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(54) Title: IMPROVED LCD BACKLIGHT DISPLAY

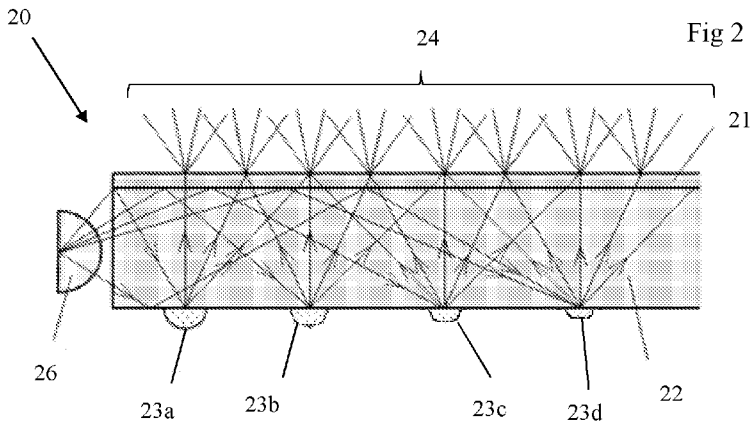

Fig 2

(57) Abstract: The following invention relates to an improved LCD Backlight, particularly to an improved arrangement of the optical scattering dots within the light guiding plate. The light guiding plate (22) comprises a lower surface which is formed with a plurality of optical scattering dots (23a-23d), which scatter and reflect the light beams to convert the light beams into a uniform surface light source, characterised wherein the surface area of each optical dot decreases as a function of its distance from at least one of the three edges comprising the LED lights (26).

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Improved LCD Backlight Display

The following invention relates to an improved Liquid Crystal Display (LCD) Backlight, particularly to a compact backlight display module for use with a Head Up Display (HUD) device, more particularly to an improved arrangement of the optical scattering dots within the diffusing plate.

LCD devices typically comprise a backlight module having a light source, with various light manipulating devices to illuminate a liquid crystal panel. The light output from the module is preferably uniform to ensure that the image is adequately illuminated and there is an acceptable degree of luminance from the output. A typical backlight module is shown in US2011317447.

Before the present invention is described in further detail, it is to be understood that the invention is not limited to the particular embodiments described, as such may, of course, vary. It is also to be understood that the terminology used herein is for the purpose of describing particular embodiments only, and is not intended to be limiting, since the scope of the present invention will be limited only by the appended claims.

According to a first aspect of the invention there is provided a backlight module device for illuminating an LCD, comprising: a housing comprising a first reflective coating located on an inner surface of the housing;

a light guide plate with an upper and lower surface, received within the housing for converting light beams into a corresponding surface light source, emitted from said upper surface.

the light guide plate comprises of a lower surface which is formed with a plurality of optical scattering dots, which scatter and reflect the light beams to convert the light beams into a uniform surface light source,

an illumination source, comprising a plurality of LED lights located on three edges of the light guide plate, said plate received within the housing, for providing light beams;

a diffuser film received within the housing and mounted on the upper surface of the light guide plate, the diffuser film further unifying the light beams from the light guide plate;

two orthogonally co-located brightness enhance films received within the housing and mounted on the diffuser film,

characterised wherein the surface area of each optical dot decreases as a function of its distance from at least one of the three edges comprising the LED lights.

Edge lit displays may be illuminated from any number of edges, clearly the more edges that are illuminated the greater the brightness output from the backlight module. However, LCD devices are required to fit into ever smaller volumes. There is a desire to reduce the size of the device and hence reduce the number of edges that are required to be illuminated, retaining a high light output. Conventionally light guide plates with optical dot scatterers are typically arranged such that as the surface area of the optical dot increases as a function of distance from the LED edge illumination source. However, where the distance between the edge of the guide plate and the start of the optically transparent aperture is minimised, such as, for example less than 10% of the total width of the aperture, preferably less than 5%, then the arrangement of the optical scattering dots is preferably configured to enhance output uniformity such that the surface area of each optical dot decreases as a function of its distance from at least one of the three edges comprising the LED lights.

These modifications have provided backlight luminance of 400,000 cd/m^2 compared with an expected 160,000 cd/m^2, without modification.

The optical scattering dots may be selected from any polygonal shape, but are preferably substantially circular and the effective radius of said optical scattering dots decreases as a function of distance from at least one of the three edges comprising the LED lights. The optical scattering dots may have a three dimensional geometry to increase further the surface area.

In a preferred arrangement the effective radius of each of said optical scattering dots decreases as a function of distance from all three edges comprising the LED lights.

The housing is simply a means for protecting the optical guide, and the illumination source. In a preferred arrangement to further reduce the volume of the device the housing may be formed from a mounting plate and substantially vertically upstanding walls, said walls comprising the illumination source.

The illumination source is formed from a plurality of LEDs, mounted on printed circuit boards (PCB), said boards being further mounted on a heat sink, wherein each LED comprises an emitting structure and a lens to reduce the divergence of the light output and hence enhance coupling efficiency into the optical guide.

Backlight module devices try to minimise light leakage from the light guide plate and attempt to re-reflect any light that is emitted from the other face or un illuminated edges. In a preferred arrangement the light guide plate has a white reflector located on the upper and lower surface, wherein the white reflector on said upper surface has an optically transparent aperture which corresponds to the size of the LCD display. The white reflector reflects light back into the light guide.

The outmost optical component is a display mask plate, which is located on the two BEF films, wherein said display mask plate comprises a reflective or absorptive coating, with an optically transparent aperture which corresponds to the size of the LCD display. The display mask transparent aperture ensures that only light being emitted from the module is that which corresponds to the same area as the LCD unit optionally located thereupon.

The display mask provides an aperture, wherein along at least two opposing edges, the width of said reflective or absorptive coating is 10% of the aperture width, preferably 5%.

The light guide plate may be fabricated from any optically transparent material, preferably acrylic.

An embodiment of the invention will now be described by way of example only and with reference to the accompanying drawings of which:-

Figures 1a and 1b show side and top views of the backlight module.

Figure 2 shows a side view of the light guide plate and optical scattering dots.

Turning to figure 1a there is provided a backlight module generally shown at 1. There are a plurality of illumination sources 16. The illumination source is formed from a heat sink 6, onto which is mounted a printed circuit board 5. The circuit 5 contains a plurality of LEDs 4, which have their output focused by means of a lens 3.

The illumination source 16 is located on three of the edges (as shown in Figure 1b) of a light guide plate 2. The lower surface of the light guide plate 2 is formed with a plurality of optical scattering dots (not-shown - see figure 2) and is encapsulated by at least one layer of a white reflector 8a, 8b. The lower white reflector layer 8a covers the entire lower face of the light guide plate 2. White reflectors 8a, 8b, reflects light back into the light guide plate. The upper white reflector layer 8b, has an optically transparent aperture 9 which allows the light from the light guide to leave the device. Located on top of the aperture 9, is a diffuser film 10, which further unifies the output luminance. Two orthogonally co-located brightness enhancement films shown generally at 11, are located on the diffusing plate 10. The final optical component is a display mask layer 12, with an optically transparent aperture 13, wherein the aperture 13 has substantially the same area as the LCD display 17 which is to be illuminated and projected.

The housing 15, is formed from a mounting plate 7, on which is located three sides of edge illumination sources 16. From figure 2, the fourth edge 14, has no illumination source, and is provided instead with a layer of white reflector.

Turning to figure 2, there is shown a light guide 20, comprising a light guide plate 22, with light entering from the illumination source 26. On the lower surface of light guide plate 22, is located a plurality of optical scattering dots (23a-23d), whose surface area decreases as a function of their distance from the edge illumination source 26. The light guide employs a diffusing film 21, to further unify the light output 24, to the LCD display.

Claims

1. A backlight module device for illuminating an LCD, comprising: a housing comprising a first reflective coating located on an inner surface of the housing;

a light guide plate with an upper and lower surface, received within the housing for converting light beams into a corresponding surface light source emitted from said upper surface.

the light guide plate comprising a lower surface which is formed with a plurality of optical scattering dots, which scatter and reflect the light beams to convert the light beams into a uniform surface light source,

an illumination source, comprising a plurality of LED lights located on three edges of the light guide plate, said plate received within the housing, for providing light beams;

a diffuser film received within the housing and mounted on the upper surface of the light guide plate, the diffuser film further unifying the light beams from the light guide plate;

two orthogonally co-located brightness enhance films received within the housing and mounted on the diffuser film,

characterised wherein the surface area of each optical dot decreases as a function of its distance from at least one of the three edges comprising the LED lights.

2. The device according to claim 1, wherein the optical scattering dots are substantially circular, and the effective radius of said optical scattering dots decreases as a function of distance from at least one of the three edges comprising the LED lights.

3. The device according to claim 1 or claim 2 wherein the effective radius of said optical scattering dots decreases as a function of distance from all three edges comprising the LED lights.

4. The device according to any one of the preceding claims wherein the housing is formed from a mounting plate and substantially vertically upstanding walls, said walls comprising the illumination source.

5. The device according to any one of the preceding claims wherein the illumination source is formed from a plurality of LEDs, mounted on printed circuit boards, further mounted on a heat sink, wherein each LEDs comprises an emitting structure and a lens to reduce the divergence of the light output and hence enhance coupling efficiency into the optical guide.

6. The device according to any one of the preceding claims wherein the light guide plate has a white reflector located on the upper and lower surfaces, wherein the white reflector on said upper surface has an optically transparent aperture which corresponds to the size of the LCD display.

7. The device according to any one of the preceding claims wherein a display mask plate is located on the BEF films, wherein said display mask plate comprises a reflective or absorptive coating, with an optically transparent aperture which corresponds to the size of the LCD display.

8. The device according to claim 7, wherein the display mask provides an aperture, wherein along at least two opposing edges, the width of said reflective or absorptive coating is 10% of the aperture width.

9. The device according to any one of the preceding claims, wherein the light guide plate is made from acrylic.

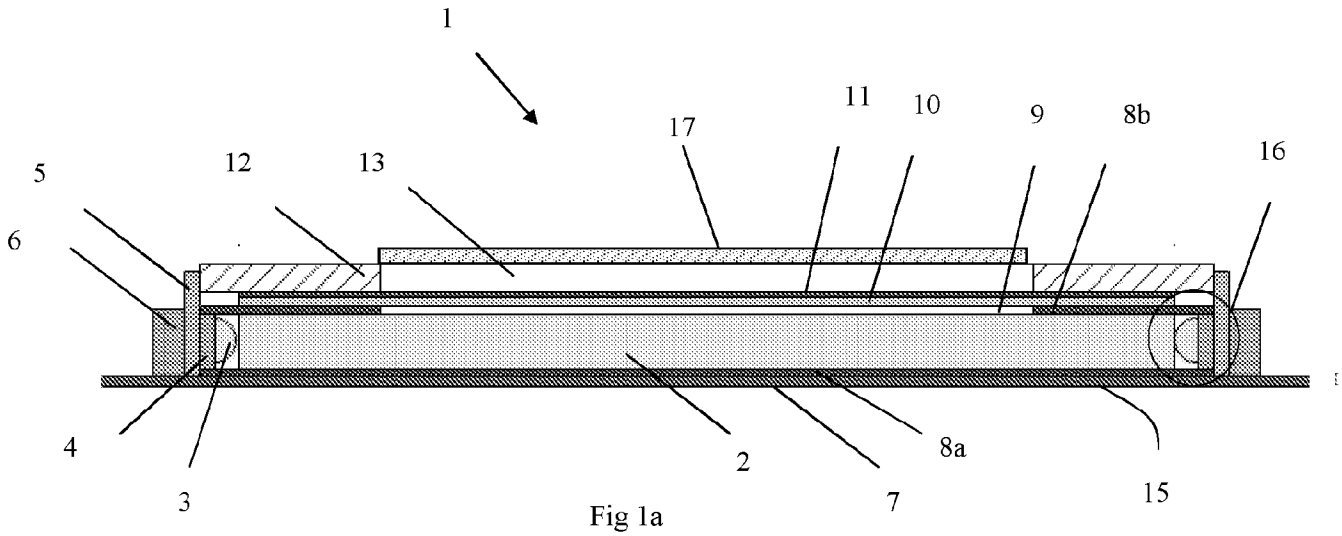

Fig 1a

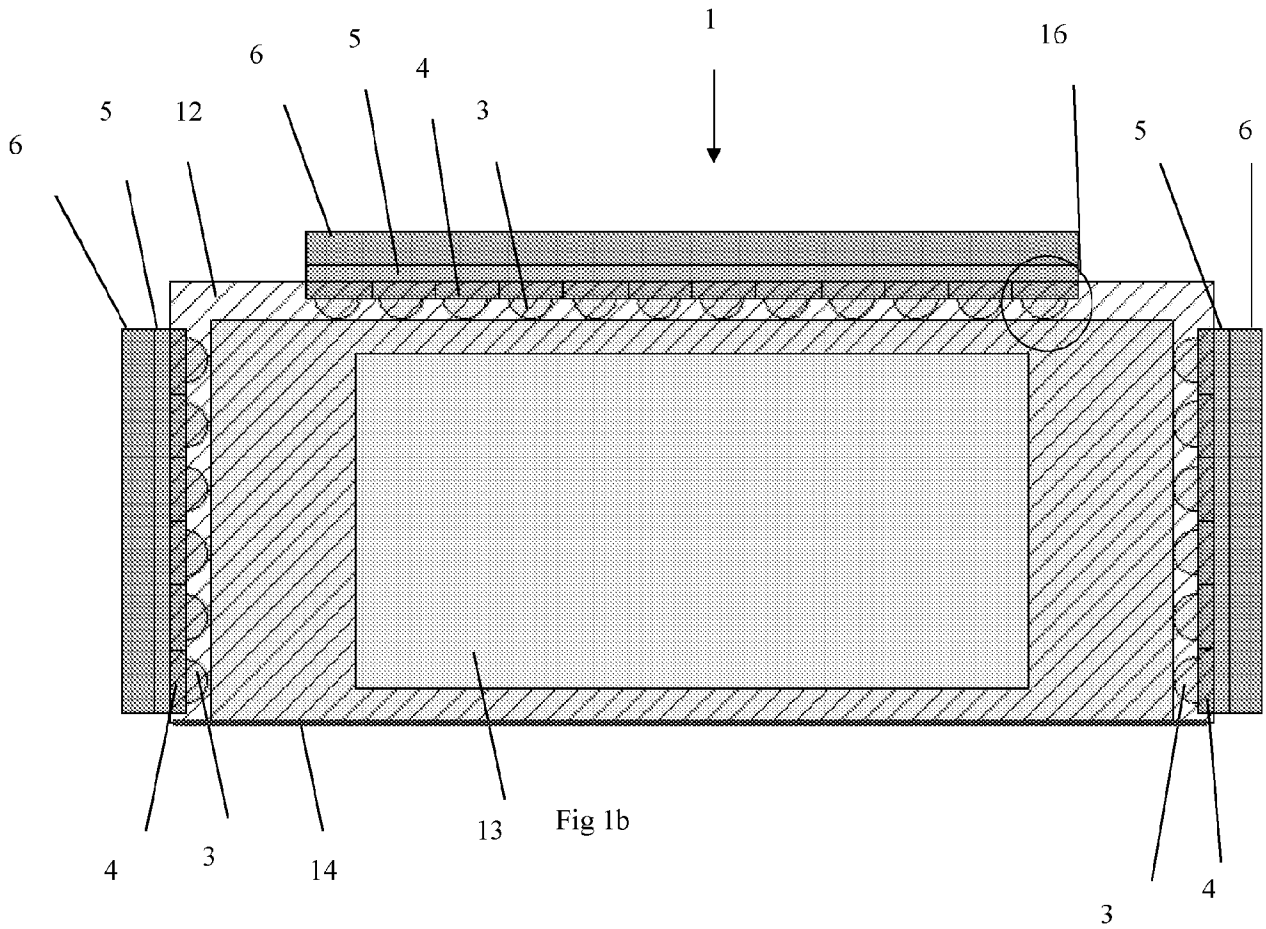

Fig 1b

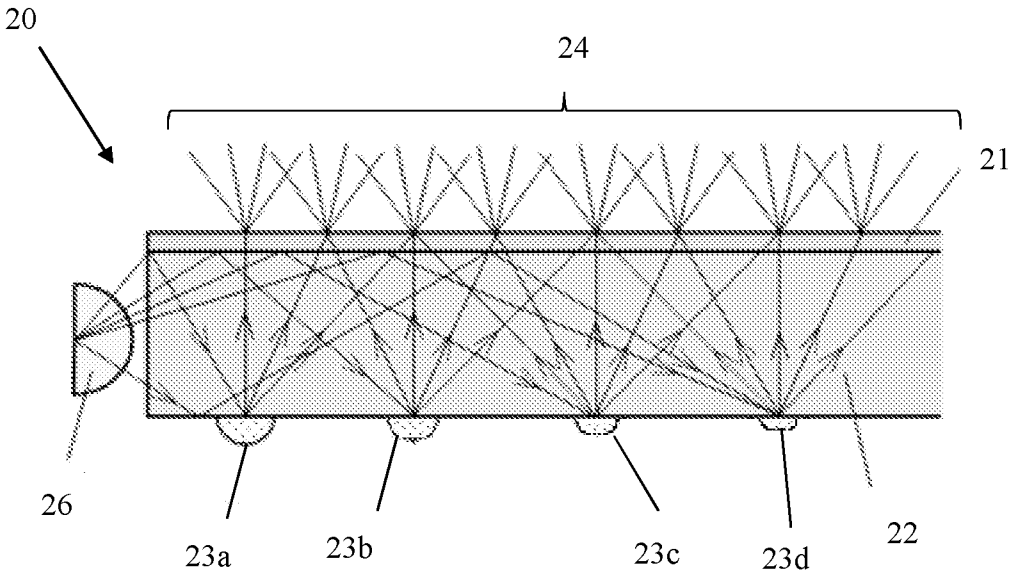

Fig 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2013/052567

A. CLASSIFICATION OF SUBJECT MATTER
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ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2008/136995 A1 (OOHIRA EIJI [JP]) 12 June 2008 (2008-06-12) the whole document	1-9
Y	US 2011/242146 A1 (UCHIDA TATSUO [JP] ET AL) 6 October 2011 (2011-10-06) paragraph [0053]	1-9
Y	US 2012/014136 A1 (LEE DONG SEOK [KR] ET AL) 19 January 2012 (2012-01-19) pages 2,3; figure 3	1-9
Y	US 2001/017774 A1 (ITO TOMOTAKA [JP] ET AL) 30 August 2001 (2001-08-30) the whole document	1-9

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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PCT/GB2013/052567

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