembly;

Fig. 22 is a perspective view, from above of the heat sink and LED assembly of Fig 21;

Fig. 23 is a perspective view, from below of the heat sink and LED assembly of Fig 21, when viewed from the opposite end; and

20 Fig. 24 is a perspective view, from below of the heat sink and LED assembly of Fig 21 when viewed obliquely;

Detailed Description of an Embodiment of the Invention

Referring to Fig. 1 an emergency sign assembly 10 of a type used for building
25 exit signs and which is suited to the use of a power LED light source is illustrated. This fitting is known as a Slide Connect ExitTM, and the predecessor of this design would have carried either one or two 10 watt linear fluorescent lamps.

The sign assembly 10 comprises a mounting base 11, and a sign body 12, an electronics board 13, either one or two translucent sign panels 14 (depending on
30 whether the sign is required to be readable from one or two sides) and one or two transparent protective covers 15. An internal illumination source is mounted within the sign body and the illumination source is driven via the electronics board 13. A backup power source is provided, in the form of a battery, mounted in an upper portion of the sign body 12, to power the illumination source when the mains power supply is
35 interrupted (as might happen for example in a fire). The electronics board 13 also carries a battery charging circuit to maintain the battery in a charged state when the

mains power is available, self testing circuits to monitor correct operation of the electronics and the light source and communications circuits to communicate with a central monitoring system for the building.

The mounting base is designed to be mounted to a ceiling without the sign body
5 attached and all power and communications wiring is routed to the mounting base and terminated in a connector 16 (partially visible) mounted in the mounting base. After the base 11 has been mounted on the ceiling, the sign body 12 slides into engagement with the mounting base on rails 17 projecting from the sides of the mounting base and which are received into slots 18 formed internally in the top of the sign body 12. When
10 the sign body 12 engages the mounting base 11, an electrical connector 19 on the sign body engages the connector 16 in the mounting base to connect power to the electronics board. Communications wiring is separately connected via another connector (not shown).

Figure 2 provides an understanding of the construction of sign body 12 by
15 providing an exploded view of the sign assembly 10, showing the battery 22, which is normally mounted in an upper portion of the sign housing 12, and the illumination source 24, which is mounted on a heat sink 71 (not shown in Figs 1 and 2 but see Figs 21, 22, 23 and 24). The heat sink 71 carrying the light source 24 clips into the sign body 12 beneath the electronics board 13 and is field replaceable in the event that a
20 light source fails. The sign body 12 is formed as two half frames 21 and 23 which are clipped together by edge clips 25 on one frame half which engage corresponding recesses 26 on the other frame half. The sign panels 14 sit inside a projecting box like structure 27 which sits over and engages with corner mounting brackets 28 projecting from the frame halves 21 and 23.

25 An emergency down light lens 31 is fitted in the bottom of the assembly where it collects light falling on it from various directions and deflects it into a dispersed pattern below the sign assembly to provide an emergency down light function.

Figs 3, 4 & 5 provide ray diagrams showing the distribution of light from the source through the lens and out to the sign surfaces of the sign assembly. Note that the
30 internal surfaces of the sign body 12 are gloss white and enhance optical performance by further reflecting the light that is scattered sideways within the light box portion of the sign housing by the lens, thereby further evening out the illumination of the sign panels 14.

The illumination source 24 includes an LED emitter 41 (see figs 3, 4, 5, 21, 22,
35 23 and 24) mounted in a sub-mount 72 (Figs 21, 22, 23 and 24) which is in turn mounted on a heat sink 71. The sub-mount is shown fixed by screws 73 in Figs. 21, 23

and 24, but may also be attached by bonding with thermal tape or similar bonding agent. The LED and heat sink assembly is field replaceable and is located beneath the circuit board 13 and snap fits into the sign assembly. Electrical connection to the LED emitter 41 is by way of pads (not shown) to which flying leads and pin connectors (also
5 not shown) connect after passing from the electronics board 13 through holes 75 in the heat sink 71.

A lens 42, which will be described in greater detail below, fits over the LED emitter 41 and is held by clipping to the sign body 12. The lens 42 scatters light from the LED 41 to evenly illuminate the rear surfaces of the sign panels 14 (see Fig. 1 and
10 2) and to provide an emergency down light function via the Fresnel lens 31 located in the bottom of the sign assembly. The preferred LED is a Luxeon StarTM 3 watt LED manufactured by Lumileds (a joint venture between Philips and Agilent Technologies (Hewlett Packard)), although other suitable LEDs may be substituted if they are physically compatible and capable of the same performance.

A first embodiment of the lens 42 is illustrated in greater detail in Figs. 6 to 12
15 from which it can be seen that the lens is a hollow reflective lens and comprises an upper parabolic portion 45 having an aperture 46 which enables the LED 41 to project into the interior of the lens, a deflecting baffle 47 provided below the parabolic portion, and two pairs of wings 48 to scatter the light across the sign assembly. The deflecting
20 baffle 47 is located to deflect the on-axis light from the parabolic reflector 45, laterally towards the wings 48 and to prevent a hot spot in the middle of the sign panels 14. Scattering surfaces 49 are provided on inner facing surfaces of the wings 48 to disperse light about the sign assembly, and the wings have lateral steps 51 to scatter and "throw" the light toward the bottom of the sign assembly to thereby increase the amount of light
25 falling on the lower parts of the translucent sign panels 14.

Vertical steps 52 at the inner ends of the wings 48 provide a scattering effect in the horizontal direction, while front and rear openings 53 leak light through the upper body of the lens to provide fill in light to illuminate the sign panels 14 in regions otherwise shaded by the lens 42.

The two shell halves are joined through the parabolic reflector 45 and the wedge shaped reflector 47 as well as by cross connecting bars 61 which latch together at their meeting points. Mounting tabs 62 with fastener holes 63 extend from the parabolic reflector 45 to facilitate fastening of the lens to a circuit board or other supporting structure.

A second embodiment of the lens 42 is illustrated in greater detail in Figs. 13 to
35 19 from which it can be seen that the lens is a solid lens which relies on total internal

reflection to provide a number of internal reflective surfaces. The lens comprises an upper parabolic portion 145 having an aperture 146 which enables the LED 41 to project through the aperture wall into the interior of the lens, a deflecting notch 147 provided below the parabolic portion, and two wings 148 to scatter the light across the sign assembly. The deflecting notch 147 is located to deflect the on-axis light from the parabolic reflector 145, laterally towards the wings 148 and to prevent a hot spot in the middle of the sign assembly. Scattering surfaces 149 are provided on outer surfaces of the wings 48 to disperse light about the sign assembly, and the wings have at least one lateral step 151 on each side to scatter and "throw" the light toward the bottom of the sign assembly to thereby increase the amount of light falling on the lower parts of the translucent sign panels 14.

Large grooves 154, 156 provided in the sides of the parabolic portion 145 act to reflect and scatter light that would otherwise be lost through the parabolic surface.

Horizontal steps 153 at the inner ends of the wings 148 provide a scattering effect in the vertical direction, while also causing leaking of light through the upper body of the lens to provide fill in light to illuminate the sign panels 14 in regions otherwise shaded by the lens 42.

Smaller sub-wings 155 projecting from the side of the parabolic portion, between the grooves 156 and the wings 148 may be used to attach the lens 42 to a LED Carrier.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

CLAIMS:

1. A lens having a body shaped to project light from a single compact source approximating a point source, onto an inward facing surface of a sign panel, where the source is mounted adjacent to one edge of the sign panel, the lens body having a
5 primary axis and a lateral axis perpendicular to the primary axis, whereby the lens body is intended to be mounted with the primary axis passing through a central plane of the sign assembly in a first direction of the sign assembly and the lateral axis is intended to pass through the central plane of the sign assembly in a second lateral direction of the sign assembly,
- 10 2. the lens of claim 1 wherein the lens body comprises:
 - a) a beam forming portion, having an axis co-incident with the primary axis of the lens body, a deflecting portion to deflect light from an axial direction of the beam forming portion towards a substantially lateral direction, and
 - b) scattering portions extending laterally outwardly of the deflecting portions
15 with respect to the axis of the beam forming portion.
3. The lens of claim 1 or 2 wherein the lens body is a hollow reflective element in which the beam forming portion is a parabolic reflector, the deflecting portion is a wedge shaped reflector located on an axis of the parabolic reflector with its apex directed at the parabolic reflector, and the scattering portion comprises pairs of wings
20 extending laterally from two sides of the deflector, each of the pairs of wings having reflective inwardly facing scattering surfaces facing one another about the lateral axis.
4. The lens of claim 2 or 3 wherein the scattering surfaces include lateral steps extending from a point or points adjacent an inner end of the respective wing.
5. The lens of claim 3 or 4 wherein the lens body is moulded from plastics material
25 in two identical shell halves which snap together about the plane defined by the primary and lateral axes.
6. The lens of claim 5 wherein the shell halves are made of ABS plastic and vacuum metallised.
7. The lens of claim 2 wherein the lens body is solid and relies on total internal
30 reflection at outer surfaces of the lens body, in which the beam forming portion is a solid parabolic element into which light is projected from the source, via walls of a source aperture in which the source is located, the deflecting portion is a wedge shaped notch in a lower portion of the lens, forming a wedge shaped internally reflective surfaces located on an axis of the parabolic reflector with the apex of the wedge shape
35 directed at the parabolic reflector, and the scattering portion comprises wings extending laterally from two sides of the notch, each of the wings having internally reflective

surfaces facing one another about the lateral axis and scattering end surfaces to scatter the light reflected internally and light passing through the scattering surfaces.

8. The lens of claim 7 wherein the facing surfaces include lateral steps extending from a point or points adjacent an inner end of the respective wing.

5 9. The lens of claim 7 or 8 wherein scattering surfaces are provided in lateral planes adjacent to and angled with respect to the first axis such that they converge away from the beam forming portion.

10. The lens as claimed in any one of claims 3 to 9 wherein the lens body is moulded from plastics material in one piece.

10 11. The lens of claim 10 wherein the lens body is made of acrylic or polycarbonate plastic material.

12. A light source for a sign, comprising:

i. a Light Emitting Diode (LED); and

ii. a lens element having a lens body shaped to project light from the LED

15 onto a surface of a translucent panel,

13. the light source of claim 12 wherein the intensity of illumination of the surface by the LED enables light to be emitted from an opposite surface of the translucent panel at a level of at least 2 cd/m^2 over an area of the opposite surface of at least in the order of 0.02 m^2 .

20 14. The light source of claim 13 wherein light to be emitted from an opposite surface of the translucent panel is at a level of at least 8 cd/m^2 .

15. The light source of claim 13 or 14 wherein light is emitted over an area of the opposite surface of at least in the order of 0.05 m^2 .

25 16. The light source of claim 1, 2 or 3 wherein the emitted light from the opposite surface of the panel exhibits a luminance ratio of at least 4:1 between background areas of a translucent panel and graphic (foreground) areas carrying a translucent graphic.

17. The light source of claim 16 wherein the luminance ratio is a ratio of 5:1 or more.

30 18. The light source of claim 12, 13, 14, 15, 16 or 17 wherein light is emitted from an outer surface of the translucent panel at a level of at least 40 cd/m^2 over the panel foreground area.

19. The light source of claim 12, 13, 14, 15, 16, 17 or 18 wherein the lens is provided with an aperture which fits over the LED such that substantially the entire light output of the LED is projected into and distributed by the lens.

35 20. A sign assembly comprising a sign body having a substantially hollow light box at least one transparent sign panel mounted over an opening in the light box, and a light

source mounted internally of the light box and located to project light onto an internal facing surface of the sign panel to evenly illuminate a sign image on the sign panel by projecting light through the sign panel the light source comprising:

- i) a Light Emitting Diode (LED), and
- 5 ii) a lens element having a body shaped to concentrate light from the LED onto the inward facing surface of the sign panel,

whereby the intensity of illumination on the internal surface of the sign panel provided by the LED enables light to be emitted from the outer surface of the sign panel at a level of at least 2 cd/m^2 over the effective sign surface.

10 21. The sign assembly of claim 20 wherein the light box has internal surfaces which are gloss white and co-operate with the lens to provide even illumination of the sign panel surfaces.

22. The sign assembly of claim 20 or 21 wherein the walls of the light box reflect the light that is scattered sideways by the lens to further diffuse the illumination falling
15 on the sign panel surfaces.

23. The sign assembly of claim 20, 21 or 22 wherein the emitted light from the sign surface will generally exhibit a luminance ratio of at least 4:1 between graphic (foreground) areas and background areas of the sign panel.

24. The sign assembly of claim 23 wherein the emitted light from the sign surface
20 will generally exhibit a luminance ratio of at least 5:1 or more between graphic (foreground) areas and background areas of the sign panel.

25. The sign assembly of claim 20, 21, 22, 23 or 24 wherein the emitted light from the sign surface is emitted at a level of at least 8 cd/m^2 over the effective sign area in the background areas (generally green) of the sign and at least 4 times this level in the
25 foreground (generally white) areas of the sign.

26. The sign assembly of claim 20, 21, 22, 23, 24 or 25 wherein the lens is provided with an opening in one side such that the lens fits over the LED and substantially the entire light output of the LED is projected into and through the lens.

27. The sign assembly of claim 20, 21, 22, 23, 24, 25 or 26 wherein two sign panels
30 are provided over openings on opposite sides of the light box and the two sign panels are each illuminated by the light source.

28 The sign assembly of claim 20, 21, 22, 23, 24, 25, 26 or 27 wherein the LED is rated at 3W and is driven at 2.5 W in emergency mode.