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**Datasheet for the decision
of 13 November 2019**

Case Number: T 1980/15 - 3.4.02

Application Number: 11156643.6

Publication Number: 2365384

IPC: G02F1/13357

Language of the proceedings: EN

Title of invention:

A backlight unit for a liquid crystal display and a method of making the same

Applicant:

Vestel Elektronik Sanayi ve Ticaret A.S.

Headword:

Relevant legal provisions:

EPC Art. 56

Keyword:

Inventive step - (no)

Decisions cited:

Catchword:



Beschwerdekammern

Boards of Appeal

Chambres de recours

Boards of Appeal of the
European Patent Office
Richard-Reitzner-Allee 8
85540 Haar
GERMANY
Tel. +49 (0)89 2399-0
Fax +49 (0)89 2399-4465

Case Number: T 1980/15 - 3.4.02

D E C I S I O N
of Technical Board of Appeal 3.4.02
of 13 November 2019

Appellant: Vestel Elektronik Sanayi ve Ticaret A.S.
(Applicant) Organize Sanayi Bölgesi
45030 Manisa (TR)

Representative: Cayli, Hülya
Paragon Consultancy Inc.
Koza Sokak No: 63/2
GOP
06540 Ankara (TR)

Decision under appeal: **Decision of the Examining Division of the
European Patent Office posted on 1 June 2015
refusing European patent application No.
11156643.6 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman R. Bekkering
Members: A. Hornung
G. Decker

Summary of Facts and Submissions

- I. The applicant appealed against the decision of the examining division refusing European patent application No. 11156643.6 on the basis of Article 56 EPC.
- II. The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of claims 1 to 7 according to the main request or of claim 1 to 6 according to the auxiliary request, both requests filed with the letter dated 10 October 2019.
- III. Oral proceedings before the board were held on 13 November 2019.
- IV. The present decision refers to the following documents:
D3: US 2009/0196014 A1
D4: US 2010/0033947 A1
- V. Independent claim 1 according to the main request reads as follows:

"A backlight unit for a liquid crystal display (LCD), the backlight unit comprising;

- a diffuser layer (24);
- an optical source (10, 20) comprising one or more optical source components (12, 22) of cold cathode fluorescent lights, External Electrode Fluorescent Lamps and LED's and a reflector to direct light from the optical source components (12, 22) to the diffuser layer (24);
- a fluorescent layer (26) arranged to fluoresce in response to stimulating radiation received from the diffuser layer (24) or in response to stimulating radiation received from the optical source (10, 20), wherein the thickness and/or density of the fluorescent layer (26) varies across the area of the backlight unit to counteract defects in the

uniformity of light received from the optical source (10, 20) and optical components such that amount or density of a fluorescent material of fluorescent layer (26) in regions which are not directly above an individual optical source component is larger than the fluorescent material in regions which are directly above an individual optical source component

- a wavelength dependent reflector (28) provided between the optical source (10, 20) and the diffuser layer (24), which is configured to reflect light of certain frequencies whilst allowing light of other wavelengths through, wherein the fluorescent layer (26) is provided on the opposite side of the diffuser layer (24) than the wavelength dependent reflector (28) or wherein the fluorescent layer (26) is provided between the diffuser layer (24) and wavelength dependent reflector (28)."

First auxiliary request

Independent claim 1 according to the first auxiliary request differs from claim 1 of the main request only in that the feature "which is configured to reflect light of certain frequencies whilst allowing light of other wavelengths through" is replaced by "which is configured to obstruct visible light generated by the fluorescent layer (26) whilst allowing through the stimulating radiation generated by the optical source (10, 20)".

Reasons for the Decision

1. Main request - inventive step

1.1 The subject-matter of claim 1 is obvious in view of the disclosure of D3 in combination with D4 and common general knowledge (Article 56 EPC).

1.1.1 D3 discloses, with reference to figure 3, a backlight unit (2) for a liquid crystal display, the backlight unit comprising:

- a diffusion film (see [0045]),
- an optical source (20) comprising an LED (see [0025]),
- a fluorescent layer (25) arranged to fluoresce in response to stimulating radiation received from the diffuser layer (see [055] disclosing an embodiment of a wavelength converting layer (21) comprising a "fluorescent color-conversion-media") wherein the thickness and/or density of the fluorescent layer varies to counteract defects in the uniformity of light received from the optical source (see the following paragraphs in D3:

[0026] discloses a pattern (26) for reducing the "mura effect";

[0004] discloses that the "mura effect" means the luminance difference of a lighting area;

[0030] discloses that the pattern (26) can be made of "fluorescent color-conversion media";

[0031] discloses that the fluorescent layer has a "specially arranged contour, profile or patterns at a specific area to acquire a uniform lighting area";

[0032] discloses that the pattern (26) and the wavelength converting layer (25) are formed in one piece;

[0033] discloses that the thickness of the pattern (26) at a specific area is determined

according to the luminance at that area for producing a uniform lighting area;

[0034] discloses that the material of the pattern (26) is the same as the wavelength converting layer (25);

[0041] discloses that the thickness of the pattern (26) is variant for controlling the mura effect).

In the embodiment of D3 comprising a fluorescent layer with a pattern made of a fluorescent media, the actual profile and position of the pattern is left open (see [0030] and [0031]). Moreover, D3 does not disclose any wavelength dependent reflector for avoiding fluorescent light to be radiated back to the light source. Still further, D3 remains silent about the concrete features of the light source.

1.1.2 It follows that the subject-matter of claim 1 differs from the backlight of D3 in that

- (a) the amount or density of fluorescent material in regions which are not directly above an individual optical source component is larger than in regions which are directly above an individual optical source component,
- (b) a wavelength dependent reflector is provided between the optical source and the diffuser layer, the wavelength dependent reflector being configured to reflect light of certain frequencies whilst allowing light of other wavelengths through, wherein the fluorescent layer is provided on the opposite side of the diffuser layer than the wavelength dependent reflector or wherein the fluorescent layer is provided between the diffuser layer and wavelength dependent reflector and in that

(c) the optical source comprises a reflector to direct light from the optical source to the diffuser layer.

1.1.3 Distinguishing features (a) to (c) relate to distinct technical aspects of the backlight, namely:

- (a) non-uniform distribution of fluorescent media in the fluorescent layer generating non-uniform distribution of the emitted fluorescent light [feature (a)],
- (b) reflecting backwards the fluorescent light emitted by the fluorescent layer while letting through the light emitted from the light sources [feature (b)],
- (c) directing the light from the light sources to the diffusing layer [feature (c)].

See points 1.1.4, 1.1.5 and 1.1.6 below for further details about the respective technical effects. In other words, features (a) to (c) correspond to an aggregation of features which do not present any functional interaction achieving a combined technical effect being different from the sum of the technical effects of the individual features.

1.1.4 Feature a)

Technical effect

According to the distinguishing feature a), the amount or the density of fluorescent material in the regions between optical source components is larger than in regions directly above the optical source components. Due to the increased amount or density of fluorescent material in these regions between the optical source components, the technical effect of the distinguishing feature a) is to increase the amount of fluorescent light generated by the fluorescent layer in these regions between the optical source components when illuminated by the light sources with a predetermined light intensity. In particular, for conventional light sources

having a light intensity distribution which is either lambertian or maximum in a direction perpendicular to the plane of the printed circuit board, the light intensity received from the optical source components at the fluorescent layer corresponding to the regions between the optical source components is lower than the light intensity received from the optical source components in the regions directly above the optical source components.

As a consequence of the distinguishing feature a), the reduced amount of light arriving from the optical source components at the regions between optical sources is compensated by the increased amount or density of fluorescent material in these regions. The overall effect of the distinguishing feature a) is a better uniformity of light emitted from the backlight.

Objective technical problem

Starting from D3, the problem to be solved can, therefore, be seen in defining the actual profile and position of the pattern (26) on the fluorescent layer (25) in order to provide a backlight with a uniform optical intensity distribution across the surface of the backlight unit.

Solution

In a conventional backlight as shown, for instance, in figure 1 of D3, the skilled person is confronted with the problem of a non-uniform intensity of light across the surface of the backlight, called "Mura effect" in D3, [0004]. In particular, as shown in figure 5 by the luminance distribution identified by triangles (▲), the plurality of individual light sources (20) generate a maximum of light intensity directly above each individual light source component and a minimum of light intensity between the

positions of the individual light sources. In order to solve this problem, D3 generally teaches to provide "a patterned wavelength converting structure 21 for producing light with low mura" (see D3, [0025], figure 3).

In one of the embodiments of D3, instead of being made of diffusion particles which lower the transmittance as in a first embodiment described in [0027] and in figures 3 to 5 of D3, the pattern is made of a fluorescent color-conversion media (see D3, [0030]). D3 does not disclose a concrete example of the shape and the position of a pattern made of fluorescent media but provides guidance according to which the patterned layer "is arranged with a specially arranged contour, profile or patterns at a specific area to acquire a uniform lighting area" (see D3, [0031]). Within certain boundaries of the fluorescent layer thickness, this fluorescent color-conversion media has the additional effect of increasing the intensity of the fluorescent light emitted by the patterned layer proportionally to the amount or the density of the patterned layer. Therefore, starting from the embodiment described in D3, [0030], in order to render the optical intensity distribution across the surface of the backlight unit more uniform, it is obvious to increase the amount or density of fluorescent material in those regions where the light received from the optical source components is at a minimum, i.e. between the optical source components. This leads the skilled person in a straightforward manner to a definition of the profile and the position of the pattern (26) on the fluorescent layer (25) which results in an amount or density of fluorescent material in regions which are not directly above an individual optical source component being larger than in regions which are directly above an individual optical source component as defined in feature a) of claim 1.

1.1.5 Feature b)

According to feature b), a reflecting spectral filter is placed between the light source and the fluorescent layer. In the technical set-up of the present application, it has the technical effect of "obstructing visible light generated by the fluorescent layer (26) while allowing UV or other such radiation from the optical source components (22) to pass through to the fluorescent layer (26)" so that "all visible light generated by the fluorescent layer (26) is emitted by the device for use in the associated LCD" (see page 8, lines 19 to 24 of the patent application), thereby solving the problem of how to improve the illumination efficiency.

D3 discloses the same technical set-up since the UVc light sources irradiate the fluorescent layer (25, 26) with UV light to provide visible light illuminating a liquid crystal layer (see e.g. D3, [0026]). A part of the visible light generated by the fluorescent layer is directed backwards to the light sources and, hence, is lost for the illumination of the liquid crystal layer. In order to improve the illumination efficiency, the skilled person would implement a reflective spectral filter as taught in D4 which is transparent for the ultra-violet light emitted by the light sources and reflective for the visible light emitted by the patterned fluorescent layer (25, 26) and which is positioned between the light sources and the fluorescent layer, thereby arriving at feature b) in a straightforward manner.

1.1.6 Feature c)

According to paragraph [0025] of D3, "Fig. 3 discloses a flat light source 2 including a light source 20 disposed

inside a frame (not shown)". No further details are disclosed in D3 about the light source. However, it is common general knowledge to dispose a reflector close to the light source in order to reflect all the light generated by the light source towards the optical system, thereby solving the problem of how to improve the illumination efficiency. See, for instance, [0007] disclosing that in a prior art device "the lamps are disposed between the reflector and the diffuser plate". Therefore, feature c) does not involve an inventive step.

1.1.7 Since none of the aggregated features (a) to (c) involves an inventive step, the subject-matter of claim 1 lacks an inventive step within the meaning of Article 56 EPC in view of the disclosure of D3 in combination with D4 and common general knowledge.

1.2 Counter-arguments of the appellant

1.2.1 In its statement of grounds of appeal, the appellant argued that "[a]lthough document D3 discloses that thickness of the pattern 26 varies to reduce mura effect, it is not clear how the mura effect is reduced by varying the thickness of the pattern". Moreover, while referring to paragraph [0033] of D3, the appellant submitted that "according to the document D3, uniformity of the light is provided (...) by blocking light using the pattern", while "according to the present application, said uniformity is provided by reducing the amount/density of the fluorescent material of fluorescent layer in regions which are directly above an individual optical source". Therefore, the subject-matter of claim 1 involved an inventive step.

The board acknowledges that the embodiment referred to in D3, [0033], fourth sentence, seems to achieve uniform light distribution by somehow blocking light: the transmittance of

light is inversely proportional to the layer thickness (figure 4) and the effect of the pattern is to decrease the luminance emitted by the backlight (figure 5). In such an embodiment, the layer thickness in regions directly above the individual light sources would be larger than in other regions. However, this embodiment clearly relates to an implementation of the invention in which the pattern is made of (non-luminescent) diffusion particles which, due to the light diffusion effect, merely reduce the amount of transmitted light (see [0027]) in a manner proportional to the layer thickness. More precisely, in the embodiment described in paragraph [0027] of D3, the pattern is "a strip structure made of material with uniform density of diffusion particles and aligns to the light source 20; wherein the transmittance of light is inverse proportional to the thickness of the material according to FIG. 4 (...). According to FIG. 5, the luminance difference drops after the pattern 26 is formed".

The board, as well as the examining division in its appealed decision, refers to another embodiment (see [0030] to [0032], [0034] and [0055]) in which the pattern is made of fluorescent material. This kind of material generates fluorescent light proportionally to the layer thickness. Therefore, by increasing the layer thickness in regions which are less illuminated by the light sources, the overall light intensity of the backlight becomes more uniform.

- 1.2.2 In its letter dated 10 October 2019, page 5, last paragraph, the appellant submitted that "according to D3 the pattern 26 has a totally different task than generating visible light. Paragraph [0027] of document D3 defines the characteristics of the pattern 26 and clearly states that 'the transmittance of light [of pattern 26] is inverse proportional to the thickness'" [original emphasis].

As explained in point 1.2.1 above, the transmittance of light being inversely proportional to the thickness of the layer relates to the pattern described in [0027] of D3 and made of diffusing particles. With such a pattern, uniformity of the emitted light can only be achieved by increasing the thickness of the layer in those areas being irradiated with a maximum of light intensity. In the embodiment considered by the board in point 1.1.4 above, however, the pattern is made of fluorescent media having the additional effect of increasing the light emitted by the layer proportionally to the thickness. With such a pattern, uniformity of the emitted light can be achieved by increasing the thickness of the layer in those areas being irradiated with a minimum of light intensity. Depending on the exact circumstances (e.g. layer thicknesses of the backlight, angular distribution of the light emitted by light source, fluorescent material), the skilled person would provide a patterned layer comprising the distinguishing feature a).

- 1.2.3 During oral proceedings, the appellant reiterated its view according to which the basic principle underlying all the embodiments of D3 consisted in that the patterned layer of the backlight "cast a shadow" in order to render the emitted light by the backlight more uniform, i.e. the pattern deposited on the fluorescent layer had the effect of reducing transmittance of the light through the layer so that the patterned layer had to have a larger thickness in areas with a maximum of irradiated light intensity to render the emitted light by the backlight more uniform. This basic principle also applied to the embodiment of D3 in which the pattern was made of fluorescent media. Arguing that the skilled person would obviously consider providing a patterned layer according to the distinguishing feature a), i.e. revert the basic principle underlying all the embodiments of D3, amounted to an *ex post facto* analysis.

The board is not convinced by this argument. Achieving a uniform light intensity across the backlight by reducing the transmittance of the layer at areas being irradiated with a maximum of light intensity, i.e. the so-called "basic principle" of D3, relates to the embodiment described in paragraph [0027] and in figures 3 to 5, which is not the embodiment considered by the board in its line of argument concerning lack of inventive step. In the relevant embodiment described in paragraphs [0030] and [0031] of D3 and referred to in point 1.1.4 above, an additional effect to the lowering of the transmittance due to diffusing particles occurs in the pattern made of fluorescent media, namely the generation of fluorescent light proportionally to the amount of fluorescent media within certain boundaries of the thickness of the fluorescent media. Depending on the concrete circumstances, such as the layer thicknesses of the backlight, the angular distribution of the light emitted by light source or the exact nature of the fluorescent media, and in view of the fact that claim 1 does not define any limitations of these concrete circumstances, the skilled person, when putting the teaching of D3 into practice, i.e. providing a patterned layer "with specially arranged contour, profile or patterns at a specific area to acquire a uniform lighting area" (see D3, [0031]), would arrive at feature a) without exercising any inventive skills.

2. Auxiliary request - inventive step

The subject-matter of claim 1 is obvious in view of the disclosure of D3 in combination with D4 and common general knowledge (Article 56 EPC).

The amendment of claim 1 of the auxiliary request with respect to claim 1 of the main request merely deals with the distinguishing feature b), namely it clarifies the following properties of the wavelength dependent reflector:

- (a) the fluorescent layer generates visible light,
- (b) the wavelength dependent reflector obstructs this light,
- (c) wavelength dependent reflector lets pass through the stimulating radiation of the light sources.

These technical effects of the wavelength dependent reflector have already been taken into account when arriving at the conclusion that feature b) of claim 1 does not involve an inventive step. As explained in point 1.1.5 above, the reflective spectral filter which the skilled person would implement in the backlight of D3 comprises the amended features of claim 1 of the auxiliary request.

The appellant did not provide any further counter-arguments.

3. In view of the above, none of the appellant's requests is allowable and, therefore, the board sees no reason to set aside the contested decision. Consequently, the appeal must be dismissed.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:



C. Rodríguez Rodríguez

R. Bekkering

Decision electronically authenticated