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[Continued on next page]

(54) Title: LCD APPARATUS WITH HEAT DISSIPATION ARRANGEMENTS

(57) **Abstract:** An LCD apparatus (100) comprises an LCD screen, backlight arrangements (134) for providing back illumination to the LCD screen, video processing circuitry and air moving devices (152, 154, 156), characterized in that the air moving devices (152, 154, 156) are arranged to move air to condition the image displaying surface of the LCD screen.

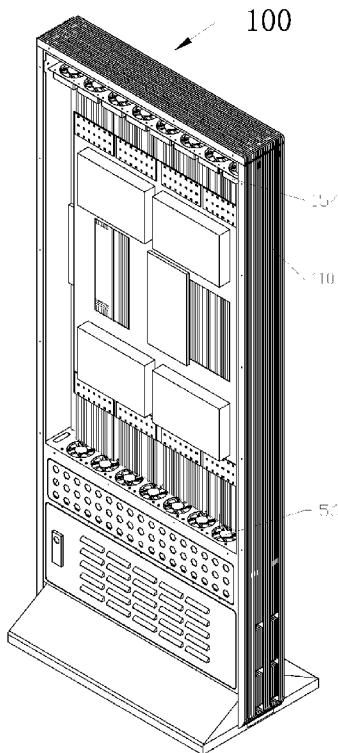


FIG. 4



(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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— with international search report (Art. 21(3))

AN LCD APPARATUS WITH HEAT DISSIPATION ARRANGEMENTS

Field of the Invention

[1] The present invention relates to LCD apparatus, and more particularly to backlit LCD apparatus for outdoor displaying of images.

Background of the Invention

[2] LCD panels are widely used in flat panel displays and are gaining increasing popularity over cathode ray tube (CRT) or LED panels because of their various advantages such as light weight, high resolution, and low power consumption. Known LCD panels are typically of the reflective or transmissive types. The reflective type LCD uses reflection to illuminate the LCD panel and its operation is dependent on the availability of external light sources. The transmissive type LCD uses an internal light source for illumination and the internal light source is commonly referred to as backlight. An advantage of the transmissive type LCD, which is also commonly referred to as backlit LCD, is its usefulness for outdoor operation because its backlight intensity can be adjusted according to the ambient light conditions of the outdoor environment which changes widely during different times of the day and according to weather conditions.

[3] Although a backlit LCD display is an appropriate candidate for outdoor use, the harsh outdoor operating conditions could be adverse to the operation of an LCD display. For example, when an LCD panel is exposed directly under sunlight, the surface temperature of the LCD cells can rise to above 80°C, and prolonged exposure to such high temperatures could result in premature darkening of an LCD screen, resulting in premature failure of the LCD panel. Another challenge which needs to be tackled to enable backlit LCD to be commercially meaningful as an outdoor image display is the need to provide sufficient backlight to provide adequate contrast for the

viewing public. However, additional backlight would lead to additional heating of the apparatus which is not compatible with preferred operating conditions of LSD. On the other hand, when the outdoor conditions become extremely cold, an LCD display would not function properly.

[4] Therefore, it would be advantageous if there could be provided improved LCD apparatus which alleviate shortcomings of conventional LCD apparatus.

Summary of the Invention

[5] According to the present invention, there is provided an LCD apparatus comprising an LCD screen, backlight arrangements for providing back illumination to the LCD screen, video processing circuitry and air moving devices, characterized in that the air moving devices are arranged to move air to condition the image displaying surface of the LCD screen. The air moving devices may be arranged to form an air curtain to promote more even conditioning to the LCD screen.

[6] In an embodiment, the apparatus comprises a transparent screen which is spaced apart from the image displaying surface of the LCD screen, characterized in that, the air moving devices are arranged to move air in the space between the transparent screen and the LCD screen to condition the LCD screen.

[7] An LCD apparatus comprising ventilation means to condition the surface temperature of an LCD display surface would substantially mitigate problems of LCD display overheating associated with harsh outdoor applications. An LCD image displaying apparatus according to the present invention could operate at brightness level of above 1000 nits, and even 3000 nits, which provides an astounding visual effect in the outdoor environment.

[8] In another aspect of the present invention, there is provided a backlight module for an LCD apparatus comprising a matrix of LEDs mounted on one side of a double sided metal coated board, and heat sinks mounted on another side of the double sided metal coated board, characterized in that metalised through holes connecting the two metal coated sides of the coated board are provided to transfer heat from the LEDs to the heat

sink for dissipating heat generated by the backlight arrangements. This backlight module provides efficient heat dissipation to facilitate very bright LCD panels suitable for outdoor applications.

[9] The heat sink of the backlight module may comprise a plurality of substantially parallel and elongate heat dissipating fins which collectively form air moving channels to guide movement of air for dissipating heat from the heatsinks. Such channels have the advantage of promoting smooth flow of ventilation within an LCD apparatus.

[10] This and other features of the invention will be explained below in further details below.

Brief Description of the Drawings

[11] Figure 1 is a front perspective view of an embodiment of an outdoor LCD apparatus of the present invention,

[12] Figure 2 is a partially truncated view exposing the interior of Figure 1,

[13] Figure 3 is an exposed rear view of the apparatus of Figure 1,

[14] Figure 4 is an exposed rear perspective view of Figure 3,

[15] Figures 5A & 5B are longitudinal cross-sectional views of the apparatus of Figure 1 taken along the center and depicting first and second operation modes respectively,

[16] Figures 6A & 6B are cross-sectional views of Figure 1 taken along the lines A-A and B-B respectively,

[17] Figure 7A is a perspective view of a backlight module of the apparatus of Figure 1, and

[18] Figure 7B is a cross-sectional view of Figure 7A.

Detailed Description of Exemplary Embodiments

[19] Referring to Figures 1 to 6B, an LCD apparatus 100 for displaying moving images illustrating a first embodiment of the present invention comprises a housing 110 on which a front transparent screen 120, an LCD panel 130 comprising a liquid crystal display cell 132, backlight modules 134, video and electronic circuitry 136, and air moving devices are mounted. The LCD panel is mounted with its image-displaying

surface facing and spaced apart from the front transparent screen for viewing from the front side. The LCD panel, the backlight modules and the circuitry are formed as an LCD panel subassembly, which is mounted on the housing of the apparatus. The housing is primarily a metal casing which is supported on a stand and includes a rear cover (not shown) to shield the various components. The transparent screen provides physical protection to the LCD panel against harsh weather conditions such as rainstorm, wind and dust storm, while permitting unobstructed viewing of images showing on the front viewing surface of the LCD panel. However, the transparent screen also acts as a glass or green house, which elevates the internal temperature in the space between the transparent screen and the image displaying surface of the LCD panel.

[20] A plurality of backlight modules more particularly shown in Figures 7A to 7D is mounted on the back of the LCD panel to provide back illumination to the LCD screen. The backlight modules are arranged such that the entire image displaying surface of the LCD screen is back-illuminated to enable image viewing from the front side under different ambient lighting conditions. In general, the backlight arrangements have to generate very strong illumination to provide a brightness of above 1000 nits when the display apparatus are operating under strong sunlight to display images of good viewing, although the requirements on the intensity of backlight illumination lessen when operating in the absence of sunlight. Such a high brightness requirement, coupled with the high temperature resulting from exposure of the apparatus under direct sunlight, creates an imminent heat dissipation problem which has to be alleviated if an LCD apparatus is of practical utility for outdoor applications.

[21] Each backlight module comprises a matrix of LEDs 142 which are mounted on one side of a double sided printed circuit board and controlled by backlight control circuitry which provides dynamic backlight control. The printed circuit board comprises an insulated board which is coated with a layer of metal, such as copper, on both sides. The side of the double sided printed circuit board mounted with the LEDs

includes a printed circuit on which associated circuitry such as the LED drivers and power supply circuitry are mounted. A plurality of metalized through holes are formed on the printed circuit board and are distributed to provide thermal connection to transport heat generated by the LEDs to the metal coated surface on the other side (the back side) of the printed circuit board. To further enhance heat dissipation efficiency, heat sinks are mounted on the back side of the printed circuit board and the thermal contact between the heatsink and the backside of the metal coated printed circuit board is enhanced by applying thermal conductive glues to the contact surfaces between the heatsink and the metal coated backside of the printed circuit board. To enhance heat dissipation efficiency, the heatsink is a singly molded metal piece made, for example, of aluminum or aluminum alloy. The backside of the heatsink, which is distal from the LCD panel, comprises a plurality of elongate and parallel heat dissipating fins, which collectively define channels with the fins forming the walls of the channel. To further enhance heat dissipation, the channels of the heatsinks are aligned to the direction of forced air flow as explained below.

[22] To meet the stringent outdoor operation requirement, especially the high brightness requirements when operating under bright sunlight, forced ventilation arrangements are provided in the apparatus. Referring to Figures 1 to 4, the arrangement of the LCD panel subassembly and the housing 110 defines a front compartment 112 and a rear compartment 114. The front compartment 112 is defined by the space between the LCD screen and the transparent screen, and the rear compartment 114 is defined between the subassembly and the backside of the housing. To provide cooling air to the LCD panel, a first set of air moving devices 152, such as rotary fans, is distributed across the width of the housing at the bottom of the housing in an in-line fashion. The first set of fans is disposed intermediate the front compartment and an empty compartment 116 located underneath the LCD panel subassembly. In a first mode of operation as depicted in Figure 5A, the first set of fans is arranged to operate to draw cooling air from outside the housing into the empty compartment via an air inlet

located at the bottom of the housing and then to blow at the front compartment. In this mode of operation, cooling air is applied directly to the front viewing surface of the LCD screen to effect cooling by forced ventilation. To promote smooth airflow, a second set of air moving devices 154 is disposed at the top of the apparatus. More specifically, the second set of fans comprising a plurality of motorized fans is distributed transversely in an in-line arrangement across the width of the LCD subassembly. The second set of fans is disposed in the space between the housing and the top of the LCD subassembly which is in communication with the front compartment. To cooperate with the first set of fans, the second set of fans is arranged to operate to draw air from the front compartment and move the air leaving the front compartment to the back compartment. The air moved by the second set of fans is then used to cool the heatsinks of the backlight modules. To promote smooth, or non-vortex air flows in the rear compartment, a third set of air moving devices 156 is disposed at the downstream end of the rear compartment of the apparatus. The third set of fans is arranged to move air coming from the second set of fans towards the air outlet located at the bottom of the rear compartment. To promote efficient air passage in the rear compartment, the heatsinks are arranged such that the channels formed by the heat dissipating fins extend in the direction of airflow defined by the second and third set of fans. This direction is substantially parallel to the axes of rotation of the fans or the longitudinal direction of the apparatus. The transversely distributed air moving devices is collectively arranged to generate a curtain of air which is moved through the LCD screen to produce conditioning thereto.

[23] In a second mode of operation as depicted in Figure 5B, which is preferred for operating in severely cold environments, the direction of operation of the three sets of fans is reversed. In this mode of operation, air is moved firstly into the rear compartment by the third set of fans and encounters heatsinks of the backlight modules. The air, after passing through the heatsinks and warmed, is then moved into the front compartment by the second set of fans to warm the LCD screen such that the

LCD panel could operate under its rated temperature conditions. The first set of fans then operate to move the air out of the front compartment.

[24] To provide weather and dust shielding to the internal components of the apparatus, sheltered air inlets are located at the bottom of the housing and are provided with air filters 122 which are mounted on grilled covers 118. The sheltering and filters mitigate the problems of dust contamination and weathering of the internal components to promote longer service life in harsh outdoor environments. In this regard, it would be understood that the nomenclature of the terms “air-inlet” and “air-outlet” are dependent on the mode of operation and shall be accordingly named.

[25] While the present invention has been explained with reference to the embodiments described herein, it would be appreciated by persons skilled in the art that the embodiments are non-limiting example only, and the invention is independent of any particular types of fans, backlight modules or heatsinks without loss of generality. For example, while air moving devices in the above embodiments are arranged to cause airflow to move between the front and rear compartments, it would be appreciated that air could be caused to flow to condition the LCD screen only. In addition, or alternatively, the airflow could be from one transverse side of the front compartment to another transverse side and then exits from that another side via side apertures on the housing, or move from the bottom portion of the LCD screen to the top portion thereof and exit at apertures located at the top portion of the housing without loss of generality.

[26] List of numerals: 100 LCD apparatus, 132 LCD cell, 110 housing, 134 Backlight module, 112 Front compartment, 136 Peripheral circuitry, 114 Rear compartment, 142 LED, 116 Empty compartment, 144 heatsink, 118 Grilled covers, 146 fins, 120 Transparent screen, 152 First fan set, 122 Air-filter, 154 Second fan set, 130 LCD panel, 156 Third fan set.

CLAIMS

- [1] An LCD apparatus comprising an LCD screen, backlight arrangements for providing back illumination to the LCD screen, video processing circuitry and air moving devices, characterized in that the air moving devices are arranged to move air to condition the image-displaying surface of the LCD screen.
- [2] An LCD apparatus according to Claim 1, wherein the apparatus comprises a transparent screen which is spaced apart from the image displaying surface of the LCD screen, characterized in that, the air moving devices are arranged to move air in the space between the transparent screen and the LCD screen to condition the LCD screen.
- [3] An LCD apparatus according to Claim 2, wherein the backlight unit comprises a matrix of LEDs mounted on one side of a double sided metal coated board, and a heat sink is mounted on the other side of the double sided metal coated board, characterized in that metalised through holes connecting the two metal coated sides of the coated board are provided to transfer heat from the LEDs to the heat sink.
- [4] An LCD apparatus according to any of Claim 3, wherein the heat sink is attached to the back of the backlight unit and comprises a plurality of substantially parallel and elongate heat dissipating fins, characterized in that the elongate heat dissipating fins extend substantially parallel to the direction of air flow and collectively define air flow channels to guide the movement of air due to the air moving devices.
- [5] An LCD apparatus according to any of Claim 4, wherein the air moving devices are arranged to move external cooling air into the LCD apparatus via an entry at the bottom of the LCD screen and then to move the cooling air to the space between the LCD screen and the transparent screen to cool the LCD screen.
- [6] An LCD apparatus according to Claim 5 wherein the air moving devices are further arranged to move the air leaving the space between the LCD screen and

the transparent screen into the back of the backlight units to cool the heatsinks.

[7] An LCD apparatus according to any of Claims 1 to 4, wherein the air moving devices are arranged to move external cooling air into the display via the bottom of the display, to move the cooling air across the heat sink to cool the backlight unit, and then to move the warm air exiting from the heatsink to the space between the LCD screen and the transparent screen to warm the LCD screen.

[8] An LCD apparatus according to any of any of Claims 1 to 6, wherein the air moving devices are operable to change the direction of movement of air from between moving from the LCD screen to the heatsink and vice versa.

[9] An LCD apparatus according to any of Claims 1 to 6, wherein the LCD screen, the backlight arrangements, and the transparent screen are mounted on a housing, characterized in that the housing and the heatsinks collectively define a compartment, the compartment being communicable with the space between the LCD screen and the transparent screen via a passageway located between the top of the LCD screen and the housing, characterized in that, a plurality of air moving devices are distributed at the passageway to move air between the compartment and the space between the LCD screen and the transparent screen.

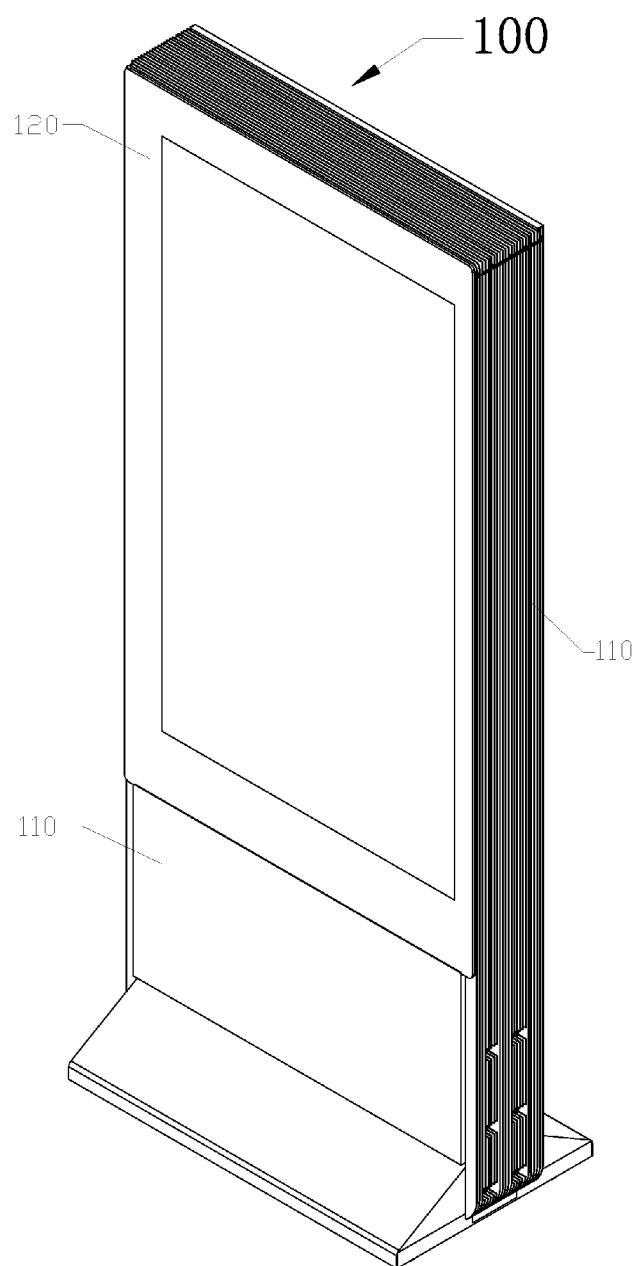
[10] An LCD apparatus according to any of Claims 1 to 6, wherein the air moving devices are arranged such that air enters at the bottom of the LCD display via a filtered entry and moves upwardly towards the heatsinks to dissipate heat from the heatsinks.

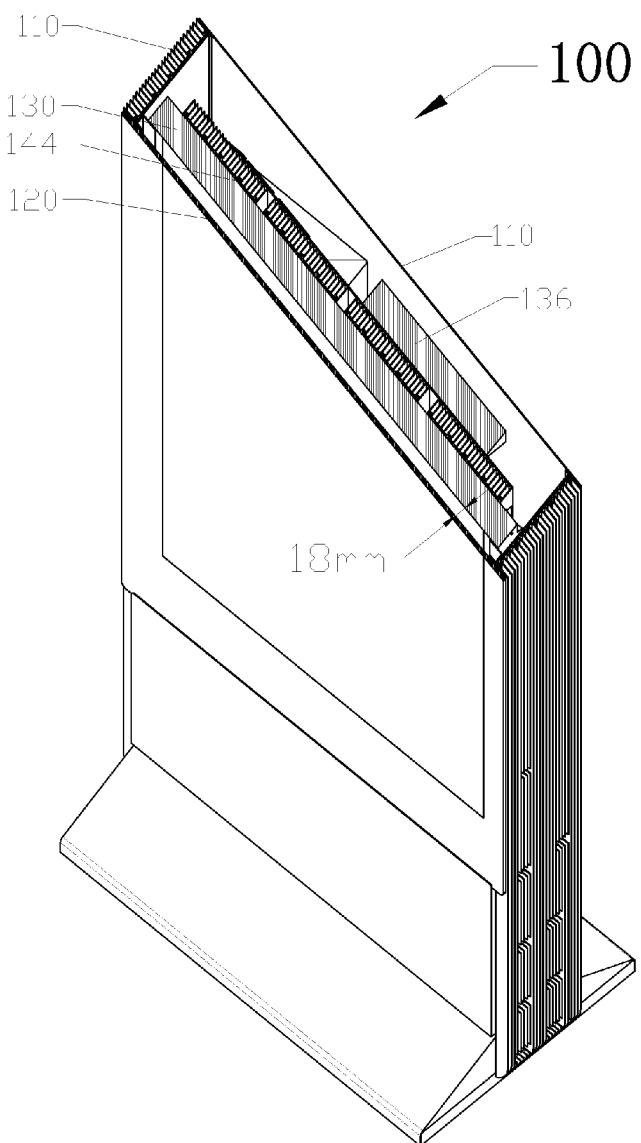
[11] A backlight module for an LCD apparatus comprising a matrix of LEDs mounted on one side of a double sided metal coated board, and heat sinks mounted on another side of the double sided metal coated board, characterized in that metalised through holes connecting the two metal coated sides of the coated board are provided to transfer heat from the LEDs to the heat sink for dissipating heat generated by the backlight arrangements.

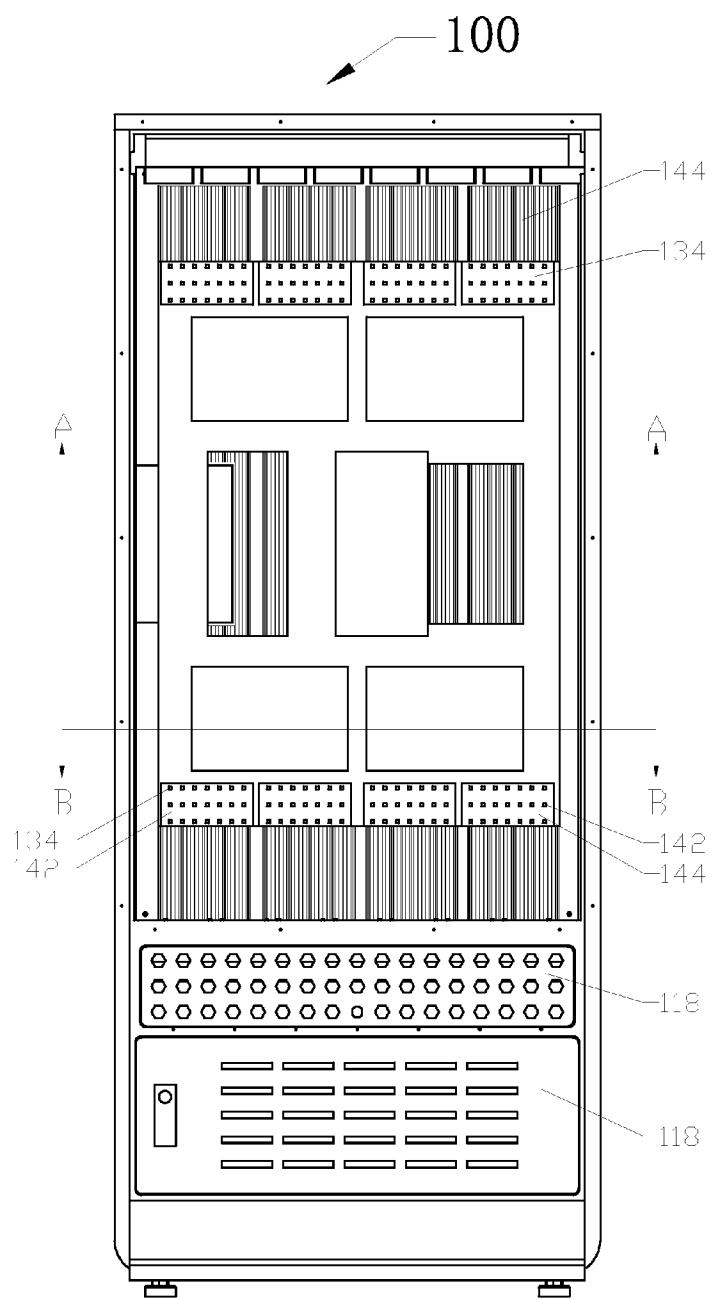
[12] A backlight module according to Claim 11, wherein the heat sink comprises a

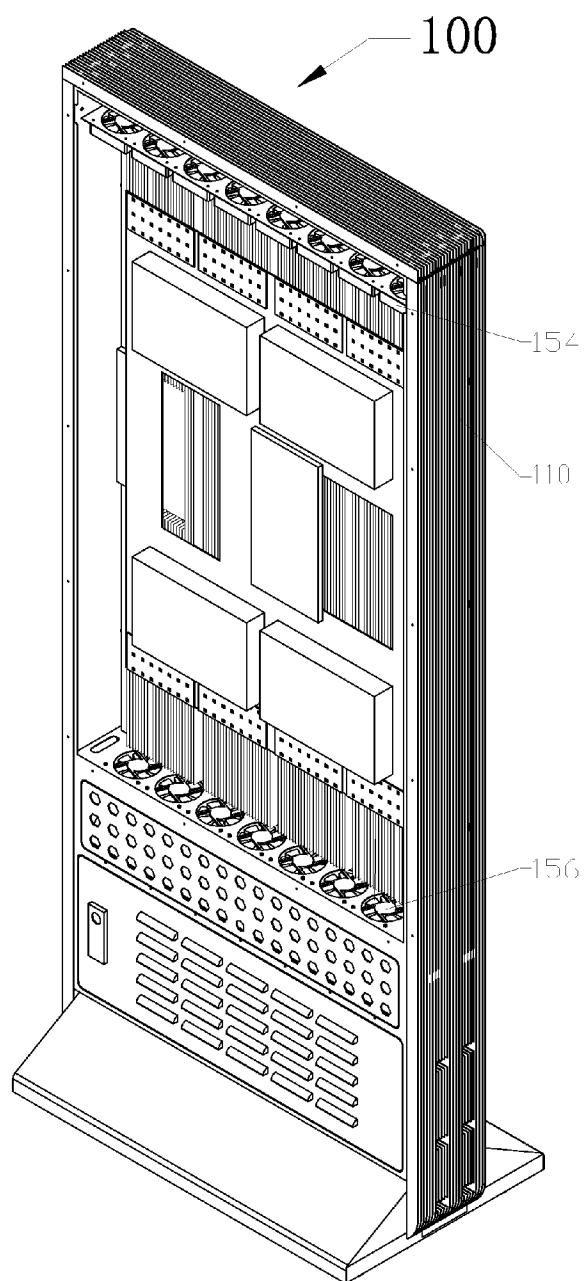
plurality of substantially parallel and elongate heat dissipating fins which collectively form air moving channels to guide movement of air for dissipating heat from the heatsinks.

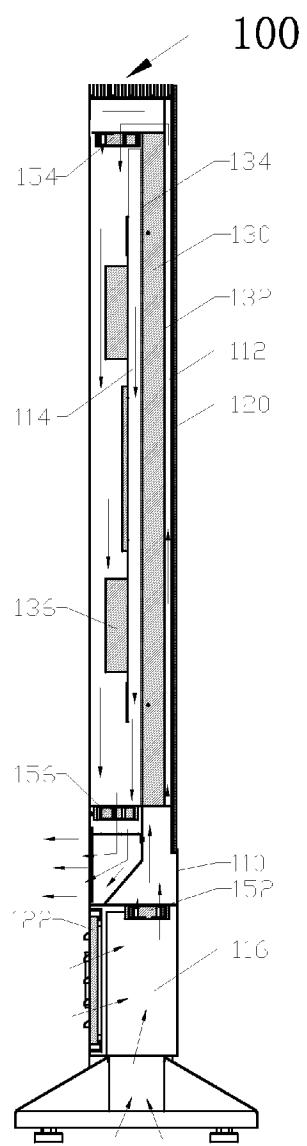
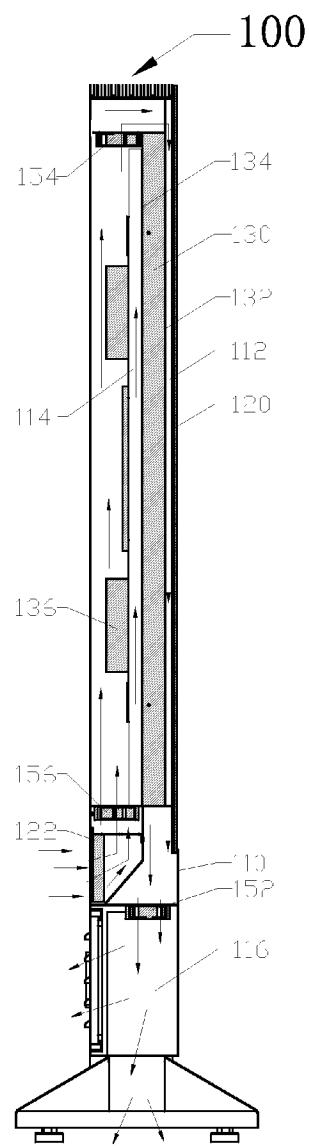
[13] A backlight module according to Claims 11 or 12, wherein the one side of the double sided metal-coated board on which the LEDs are mounted is a printed circuit board.

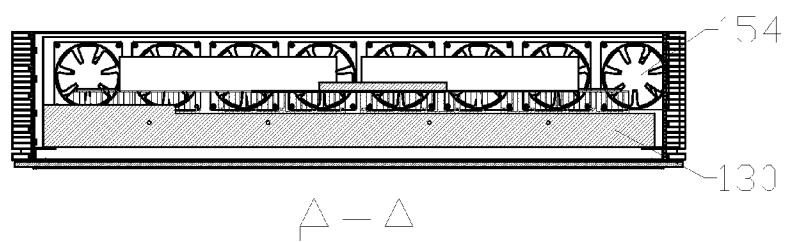
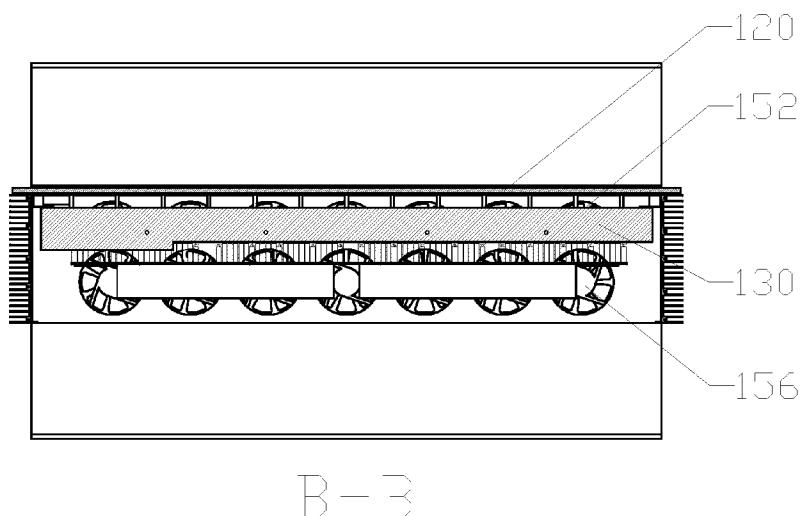
**FIG. 1**

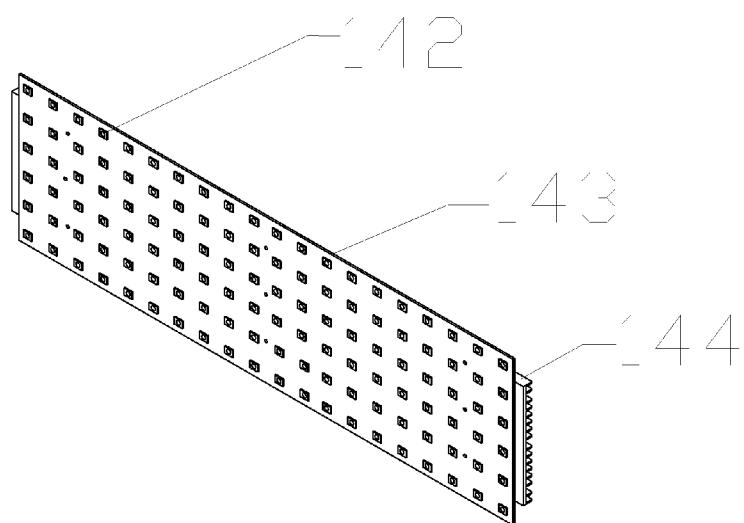
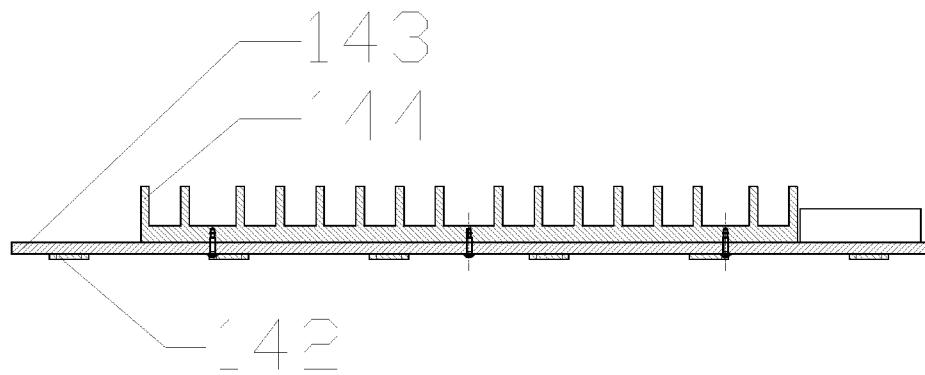
**FIG. 2**

**FIG. 3**

**FIG. 4**



**FIG. 6A****FIG. 6B**

**FIG. 7A****FIG. 7B**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2009/071975

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

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)

IPC:G02F, F21V

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)

CNKI, CNPAT, WPI, EPDOC, PAJ: CASE+, BOX+, CHEST+, SHELL+, COVER+, HEAT+, COOL+, FIN?, FIM?, HOLE+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN201199303Y (SHENZHEN NEW SUPER-BRIGHT LCD DISPLAY DEVICE CO., LTD.) 25 Feb. 2009 (25.02.2009) The whole	1-13
X	CN2687706Y (SHENKAI SCI & TECH ENGINEERING) 23 Mar. 2005 (23.03.2005) Page 4, line 2 to page 5, line 13, and Figs. 3-4	1-2
Y		3-10
Y	JP2005283852A (KYOCERA CORP) 13 Oct. 2005(13.10.2005) Paragraphs: [0034] to [0044], and Figs. 2-4	3-13

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

“E” earlier application or patent but published on or after the international filing date

“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
20 Aug. 2009(26.05.2009)

Date of mailing of the international search report
03 Sep. 2009 (03.09.2009)

Name and mailing address of the ISA/CN
The State Intellectual Property Office, the P.R.China
6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China
100088
Facsimile No. 86-10-62019451

Authorized officer

WANGCAN

Telephone No. (86-10)62085896

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2009/071975

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN101101404A (JIANZHUN ELECTRIC MACHINE IND CO LTD) 09 Jan. 2008 (09.01.2008) Page 4, line 6 to page 6, line 8, and Figs. 2-3	3-13
X	CN1469164 A (SEIKO EPSON CORP) 21 Jan. 2004 (21.01.2004) Page 5, line 13 to page 11, line 24, and Figs. 1-5	1-2
A	CN101078835A (SVA GROUP CO LTD) 28 Nov. 2007 (28.11.2007) The whole	1-13
A	CN201018745Y (SHANGHAI HIGHLY COOLER CO LTD) 06 Feb. 2008(06.02.2008) The whole	1-13

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2009/071975

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

I: Claims 1-10 directed to an LCD apparatus

II: Claims 11-13 directed to a backlight module for an LCD apparatus

The same or corresponding technical feature among the inventions above is the backlight. Since the backlight is common knowledge in the art, it does not make a contribution over the prior art and cannot be considered as a special technical feature within the meaning of Rule 13.2 PCT. The application, hence does not meet the requirements of unity of invention as defined in the Rules 13.1 PCT.

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of any additional fee.

3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on protest The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
 PCT/CN2009/071975

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN201199303Y	25.02.2009	None	
CN2687706Y	23.03.2005	None	
JP2005283852A	13.10.2005	None	
CN101101404A	09.01.2008	None	
CN1469164 A	21.01.2004	US2003231271A1	18.12.2003
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		KR100543266B1	20.01.2006
		CN1295550C	17.01.2007
CN101078835A	28.11.2007	None	
CN201018745Y	06.02.2008	None	

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2009/071975

A. CLASSIFICATION OF SUBJECT MATTER

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

G02F1/133 (2006.01) i

F21V29/00 (2006.01) i