

Description

Display for Creating Colour Images and Texts Recognisable by Incident Light**Technical Field**

[001] The invention pertains to a display for creating colour images and texts recognisable by incident light, in which the image area consists of numerous electronically controllable pixels in a raster-like arrangement and in which each pixel has at least three colour levels arranged beside one another (side by side) or behind one another (back to back) for the colours red, green, blue or cyan, magenta, yellow that are formed by flat transparent containers and whose inner chambers are connected to colour reservoirs whose content can be moved by electronic control in such a way that transparent colour fluids is fed from the colour reservoirs into the colour levels or from the colour levels into the colour reservoirs.

[002] Displays of this type are known from US 6,037,955, US 6,747,777 and EP 1 090 384. With these displays illuminated from outside by sunlight, daylight or lamps there is also the desire – depending on location and time of day – to illuminate the image formed by the pixels also from the back. Therefore, in EP 1 090 384 it is already suggested that one or more light sources be arranged behind the colour levels made of transparent material and in front of the colour reservoirs, so that the image formed by the pixels is also visible in darkness.

Disclosure of the invention

[003] It is the task of this invention to create a colour display, in which there is the possibility, with incident light particularly daylight, to optically highlight and/or colour-wise alter parts of the image formed by the controlled pixels.

[004] This task is fulfilled according to the invention, in that light sources are arranged behind the colour levels of the pixels, each of the light sources being allocated to one pixel and being individually electronically controllable.

[005] With the help of these light sources parts of the image illuminated by daylight can be optically highlighted or altered in their colours. The colour mixing can

take place – as in a colour TV – by additive mixing of the three basic colours red, green blue, or – as in the case of colour photography – by subtractive mixing of the colours yellow, magenta, and cyan.

- [006] The light sources allocated to the pixels could especially be white light emitting diodes.
- [007] The light sources could however also consist of plane illuminating bodies that illuminate a larger number of pixels from the back and of masks arranged between the illuminating bodies and the colour levels of the pixels, which can be controlled for each pixel in such a way that the light passage through the mask is open for each pixel or more or less closed.
- [008] For backlighting of a larger pixel field, particularly illuminating device as known in flat screens are suitable, which consist of a rectangular or quadratic light-conducting illuminating surface covering the pixel field and light emitting diodes (LEDs) or cathode ray tubes arranged on the side edges of the illuminating surface.
- [009] The masks can be formed by polarisation filters, whose light passage can be controlled for each pixel with the help of electronic fields. Two polarisation filters can be arranged and controlled in such a way that they block passage of all planes of polarisation of the light. The polarisation filters are foil-type and can be placed directly on the illuminating surface.
- [010] So that the colour levels can give an as brilliant image as possible with incident daylight, a white or silvery but non-reflective reflection layer, that is partially or temporarily light-permeable, is arranged behind the layer of the colour level. The reflection layer can be formed by a milky-turbid glass surface or plastic foil, or by a glass pane or plastic foil that is provided with a mat, white or silvery structure.
- [011] For improving the reflection of incident light and for improving the light-permeability of the backlighting a reflection layer is suggested that contains

leaf-shaped white or silvery pigments, and the pigments can be aligned parallel to the layer plane or perpendicular to it by means of an electrical or magnetic field. The swimming leaf-shaped pigments distributed uniformly in a fluid form a good reflection layer when they are aligned parallel to the layer plane, and this layer is largely light-permeable when the leaf structure of the pigments extends perpendicular to the reflection plane.

[012] However, the reflection layer can also be formed from one flat container made of transparent material that is filled with a white or silvery colour, when this layer is not supposed to reflect, and is filled with a clear transparent fluid when it is supposed to be light-permeable.

[013] The flat containers filled with white or silvery colour fluid or with colourless fluid can be arranged behind a pixel field or even as fourth colour level for each pixel. In both cases, the display can be switched over from day operation to night operation by changing the white or silvery reflection layer to a light-permeable layer allowing backlighting.

Brief description of drawings

[014] In the following description design embodiments of the invention are explained in more details on the basis of drawings.

[015] Fig. 1 shows a sectional view of a portion of the display according to the invention.

[016] Fig. 2 shows a top view on eight pixels of the display shown in Fig. 1.

[017] Fig. 3 shows a sectional view of a pixel field with flat backlighting.

[018] Each pixel 1 of the display has three colour level layers 2, 2', 2'' – with an upper colour level 3, a central colour level 3' and a rear colour level 3''. The colour levels 3, 3', 3'' are flat containers made of transparent material that are connected to colour reservoirs through channels 8, 8', 8'' and 9, 9', 9''.

Transparent colour fluids of the colours CYAN, MAGENTA and YELLOW (CMY) or RED, GREEN, BLUE (RGB) can be moved out of the colour reservoirs into the colour levels 3, 3', 3'' and back into the colour reservoirs. The colour fluid can be moved back and forth against an air cushion, or it can be moved along with a non-mixable colourless fluid in a closed loop or back and forth. If the colour levels 3, 3', 3'', the channels 8, 8', 8'' and 9, 9', 9'' as well as the corresponding colour reservoir are partly filled with a colour fluid and partly with a colourless fluid that is non-mixable with the colour fluid, and transportation of the colour fluid and the colourless fluid takes place in the known method by means of electro-wetting (US 6,037,955) or by means of another micro-pump, then the colour fluids can be fed to the colour levels 3, 3', 3'' through the channels 8, 8', 8'' and simultaneously the colourless fluid can be drained from the colour levels 3, 3', 3'' through the channels 9, 9', 9'' or vice-versa. Behind the colour levels 3, 3', 3'' of each pixel 1 a light source 6 is arranged, in particular a white emitting LED. This light source can be switched on and off independent of the other light sources 6 and, if required, can also be controlled in light intensity. These light sources are fixed on a carrier plate 7.

- [019] Behind the colour levels and in front of the light sources 6 there is a light-permeating white or silvery reflection layer 5, which can be formed by a plastic foil or a thin glass pane and whose light-permeability is at least 40%.
- [020] According to Fig. 3 the reflection layer can also be formed by a flat container 5', in which leaf-shaped silvery pigments swim in a fluid, which can be aligned parallel to the layer or perpendicular to it.
- [021] This flat container 5' covering one pixel field can however also be connected to a system that is filled with two fluids that cannot be mixed with one another. One fluid is a white or silvery colour fluid and the other fluid is colourless fluid or a colourless gas. With the help of electro-wetting or a micro-pump the fluids can be moved in such a way that the transparent flat container is filled only with white or silvery colour, or only with the colourless clear transparent fluid, depending on whether this layer is supposed to reflect

the incident light or is supposed to allow the back-illuminating light to pass through.

- [022] The colour reservoirs (not shown) are arranged behind the reflection layer, so that the colour fluids can be moved out of the visible range of the person observing the display.
- [023] In Fig. 3 the light sources allocated to the pixels consist of a plane illuminating device that consists of a light-conducting luminous surface 12, on whose side edges cathode ray tubes 13 or light emitting diodes are arranged, and two polarisation filters 14, 15 serving as masks.
- [024] The size of the pixels 1 is dependent on the size of the display and the distance of the observer from this display and lies in the range of 0.5 mm² to 16 mm², that in case of a quadratic pixel conforms to a pixel width of 0.7 to 4 mm.
- [025] The channels 8, 9; 8', 9' and 8'', 9'' leading from the colour reservoirs behind the reflection layer to the colour levels 3, 3', 3'' are worked into the webs 10 that separate the pixels 1 or their colour levels 3, 3', 3'' from one another and that rest with their surface against under face of the cover layer 4 as well as lie against the front and middle colour level layer 2 and 2' and are tightly welded or affixed on to them.
- [026] List of reference signs:
- | | |
|-----|---------------------------|
| 1 | Pixel |
| 2 | first colour level layer |
| 2' | second colour level layer |
| 2'' | third colour level layer |
| 3 | front colour level |
| 3' | middle colour level |
| 3'' | rear colour level |
| 4 | cover layer |
| 5 | reflection layer |

6	light source LED
7	carrier plate
8	channel
8'	channel
8''	channel
9	channel
9'	channel
9''	channel
10	web
11	plane illuminating device
12	Luminous surface
13	cathode ray tubes
14	first polarisation filter
15	second polarisation filter

Claims

- [001] Display for creating colour images and texts recognisable by incident light, in which the image area consists of numerous electronically controllable pixels (1) in a raster-like arrangement and in which each pixel (1) has at least three colour levels (3, 3', 3'') arranged beside one another or behind one another for the colours red, green, blue or cyan, magenta, yellow that are formed by flat transparent containers and whose inner chambers are connected via channels (8, 9) to colour reservoirs whose content can be moved by electronic control in such a way that transparent colour fluids is fed from the colour reservoirs into the colour levels or from the colour levels into the colour reservoirs,
characterized in that
light sources (6) are arranged behind the colour levels (3) of the pixels (1), each of the light sources (6) being allocated to one pixel (1) and being individually electronically controllable.
- [002] Display according to claim 1
characterized in that
the controllable light sources (6) are in particular white emitting light emitting diodes (LED).
- [003] Display according to claim 1
characterized in that
the light sources controllable for each pixel consist of at least one plane illuminating device back-illuminating a larger group of pixels (1) and a mask arranged between the illuminating devices and the colour levels of the pixels (1), which can be controlled for each pixel (1) in such a way that the light passage through the masks is open or more or less shut.
- [004] Display according to claim 3
characterized in that
the masks are formed by polarisation filters, whose light passage or filter effect can be controlled by means of electric fields for each pixel (1).
- [005] Display according to one of the claims 1 to 4
characterized in that
behind the colour levels (3, 3', 3'') a white or silvery reflection layer is arranged that is partly or temporarily light-permeable.

[006] Display according to claim 5

characterized in that

the reflection layer (5) is formed by plastic foil or thin glass pane provided with a light-permeable, mat white or silvery layer.

[007] Display according to one of the claims 1 to 4

characterized in that

a layer with silvery or white leaf-shaped pigments is arranged behind the colour levels (3, 3', 3'') and in front of the light sources (6), wherein by means of an electrical or magnetic field, the pigments can be aligned parallel to the display plane and thus form a reflection layer or the pigments can be aligned perpendicular to the display plane and thus form a light-permeating layer.

[008] Display according to one of the claims 1 to 4

characterized in that

between the light sources (6) and the colour levels (3, 3', 3'') a reflection layer (5') is arranged, which is formed by a flat container made of transparent material that can be filled with a white or silvery colour when the layer is supposed to reflect the light, and with a clear transparent fluid when the layer is supposed to be light-permeable.

[009] Display according to one of the claims 1 to 4

characterized in that

behind the three colour levels (3, 3', 3'') and in front of the light source (6) of a pixel a fourth colour level is fixed, which can be filled with an opaque white or silvery colour or with a clear transparent medium.