US Patent & Trademark Office
Patent Public Search | Text View

United States Patent	12396145
Kind Code	B2
Date of Patent	August 19, 2025
Inventor(s)	Wu; Ching-Chun et al.

Display case and dual sided display

Abstract

The present disclosure provides a display case. The display case includes a central portion having an inlet and an outlet opposite to the inlet, a first transparent lid disposed on a first side of the central portion, a second transparent lid disposed on a second side of the central portion, and a heat exchanger in the central portion. The first transparent lid is configured to define a first space on the first side of the central portion and the second transparent lid is configured to define a second space on the second side of the central portion. The heat exchanger includes a first channel and a second channel. The first channel of the heat exchanger is fluidly conducted to the first space and defines a part of a first internal heat exchange loop. The second channel of the heat exchanger is fluidly conducted to the second space and defines a part of a second internal heat exchange loop. The present disclosure also provides a dual sided display.

Inventors: **Wu; Ching-Chun (Taoyuan, TW), Yang; Chia-Liang (Taoyuan, TW), Wang; Chin Liang (Taoyuan, TW)**

Applicant: **DYNASCAN TECHNOLOGY CORP.** (Taoyuan, TW)

Family ID: **1000008767272**

Assignee: **DYNASCAN TECHNOLOGY CORP. (Taoyuan, TW)**

Appl. No.: **18/242988**

Filed: **September 06, 2023**

Prior Publication Data

Document Identifier	Publication Date
US 20250081419 A1	Mar. 06, 2025

Publication Classification

Int. Cl.: **H05K7/20** (20060101); **H05K9/00** (20060101)

U.S. Cl.:

CPC **H05K7/20963** (20130101); **H05K7/20981** (20130101); **H05K9/0054** (20130101);

Field of Classification Search

USPC: None

References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
8351014	12/2012	Dunn	349/161	H05K 7/20972
9622392	12/2016	Bowers	N/A	G06F 1/206
9835893	12/2016	Dunn	N/A	F28F 3/02
10194564	12/2018	Dunn	N/A	H05K 7/20145
10314212	12/2018	Hubbard	N/A	G02F 1/133308
10398066	12/2018	Dunn	N/A	G02F 1/133385
10524397	12/2018	Dunn	N/A	H05K 7/202
10820445	12/2019	Diaz	N/A	H05K 7/20145
11019735	12/2020	Dunn	N/A	G09F 9/30
11690205	12/2022	Wang	N/A	N/A
11744054	12/2022	Dunn	361/695	H05K 7/202
2011/0058326	12/2010	Idems	361/679.21	G09F 9/30
2012/0026432	12/2011	Dunn et al.	N/A	N/A
2017/0083062	12/2016	Bowers	N/A	G06F 1/206
2023/0164964	12/2022	Dunn	361/688	H05K 7/20981

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
116634724	12/2022	CN	N/A
202333121	12/2022	TW	N/A

OTHER PUBLICATIONS

International Search Report and Written Opinion in International Patent Application No. PCT/CN2024/101793, dated Sep. 20, 2024, in 8 pages. cited by applicant

---

Primary Examiner: Relford; Xanthia C

Assistant Examiner: Cunningham; Xanthia C

Attorney, Agent or Firm: Duane Morris LLP

Background/Summary

BACKGROUND

1. Technical Field

(1) The present disclosure generally relates to a display case and a dual sided display.

2. Description of the Related Art

(2) A cooling system may be used in a display apparatus to prevent overheating. A cooling system may include an external heat dissipation path in thermal conduction with an external heat dissipation path, facilitating the dissipation of heat to the outside. Conventionally, the external heat dissipation path may extend to both sides of the cooling system, making the cooling system susceptible to water leakage. In addition, increasing environmental awareness calls for a universal display case that can accommodate various displays.

SUMMARY

(3) In one or more embodiments, the present disclosure provides a display case. The display case includes a central portion having an inlet and an outlet opposite to the inlet, a first transparent lid disposed on a first side of the central portion, a second transparent lid disposed on a second side of the central portion, and a heat exchanger in the central portion. The first transparent lid is configured to define a first space on the first side of the central portion and the second transparent lid is configured to define a second space on the second side of the central portion. The heat exchanger includes a first channel and a second channel. The first channel of the heat exchanger is fluidly conducted to the first space and defines a part of a first internal heat exchange loop. The second channel of the heat exchanger is fluidly conducted to the second space and defines a part of a second internal heat exchange loop.

(4) In one or more embodiments, the present disclosure provides a display case. The display case includes a central portion having an inlet and an outlet opposite to the inlet, a first transparent lid disposed on a first side of the central portion, a second transparent lid disposed on a second side of the central portion, and a heat exchanger in the central portion. The first transparent lid is configured to define a first space on the first side of the central portion and the second transparent lid is configured to define a second space on the second side of the central portion. The heat exchanger includes a first channel fluidly conducted to the first space, a second channel fluidly conducted to the second space, a third channel, and a fourth channel. The third channel and the fourth channel define an external heat dissipation path connected between the inlet and the outlet of the central portion, and the external heat dissipation path is isolated from the first space and the second space.

(5) In one or more embodiments, the present disclosure a dual sided display. The dual sided display includes a central portion having an inlet and an outlet opposite to the inlet, a first display module disposed in a first space on a first side of the central portion, a second display module disposed in a second space on a second side of the central portion, and a heat exchanger in the central portion. The heat exchanger includes a first channel fluidly conducted to the first space, a second channel fluidly conducted to the second space, a third channel, and a fourth channel. The third channel and the fourth channel define an external heat dissipation path connected between the inlet and the outlet of the central portion, and the external heat dissipation path is isolated from the first space and the second space.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) Aspects of the present disclosure are readily understood from the following detailed description when read with the accompanying figures. It should be noted that various features may not be drawn to scale. The dimensions of the various features may be arbitrarily increased or reduced for clarity of discussion.

(2) FIG. **1** is a perspective view of a display case, in accordance with an embodiment of the present disclosure.
(3) FIG. **2** is an explosive view of a display case, in accordance with an embodiment of the present disclosure.
(4) FIG. **3** is a cross-section of a display case, in accordance with an embodiment of the present disclosure.
(5) FIG. **4** is a cross-section of a part of a display case, in accordance with an embodiment of the present disclosure.
(6) FIG. **5** is a cross-section of a part of a display case, in accordance with an embodiment of the present disclosure.
(7) FIG. **6** is a perspective view of a part of a display case, in accordance with an embodiment of the present disclosure.
(8) FIG. **7**A is a cross-section of a part of a display case, in accordance with an embodiment of the present disclosure.
(9) FIG. **7**B is a cross-section of a part of a display case, in accordance with an embodiment of the present disclosure.
(10) FIG. **7**C is a cross-section of a part of a display case, in accordance with an embodiment of the present disclosure.
(11) FIG. **7**D is a cross-section of a part of a display case, in accordance with an embodiment of the present disclosure.
(12) FIG. **7**E is a cross-section of a part of a display case, in accordance with an embodiment of the present disclosure.
(13) FIG. **7**F is a cross-section of a part of a display case, in accordance with an embodiment of the present disclosure.
(14) FIG. **7**G is a cross-section of a part of a display case, in accordance with an embodiment of the present disclosure.
(15) Common reference numerals are used throughout the drawings and the detailed description to indicate the same or similar elements. The present disclosure will be more apparent from the following detailed description taken in conjunction with the accompanying drawings.

DETAILED DESCRIPTION

(16) The following disclosure provides many different embodiments, or examples, for implementing different features of the provided subject matter. Specific examples of components and arrangements are described herein. These are, of course, merely examples and are not intended to be limiting. The present disclosure may repeat reference numerals and/or letters in the various examples. This repetition is for simplicity and clarity and does not in itself dictate a relationship between the various embodiments and/or configurations discussed.
(17) Embodiments of the present disclosure are discussed in detail as follows. It should be appreciated, however, that the present disclosure provides many applicable concepts that can be embodied in a wide variety of specific contexts. The specific embodiments discussed are merely illustrative and do not limit the scope of the disclosure.
(18) FIG. **1** is a perspective view of a display case **1**, in accordance with an embodiment of the present disclosure. FIG. **2** is an explosive view of the display case **1**, in accordance with an embodiment of the present disclosure.
(19) In some embodiments, the display case **1** may include a central portion **10**, transparent lids **11**, **12**, a heat exchanger **13** (labelled in FIG. **2**), an internal flow generator **14** (labelled in FIG. **2**), and an external flow generator **15** (labelled in FIG. **2**).
(20) The central portion **10** may have an inlet **10***i* and an outlet **10***u* opposite to the inlet **10***i*. The central portion **10** may have a side **101** and a side **102** opposite to the side **101**. The central portion **10** may be configured to accommodate the heat exchanger **13**. The internal flow generator **14** and the external flow generator **15** may be disposed adjacent to the central portion **10** and the heat

exchanger **13**.
(21) The transparent lid **11** may be disposed on the side **101** of the central portion **10**. The transparent lid **11** may be rotatably connected to the central portion **10** through one or more pivot joints (such as the pivot joint **11***p* in FIG. **3**). The transparent lid **11** may be closed (such as at a first location) or opened (such as at a second location) with respect to the central portion **10** through one or more pivot joints.
(22) The transparent lid **11** may be removably attached to the central portion **10** through one or more sealing components (such as the sealing component **11***r* in FIG. **3**). In some embodiments, the sealing component may include rubber gaskets or O-rings. In some embodiments, the sealing component may be disposed between the transparent lid **11** and the central portion **10**. In some embodiments, the sealing component may be arranged at a periphery of the transparent lid **11**.
(23) The transparent lid **11** and the central portion **10** may define a space on the side **101**. A display module **21** may be disposed in the space on the side **101**. In some embodiments, as shown in FIG. **1**, when the transparent lid **11** is opened (such as at a second location), the display module **21** may be exposed to the external environment (such as air) or to the outside of the display case **1**.
(24) In some embodiments, as shown in FIG. **3**, when the transparent lid **11** is closed (such as at a first location), the transparent lid **11** may be attached to the central portion **10** through the sealing component **11***r*. The transparent lid **11** and the sealing component **11***r* may isolate the space on the side **101** from the external environment (such as air). For example, the transparent lid **11**, the central portion **10**, and the sealing component **11***r* may define an airtight space for the display module **21**.
(25) The transparent lid **12** may be disposed on the side **102** of the central portion **10**. The transparent lid **12** may be rotatably connected to the central portion **10** through one or more pivot joints (such as the pivot joint **12***p* in FIG. **3**). The transparent lid **12** may be closed (such as at a first location) or opened (such as at a second location) with respect to the central portion **10** through one or more pivot joints.
(26) The transparent lid **12** may be removably attached to the central portion **10** through one or more sealing components (such as the sealing component **12***r* in FIG. **3**). In some embodiments, the sealing component may include rubber gaskets or O-rings. In some embodiments, the sealing component may be disposed between the transparent lid **12** and the central portion **10**. In some embodiments, the sealing component may be arranged at a periphery of the transparent lid **12**.
(27) The transparent lid **12** and the central portion **10** may define a space on the side **102**. A display module **22** (labelled in FIG. **2**) may be disposed in the space on the side **102**. In some embodiments, as shown in FIG. **1**, when the transparent lid **12** is opened (such as at a second location), the display module **22** (labelled in FIG. **2**) may be exposed to the external environment (such as air) or to the outside of the display case **1**. In some embodiments, the display module **22** is detachable. Once the display module **22** disposed in display case is malfunctioned or broken, the display case can be re-used.
(28) In some embodiments, as shown in FIG. **3**, when the transparent lid **12** is closed (such as at a first location), the transparent lid **12** may be attached to the central portion **10** through the sealing component **12***r*. The transparent lid **12** and the sealing component **12***r* may isolate the space on the side **102** from the external environment (such as air). For example, the transparent lid **12**, the central portion **10**, and the sealing component **12***r* may define an airtight space for the display module **22**.
(29) The display case **1**, the display module **21**, and the display module **22** may be collectively referred to as a dual sided display.
(30) Although the display case **1** used in combination with the display module **21** and the display module **22** is illustrated, the present invention is not limited thereto. The display case **1** can be a universal display case used in combination with other devices, other displays, or other panels.
(31) The heat exchanger **13** may be disposed in the central portion **10**. In some embodiments, the

heat exchanger **13** may be integrated in the central portion **10**. In some embodiments, the heat exchanger **13** may be defined by the central portion **10**. In some embodiments, the heat exchanger **13** may be a part of the central portion **10**. The heat exchanger **13** may include channels for internal heat exchange loops and channels for external heat dissipation paths (further described with respect to FIG. **3**).

(32) The internal flow generator **14** may be disposed adjacent to the inlet **10***i* of the central portion **10**. In some embodiments, the internal flow generator **14** may include a fan. In some embodiments, the internal flow generator **14** may be configured to generate an internal airflow through the internal heat exchange loops.

(33) The external flow generator **15** may be disposed adjacent to the outlet **10***u* of the central portion **10**. In some embodiments, the external flow generator **15** may include a fan. In some embodiments, the external flow generator **15** may be configured to generate an external or ambient airflow through the external heat dissipation paths.

(34) FIG. **3** is a cross-section of the display case **1**, in accordance with an embodiment of the present disclosure.

(35) In some embodiments, the heat exchanger **13** may include an aluminum extrusion (such as an aluminum t-slot extrusion). In some embodiments, the heat exchanger **13** may include a plurality of channels or cells. For example, the central portion **10** may include or define a channel C**1**, a channel C**2**, a channel C**3**, and a channel C**4**. In some embodiments, the channel C**1**, the channel C**3**, the channel C**4**, and the channel C**2** may be sequentially stacked on top of each other. In some embodiments, the heat exchanger **13** may be integrally formed or formed as one piece.

(36) The channel C**1** of the heat exchanger **13** may be fluidly conducted to the space defined by the transparent lid **11**, the central portion **10**, and the sealing component **11***r* for accommodating the display module **21**. The channel C**1** may be adjacent to and thermally connected to the display module **21**. The channel C**1** may define a part of an internal heat exchange loop C**1***i*.

(37) The channel C**2** of the heat exchanger **13** may be fluidly conducted to the space defined by the transparent lid **12**, the central portion **10**, and the sealing component **12***r* for accommodating the display module **22**. The channel C**2** may be adjacent to and thermally connected to the display module **22**. The channel C**2** may define a part of an internal heat exchange loop C**2***i*.

(38) The internal heat exchange loop C**2***i* may be fluidly conducted to the internal heat exchange loop C**1***i* (further described with respect to FIG. **6**). Therefore, the space defined by the transparent lid **11**, the central portion **10**, and the sealing component **11***r* for accommodating the display module **21** may be fluidly conducted to the space defined by the transparent lid **12**, the central portion **10**, and the sealing component **12***r* for accommodating the display module **22**.

(39) The channels C**3** and C**4** of the heat exchanger **13** may be fluidly conducted to the external environment through the inlet **10***i* and the outlet **10***u*. For example, external airflows may enter the channels C**3** and C**4** through the inlet **10***i* and exit the channels C**3** and C**4** through the outlet **10***u*. The channel C**3** may define an external heat dissipation path C**3***e*. The channel C**4** may define an external heat dissipation path C**4***e*. The external flow generator **15** may be disposed adjacent to the channels C**3** and C**4** and configured to generate external airflows through the external heat dissipation paths C**3***e* and C**4***e*.

(40) The channel C**3** may be adjacent to and thermally connected to the channel C**1**. In some embodiments, the external heat dissipation path C**3***e* defined by the channel C**3** may be configured to dissipate heat from the internal heat exchange loop C**1***i* defined by the channel C**1**. In some embodiments, the flow direction of the channel C**1** may be opposite to the flow direction of the channel C**3**.

(41) The channel C**4** may be adjacent to and thermally connected to the channel C**2**. In some embodiments, the external heat dissipation path C**4***e* defined by the channel C**4** may be configured to dissipate heat from the internal heat exchange loop C**2***i* defined by the channel C**2**. In some embodiments, the flow direction of the channel C**2** may be opposite to the flow direction of the

channel C**4**.
(42) In some embodiments, the display module **21** may be supported or carried on the heat exchanger **13** through one or more carriers (or supporting elements) **21***s*. For example, the carrier **21***s* may provide mechanical support for the display module **21**. For example, the carrier **21***s* may directly contact the display module **21** (such as a backlight layer **21***c* of the display module **21**) and directly contact the heat exchanger **13**. For example, the display module **21** may have a front side configured to emit a light and a rear side directly contacting the carrier **21***s*.
(43) In some embodiments, the display module **21** may include a display panel **21***a*, an optical film **21***b*, and the backlight layer **21***c*. The display panel **21***a* may be disposed between the optical film **21***b* and the transparent lid **11**. The optical film **21***b* may be disposed between the display panel **21***a* and the backlight layer **21***c*. The backlight layer **21***c* may be disposed between the optical film **21***b* and the carrier **21***s*.
(44) The display panel **21***a* may include, for example, a glass panel, a liquid crystal panel, a plastic panel, or other types of panels. The optical film **21***b* may include, for example, a diffuser, a reflector, a polarizer, a filter, a light guiding element, a lens, or other optical elements. The backlight layer **21***c* may include a plurality of light emitting pixels.
(45) In some embodiments, the internal flow generator **14** may be disposed adjacent to the carrier **21***s*. In some embodiments, the internal flow generator **14** may be disposed adjacent to the channel C**1** of the heat exchanger **13**. In some embodiments, the internal flow generator **14** may be configured to generate an internal airflow through the internal heat exchange loop C**1***i*. For example, the internal flow generator **14** may be fluidly conducted to the channel C**1**. The internal flow generator **14** may be configured to exhaust air from the channel C**1** into the space defined by the transparent lid **11**, the central portion **10**, and the sealing component **11***r* for accommodating the display module **21**.
(46) In some embodiments, the internal airflow generated by the internal flow generator **14** may flow between the transparent lid **11** and the display panel **21***a*, and flow between the display panel **21***a* and the optical film **21***b*. Then, the internal airflow may flow into the channel C**1** through an opening (or a hole) C**1***h* on the sidewall of the channel C**1**.
(47) In some embodiments, the internal heat exchange loop C**1***i* may be isolated from the external environment. For example, the external airflow may not enter the internal heat exchange loop C**1***i*. For example, the internal heat exchange loop C**1***i* may be isolated from the external heat dissipation path C**3***e* by a baffle C**1***b*. The baffle C**1***b* may be a part of the heat exchanger **13** or may be connected to the heat exchanger **13**. The baffle C**1***b* may extend from the sidewall of the channel C**1**.
(48) In some embodiments, the display module **22** may be supported or carried on the heat exchanger **13** through one or more carriers (or supporting elements) **22***s*. For example, the carrier **22***s* may provide mechanical support for the display module **22**. For example, the carrier **22***s* may directly contact the display module **22** (such as a backlight layer **22***c* of the display module **22**) and directly contact the heat exchanger **13**. For example, the display module **22** may have a front side configured to emit a light and a rear side directly contacting the carrier **22***s*.
(49) In some embodiments, similar to the display module **21**, the display module **22** may include a display panel **22***a*, an optical film **22***b*, and the backlight layer **22***c*.
(50) In some embodiments, the internal flow generator **14** may be disposed adjacent to the carrier **22***s*. In some embodiments, the internal flow generator **14** may be disposed adjacent to the channel C**2** of the heat exchanger **13**. In some embodiments, the internal flow generator **14** may be configured to generate an internal airflow through the internal heat exchange loop C**2***i*. For example, the internal flow generator **14** may be fluidly conducted to the channel C**2**. The internal flow generator **14** may be configured to exhaust air from the channel C**2** into the space defined by the transparent lid **12**, the central portion **10**, and the sealing component **12***r* for accommodating the display module **22**.

(51) In some embodiments, the internal airflow generated by the internal flow generator **14** may flow between the transparent lid **12** and the display panel **22***a*, and flow between the display panel **22***a* and the optical film **22***b*. Then, the internal airflow may flow into the channel C**2** through an opening (or a hole) C**2***h* on the sidewall of the channel C**2**.
(52) In some embodiments, the internal heat exchange loop C**2***i* may be isolated from the external environment. For example, the external airflow may not enter the internal heat exchange loop C**2***i*. For example, the internal heat exchange loop C**2***i* may be isolated from the external heat dissipation path C**4***e* by a baffle C**2***b*. The baffle C**2***b* may be a part of the heat exchanger **13** or may be connected to the heat exchanger **13**. The baffle C**2***b* may extend from the sidewall of the channel C**2**.
(53) FIG. **4** is a cross-section of a part of the display case **1** in FIG. **3**, in accordance with an embodiment of the present disclosure.
(54) The external heat dissipation path C**3***e* defined by the channel C**3** may be isolated from the space on the side **101** (and from the channel C**1**) by the baffle C**1***b*. The baffle C**1***b* may extend from a sidewall of the channel C**3** (or a sidewall of the channel C**1**) to a part of the transparent lid **11**.
(55) With or without the transparent lid **11** is closed, the external heat dissipation path C**3***e* defined by the channel C**3** may be isolated from the space on the side **101** by the baffle C**1***b*.
(56) The internal airflow of the internal heat exchange loop C**1***i* may flow into the channel C**1** through the opening C**1***h* on the sidewall of the channel C**1**.
(57) The external heat dissipation path C**4***e* defined by the channel C**4** may be isolated from the space on the side **102** (and from the channel C**2**) by the baffle C**2***b*. The baffle C**2***b* may extend from a sidewall of the channel C**4** (or a sidewall of the channel C**2**) to a part of the transparent lid **12**.
(58) With or without the transparent lid **12** is closed, the external heat dissipation path C**4***e* defined by the channel C**4** may be isolated from the space on the side **102** by the baffle C**2***b*.
(59) The internal airflow of the internal heat exchange loop C**2***i* may flow into the channel C**2** through the opening C**2***h* on the sidewall of the channel C**2**.
(60) FIG. **5** is a cross-section of a part of the display case **1** in FIG. **3**, in accordance with an embodiment of the present disclosure.
(61) The internal flow generator **14** (on the leftside) may be disposed adjacent to the channel C**1** and may be fluidly conducted to the channel C**1**. The internal flow generator **14** may be configured to exhaust air from the channel C**1** and generate an internal airflow of the internal heat exchange loop C**1***i*, which flows between the transparent lid **11** and the display panel **21***a* and flows between the display panel **21***a* and the optical film **21***b*.
(62) The internal flow generator **14** (on the rightside) may be disposed adjacent to the channel C**2** and may be fluidly conducted to the channel C**2**. The internal flow generator **14** may be configured to exhaust air from the channel C**2** and generate an internal airflow of the internal heat exchange loop C**2***i*, which flows between the transparent lid **12** and the display panel **22***a* and flows between the display panel **22***a* and the optical film **22***b*.
(63) FIG. **6** is a perspective view of a part of the display case **1**, in accordance with an embodiment of the present disclosure. For conciseness and clearness, the transparent lid **11**, the internal flow generator **14**, the external flow generator **15**, and the display module **22** are not shown in FIG. **6**.
(64) The width w**1** of the transparent lid **12** (and the transparent lid **11**) of the display case **1** may be greater than the width w**2** of the display module **21** (and the display module **22**). When the transparent lids **11** and **12** are closed, the transparent lids **11** and **12** may define an airtight space for the display modules **21** and **22**. The internal heat exchange loop C**1***i* may be fluidly conducted to the internal heat exchange loop C**2***i* on at least a side of the display case **1**. For example, the internal heat exchange loop C**1***i* and the internal heat exchange loop C**2***i* may be fluidly conducted through a path P crossing the channels C**1**, C**2**, C**3** and C**4**.

(65) According to some embodiments of the present disclosure, the size of the display case **1** is reduced because the channels C**1**, C**2**, C**3** and C**4** of the heat exchanger **13** are integrated in the central portion **10**. In addition, by isolating the external heat dissipation path C**3***e* and the external heat dissipation path C**4***e* from the internal heat exchange loop C**1***i* and the internal heat exchange loop C**2***i*, the water resistance of the display case **1** is improved. Furthermore, since the internal heat exchange loop C**1***i* and the internal heat exchange loop C**2***i* are fluidly conducted, the temperature on the sides **101** and **102** of the central portion **10** can be balanced. The heat dissipation efficiency can be improved.

(66) FIGS. **7**A, **7**B, **7**C, **7**D, **7**E, **7**F, and **7**G are cross-sections of a part of a display case, in accordance with an embodiment of the present disclosure. In some embodiments, the heat exchanger **13** of the display case **1** may have variations as shown in FIGS. **7**A, **7**B, **7**C, **7**D, **7**E, **7**F, and **7**G.

(67) Referring to FIG. **7**A, the heat exchanger **13** may have four sets, and each set has the channel C**1**, the channel C**3**, the channel C**4**, and the channel C**2** sequentially stacked on top of the other. In some embodiments, the heat exchanger **13** may include, but are not limited to, one set, two sets, three sets, four sets, or more.

(68) Referring to FIG. **7**B, the heat exchanger **13** in FIG. **7**B is similar to the heat exchanger **13** in FIG. **7**A, with differences in that the heat exchanger **13** in FIG. **7**B is exclusive of the channel C**4**. For example, in one set of the heat exchanger **13** in FIG. **7**B, the channel C**1**, the channel C**3**, and the channel C**2** are sequentially stacked on top of the other. The channel C**3** defines an external heat dissipation path that is shared by the channel C**1** and the channel C**2**.

(69) Referring to FIG. **7**C, the heat exchanger **13** in FIG. **7**C is similar to the heat exchanger **13** in FIG. **7**B, with differences in that the heat exchanger **13** in FIG. **7**C has an interconnecting channel C**5** extending between the sides **101** and **102**. The interconnecting channel C**5** may cross the channel C**1**, the channel C**3**, and the channel C**2**. The channel C**1** and the channel C**2** may be fluidly conducted (or thermally conducted) through the interconnecting channel C**5**, as indicated by the arrows. For example, one or more openings may be formed between the channel C**1** and the interconnecting channel C**5**, and one or more openings may be formed between the channel C**2** and the interconnecting channel C**5**. The channel C**1** and the channel C**2** may be fluidly conducted through the interconnecting channel C**5** by heat convection. Alternatively, the channel C**1** and the channel C**2** may be thermally conducted through the interconnecting channel C**5** by heat conduction. Therefore, in addition to fluidly conducting on at least one side of the display case (as shown in FIG. **6**), the display case may further have fluidly conducting (or thermally conducting) on the central portion thereof to facilitate temperature balancing.

(70) Referring to FIG. **7**D, the heat exchanger **13** in FIG. **7**D is similar to the heat exchanger **13** in FIG. **7**C, with differences in that channel C**3** may be surrounded by the channel C**1** and the channel C**2** and that the channel C**1** and the channel C**2** may be fluidly conducted (or thermally conducted) without the interconnecting channel C**5**, as indicated by the arrows. For example, one or more openings may be formed between the channel C**1** and the channel C**2**. The channel C**1** and the channel C**2** may be fluidly conducted by heat convection. Alternatively, the channel C**1** and the channel C**2** may be thermally conducted by heat conduction.

(71) Referring to FIG. **7**E, the heat exchanger **13** in FIG. **7**E is similar to the heat exchanger **13** in FIG. **7**D, with differences in that the channel C**1** and the channel C**2** are collectively formed as one piece. For example, the channel C**1** and the channel C**2** may be a combination of channels on sides **101** and **102**.

(72) Referring to FIG. **7**F, the heat exchanger **13** in FIG. **7**F is similar to the heat exchanger **13** in FIG. **7**E, with differences in that the heat exchanger **13** in FIG. **7**F includes two combinations of channels on sides **101** and **102**. In addition, the heat exchanger **13** in FIG. **7**F includes three channels C**3** for circulating external airflows.

(73) Referring to FIG. **7**G, the heat exchanger **13** in FIG. **7**G is similar to the heat exchanger **13** in

FIG. **7**F, with differences in that the heat exchanger **13** in FIG. **7**G includes three combinations of channels on sides **101** and **102**. In addition, the heat exchanger **13** in FIG. **7**G includes two channels C**3** for circulating external airflows. Each of the channels C**3** is surrounded by the combinations of channels on sides **101** and **102**.

(74) Spatially relative terms, such as “beneath,” “below,” “lower,” “above,” “upper,” “left,” “right” and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. The spatially relative terms are intended to encompass different orientations of the device in use or operation, in addition to the orientation depicted in the figures. The apparatus may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein may likewise be interpreted accordingly. It should be understood that when an element is referred to as being “connected to” or “coupled to” another element, it may be directly connected to or coupled to the other element, or intervening elements may be present.

(75) As used herein, the terms “approximately”, “substantially”, “substantial” and “about” are used to describe and account for small variations. When used in conduction with an event or circumstance, the terms can refer to instances in which the event or circumstance occurs precisely as well as instances in which the event or circumstance occurs to a close approximation. As used herein with respect to a given value or range, the term “about” generally means within ±10%, ±5%, ±1%, or ±0.5% of the given value or range. Ranges can be expressed herein as from one endpoint to another endpoint or between two endpoints. All ranges disclosed herein are inclusive of the endpoints unless specified otherwise. When referring to numerical values or characteristics as “substantially” the same, the term can refer to the values lying within ±10%, ±5%, ±1%, or ±0.5% of an average of the values.

(76) The foregoing outlines features of several embodiments and detailed aspects of the present disclosure. The embodiments described in the present disclosure may be readily used as a basis for designing or modifying other processes and structures for carrying out the same or similar purposes and/or achieving the same or similar advantages of the embodiments introduced herein. Such equivalent constructions do not depart from the spirit and scope of the present disclosure, and various changes, substitutions, and alterations may be made without departing from the spirit and scope of the present disclosure.

Claims

1. A display case, comprising: a central portion having an inlet and an outlet opposite to the inlet; a first transparent lid disposed on a first side of the central portion and configured to define a first space on the first side of the central portion; a second transparent lid disposed on a second side of the central portion and configured to define a second space on the second side of the central portion; and a heat exchanger in the central portion and comprising a first channel and a second channel, wherein the first channel of the heat exchanger is fluidly conducted to the first space and defines a part of a first internal heat exchange loop, and the second channel of the heat exchanger is fluidly conducted to the second space and defines a part of a second internal heat exchange loop.

2. The display case of claim 1, wherein the first space is fluidly conducted to the second space.

3. The display case of claim 2, wherein the first internal heat exchange loop is fluidly conducted to the second internal heat exchange loop on at least one side of the display case.

4. The display case of claim 1, further comprising a first internal flow generator disposed adjacent to the first channel and a second internal flow generator disposed adjacent to the second channel.

5. The display case of claim 4, wherein the first internal flow generator is configured to exhaust air from the first channel into the first space, and the second internal flow generator is configured to exhaust air from the second channel into the second space.

6. The display case of claim 1, wherein the heat exchanger further comprises a third channel and a

fourth channel, wherein the third channel and the fourth channel define an external heat dissipation path connected between the inlet and the outlet of the central portion.
7. The display case of claim 6, wherein the first channel, the third channel, the fourth channel, and the second channel are sequentially stacked on top of each other.
8. The display case of claim 6, wherein the first internal heat exchange loop and the second internal heat exchange loop are isolated from the external heat dissipation path by a baffle.
9. The display case of claim 6, further comprising an external flow generator fluidly conducting to the external heat dissipation path.
10. The display case of claim 1, wherein the first transparent lid is rotatably connected to the display case through a first pivot joint and the second transparent lid is rotatably connected to the display case through a second pivot joint.
11. The display case of claim 10, wherein the first transparent lid has a first location and a second location with respect to the central portion, wherein the first transparent lid at the first location and a first sealing component seals the first internal heat exchange loop in the display case and isolates the first internal heat exchange loop from outside of the display case, and wherein the first transparent lid at the second location exposes the first internal heat exchange loop to outside of the display case.
12. The display case of claim 1, further comprising a first carrier for carrying a first display module in the first space and a second carrier for carrying a second first display module in the second space.
13. The display case of claim 12, wherein the first carrier and the second carrier directly contact the heat exchanger.
14. A display case, comprising: a central portion having an inlet and an outlet opposite to the inlet; a first transparent lid disposed on a first side of the central portion and defines a first space on the first side of the central portion; a second transparent lid disposed on a second side of the central portion and defines a second space on the second side of the central portion; and a heat exchanger in the central portion and comprising a first channel fluidly conducted to the first space, a second channel fluidly conducted to the second space, a third channel, and a fourth channel, wherein the third channel and the fourth channel define an external heat dissipation path connected between the inlet and the outlet of the central portion, and the external heat dissipation path is isolated from the first space and the second space.
15. The display case of claim 14, wherein the first space is fluidly conducted to the second space.
16. The display case of claim 14, further comprising a first internal flow generator disposed adjacent to the first channel and a second internal flow generator disposed adjacent to the second channel.
17. The display case of claim 16, wherein the first internal flow generator is configured to exhaust air from the first channel into the first space, and the second internal flow generator is configured to exhaust air from the second channel into the second space.
18. The display case of claim 14, wherein the first channel, the third channel, the fourth channel, and the second channel are sequentially stacked on top of each other.
19. The display case of claim 14, further comprising an external flow generator fluidly conducting to the external heat dissipation path.
20. The display case of claim 14, wherein the first transparent lid is rotatably connected to the display case through a first pivot joint and the second transparent lid is rotatably connected to the display case through a second pivot joint.
21. The display case of claim 20, wherein the first transparent lid has a first location and a second location with respect to the central portion, wherein the first transparent lid at the first location and a first sealing component seals a first internal heat exchange loop in the display case and isolates the first internal heat exchange loop from outside of the display case, and wherein the first transparent lid at the second location exposes the first internal heat exchange loop to outside of the

display case.
22. The display case of claim 14, further comprising a first carrier for carrying a first display module in the first space and a second carrier for carrying a second first display module in the second space.
23. The display case of claim 22, wherein the first carrier and the second carrier directly contact the heat exchanger.
24. A dual sided display, comprising: a central portion having an inlet and an outlet opposite to the inlet; a first display module disposed in a first space on a first side of the central portion; a second display module disposed in a second space on a second side of the central portion; and a heat exchanger in the central portion and comprising a first channel fluidly conducted to the first space, a second channel fluidly conducted to the second space, a third channel, and a fourth channel, wherein the third channel and the fourth channel define an external heat dissipation path connected between the inlet and the outlet of the central portion, and the external heat dissipation path is isolated from the first space and the second space.
25. The dual sided display of claim 24, further comprising a first internal flow generator disposed adjacent to the first channel and a second internal flow generator disposed adjacent to the second channel.
26. The dual sided display of claim 25, wherein the first internal flow generator is configured to exhaust air from the first channel into the first space, and the second internal flow generator is configured to exhaust air from the second channel into the second space.
27. The dual sided display of claim 24, wherein the first channel, the third channel, the fourth channel, and the second channel are sequentially stacked on top of each other.
28. The dual sided display of claim 24, further comprising an external flow generator fluidly conducting to the external heat dissipation path.
29. The dual sided display of claim 24, further comprising a first carrier for carrying the first display module in the first space and a second carrier for carrying the second display module in the second space.
30. The dual sided display of claim 29, wherein the first carrier and the second carrier directly contact the heat exchanger.