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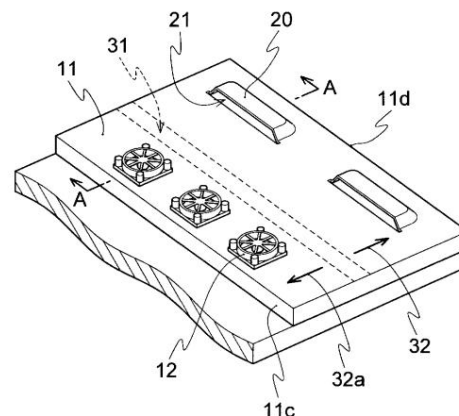
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(57) [Abstract]

[Problem] To provide a display device that can sufficiently dissipate heat from LEDs with a simple structure and that is also required to be thin, and a surface light source device to be installed in the

display device. [Solution] A surface light source device comprising a point light source mounted on a substrate, and a heat sink having at least one hole and equipped with a blower that blows air onto a support surface that supports the surface of the substrate opposite to the surface on which the point light source is mounted, the surface light source device comprising an air direction changing means that directs the air blown onto the support surface through the hole toward the back side

of the support surface of the heat sink. [Selected drawing] Figure 1



[Claims] [Claim 1] A surface

light source

device comprising: a point light source mounted

on a substrate; and a heat sink having at least one hole and equipped with a blower for blowing air onto a supporting surface supporting the surface of the substrate opposite the surface on which the point light source is mounted,

the surface light source device further comprising air

direction changing means for directing the air blown onto the supporting surface through the hole towards the back side of the supporting surface of the heat sink.

[Request item 2]

2. A surface light source device according to claim 1, wherein said airflow direction changing means is formed integrally with said heat sink.

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Request item 3

The surface light source device according to claim 1, wherein the airflow direction changing means is formed as a separate member near the hole in the heat

sink.

The surface light source device according to claim 1, wherein the airflow direction changing means is formed of a circuit board in the vicinity of the hole in the heat sink.

5. The surface light source device according to claim 1, 2, 3 or 4, wherein said point light source is an LED.

Request item 6

The surface light source device according to claim 1, wherein the point light source is an LED, and the airflow direction changing means is formed by a circuit board on which an LED driver is mounted near the hole in the heat sink. [Claim 7] A display device comprising: a

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display panel, a

point light source

mounted on a board arranged on the surface opposite to the display surface of the display panel, a heat sink supporting the surface of the

board opposite to the surface on which the point light source is mounted and having at least one hole, and a frame formed to surround the display panel and the heat

sink and equipped with a fan that blows air through the at least one hole onto the supporting surface of the heat sink, wherein the at least one hole is equipped with airflow direction changing means that directs the air blown onto the supporting

surface of the heat sink toward the back surface

of the supporting surface. [Claim 8]

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8. The display device according to claim 7, wherein said airflow direction changing means is formed integrally with said heat sink.

[Request item 9]

The display device according to claim 8, wherein the airflow direction changing means is formed of a separate member near the hole of the heat sink.

[Claim 10]

The display device according to claim 9, wherein the airflow direction changing means is formed of a circuit board in the vicinity of the hole in the heat sink.

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The display device according to claim 7, 8, 9 or 10, wherein the point light source is an LED. [Claim 12] The surface light source device

according to claim 7, wherein the point light source is an LED, and the airflow direction changing means is formed of a circuit board having an LED driver mounted thereon in the vicinity of the hole in the heat sink. [Detailed Description of the Invention] [0001] [Technical Field to which the Invention Pertains]

The present invention relates to a surface light source device, and more particularly to a surface light source device and a display device that are arranged in a display device having a plurality of light emitting diode chips on a substrate.

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[Prior Art]

2. Description of the Related Art Conventionally, surface light source devices in which a large number of light emitting diodes (hereinafter referred to as LEDs) or the like are arranged have been used as backlights for display devices, illumination for microscopes, and the like.

¶ ¶¶¶¶¶

In a surface light source device (illumination device) such as the one described above, heat from the LED is dissipated to a heat sink via the leads and heat dissipation sheet, and is also dissipated by blowing forced air onto the leads as well as the body (see, for example, Patent Document 1). [0004] [Patent Document 1]

Japanese

Patent Laid-Open

Publication No. 10-133608 (pages 3-4, Figure 2)

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[0005] [Problem

to be solved by the invention]

When constructing a surface light source device in which LEDs are arranged as described above, as the heat value of the LEDs increases, the light emission efficiency of the LEDs themselves decreases, and the durability of the junctions also deteriorates. For example, in the surface light source device (illumination device) described in Patent Document 1, the heat of the leads is dissipated by a heat dissipation sheet and a heat sink installed on the back of the printed circuit board on which the LEDs are installed. Furthermore, in order to dissipate the heat transmitted from the leads, the fan installed on the back sends air through fins, and part of the air is exhausted, and another part is conveyed to the surface of the printed circuit board so that it also flows to the body and the surface of the printed circuit board. However, in the surface light source device (illumination device) of this configuration, the air blown by the fan dissipates heat from the heat dissipation sheet through the fins and the heat sink, so the heat dissipation effect of the heat dissipation sheet is not sufficient. For this reason, although a heat dissipation means is configured with many parts to dissipate heat from the heat dissipation sheet, it is not possible to manufacture a thin display device, which is currently required for display devices.

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¶ ¶¶¶¶

The present invention has been made to solve such problems, and provides a display device that can sufficiently dissipate heat from LEDs with a simple structure and that is required to be thin, and a surface light source device to be installed in the display device.

The surface light source device of the

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present invention is a surface light source

device comprising: a point light source mounted on a substrate; and a heat sink having at least one hole formed therein and equipped with a blower for blowing air to a support surface that supports the surface of the substrate opposite to the surface on which the point

light source is mounted, characterized in that the surface light source device is equipped with an air direction changing means for directing the air blown to the support surface through the hole toward the back surface of the support surface of the heat sink.

[0008] A display

device of the present invention

comprises a display

panel, a point light source mounted on a substrate arranged on the surface opposite to the display surface of the display

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panel, a heat sink supporting the surface of the substrate opposite to the surface on which the point light source is mounted and having at least

one hole, and a frame formed to surround the display panel and the heat sink and equipped with a blower that blows air through the at least one hole onto the supporting surface of the heat sink, wherein the at least one hole is equipped with an air

direction changing means for directing the air blown onto the supporting surface of the heat sink toward the back surface of the supporting surface.

[0009]

[Embodiments of the

Invention] Embodiment 1

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The structure of a surface light source device according to an embodiment of the present invention will be described in detail below with reference to the drawings. Fig. 1 shows a perspective view of a surface light source device according to an embodiment of the present invention, and Fig. 2 shows a cross-sectional view taken along line A-A in Fig. 1. In the figure, 1 denotes an LED, 2 denotes a substrate such as an MCPCB, 3 denotes a first reflector, 4 denotes a first light guide plate, 5 denotes a second reflector, 6 denotes a rear metal, 7 denotes a mold frame, 8 denotes a second light guide plate, 9 denotes a reflective sheet, 10 denotes an optical sheet, 11 denotes a heat sink, and 12 denotes a blower, and the surface light source device is constituted by the above. 13 denotes a liquid crystal panel, and a liquid crystal display device is formed by arranging the surface light source device on the surface opposite to the display surface.

[0010] The LED

unit 31, in which the LED 1 is mounted on the substrate 2, is supported by the heat sink 11. A first reflector 3, whose inner surface is mirror-finished, is placed near the LED 1 so that the light emitted from the LED 1 is incident on the first light guide plate 4. The first light guide plate 4 receives the multiple lights generated by the LED 1 from the incident surface 4a, and mixes the lights while repeating total reflection on the top, bottom, left, and right surfaces, generating a uniform white light, which is emitted from the exit surface 4b opposite the incident surface 4a. The light guide plate used in the present invention must have a mirror-finished surface on the entire surface to achieve total reflection, and must have a bending coefficient of $n = 1.41$ or more. The material of the first light guide plate 4 is mainly highly light-transmitting, lightweight, and inexpensive methacrylic resin (PMMA) or polycarbonate resin. The light emitted from the exit surface 4b of the first light guide plate 4 is turned 180 degrees by the second reflector 5, whose inner surface is mirror-finished and arranged in a curved, approximately semicircular shape, and enters the entrance surface 8a of the second light guide plate 8. The light incident on the second light guide plate 8 is repeatedly totally reflected in the same manner as the first light guide plate 4, and is emitted to the exit surface 8b. The second light guide plate 8 has an opposite exit surface 8c opposite to the exit surface 8b, which is provided with ink dots or formed into an uneven shape, and the light is directed to the ink dots or uneven shape, and diffused to emit the light over the entire exit surface 8b. The light emitted to the opposite entrance surface 8d opposite to the entrance surface 8a is reflected by the reflection sheet 9 and enters the second light guide plate 8 again. Furthermore, optical sheets 10 consisting of a diffusion sheet, a protective sheet, a lens sheet, a prism sheet, etc. are arranged so that the light emitted from the exit surface 8b of the second light guide plate 8 passes through and enters the liquid crystal panel 13, completing the surface light source device.

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The liquid crystal panel 13 is composed of a color filter substrate and a TFT array substrate that sandwich a liquid crystal layer. The color filter substrate has R (Red), G (Green), and B (Blue) colored layers and a light-shielding layer. The TFT array substrate has switching elements and pixel electrodes. The liquid crystal panel 13, which has polarizing plates attached to the outside of the color filter substrate and the TFT array substrate, aligns the liquid crystal layer by turning the voltage on and off using the switching elements.

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The liquid crystal panel 13 is provided with a source substrate (not shown) for inputting voltage ON/OFF signals, and the source substrate is connected to the liquid crystal panel by a flexibly bendable TCP (Tape Carrier Package). The source substrate is fixed to the heat sink 11 by bolts and nuts, and a connector is attached to input a video signal from the outside. The liquid crystal panel 13 is supported and fixed by the rear metal 6 and mold frame 7, and the planar light source device is disposed on one of the substrate sides of the liquid crystal panel 13, forming a liquid crystal display device. With this configuration, the light from the planar light source device that reaches the liquid crystal panel 13 is modulated according to the video signal, and displays each of the RGB colors. [0013]

FIG. 4 is a perspective view of an LED unit 31. As shown in the figure, multiple RGB LEDs 1 are densely mounted in a straight line on a substrate 2. The RGB colors emitted from the LEDs 1 are mixed in the first light guide plate 4 of FIG. 1 to generate white light. The advantage of using RGB LEDs 1 is that the method of generating white light by mixing RGB colors has a higher luminous efficiency (= luminous flux amount/input power) than white LEDs. In addition, a liquid crystal display device with high color reproducibility can be realized by approximating the RGB emission spectrum and the transmission characteristics of the liquid crystal panel's color filter RGB (not shown). [0014]

FIG. 5 shows a cross-sectional view taken along the line B-B of FIG. 4. 14 is an LED chip, 15 is a die, 16 is a lens, 1

Reference numeral 17 denotes an electrode. A lens 16 is provided to protect the LED chip 14 and adjust its orientation characteristics. The LED chip 14 is placed on a die 15 for heat conduction, and is mounted with a highly thermally conductive adhesive to conduct heat generated by the LED chip 14 to the substrate 2. The LED chip 14 and the electrode 17 are electrically connected by a gold wire 17a to form the LED 1. The electrode 17 is also connected to the substrate 2 by solder or the like.

[0015] Currently,

85% to 95% of the power consumed by the LED chip 14 is generated as heat, and the remaining 5% to 15% is generated as light, which is emitted through the lens 16. Although some of the generated heat is transferred to the LED lens 16, most of the heat is transferred to the substrate 2 via the die 15 and electrodes 17. [0016]

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Furthermore, when LEDs are mounted at a high density as shown in Fig. 4, the LED junction temperature, which is the temperature of the heat generating part of the LED chip, rises, causing a decrease in the brightness of the surface light source device. The LED junction temperature has a significant effect on the life and stability of the LED.

図 4

The substrate 2 is made of a glass epoxy substrate 18 and an aluminum plate 19. A copper pattern is formed on the glass epoxy substrate 18 to supply power to the multiple LEDs 1 for each RGB. The glass epoxy substrate is made of glass and epoxy resin, and has a thermal conductivity of 1/1000 compared to metal materials, so it cannot be formed thick. For this reason, the glass epoxy substrate 18 is generally made as thin as possible, and the aluminum plate 19 is arranged to provide strength to the back surface and improve thermal conductivity. It is preferable to use pure aluminum (A1050, A1100), which has a higher thermal conductivity than other aluminum materials, for the aluminum plate 19. The substrate 2 is also equipped with a connector (not shown) for inputting an electrical signal to the LEDs 1, a temperature sensor (not shown) for measuring the temperature of the substrate 2, and the like.

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図 2

As shown in Fig. 2, the LED unit 31 is supported by a heat sink 11 on the surface of the substrate 2 opposite to the surface on which the LEDs 1 are mounted, and is attached to the heat sink 11 using a number of screws (not shown). The heat sink 11 not only supports the LED unit 31, but also diffuses heat from the LEDs 1. The heat sink 11 also ensures the positioning and fixing of other components used in the surface light source device, and the strength of the entire surface light source device.

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図 3

In addition, there is a contact thermal resistance at the contact portion between the LED unit 31 and the heat sink 11, which is a resistance when heat is conducted. It is important to reduce the contact thermal resistance in order to facilitate the transfer of heat from the LED unit 31, which is a heat source, to the heat sink 11. Reducing the contact thermal resistance reduces the LED junction temperature. In order to reduce the contact thermal resistance, it is necessary to increase the surface area of the contact surface, smooth the surface of the contact surface, and increase the contact pressure. The area of the contact surface between the LED unit 31 and the heat sink 11 is increased, and the contact surface is formed smooth. In order to increase the contact pressure, it is preferable to attach the LED unit 31 to the heat sink 11 at multiple points using screws, but double-sided tape with high thermal conductivity may also be used. Pure aluminum (A1050, A1100, etc.), which has high thermal conductivity, is often used for the heat sink 11.

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[0020] There

are three types of heat flow (heat transfer): heat conduction, in which the temperature moves from a high temperature area to a low temperature area, heat radiation, and convection heat transfer. Convection heat transfer is convection that occurs when there is a temperature difference between the air and the heat sink 11. Heat radiation is a phenomenon in which a portion of the radiated energy of the thermal energy generated by the motion of molecules in a high temperature object is transmitted through the space between electromagnetic waves. For this reason, the amount of heat transferred by the heat sink 11 can be increased not only by heat conduction, but also by increasing the thermal emissivity. The thermal emissivity can be increased by oxidizing the surface of the heat sink 11 or by applying an organic substance to it.

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Furthermore, in order to dissipate heat from the LED unit 31, a fan 12 is provided on the heat sink 11 in the first embodiment.

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The fan 12 is attached to the heat sink 11. The fan 12 generates forced convection to promote heat dissipation from the heat sink 11. As shown in Figs. 1 and 2, the fan 12 is attached near the side 11c of the heat sink 11, for example, near where the LED unit 31 is arranged. Therefore, the air blown by the fan 12 passes through the gaps between the LEDs 1, flows along the support surface 11a of the heat sink 11, and flows between the support surface 11a of the heat sink 11 and the surface 4c of the first light guide plate 4. Furthermore, at least one hole 21 is provided on the back surface 11b, which is the surface opposite to the support surface of the heat sink 11, to exhaust this air. The hole 21 is provided approximately perpendicular to the heat conduction direction 32 of the heat sink 11. At least one hole 21 is provided with a means for changing the air direction so that the air blown from the blower 12 and flowing along the support surface 11a of the heat sink 11 can be discharged through the hole 21, and can also be directed toward the back surface 11b of the support surface 11a of the heat sink 11. The hole 21 is provided at a position away from the blower 12 and as close to the end of the side surface 11d of the heat sink 11 as possible, so that the air flows over the entire support surface 11a of the heat sink, and all the air flowing along the support surface 11a can be directed toward the back surface 11b.

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If the hole 21 cannot be provided at the end, a protrusion 20a may be provided to facilitate the change of airflow direction as shown in Fig. 3. Note that the heat conduction direction 32a shown in Fig. 1 is near the blower 12 in this embodiment, and is not taken into consideration in this embodiment because it promotes heat dissipation. [0023]

The present invention does not particularly limit the type of fan 12, but the number, size, propeller rotation speed, air volume, and air pressure of the fan 12 can be set arbitrarily by taking into consideration the amount of heat generated and the amount of heat dissipated by the LED 1. The amount of heat dissipation can also be increased or decreased by turning the fan 12 on or off or adjusting the rotation speed based on information from a temperature sensor attached to the substrate 2.

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Also, since the LEDs 1 are arranged at high density, the gaps between the LEDs 1 become narrow and the LEDs 1 themselves become resistance to the air blown from the blower 12, generating vortexes around the LEDs 1. In this way, the LEDs 1 become turbulence promoters, increasing the amount of heat dissipation around the LEDs 1. In this embodiment, the gaps between the LEDs 1 become resistance to the air blown from the blower, reducing the amount of air blown from the blower 12, but the amount of heat dissipation into the air due to turbulence increases, resulting in a greater heat dissipation effect.

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As shown in Figs. 1 and 2, the airflow direction changing means provided in the holes 21 is, for example, a duct 20, which is formed integrally with the heat sink 11. The air blown by the blower 12 is blown to the support surface 11a of the heat sink 11, and then directed by the duct 20 to the back surface 11b of the support surface of the heat sink 11. The duct 20 protrudes from the back surface 11b of the support surface of the heat sink 11 so as to cover the holes 21, and has a curved or angled shape so that the air (airflow direction) is changed 180 degrees and directed to the back surface 11b of the support surface of the heat sink 11. In this embodiment 1, three blowers and two holes 21 and airflow direction changing means 20 are formed. [0026]

By adopting the configuration of the first embodiment, the air blown by the blower 12 can dissipate heat from both the support surface 11a and the back surface 11b of the heat sink 11. This makes it possible to increase the thermal conduction from the LED 1 to the air by utilizing the strong airflow from the blower 12, and to direct the air from the support surface 11a of the heat sink 11 along the back surface 11b by the airflow direction changing means, and to forcibly speed up the air convection (mixing of air). Since the heat sink 11 can dissipate heat, the LED junction temperature can be reduced, and the brightness and reliability of the liquid crystal display surface are improved. In addition, as shown in Figures 1 to 3, the duct 20, which is the airflow direction changing means, can be realized by integral molding with the heat sink 11, so that a separate member is not required, and a low-cost and highly reliable heat dissipation mechanism can be realized. [0027]

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In addition, by making the surface light source device have the above-mentioned structure, the air discharged from the hole 21 is exhausted to the outside of the surface light source device along the back surface 11b of the support surface of the heat sink 11, so that the directly discharged air can be used.⁵⁰

The exhaust port can be set at any position that does not cause discomfort to the user. When this surface light source device is installed, the exhaust port can be provided at any position on a notebook PC, monitor, etc. that does not cause discomfort to the user.

[0028]

Embodiment 2 In

the embodiment 1, the duct 20 is arranged perpendicular to the heat conduction direction 32, but in the embodiment 2, the duct 20 is arranged approximately parallel to the heat conduction direction 32 as shown in FIG. 6. By arranging the duct 20 approximately parallel to the heat conduction direction 32, the air from the blower 12 can be directed to the back surface 11b of the heat sink 11 near the LED unit 31 where the heat generation temperature is high, and the heat can be dissipated from the heat sink 11. Therefore, the heat dissipation from the back surface 11b of the heat sink 11 can be made more efficient than in the embodiment 1. The other configurations are the same as those in the embodiment 1. In this way, the number, position, and shape of the duct 20 can be set at any position based on the heat distribution of the heat sink 11.

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By adopting the configuration described in the second embodiment, the air blown by the blower 12 can dissipate heat from both the support surface 11a and the back surface 11b of the heat sink 11, as in the first embodiment. This makes it possible to increase the thermal conduction from the LED 1 to the air by utilizing the strong airflow from the blower 12, and to direct the air from the support surface 11a of the heat sink 11 along the back surface 11b by the airflow direction changing means, and to forcibly accelerate the air convection (mixing of the air). Since the heat sink 11 can dissipate heat, the LED junction temperature can be reduced, and the brightness and reliability of the liquid crystal display surface are improved. In addition, as shown in FIG. 6, the duct 20, which is the airflow direction changing means, can be realized by integral molding with the heat sink 11, so that a separate member is not required, and an inexpensive and highly reliable heat dissipation mechanism can be realized. Furthermore, by providing the duct 20 approximately parallel to the heat conduction direction 32, heat can be dissipated more efficiently from the rear surface 11b of the heat sink 11 near the LED 1, which has a higher heat generation temperature than in the first embodiment.

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In addition, by making the surface light source device have the above-mentioned structure, the air discharged from the hole 21 is discharged outside the surface light source device along the back surface 11b of the support surface of the heat sink 11, so that it can be set at any position where the directly discharged air does not cause discomfort to the user. When this surface light source device is mounted, an exhaust port can be provided at a position where the user does not feel uncomfortable, such as in a notebook

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PC or a monitor.

[0031] Embodiment

3 In the first and second embodiments, the duct 20, which is the airflow direction changing means, is formed integrally with the heat sink 11, but in the third embodiment, the airflow direction changing means is formed in the hole 21 by a separate member 22. As shown in FIG. 7, the separate member 22 is located near the formation of the hole 21, and is fixed by a screw or the like (not shown) with a certain gap provided by a pin 23a or the like on the back surface 11b side of the support surface of the heat sink 11. Also, as shown in FIGS. 8A and 8B, instead of using pins, the separate member 22 can be fixed to the drawers 23b and 23c formed by drawing the heat sink 11 with screws or the like (not shown).

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By providing a separate member 22 as a wind direction changing means near the hole 21, the air blown from the blower 12 is blown onto the support surface 11a of the heat sink 11, and then directed along the back surface 11b of the heat sink 11. The separate member 22 is fixed to the back surface 11b side of the heat sink 11, and is formed so as to change the wind direction.

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[0033]

Also, the separate member 22, which is the airflow direction changing means, may be formed by a circuit board. For example, the circuit board may be equipped with an LED driver and boards other than the LED driver, such as a source board, a gate board, a control board, and a power supply board. [0034] The

LED 1 is driven

by an LED driver, which supplies a constant current to the LED 1 for each RGB color, controls the duty ratio for each RGB color, and arbitrarily adjusts the light intensity of each color.

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It is also possible to provide a function for adjusting the duty ratio for each of RGB by monitoring the tristimulus values of the second light guide plate 8 with a sensor (not shown) and keeping the white point of the display surface constant. LED drivers generally have coils and other high heat generating components mounted thereon, and dissipating the heat from these components improves the reliability and efficiency of the LED driver, thereby reducing power consumption. When an LED driver mounted with a coil or other high heat generating component is mounted on the surface 22a (see FIG. 7) facing the back surface 11b of the heat sink 11, it acts as a turbulence promoter, further improving the heat dissipation efficiency of the LED driver. The efficiency of the LED driver is also increased. [0035]

By adopting the configuration described in the third embodiment, the air blown by the blower 12 can dissipate heat from both the support surface 11a and the back surface 11b of the heat sink 11. This makes it possible to increase the heat conduction from the LED 1 to the air by utilizing the strong airflow from the blower 12, and to direct the air from the support surface 11a of the heat sink 11 along the back surface 11b by the air direction changing means 22, and to forcibly accelerate the air convection (mixing of air) by setting the air flow direction. Since the heat sink 11 can dissipate heat, the LED junction temperature can be reduced, and the brightness and reliability of the liquid crystal display surface are improved. In addition, since the air direction changing means is made of a separate member 22 as shown in Figures 7 and 8, heat can also be dissipated from the separate member, and the brightness and reliability of the liquid crystal display surface are further improved. [0036]

Furthermore, by constructing the surface light source device as described above, the air discharged from the hole 21 is discharged outside the surface light source device along the back surface 11b of the support surface of the heat sink 11, so that the location can be set arbitrarily where the air discharged directly does not cause discomfort to the user. When this surface light source device is mounted, an exhaust port can be provided in a position where the user does not feel uncomfortable, such as in a notebook PC or monitor. [0037] Embodiment 4 In embodiment 4, as shown in Figure 9,

the duct 20,
which is the air

direction changing means described in embodiments 1 and 2, is used in combination with the separate member 22 described in embodiment 3. The separate member 22 is fixed adjacent to the opening 20b of the duct 20 provided in the heat sink 11. The fixing method is the same as in embodiment 3. [0038]

The duct 20 provided in the hole 21 blows the air blown by the blower 12 onto the support surface 11a of the heat sink 11, and then directs it towards the back surface. The air whose direction has been changed can be set by the separate member 22 fixed near the opening 20b of the duct 20, so that no unnecessary air flow is generated, and the wind speed can be increased locally, so that heat can be effectively dissipated from the separate member 22 and the back surface 11b of the heat sink 11 near the LED unit 31. [0039]

By adopting the configuration described in the fourth embodiment, the air blown by the blower 12 can dissipate heat from both the support surface 11a and the back surface 11b of the heat sink 11. This makes it possible to increase the thermal conduction from the LED 1 to the air by utilizing the strong airflow from the blower 12, and to direct the air from the support surface 11a of the heat sink 11 along the back surface 11b by the air direction changing means, and to forcibly accelerate the air convection (mixing of air). Since the heat sink 11 can dissipate heat, the LED junction temperature can be reduced, and the brightness and reliability of the liquid crystal display surface are improved. In addition, since the configuration uses both the duct 20 and a separate member as shown in FIG. 9, it is possible to dissipate heat from the separate member, and the flow path (direction) of the air can be secured, and the wind speed can be increased, so that the amount of heat dissipated by the heat sink 11 can be increased.

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In addition, by making the surface light source device have the above-mentioned structure, the air discharged from the hole 21 is guided to the heat sink 11.

Since the air is exhausted to the outside of the surface light source device along the rear surface 11b of the support surface, it can be set at any position where the directly exhausted air does not cause discomfort to the user. When this surface light source device is installed, an exhaust port can be provided in a position where the user does not feel uncomfortable, such as in a notebook PC or monitor.

In addition, the blower 12 described in the above-mentioned embodiments 1 to 4 is attached to the back surface 11b side of the heat sink 11 as shown in Figs. 1 to 9, but the same effect can be obtained even if it is attached to the support surface 11a side.

[0042] In the first

to fourth embodiments,

the fan is formed on the heat sink 11, but in the display device of the fifth embodiment, the fan 12 is attached to a frame 29 formed to surround the surface light source device and the liquid crystal panel 13 as shown in Fig. 10. The frame 29 is composed of a metal frame 24, which is a metal sheet metal frame that fixes the display device in a desired position, an upper case 26, and a lower case 25. The metal frame 24 fixes the heat sink 11 and has a hole 24a formed therein to further exhaust the air discharged from the hole 21 to the outside. The upper case 26 and the lower case 25 surround the liquid crystal panel 13 and protect the outside of the display device. The lower case 25 and the upper case 26 are both design parts that require aesthetics, and resin or metal molded by die casting is used. The lower case 25 is formed with a hole 25a for discharging the air discharged from the hole 24a to the outside of the liquid crystal display device. The blower 12 is attached to the sheet metal frame 24 or the lower case 25.

¶ ¶¶¶¶

In addition, the air direction changing means installed near the hole 21 can be the same as those in the first to fourth embodiments.

By adopting the configuration described in the fifth embodiment, the air blown by the blower 12 can dissipate heat from both the support surface 11a and the back surface 11b of the support surface of the heat sink 11. This makes it possible to increase the thermal conduction from the LED 1 to the air by utilizing the strong airflow from the blower 12, and to direct the air from the support surface 11a of the heat sink 11 along the back surface 11b by the air direction changing means, and to forcibly accelerate the air convection (mixing of air) by setting the direction of the air flow. Since the heat sink 11 can dissipate heat, the LED junction temperature can be lowered, and the brightness and reliability of the liquid crystal display surface are improved.

¶ ¶¶¶¶

10, since the fan 12 is attached to the frame 29, it is possible to take in outside air into the display device, and even if used for a long period of time, the temperature of the air blown by the fan 12 can be kept almost constant. Also, since the heat generating element installed in the frame 29 can dissipate heat at the same time, and the fan 12 of the frame 29 and the surface light source device can be shared, it is also possible to reduce the number of fans 12.

[0046] [Advantages
of the Invention]

As explained above, the surface light source device of the present invention is a surface light source device including a point light source mounted on a substrate, and a heat sink having at least one hole formed therein and equipped with a blower for blowing air to a support surface supporting the surface opposite to the surface on which the point light source is mounted of the substrate, and is characterized by being equipped with a wind direction changing means for directing the air blown to the support surface at the hole toward the back surface of the support surface of the heat sink, so that the air blown by the blower can dissipate heat on both the support surface of the heat sink and the back surface of the support surface. This makes it possible to forcibly accelerate air convection (air mixing) by utilizing the strong wind from the blower to increase heat conduction from the LED to the air, and by directing the air from the support surface of the heat sink along the back surface by the wind direction changing means and setting the direction of air flow. Since the heat sink can dissipate heat, the LED junction temperature can be reduced, and the brightness and reliability of the liquid crystal display surface can be improved.

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¶ ¶¶¶¶¶

In addition, the display device of the present invention is a display device comprising: a display panel; a point light source mounted on a substrate arranged on the surface opposite to the display surface of the display panel; a heat sink supporting the surface of the substrate opposite to the surface on which the point light source is mounted and having at least one hole; and a frame formed to surround the display panel and the heat sink and equipped with a fan that blows air through the at least one hole onto the supporting surface of the heat sink, wherein the at least one hole is equipped with an air direction changing means for directing the air blown onto the supporting surface of the heat sink toward the back surface of the supporting surface, thereby making it possible to forcibly accelerate air convection (air mixing) by utilizing the strong airflow from the fan and directing the air from the supporting surface of the heat sink along the back surface by the air direction changing means and setting the direction of the air flow. Since the heat sink can dissipate heat, the LED junction temperature can be reduced, improving the brightness and reliability of the liquid crystal display surface.

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¶ ¶¶¶¶¶

Also, it becomes possible to take in outside air into the display device, and the temperature of the air blown by the fan can be kept almost constant even during long periods of use.

¶ ¶¶¶¶¶

In addition, the heat generating element installed in the frame can also dissipate heat at the same time, and the frame and the surface light source device can share a fan, making it possible to reduce the number of fans.

BRIEF DESCRIPTION OF THE

DRAWINGS Fig. 1 is a perspective view of a surface light source device according to an embodiment of the present invention. Fig. 2 is a cross-sectional view taken

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along line A-A in Fig. 1. Fig. 3 is a cross-sectional explanatory view of another embodiment of the present invention, in which a protrusion 20a is further provided in the surface light source device

of Fig. 2. Fig. 4 is a perspective view of an LED unit mounted in the surface light source device according to an embodiment of the present invention. Figure.

Fig. 5 is a cross-sectional view taken along line B-B in

Fig. 4. Fig. 6 is a perspective view of a surface light source device according to another embodiment of the present invention. Fig. 7 is a cross-sectional view of a surface light source device according to yet another embodiment of the present invention. Figs. 8(a) and (b) are respectively still other embodiments of the present invention, and are the pins of Fig. 7.

FIG. 13 is a cross-sectional explanatory view showing a case where a drawing formed by drawing a heat sink is used instead of the heat sink.

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FIG. 9 is a cross-sectional view of a surface light source device according to another embodiment of the present invention. FIG. 10 is a cross-sectional view of a display device according to still another embodiment of the present invention.

¶ ¶¶¶¶¶

2 Substrate 3

First reflector 4 First light guide

plate 5 Second reflector 6

Rear metal

[0033] 7 mold frame 8 second light

40

guide plate 9 reflection

sheet 10 optical sheets 1

1 heat sink 12 blower 13 liquid

crystal panel 14 LED

chip 15 die

16 Lens

17 electrodes

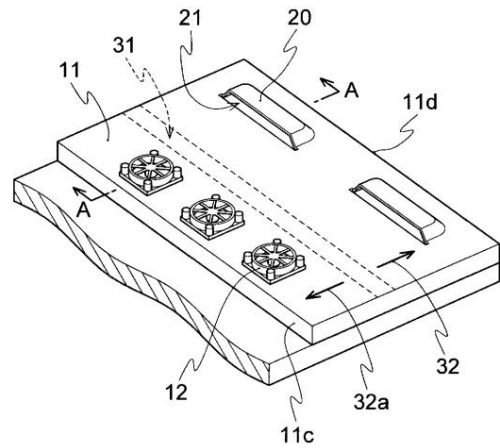
50

17a Gold wire 18 Glass
epoxy board 19 Aluminum plate 20 Duct
20b Opening 21 Hole 22 Air
direction changing
means

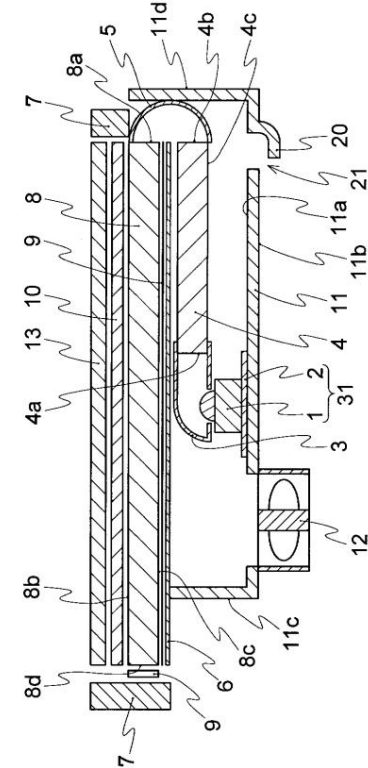
2 3a Pin
2 3b Aperture 2
4 Metal frame 2 4a
Hole 2 5 Lower
case 2 6 Upper case 2
9 Frame 3 1 LED unit 3
2 Heat conduction
direction 3 2a Heat conduction
direction

10

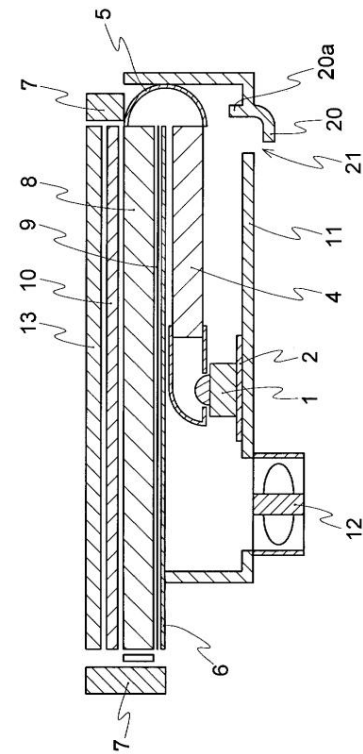
[Figure 1]



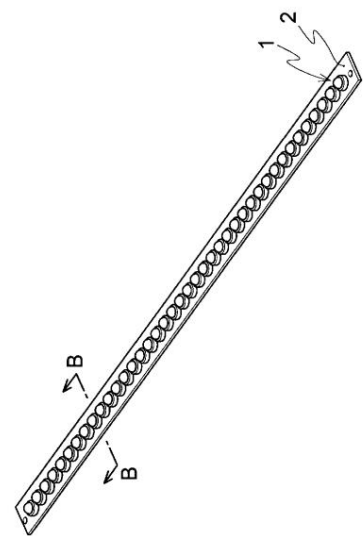
[Figure 2]



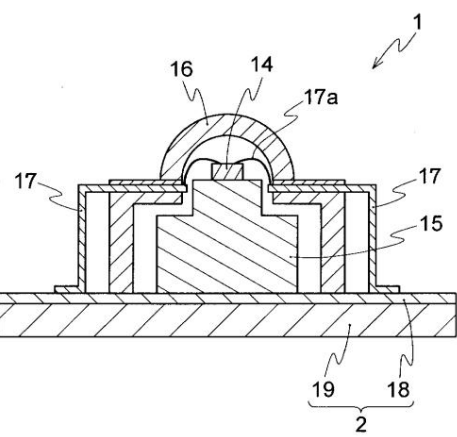
[Figure 3]



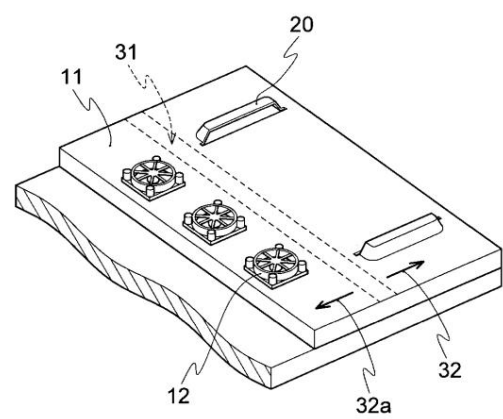
[Figure 4]



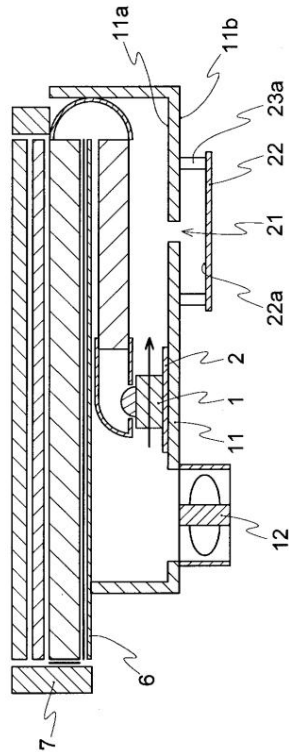
[Figure 5]



[Figure 6]

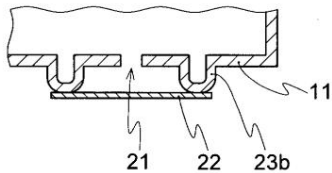


[Figure 7]

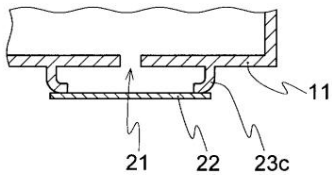


[Figure 8]

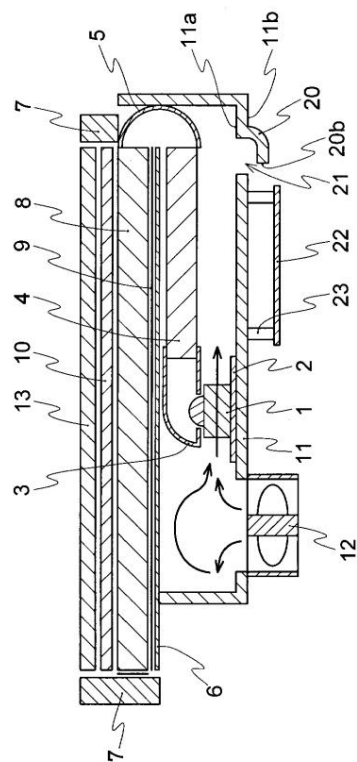
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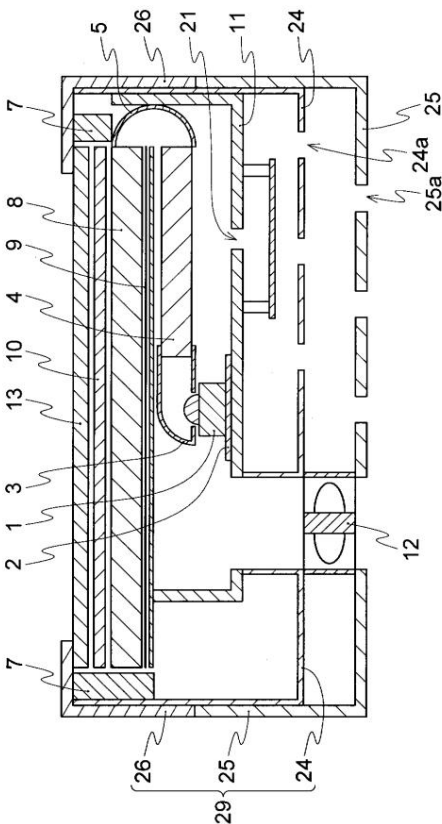
(b)



[Figure 9]



[Figure 10]



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