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US 20110051460 A1 **US 20090322986 A1**

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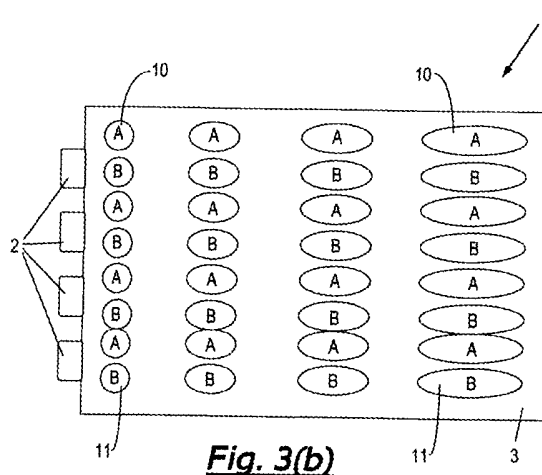
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(54) Title of the Invention: **Light guide device**
Abstract Title: **Light guide with first and second interleaved extraction features**

(57) A light guide device (9) suitable for illumination, lighting and display purposes that exhibits an output light having a predetermined, and preferably uniform, angular luminance profile is described. The device comprises a light guide (3) suitable for guiding light (4) coupled thereto and a plurality of extraction features (10, 11) located on one or more surfaces of the light guide (3). The plurality of extraction features (10, 11) comprises an interleaved pattern of first (10) and second (11) extraction features the arrangement of which provides a means for defining the predetermined angular and spatial luminance profiles for the output light. The device (9) allows for a uniform angular luminance profile to be produced that is maintained even when the light guide (3) is curved or bent.



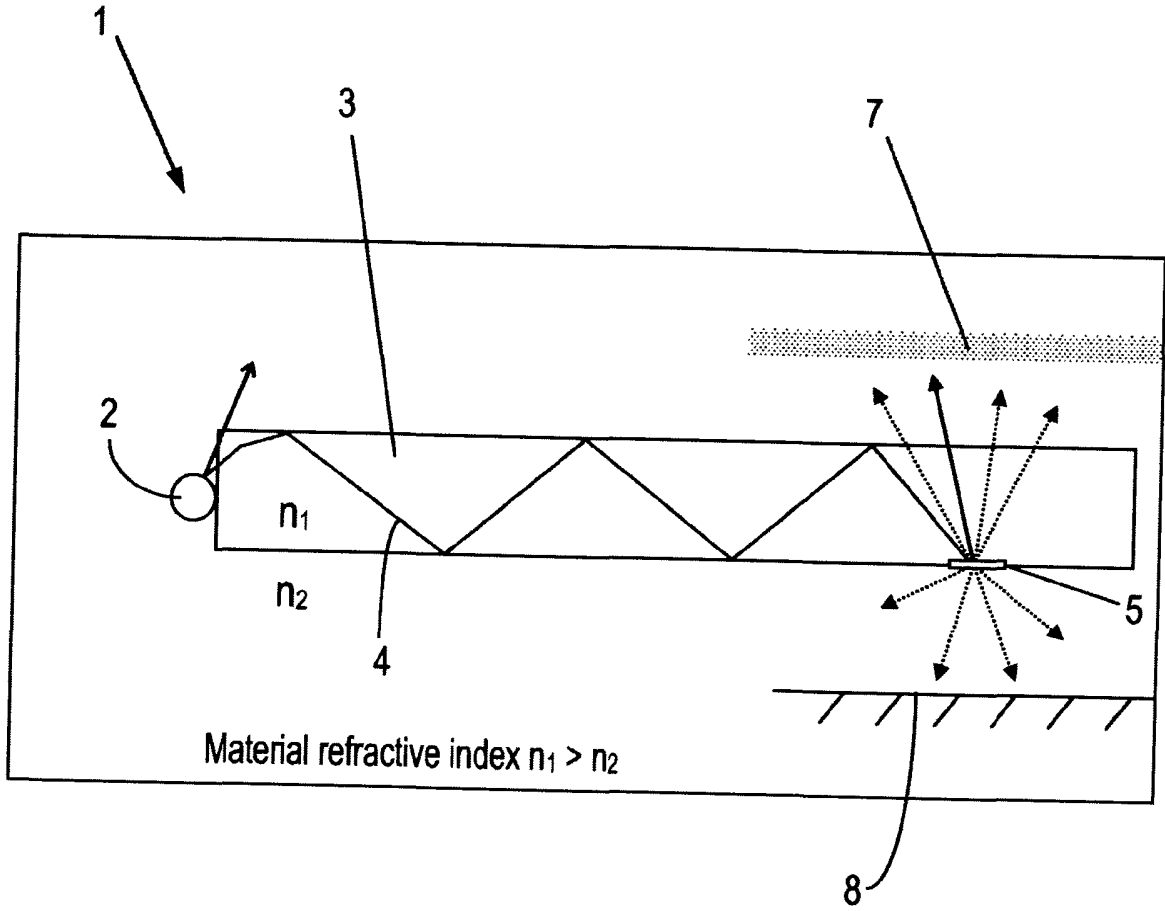


Fig. 1
(Prior Art)

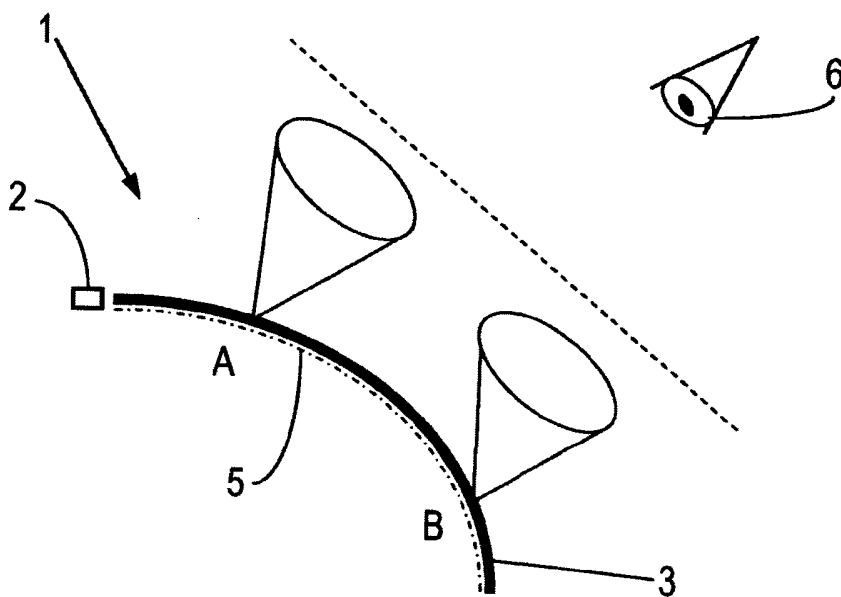


Fig. 2
(Prior Art)

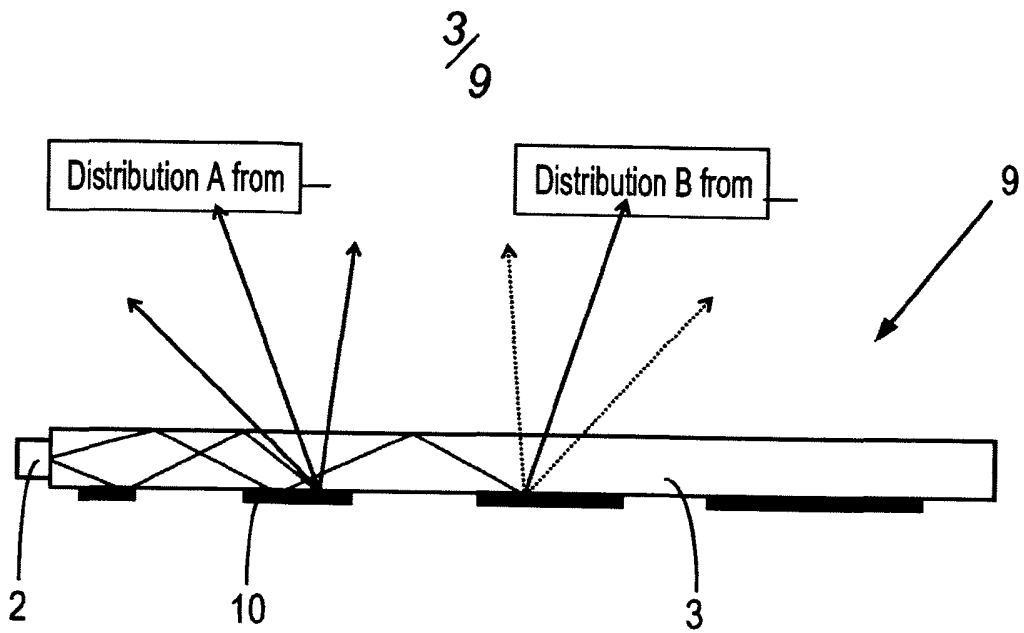


Fig. 3(a)

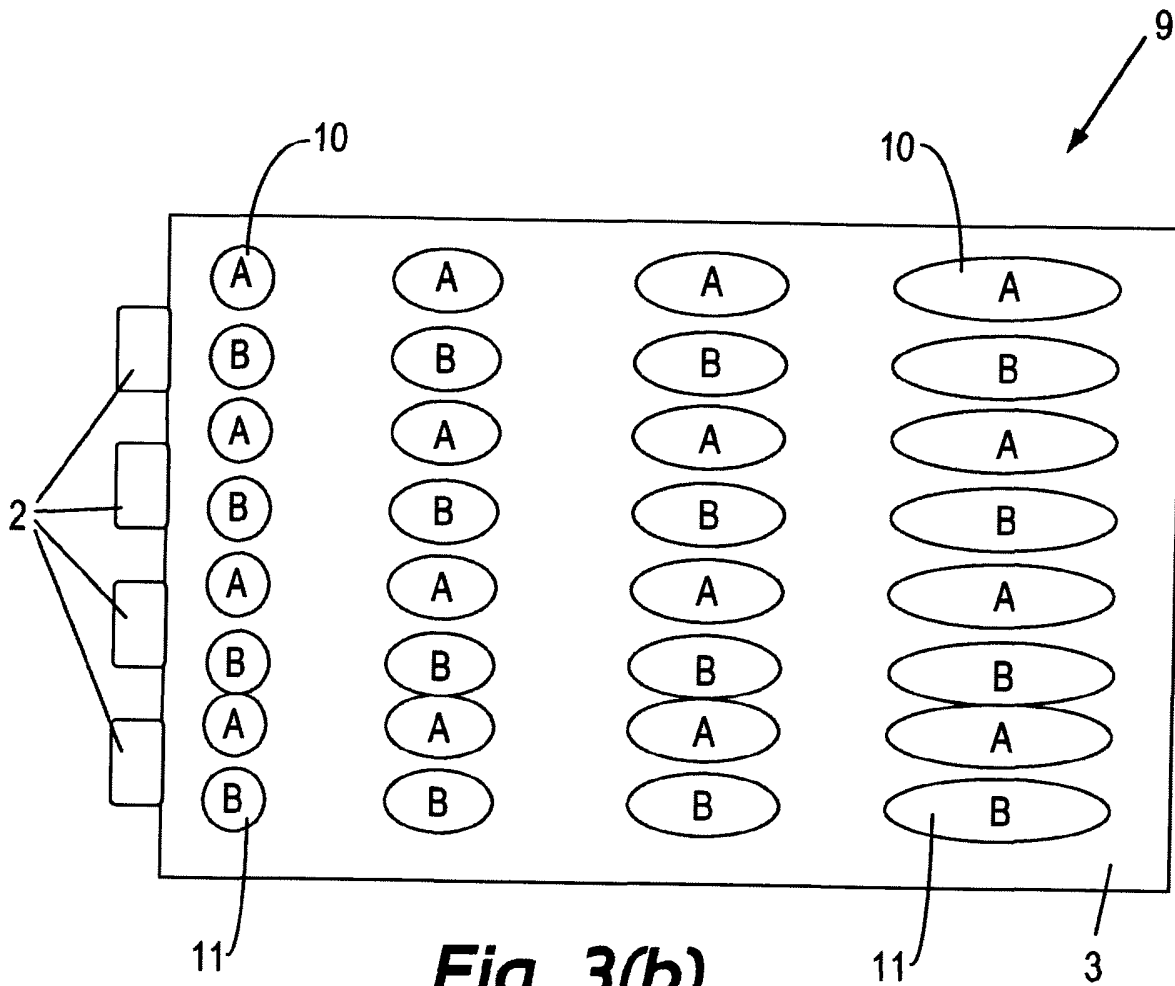


Fig. 3(b)

17 06 11

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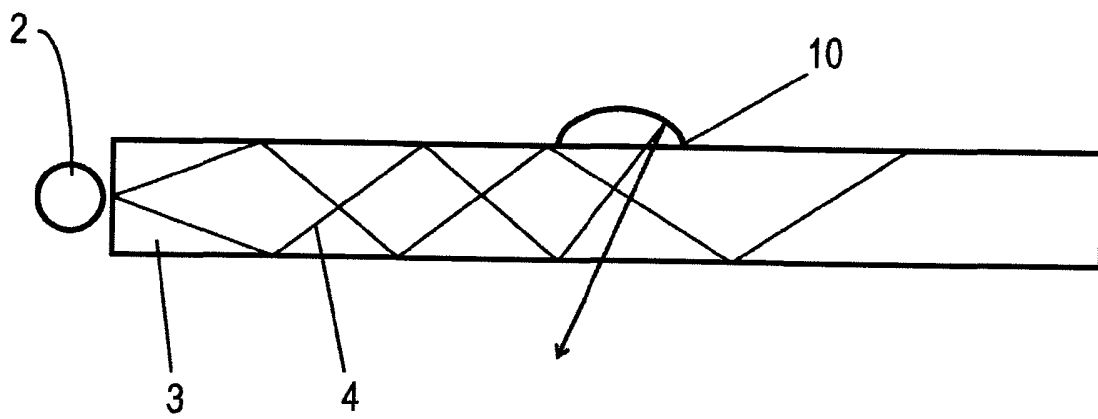
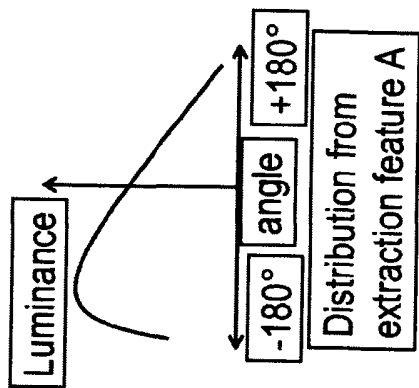
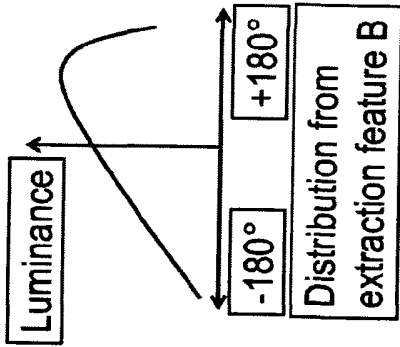


Fig. 4



+



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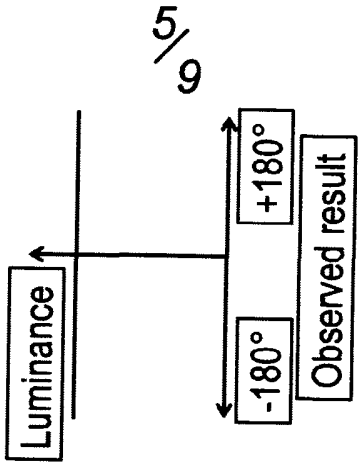


Fig. 5(a)

Fig. 5(b)

Fig. 5(c)

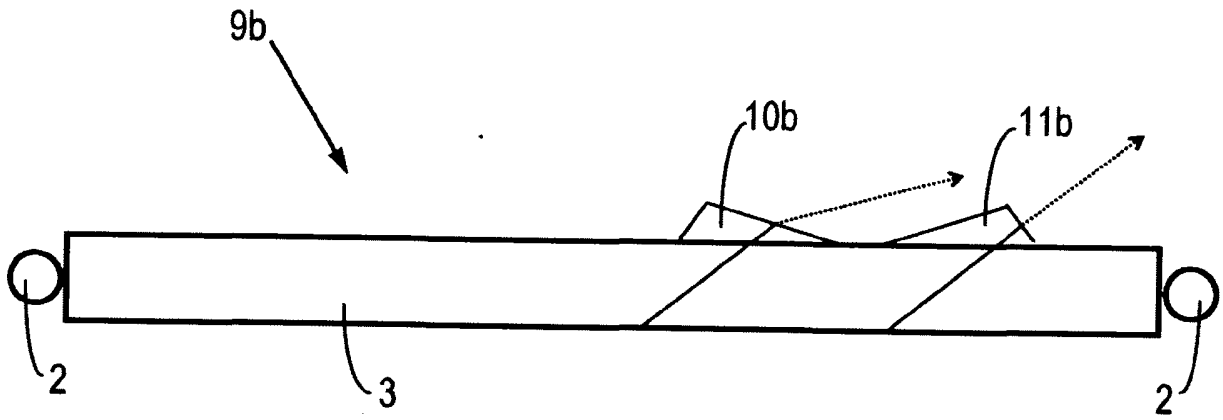


Fig. 6

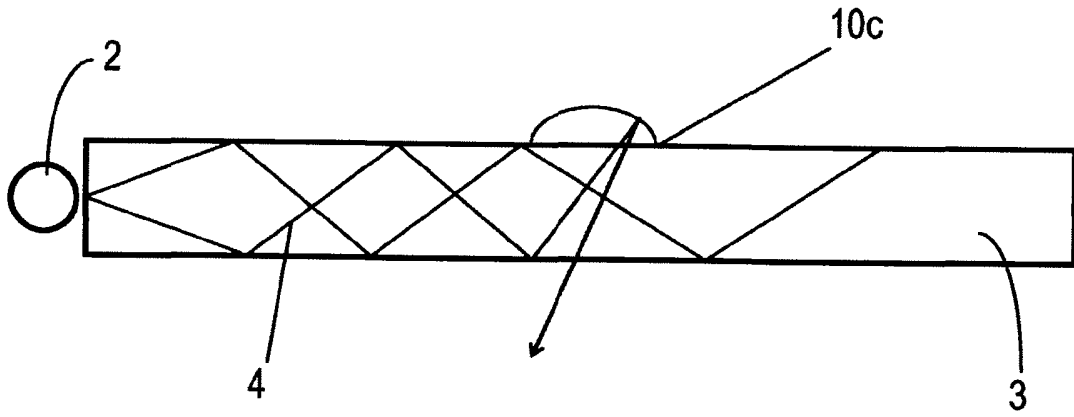


Fig. 7(a)

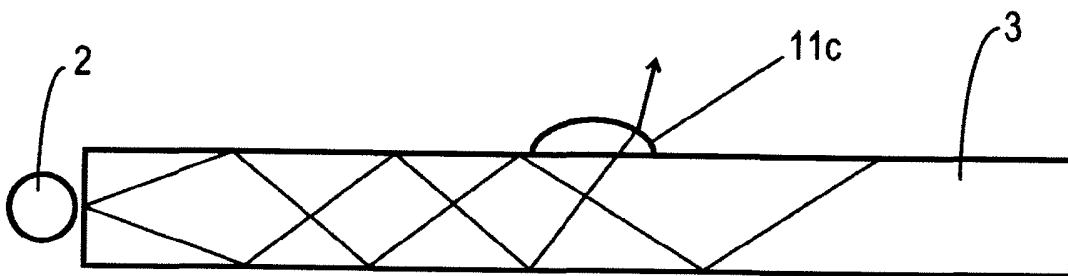


Fig. 7(b)

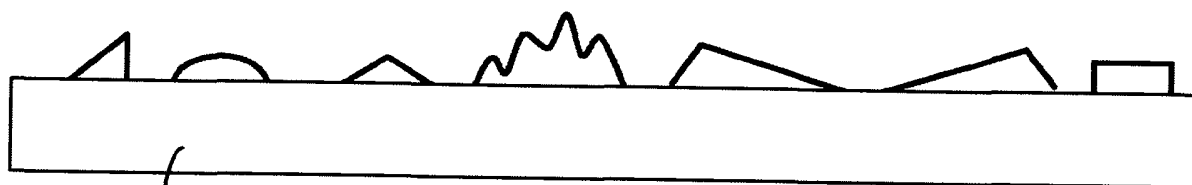


Fig. 8(a)



Fig. 8(b)

17 06 11

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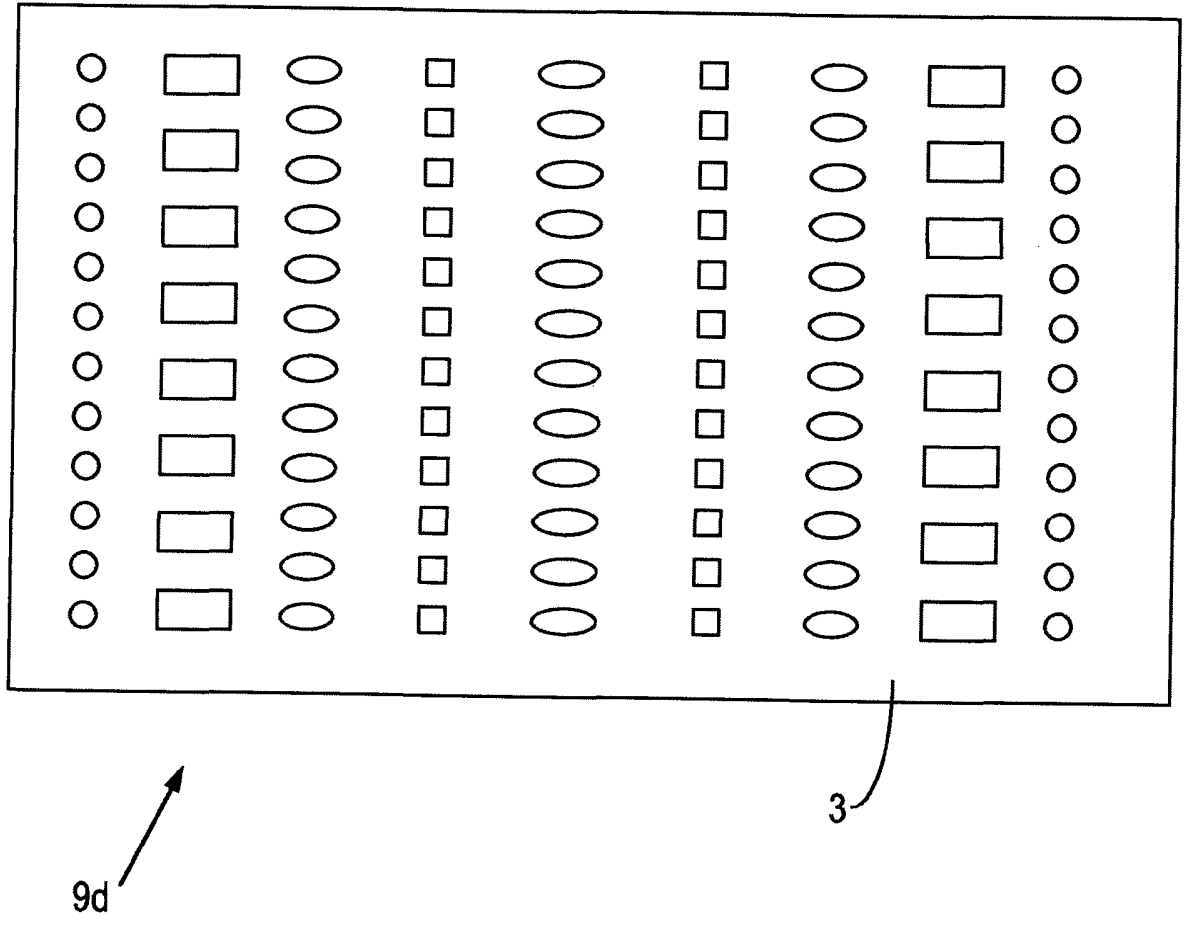


Fig. 9

1 Light Guide Device

2

3 The present invention relates to a light guide device for illumination, lighting and display
4 purposes and, particularly, to a light guide device that exhibits an output light having a
5 predetermined, and preferably uniform, angular luminance profile.

6

7 A number of light-guide devices are known to those skilled in the art. These devices are
8 employed for a range of functions including illumination, backlighting, signage and display
9 purposes. For example, it is known in the art to employ fibre optic lighting technology to
10 produce flat, bendable lighting panels for LCD backlighting. In such devices a plastic or
11 glass optical fibre employed to guide the light is woven into a flat, bendable lighting panel,
12 see for example US patent No. 6,874,925. Such devices however have a light output that
13 exhibits low angular uniformity particularly when the panel is curved or bent.

14

15 Alternatively, it is known to employ flat or wedged shaped transparent panels for
16 backlighting illumination, backlighting, signage and display purposes. Examples of such
17 devices are provided by the inventors within PCT Publication No. WO 2005/101070 and
18 presented schematically in Figure 1, as generally represented by reference numeral 1.
19 Here a light source 2 is edge-coupled into a planar light guide 3. The light 4 generated by

1 the light source 2 then propagates within the planar light-guide 3 due to the effects of total
2 internal reflection. Extraction features 5 e.g. bumps, indents, grooves, ink dots or lines on
3 the surface of the planar light guide 3 then enable the light 4 to escape the total internal
4 reflection condition.

5

6 There are two main physical principles employed by the extraction features 5 to disturb the
7 total internal reflection, namely reflection and refraction. Reflection involves the light 4
8 interacting with a reflecting material on the surface of the light guide 3 which is absorbed
9 and then re-emitted and so breaks down the effect of total internal reflection. A white
10 material, for example, a white ink is commonly employed as the reflecting medium. The
11 white ink emits the light in random directions (commonly called scattering) and as a result
12 a proportion of the scattered light is incident on the opposing surface at an angle lower
13 than the critical angle for the total internal reflection condition to apply and so the light can
14 then exit the light guide 3 from this surface.

15

16 An alternative solution is to use refractive effects, where the shape of the exit surface is
17 locally modified on small scale such that the effective angle of incidence of the guided light
18 is changed below the critical angle and light can therefore exit in accordance with Snell's
19 Law. Mechanical machining or laser machining of the surfaces of the light-guide 3 have
20 been deployed to achieve this effect. Alternatively, it is known to injection mould, micro-
21 mould or micro-emboss transparent hemispherical micro lens features, or uneven surfaced
22 extraction features as described by the inventors within PCT Publication No
23 WO 2009/141663, onto the light guide 3. Refraction techniques generally give more
24 efficient and controllable interference with the guided light 4 than those employing
25 reflection extraction features.

26

27 A common trait of all of the above described extraction features 5 is that they exhibit a low
28 angular luminance uniformity which translates onto the light output from the devices 1. In
29 order to provide an observer 6 with the appearance of uniform angular luminance it is
30 known in the art to locate a diffuser 7 between the planar light guide 3 and the observer 6.
31 A reflector 8, located on the opposite side of the planar light guide 3 to the observer 6, is
32 also often employed to increase the light levels reaching the observer 6. Although the
33 incorporation of the diffuser 7 and the reflector 8 can improve the angular uniformity of
34 the output from a planar device e.g. to greater than 90%, the incorporation of the diffuser 7

1 and the reflector 8 not only add to the cost of the manufacture of the device 1 but also
2 adds to its overall thickness.

3

4 Furthermore, it is found that the effectiveness of the diffuser 7 is significantly reduced when
5 the planar light-guide 3 is bent or curved, as is desirable for certain applications. Figure 2
6 presents a schematic representation of the situation where the light-guide device 1 of
7 Figure 1 is formed into the shape of a curve. As a result of the low angular uniformity of
8 the light harnessed by the extraction features 5, the observer 6 looking at points A and B
9 of the device 1 will see different luminance levels. Thus the output light levels of non-
10 planar light-guide device 1 known in the art are found to vary significantly with viewing
11 angle resulting in bright and dark areas as seen by the observer 6.

12

13 In PCT Publication No WO 2009/141663 the inventors describe a technique where the
14 employment of extraction features 5 formed in arrays upon the light guide 3 provide a
15 means for improving the spatial luminance uniformity of the output light i.e. the luminance
16 as observed along the normal of different areas of the output surface of the light guide 3.
17 However, the described apparatus still requires the incorporation of a diffuser 7 in order to
18 compensate for variations in the angular luminance of the output light.

19

20 In addition to the above, there exist industry standards regarding the control of the angle of
21 light distribution for luminary requirements e.g. European Standard EN 12464-1: "*The*
22 *Lighting of Workplaces*". There are various reasons for the existence of these standards,
23 for example, lighting can cause interfering reflections on modern computer screens. For
24 this reason the standard specifies requirements for controlling the average luminances.
25 For normal workstations, a limit applies of 1000 cd/m² or 200 cd/m² depending on the
26 computer screen. This limit applies for angles starting from 65° all-around. For critical
27 computer screen activities this starts from 55° all-around.

28

29 It is therefore an object of an aspect of the present invention to obviate or at least mitigate
30 the foregoing disadvantages of the light guide apparatus known in the art.

31

32 It is a further object of an aspect of the present invention to provide a light guide apparatus
33 that allows for predetermined angular luminance profiles for the output light e.g. light guide
34 apparatus that exhibit a light output of substantially uniform angular luminance.

35

1 A yet further object of an aspect of the present invention is to provide a non-planar light
2 guide apparatus that exhibits a light output of substantially uniform angular luminance.

3

4 Summary of Invention

5

6 According to a first aspect of the present invention there is provided a light guide device
7 the light guide device comprising a light guide suitable for guiding light coupled thereto and
8 a plurality of extraction features located on a surface of the light guide and arranged to
9 redirect a portion of the guided light so as to provide an output light wherein the plurality of
10 extraction features comprises an interleaved pattern of first and second extraction
11 features.

12

13 By providing an interleaved pattern of first and second extraction features predetermined
14 angular luminance profiles for the output light can be produced.

15

16 The first extraction features preferably produce a first angular luminance profile component
17 for the output light. The second extraction features preferably produce a second angular
18 luminance profile component for the output light.

19

20 Most preferably the interleaved pattern of the first and second extraction features and
21 hence the combination of the first and second angular luminance profiles provide the
22 output light with a uniform angular luminance profile. Advantageously, the uniform angular
23 luminance profile of the light-guide device is achieved without the need to employ a
24 diffuser or a reflector. This provides a light guide device suitable for providing an output
25 light of uniform angular luminance that has a reduced thickness and manufacturing costs
26 when compared to those known in the art.

27

28 Preferably the light guide device further comprises one or more light sources arranged to
29 couple light into the light guide.

30

31 Optionally the interleaved pattern comprises an array of elements made up of the first and
32 second extraction features.

33

34 The array may comprise an array of irregularly spaced elements. Preferably the spacing
35 between the elements of the array decreases the further the elements are located from the

1 one or more light sources. In this way the extraction features provide a means for
2 improving the spatial luminance uniformity of the output light of the device.

3

4 Alternatively the array comprises an array of regularly spaced elements. Preferably the
5 area of the elements of the array increase the further the elements are located from the
6 one or more light sources. In this way the extraction features provide a means for
7 improving the spatial luminance uniformity of the output light of the device.

8

9 The array may comprise alternative rows or columns of the first and second extraction
10 features. Alternatively the array comprises a chequered pattern of first and second
11 extraction features.

12

13 In a yet alternative embodiment the interleaved pattern may comprise more than two types
14 of extraction features.

15

16 It is preferable for the extraction features to be located on a common surface of the light
17 guide. The extraction features may however be located on opposite surface of the light
18 guide.

19

20 The extraction features may comprise a reflective extraction feature or a refractive
21 extraction feature.

22

23 The light guide may be planar. Alternatively the light guide may be non-planar e.g. bent or
24 curved.

25

26 According to a second aspect of the present invention there is provided a light guide
27 device the light guide device comprising a non-planar light guide suitable for guiding light
28 coupled thereto and a plurality of extraction features located on a surface of the light guide
29 and arranged to redirect a portion of the guided light so as to provide an output light
30 wherein the plurality of extraction features comprises an interleaved pattern of first and
31 second extraction features.

32

33 By providing an interleaved pattern of first and second extraction features predetermined
34 angular luminance profiles for the output light can be produced.

35

1 Embodiments of the second aspect of the invention may comprise features to implement
2 the preferred or optional features of the first aspect of the invention or vice versa.

3

4 According to a third aspect of the present invention there is provided a method of
5 producing a light guide device the method comprising the steps of:

6 -providing a light guide suitable for guiding light coupled thereto; and

7 -locating an interleaved pattern of first and second extraction features on a surface of
8 the light guide so as to provide a means for forming an output light.

9

10 The step of locating the interleaved pattern may provide the output light with a uniform
11 angular luminance profile.

12

13 The step of locating the interleaved pattern may comprise locating the first and second
14 extraction features on a common surface of the light guide. The extraction features may
15 however be located on opposite surface of the light guide.

16

17 The method may further comprise the step of coupling a light source to the light guide.

18

19 Embodiments of the third aspect of the invention may comprise features to implement the
20 preferred or optional features of the first and second aspects of the invention or vice versa.

21

22 According to a fourth aspect of the present invention there is provided a method of
23 producing a light guide device the method comprising the steps of:

24 -providing a non-planar light guide suitable for guiding light coupled thereto; and

25 -locating an interleaved pattern of first and second extraction features on a surface of
26 the light guide so as to provide a means for forming an output light.

27

28 Embodiments of the fourth aspect of the invention may comprise features to implement the
29 preferred or optional features of the first, second and third aspects of the invention or vice
30 versa.

31

32 Brief Description of Drawings

33

34 Aspects and advantages of the present invention will become apparent upon reading the
35 following detailed description and upon reference to the following drawings in which:

1

2 Figure 1 presents a side view of a light guide device as known in the art;

3

4 Figure 2 presents a schematic representation of the light guide device Figure 1 when bent
5 or curved; and

6

7 Figure 3 presents:

8 (a) a side view; and

9 (b) a bottom view

10 of a light guide device in accordance with an aspect of the present invention.

11

12 Figure 4 presents a schematic representation of the interaction of a mirrored micro lens
13 extraction feature with the light coupled within the light guide device of Figure 3;

14

15 Figure 5 presents luminance versus angle of observation graphs for:

16 (a) the first extraction feature of the light guide device of Figure 3;

17 (b) the second extraction feature of the light guide device of Figure 3; and

18 (c) the combined output of the first and second extraction features of Figure 3.

19

20 Figure 6 presents an example of structures suitable for use as refractive extraction
21 features, namely cylinders having asymmetric triangular shaped cross sections;

22

23 Figure 7 presents a further alternative example of structures suitable for use as:

24 (a) the first extraction feature of the light guide device of Figure 3, namely a micro lens
25 having a reflective coating; and

26 (b) the second extraction feature of the light guide device of Figure 3, namely a micro
27 lens;

28

29 Figure 8 side profiles of alternative surface features that may be employed as the
30 extraction features within the light guide device; and

31

32 Figure 9 shows a plan view of an alternative embodiment of light guide device.

33

34

35

1 Detailed Description

2

3 Referring to Figure 3, a side view and bottom view of a light guide device 9 in accordance
4 with an aspect of the present invention is presented. The light guide device 9 can be seen
5 to comprise an array of light sources 2, in the form of LEDs, that is edge coupled to a
6 planar light guide 3. Located across an outer surface of the planar light guide 3 are a
7 plurality of first and second light extraction features 10 and 11. The first 10 and second
8 light extraction features 11 are deployed across the surface of the planar light-guide 3
9 within an interleaved pattern.

10

11 Figure 3(b) provides further detail of the interleaved pattern between the first 10 and
12 second light extraction features 11. As can be seen the interleaved pattern comprises
13 alternative rows of first 10 and second light extraction features 11. The surface area of the
14 extraction features 10 and 11 can be seen to increase the further the extraction features
15 are from the light source 2.

16

17 In the embodiment presented in Figure 3 the first 10 and second light extraction features
18 11 are reflective extraction features and are located on a common surface of the planar
19 light guide 3. In particular the first extraction features 10 comprise micro lenses coated
20 with a reflective coating. Further detail of the interaction of these mirrored micro lenses
21 with the light 4 coupled within the light guide 3 is presented schematically within Figure 4.
22 The second light extraction features 11 may comprise asymmetrical or symmetrical 3-d
23 shapes forming, triangle or pyramid shapes, random micro lenses, v-grooves, cylinders as
24 presented below within Figure 8(a).

25

26 Figure 5 presents three, luminance versus angle of observation graphs. The first of these
27 graphs, presented in Figure 5(a), shows the luminance versus angle of observation for the
28 first extraction feature 10 of the light guide device 9. The luminance profile for the first
29 extraction feature 10 is non-uniform. In particular, the luminance curve of Figure 5(a) is
30 seen to be asymmetric about the zero angle of observation with more light being extracted
31 within the -180° to 0° range.

32

33 The second of these graphs, presented in Figure 5(b), shows the luminance versus angle
34 of observation for the second extraction feature 11 of the light guide device 9. Again the
35 luminance profile is non-uniform but this time the luminance curve is seen to be

1 asymmetric about the zero angle of observation with more light being extracted within the
2 0° to 180° range.

3

4 Since the first 10 and second light extraction features 11 are deployed across the surface
5 of the planar light-guide 3 within an interleaved pattern they tend to compensate for each
6 other such that the luminance versus angle of observation graphs for the light guide device
7 9 as a whole is substantially uniform, as presented in Figure 5(c). As a result the light
8 guide device 9 exhibits a light output of substantially uniform angular luminance.

9

10 By arranging for the surface area of the extraction features 10 and 11 to increase the
11 further the extraction features 10 and 11 are from the light source 2 the extraction features
12 10 and 11 also provide a means for improving the spatial luminance uniformity of the
13 output light of the device 9. Alternatively, improved uniformity of the spatial luminance of
14 the output light of the device 9 can be achieved by arranging for the spacing between the
15 extraction features 10 and 11 to decrease the further the extraction features 10 and 11 are
16 located from the light source 2.

17

18 In an alternative embodiment of the light-guide device 9b the first 10b and second light
19 extraction features 11b are both refractive extraction features and are again located on a
20 common surface of the planar light-guide 3. Figure 6 presents an example of such
21 extraction features 10b and 11b in the form of cylinders having an asymmetric triangular
22 shaped cross sections. It will be appreciated by those skilled in the art that in order to
23 provide a uniform angular luminance profile with the extraction features 10b and 11b of
24 Figure 6 it is necessary to employ a light source 2 at either end of the light guide 3. As a
25 result, light coupled from the right hand side of Figure 6 provides the luminance versus
26 angle of observation curve of Figure 5(a) while the light coupled from the left provides the
27 luminance versus angle of observation curve of Figure 5(b). The overall effect is that an
28 interleaved pattern of these refractive extraction features 10b and 11b provides a
29 luminance versus angle of observation curve for the light-guide device 9b as presented in
30 Figure 5(c). As a result the light guide device 9b exhibits a light output of substantially
31 uniform angular luminance.

32

33 In a similar manner to that described above an appropriate choice of surface area or
34 spacing of the extraction features 10b and 11b can be employed to also provide the light
35 guide device 9b with uniform spatial luminance.

1

2 It will be appreciated by those skilled in the art that the first extraction features 10 may
3 comprise reflective extraction features while the second light extraction features 11 may
4 comprise refractive extraction feature, or vice versa. Figure 7(a) presents one such
5 suitable reflective extraction feature 10c which comprises a change in shape of the surface
6 of the planar light-guide 3, in the form of a first transparent hemispherical micro lens
7 having a reflecting coating. Such components provide a luminance versus angle of
8 observation graphs of the type shown in Figure 5(a). In a similar manner a second
9 transparent hemispherical micro lens 11c, with no mirrored coating, is also employed to
10 provide the second refractive extraction features. Such components provide a luminance
11 versus angle of observation graph of the type shown in Figure 5(b). In this embodiment it
12 is necessary to incorporate a reflector 8 on the side of the planar light-guide 3 opposite to
13 where the output light is to be viewed in order to provide the light-guide device 9c with a
14 light output of substantially uniform luminance.

15

16 It will be appreciated that alternative interleaved patterns may be adopted. For example
17 the interleaved pattern may comprise:

- 18 1) alternative columns of first 10 and second light extraction features 11;
- 19 2) the first 10 and second light extraction features 11 arranged as a chequered
20 pattern;
- 21 3) less regular arrangements of the first 10 and second light extraction features 11
22 e.g. the extraction features may be grouped in two or more rows or columns, or
23 randomly located within an array across the surface of the planar light-guide 3. In
24 such embodiments the uniformity of the output light may be reduced.
- 25 4) more than two types of extraction features arranged in any of the patterns
26 described in 1) to 3).

27

28 In all of the above described embodiments, except for those comprising solely reflective
29 extraction features 5, the extraction features 5 may be located on opposite surfaces of the
30 planar light-guide 3. This is a less preferable arrangement however since it is likely to
31 make the device thicker and increase the manufacturing costs.

32

33 With the above arrangements it will be appreciated by those skilled in the art that the
34 uniform nature of the output light from the light guide device 9 is not dependent upon the
35 light guide being planar. Thus the light guide may now be curved or bent without

1 significant deterioration of the uniform nature of the output light. Thus an observer will not
2 see bright and dark areas as they change their viewing angle of the light guide device 9,
3 even when it is non-planar. In practice high uniformity levels (>70%) for an observer have
4 been achieved with the above described apparatus for light guide devices exhibiting large
5 curvatures (bend radius > 10cm).

6

7 Alternative embodiments of the light guide device 9 may comprise the first 10 and second
8 light extraction features 11 being located upon opposite surfaces of the planar light guide
9 3. By way of example Figure 8 presents alternative surface features that may be
10 employed as the extraction features 10 and 11. The extraction features shown in Figure
11 8(a) comprise a reflective coating and so are suitable for use as reflective extraction
12 features while the extraction features shown in Figure 8(b) do not comprise a reflective
13 coating and so are suitable for use as refractive extraction features. As can be seen the
14 surface features of Figure 8 include asymmetrical or symmetrical 3-d shapes forming
15 micro lenses, triangle or pyramid shapes, random micro lenses, v-grooves, cylinders.

16

17 The flexibility of the light guide device 9 is further demonstrated with reference to Figure 9.
18 In particular, Figure 9 shows a plan view of a light guide device 9d comprising an
19 interleaved pattern having two different types of extraction features. In this embodiment
20 the light-guide device 9d is intended to be illuminated from either side of the light guide 3
21 therefore the extraction features exhibit different surface area densities so as to allow for a
22 uniform spatial illumination profile, as well as a uniform angular luminance profile to be to
23 be provided by the device.

24

25 The reflective coatings employed with the extraction features may be specular (mirror) or
26 non-specular (white).

27

28 The light source 2 may comprise a single LED or multiple LEDs of the same or differing
29 colours. The light sources can be located at one or more edges of the light guide. The
30 light sources 2 can be embedded within the light guide 3 or located in apertures or ports
31 formed in the light guide 3. The distribution of the light sources 2 within or across the light
32 guide 3 can be a regular 2-d pattern such as hexagonal or square, or can vary in an
33 irregular manner with the density of LEDs changing across the light guide. The light
34 sources 2 can be edge-emitting, side emitting, or top emitting LED packages. The light

1 sources 2 may be LED, super luminescent LED, micro cavity or laser diode chips. The
2 light sources 2 may be fluorescent lamps.

3

4 The light guide 3 may be square, rectangular, circular or any other regular shape in cross
5 section. Alternatively, the light guide 3 may have an irregular shaped cross-section. The
6 size of the light guide 3 may vary from 1cm to 2m, with a thickness range from 0.1mm to
7 10mm.

8

9 The size (x,y,z) of the individual light extraction features 10 and 11 may be in the range of
10 1 micron to 1cm. The light extraction features 10 and 11 may be a nanostructure with
11 photonic bandgap, diffractive or non-linear optical prosperities.

12

13 Although the above described interleaved patterns of the first 10 and second extraction
14 features 11 have been designed to produce an output for the device that is uniform it will
15 be appreciated that alternative predetermine luminance profiles for the output light can be
16 produced through the careful selection and deployment of the extraction features 10 and
17 11. Being able to control the angular distribution of “task” lighting and/or “decorative”
18 lighting is important for example, to reduce glare, for interior roof lights within cars where it
19 is desirable to direct the output light towards only the two front passengers, or within an
20 office environment where it is desirable for the majority of the light to be directed towards
21 desks in work area.

22

23 The present invention is inherent with significant advantages over the light guide devices
24 known in the art. In the first instance a uniform light output can be achieved for a planar
25 light guide device without the need to employ a diffuser or a reflector. This provides a light
26 guide device suitable for having reduced thickness and manufacturing costs when
27 compared to those known in the art.

28

29 In addition, the uniform nature of the output light from the light guide device is maintained
30 even when the device is curved or bent i.e. non-planar. This significantly increases the
31 potential application of the presently described light-guide devices e.g. as low cost, energy
32 efficient, aesthetically pleasing lights, backlights for curved or flexible displays and
33 signage, automotive and avionic interiors for display and lighting, lighting for medical
34 products. These are all applications where the spatial luminance distribution and the
35 angular distribution can be optimised for delivering light where required.

1

2 A light guide device for illumination, lighting and display purposes that exhibits an output
3 light having a predetermined, and preferably uniform, angular luminance profile is
4 described. The device comprises a light guide suitable for guiding light coupled thereto
5 and a plurality of extraction features located on one or more surfaces of the light guide.
6 The plurality of extraction features comprises an interleaved pattern of first and second
7 extraction features the arrangement of which provides a means for defining the
8 predetermined angular and spatial luminance profiles for the output light. The device
9 allows for a uniform angular luminance profile to be produced that is maintained even
10 when the light guide is curved or bent.

11

12 The foregoing description of the invention has been presented for purposes of illustration
13 and description and is not intended to be exhaustive or to limit the invention to the precise
14 form disclosed. The described embodiments were chosen and described in order to best
15 explain the principles of the invention and its practical application to thereby enable others
16 skilled in the art to best utilise the invention in various embodiments and with various
17 modifications as are suited to the particular use contemplated. Therefore, further
18 modifications or improvements may be incorporated without departing from the scope of
19 the invention as defined by the appended claims.

20

21

1 Claims

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3 1) A light guide device comprising a light guide suitable for guiding light coupled
4 thereto and a plurality of extraction features located on one or more surfaces of the
5 light guide and arranged to redirect a portion of the guided light so as to provide an
6 output light wherein the plurality of extraction features comprises an interleaved
7 pattern of first and second extraction features.

8

9 2) A light guide device as claimed in claim 1 wherein the first extraction features
10 produce a first angular luminance profile component for the output light.

11

12 3) A light guide device as claimed in claim 1 or claim 2 wherein the second extraction
13 features produce a second angular luminance profile component for the output
14 light.

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16 4) A light guide device as claimed in any of the preceding claims wherein the
17 interleaved pattern of the first and second extraction features provide the output
18 light with a uniform angular luminance profile.

19

20 5) A light guide device as claimed in any of the preceding claims wherein the light
21 guide device further comprises one or more light sources arranged to couple light
22 into the light guide.

23

24 6) A light guide device as claimed in any of the preceding claims wherein the
25 interleaved pattern comprises an array of elements made up of the first and second
26 extraction features.

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28 7) A light guide device as claimed in claim 6 wherein the array comprises an array of
29 irregularly spaced elements.

30

31 8) A light guide device as claimed in claim 7 wherein the spacing between the
32 elements of the array decreases the further the elements are located from the one
33 or more light sources.

34

- 1 9) A light guide device as claimed in claim 6 wherein the array comprises an array of
2 regularly spaced elements.
3
- 4 10) A light guide device as claimed in claim 9 wherein the area of the elements of the
5 array increase the further the elements are located from the one or more light
6 sources.
7
- 8 11) A light guide device as claimed in any of claims 6 to 10 wherein the array
9 comprises alternative rows or columns of the first and second extraction features.
10
- 11 12) A light guide device as claimed in any of claims 6 to 10 wherein the array
12 comprises a chequered pattern of first and second extraction features.
13
- 14 13) A light guide device as claimed in any of the preceding claims wherein the
15 interleaved pattern comprises more than two types of extraction features.
16
- 17 14) A light guide device as claimed in any of the preceding claims wherein the
18 extraction features are located on a common surface of the light guide.
19
- 20 15) A light guide device as claimed in any of claims 1 to 13 wherein the extraction
21 features are located on opposite surfaces of the light guide.
22
- 23 16) A light guide device as claimed in any of the preceding claims wherein the
24 extraction features comprise a reflective extraction feature or a refractive extraction
25 feature.
26
- 27 17) A light guide device as claimed in any of the preceding claims wherein the light
28 guide is planar.
29
- 30 18) A light guide device as claimed in any of claims 1 to 16 wherein the light guide is
31 non-planar.
32
- 33 19) A method of producing a light guide device the method comprising:
34 -providing a light guide suitable for guiding light coupled thereto; and

1 -locating an interleaved pattern of first and second extraction features one or
2 more surfaces of the light guide so as to provide a means for forming an output
3 light.

4

5 20) A method of producing a light guide device as claimed in claim 19 wherein the
6 interleaved pattern is located so as to provide the output light with a uniform
7 angular luminance profile.

8

9 21) A method of producing a light guide device as claimed in claim 19 or claim 20
10 wherein the interleaved pattern is formed by locating the first and second extraction
11 features on a common surface of the light guide.

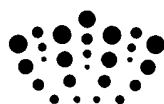
12

13 22) A method of producing a light guide device as claimed in claim 19 or claim 20
14 wherein the interleaved pattern is formed by locating the first and second extraction
15 features on opposite surfaces of the light guide.

16

17 23) A method of producing a light guide device as claimed in any of claims 19 to 22
18 wherein the method further comprise the step of coupling a light source to the light
19 guide.

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Claims searched: All

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Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-6, 9, 15-20, 22, 23	WO2009/073470 A1 (3M INNOVATIVE PROPERTIES CO) See figures 11, 12, 13, pages 18, 19 and claim 5
X	1, 5, 6, 7, 11, 13, 14, 17, 19, 21, 22	US2009/0322986 A1 (CHUNGHWA PICTURE TUBES LTD) See figure 2 and paragraphs 0034, 0051
X,P	1, 5, 6, 8, 10, 11, 14, 16, 17, 19, 21, 23	WO2011/019785 A1 (3M INNOVATIVE PROPERTIES CO) See figures 1a, 1b, 7 and pages 8, 11, 12
A,P	-	US2011/051460 A1 (SHARP KK) See figure 4, paragraph 0065 and claim 15

Categories:

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Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X :

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Worldwide search of patent documents classified in the following areas of the IPC

G02B

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC, TXTE

International Classification:

Subclass	Subgroup	Valid From
G02B	0006/00	01/01/2006