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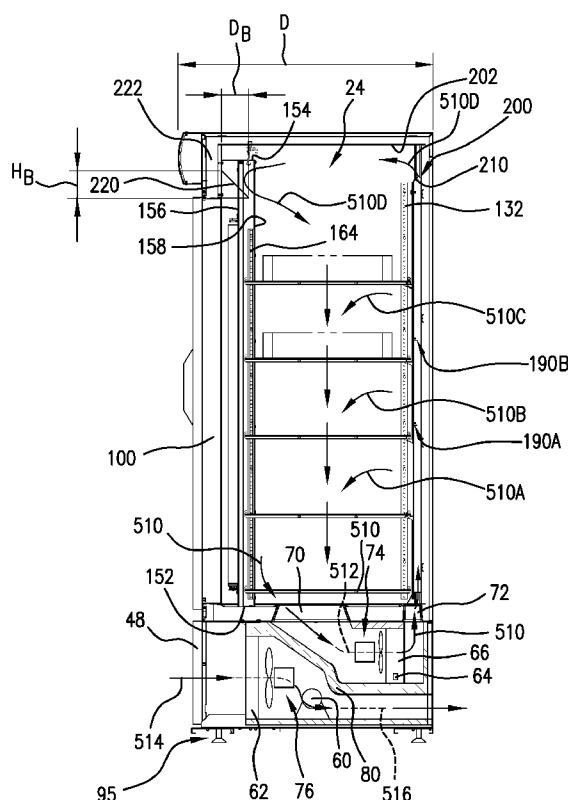
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[Continued on next page]

(54) Title: REFRIGERATED CASE



(57) Abstract: A refrigerated case (20) includes a body (22) having a left and a right side, a top, and a back. A refrigerated compartment (24) is located within the body. At least one vertical array (120, 122) of shelves is within the refrigerated compartment. A base compartment (44) is below the refrigerated compartment. A refrigeration module (50) is located within the base compartment. A cold air flowpath (512) extends from the module upward through a rear duct (146, 147) of the body and returns to the module. The cold air flowpath includes a number of branches extending through apertures in the rear duct. The cold air flowpath returns downwardly through the shelf array.



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— *with international search report*

REFRIGERATED CASE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] Benefit is claimed of U.S. Patent Application Ser. No. 60/882,726, filed December 29, 2006, and entitled "Refrigerated Case", the disclosure of which is incorporated by reference herein as if set forth at length.

BACKGROUND

[0002] The disclosure relates to refrigerated cases. More particularly, the disclosure relates to case airflow.

[0003] A basic refrigerated case (including freezers) is a narrow case with a single hinged door and a single vertical array of shelves. Multi-door refrigerated cases exist in many configurations. Some configurations include sliding doors whereas other configurations include hinged doors. Hinged-door refrigerated cases typically include a vertical mullion (post) between each pair of adjacent doors. Sliding door cases may mount doors in sliding pairs or other groupings. Such cases may typically have multiple vertical arrays of shelves (e.g., one array associated with each door).

[0004] In several configurations of refrigerated case, the refrigeration equipment is located in a self-contained module which may be installed to and removed from the case as a unit. An exemplary module includes the compressor, condenser, expansion device, evaporator, and associated fans. The module is typically installed in a base of the case below the refrigerated compartment.

[0005] Direction of the recirculating airflow has been the subject of several variations. US Patent 5,417,079 discloses a case having an air distribution duct. An air path extends up the back through the duct. Air vented through apertures in the duct passes forward across the shelves, and down the front of the case. US Patent Publication 2001003248 discloses a similar system with a top duct. US Patent Publication 20060207279 discloses a similar system with another top duct.

SUMMARY

[0006] One aspect of the disclosure involves a refrigerated case. The case includes a body having a left and a right side, a top, and a back. A refrigerated compartment is located within the body. At least one vertical array of shelves is within the refrigerated compartment. A base compartment is below the refrigerated compartment. A refrigeration module is located within

the base compartment. A cold air flowpath extends from the module upward through a rear duct of the body and returns to the module. The cold air flowpath includes a number of branches extending through apertures in the rear duct. The cold air flowpath returns downwardly through the shelf array.

- 5 [0007] In various implementations, the case may lack a top duct so that a discharge branch from the rear duct passes directly between a top of the refrigerated compartment and a storage area of the top shelf. A downward and rearward directed baffle may be positioned along a forward portion of the refrigerated compartment above the top shelf to downwardly and rearwardly redirect that discharge branch. A return port in a bottom wall of the
- 10 compartment may have a central blocking member and a peripheral opening. The central blocking member may be above the peripheral opening. There may be left and right shelf arrays and left and right ducts. The return port may span a dividing plane between the left and right arrays.

- [0008] The details of one or more embodiments are set forth in the accompanying
- 15 drawings and the description below. Other features, objects, and advantages will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

- [0009] FIG. 1 is a partially exploded view of a refrigerated case.
- [0010] FIG. 2 is a partially cutaway view of a main body of the case of FIG. 1 with a
- 20 refrigeration module shown in broken lines.
- [0011] FIG. 3 is a longitudinal vertical sectional view of the case of FIG. 1.
- [0012] FIG. 4 is a front view of the main body of the case of FIG. 1.
- [0013] FIG. 5 is a partial horizontal cutaway view of the case of FIG. 1.
- [0014] FIG. 6 is a partial enlarged view of rear pilaster tracks of the case of FIG. 1.
- 25 [0015] FIG. 7 is a view of a return grille area of the case of FIG. 1
- [0016] Like reference numbers and designations in the various drawings indicate like elements.

DETAILED DESCRIPTION

[0017] FIGS. 1-4 show a refrigerated case 20 having a housing (body) 22 surrounding a refrigerated interior compartment 24 (FIG. 2). The exemplary housing 22 includes a main body 25. Left and right doors 26 and 27 (FIG. 1) are positioned to close and open across a front opening 28 (FIG. 2) of the main body 25. The exemplary main body 25 has a left sidewall 30, a right sidewall 32, a back 34, and a top 36. For non-limiting reference, left and right are viewed from the perspective of the case rather than a user facing the case. A lower portion of the body 22 forms a base 40 including an exemplary platform 42. A base compartment 44 is separated from the compartment 24 by a compartment bottom wall (dividing wall) 46. A front of the compartment 44 may be closed by a removable grille 48. An overall case depth D is shown in FIG. 2. An overall case body height H_1 , an overall case height H_2 , and an overall case width W are shown in FIG. 1.

[0018] In the exemplary case 20, a recirculating airflow is directed from/to the compartment 24 by a refrigeration equipment module 50 (e.g., containing the compressor, heat exchangers, expansion device, fans, and the like). The module 50 (discussed in further detail below) has an installed position within the compartment 44. The module 50 is removable from the compartment 44 as a unit (e.g., after removing the grille 48, if present), advantageously without the use of tools or with only slight tool use. The exemplary module 50 (FIG. 2) has a front 51, a back 52, a top 53, a bottom 54, a left side 55, and a right side 56.

[0019] FIG. 3 shows further details of the exemplary case 20 and module 50. The exemplary module 50 contains the compressor 60, the heat rejection heat exchanger (e.g., condenser and/or gas cooler) 62, the expansion device 64, and the heat absorption heat exchanger (evaporator) 66 sequentially along a recirculating refrigerant flowpath (e.g., further defined by appropriate refrigerant lines/conduits). A recirculating airflow 510 passes along a recirculating flowpath (the cold air flowpath) 512 through the module 50 and compartment 24 to cool the compartment. The exemplary flow 510 passes from the compartment 24 into the module 50 through a first port 70 in the wall 46 and returns to the compartment 24 via a second port 72 in the wall 46. The exemplary flow 510 is driven by an electric fan 74 in the flowpath 512 in the module 50.

[0020] An airflow 514 passes along a flowpath (the warm air flowpath) 516 which extends through the heat rejection heat exchanger 62. Subject to considerations discussed further below, the exemplary path 516 is an open path entering through the grille 48, then entering the front 51 of the module 50 and passing through the heat rejection heat exchanger 62 before exiting the rear 52 of the module and rear of the case. An electric fan 76 may be in

the warm air flowpath 516 in the module 50 to drive the airflow 514. A wall 80 may separate the flowpaths 512 and 516 within the module. Feet 95 or casters may support the case atop a ground/floor surface 96. As so far described, the case may be representative of a portion of the possible cases to which the present disclosure may be applied (e.g., to reengineer or
5 further engineer a baseline case configuration).

[0021] The exemplary front opening 28 of the refrigerated compartment is divided by a vertical mullion (post) 100 (FIG. 3). In the exemplary case, the left and right doors 26 and 27 (FIG. 1) may selectively close the left and right portions of the opening on left and right sides of the mullion. The exemplary doors are hinged by hinges 102 (FIG. 1). The exemplary hinge
10 locations are along the outboard edges of the doors joining the doors to the forward edges of the adjacent side walls. The doors may seal with the main body 25 along a face of the main body circumscribing a perimeter of the opening 28. This sealing may be via gaskets (e.g., a resilient magnetic gasket).

[0022] An alternative configuration has a sliding door unit (not shown). The sliding door
15 unit may include one or more sliding doors mounted for movement on tracks of a frame.

[0023] The refrigerated compartment may contain one or more vertical arrays of shelves. Various mechanisms may be used to support the shelves. Full-width shelves may be supported by the left and right side walls (e.g., via pairs of front and rear vertical tracks along the wall inboard surfaces). The shelves may additionally or alternatively be supported by the
20 back wall (e.g., via brackets mounted to the back wall). With relatively wide compartments, additional support may be appropriate. For example, full-width shelves may be subject to bowing. The full-width shelves may, advantageously, be supported front and/or back at a location intermediate the left and right side walls. Exemplary supports are vertical posts.

[0024] Alternatively, there may be more than one vertical shelf array. For example, in the
25 exemplary case 20, there are left and right vertical arrays of shelves 120 and 122 (FIG. 3). The outboard edges of the shelves may be supported by tracks (e.g., a front track 130 (FIG. 2) and a rear track 132 (FIG. 3)) along each of the side walls. The inboard edges of the shelves may be supported by the intermediate support(s).

[0025] FIGS. 4-6 show a back intermediate support in the form of left and right pilaster
30 tracks 140 and 142 along the back wall. Support brackets mounted along these tracks may support the adjacent inboard rear portions of the associated shelves. The exemplary pilaster tracks 140 and 142 are respectively mounted to front surfaces of left and right duct panels 143 and 144. The panels 143 and 144 cooperate with a front surface 145 of the back wall 34 to define left and right duct passageways 146 and 147 extending upward from the port 72.

[0026] FIGS. 3 and 5 show a front support 150 in the form of a centerpost (post) spaced behind the mullion 100. The post 150 has a lower end or bottom 152, an upper end or top 154, a front 156, a back 158, a left side 160, and a right side 162 (FIG. 4). Along each of the left and right sides, the post 150 bears a track 164, 166 to support inboard forward portions of the associated shelves.

[0027] Cold supply air from the refrigeration module 50 is circulated through the compartment 24 to cool the product located on the shelves. It is desirable to provide a combination of low pulldown time (time to cool warm product placed in the cabinet) and uniform product temperature (product to product temperature variation among differently positioned product). With relatively wide cases (e.g., cases having multiple shelf arrays) these goals may be difficult to achieve because the size of the case creates greater disparities in the positioning of product. However, these goals may be achieved by a combination of one or more of several cold air distribution features.

[0028] To distribute the air, the air is passed upward from the module 50 through one or more ducts (e.g., the passageways 146 and 147) defined behind one or more duct panels (e.g., 143 and 144). Each duct panel has vent apertures 180 (FIG. 4 - such as slots, perforations, or louvers) for forwardly distributing air. The exemplary embodiment includes arrays of apertures 180 associated with each of the intermediate shelves (i.e. between that shelf and the shelf above). The size and positioning of the apertures 180 may affect the distribution within and among the shelves. Also, the exemplary duct includes baffles 190A and 190B (FIG. 3) that may locally restrict air flow and may be shaped to further direct (e.g., scoop) the air to distribute the air amongst the shelves. The exemplary baffles 190A and 190B are progressively more restricting from bottom to top (e.g., as from bottom to top the baffles become bigger to capture similar quantities of air for each shelf). For example, with a duct depth D_D , an exemplary lower baffle 190A has a depth D_{DB} of a bit less than half D_D . An upper baffle has a depth of about half D_D . For an exemplary D_D of one inch (2.5cm), an exemplary lower baffle depth is 3/8 inch (0.95cm) and an exemplary upper baffle depth is half an inch (1.3cm). Exemplary baffle depths generally are 20-70%, more narrowly 30-60%. In the two baffle situation an exemplary upper baffle depth exceeds the lower by at least 10% (of total duct depth).

[0029] The duct configuration (aperture 180 and baffle 190A and 190B distribution) may be configured to evenly distribute air to the storage spaces above several of the shelves. As is discussed below, the exemplary embodiment provides branch airflows 510A, 510B, and 510C (and associated flowpath branches) through the apertures associated with the

intermediate shelves and not the top shelf and bottom shelf. For each of these intermediate shelves, the associated duct panel(s) have an exemplary aperture/perforation schedule that is more open toward the top of the associated storage space than near the bottom. This topward bias allows more air to flow out above the product and cool the product. As is discussed below, the airflow is not merely straight across and out of the storage space but flows down through the storage space. In certain situations, the duct configuration (aperture 180 and baffle 190A and 190B distribution) may be configured for uneven air and cooling distribution. Also, a different product mix may require a different air distribution for a given cooling distribution. Thus, for example, an intended product mix may influence the selection and location of baffles 190A and 190B even for a given shelf and aperture 180 distribution. In final assembly, the appropriate baffles may be installed (e.g., via riveting) in the appropriate locations in view of the intended product mix.

[0030] The exemplary duct passageways each have an open upper end 200 (FIG. 3) near (e.g., spaced below) the top surface 202 of the compartment 24. The exemplary top shelf does not need to have slots to direct the air over it because the air 510D that comes out of the upper end 200 of the duct may cool the product on the top shelf. An exemplary baffle or an air “flap” 210 at the upper end of the duct may be used to regulate the amount of air that is discharged out the top versus the rear slots 180 in the duct. The exemplary flap 210 is sized, in view of the slots size and distribution to provide a desired split between the flow 510D and the flows 510A-C through the slots. An exemplary split provides the flow 510D with 40-60% of the total mass flow. An exemplary flap has a depth slightly less than half of the duct depth (e.g., 0.48 inch (12.2 cm) for the exemplary one-inch duct).

[0031] The air 510D passes forward near the top 202 of the compartment. A turning baffle 220 may be positioned at the top of the front opening (e.g., mounted to the back of a header 222) to redirect this air rearward and down amongst the product in the top shelf (e.g., as distinguished from merely flowing down along the interior of the glass door). The exemplary baffle 220 turns the flow without splitting it (e.g. not splitting the flow as would a front-to-back vane array). The exemplary case lacks a top duct or grate separating the flow 510D from the product on the top shelf. The turning baffle may thus help distribute the air evenly among the product on the top shelf. Air may flow downward through each of the shelves, joining the air flowing through the apertures 180 below. To permit such through-flow, the shelves may be metal wire shelves or may be otherwise foraminate. This may help with evenness of cooling among the product on each shelf (e.g., as opposed to a purely forward flow within each storage space where product near the rear is substantially

coolest). The turning baffle also redirects the air flow away from the inside surface of the door(s) so as to not over-cool the doors. This can reduce condensation on the outside surface of the door(s). An exemplary turning baffle has a height H_B and a depth D_B . Exemplary H_B and D_B are in the vicinity of 6-20cm, more particularly, 8-10cm. An exemplary baffle extends
5 at an angle about 45° off-vertical (e.g., 38-52°).

[0032] The exemplary bottom shelf also does need air baffles or slots. The storage space of the bottom shelf may receive the combined flow returning from the shelves above. A return grille in the base of the compartment (e.g., the dividing wall) may be located directly under the bottom shelf and configured in such a way as to distribute that air flow evenly over
10 the bottom shelf. For example, the return grille may be rectangular and relatively large in planform with a raised central blocking member 240 (FIG. 7) and a perimeter opening 242. This may be distinguished from a small central upwardly open hole which might over-concentrate the return air and risk inadequate cooling of peripheral product on the lower shelf.

15 [0033] In various reengineering situations, relative to a baseline, various of these features may be used to achieve one or more of: reduced time to cool down product; reduced variation in temperature between products; reduced velocity of cold air in direct contact with inside of glass door resulting in lower thermal losses through door and/or lower chances of condensation on door.

20 [0034] For example, an exemplary reengineering is from a baseline configuration wherein the cold airflow has contact with the product to be cooled than is desirable. This may be due to baseline air circulation patterns that force air to the outside of the cabinet (up the back, across the top, down the front, and into the return). The reengineering may improve the cold air to product contact by reversing the direction of the airflow on the top of the cabinet, thus blocking the airflow across the top of the top shelf, and forcing the air through the
25 product.

[0035] One or more embodiments been described. Nevertheless, it will be understood that various modifications may be made. For example, when implemented in the reengineering or remanufacturing of an existing case configuration or case, details of the existing (baseline)
30 configuration or case may influence details of any particular implementation. Accordingly, other embodiments are within the scope of the following claims.

CLAIMS

What is claimed is:

1. A refrigerated case (20) comprising:
 - a body (22);
 - 5 a refrigerated compartment (24) within the body;
 - at least one vertical array (120, 122) of shelves in the refrigerated compartment;
 - a base compartment (44) below the refrigerated compartment (24);
 - a refrigeration module (50) within the base compartment; and
 - a cold air flowpath (512) extending from the module upward through a rear duct (146,
 - 10 147) of the body and returns to the module, the cold air flowpath path including a plurality of
 - branches extending through apertures (180) in the rear duct,
 - wherein:
 - the cold air flowpath returns downwardly through the array.
- 15 2. The case of claim 1 wherein:
 - the case lacks a top duct so that a discharge branch from the rear duct passes directly
 - between a top (202) of the refrigerated compartment and a storage area of the top shelf.
3. The case of claim 2 wherein:
 - 20 a downward and rearward directed baffle (220) is positioned along a forward portion
 - of the refrigerated compartment above the top shelf.
4. The case of claim 2 wherein:
 - the downward and rearward directed baffle has depth of 6-20cm and height of 6-
 - 25 20cm.
5. The case of claim 1 wherein:
 - a return port (70) in a bottom wall of the compartment comprises a central blocking
 - member (240) and a peripheral opening (242).
 - 30
6. The case of claim 5 wherein:
 - the central blocking member is above the peripheral opening.
7. The case of claim 1 wherein:

the rear duct includes at least one metering baffle (190A,190B) for metering flow amongst the branches.

8. The case of claim 1 wherein:

5 the rear duct includes a vertically-spaced plurality of metering baffles (190A,190B).

9. The case of claim 8 wherein:

a lower one of the metering baffles (190A) provides a lesser restriction than does an upper one (190B).

10

10. The case of claim 8 wherein:

the rear duct is non-tapering between the metering baffles..

11. The case of claim 8 wherein:

15 the metering baffles have depth of 30-60% of local depth of the rear duct.

12. The case of claim 1 wherein:

a baffle (210) is located at an upper end of the duct for regulating the amount of air that is discharged out the upper end versus the branches.

20

13. The case of claim 1 wherein:

the at least one array comprises left (120) and right (122) arrays; and
the rear duct comprises left and right ducts.

25 14. The case of claim 1 wherein:

the at least one array comprises left (120) and right (122) arrays; and
a return port (70) in a bottom wall of the compartment comprises a central blocking member (240) and a peripheral opening (242) and spans a dividing plane between the left and right arrays.

30

15. A method for operating a refrigerated case (20) comprising:

cooling a recirculating airflow (510) in a base (40) of the case;
directing the cooled airflow (510) upward through a rear duct (146, 147);

directing branches (510A, 510B, 510C) of the airflow through apertures in the rear duct;

passing the branch airflows downward, the branch airflows passing downward through successive lower shelves; and

5 returning the airflow to the base.

16. The method of claim 15 wherein the passing comprises:

rearwardly and downwardly redirecting a flow (510D) passing forward above the top shelf.

10

17. A refrigerated case (20) comprising:

a body (22);

a refrigerated compartment (24) within the body;

at least one vertical array of shelves (120, 122) in the refrigerated compartment;

15 a base compartment (44) below the refrigerated compartment;

a refrigeration module (50) within the base compartment,

a cold air flowpath (512) extending from the module upward through a rear duct (146, 147) of the body and returns to the module, the cold air flowpath including a plurality of branches extending through apertures (180) in the rear duct, and

20 means for directing the cold air downward through the array.

18. The case of claim 17 wherein:

the case lacks a top duct so that a discharge branch from the rear duct passes directly between a top of the refrigerated compartment and a storage area of the top shelf.

25

19. The case of claim 18 wherein:

a downward and rearward directed baffle (220) is positioned along a forward portion of the refrigerated compartment above the top shelf.

30 20. The case of claim 17 wherein:

a return port (70) in a bottom wall of the compartment comprises a central blocking member (240) and a peripheral opening (242).

21. The case of claim 20 wherein:

the central blocking member is above the peripheral opening.

22. The case of claim 17 wherein:
the rear duct includes a vertical array of metering baffles (190A,190B).

5

23. The case of claim 17 wherein:
the at least one array comprises left (120) and right (122) arrays; and
the rear duct comprises left (146) and right (147) ducts.

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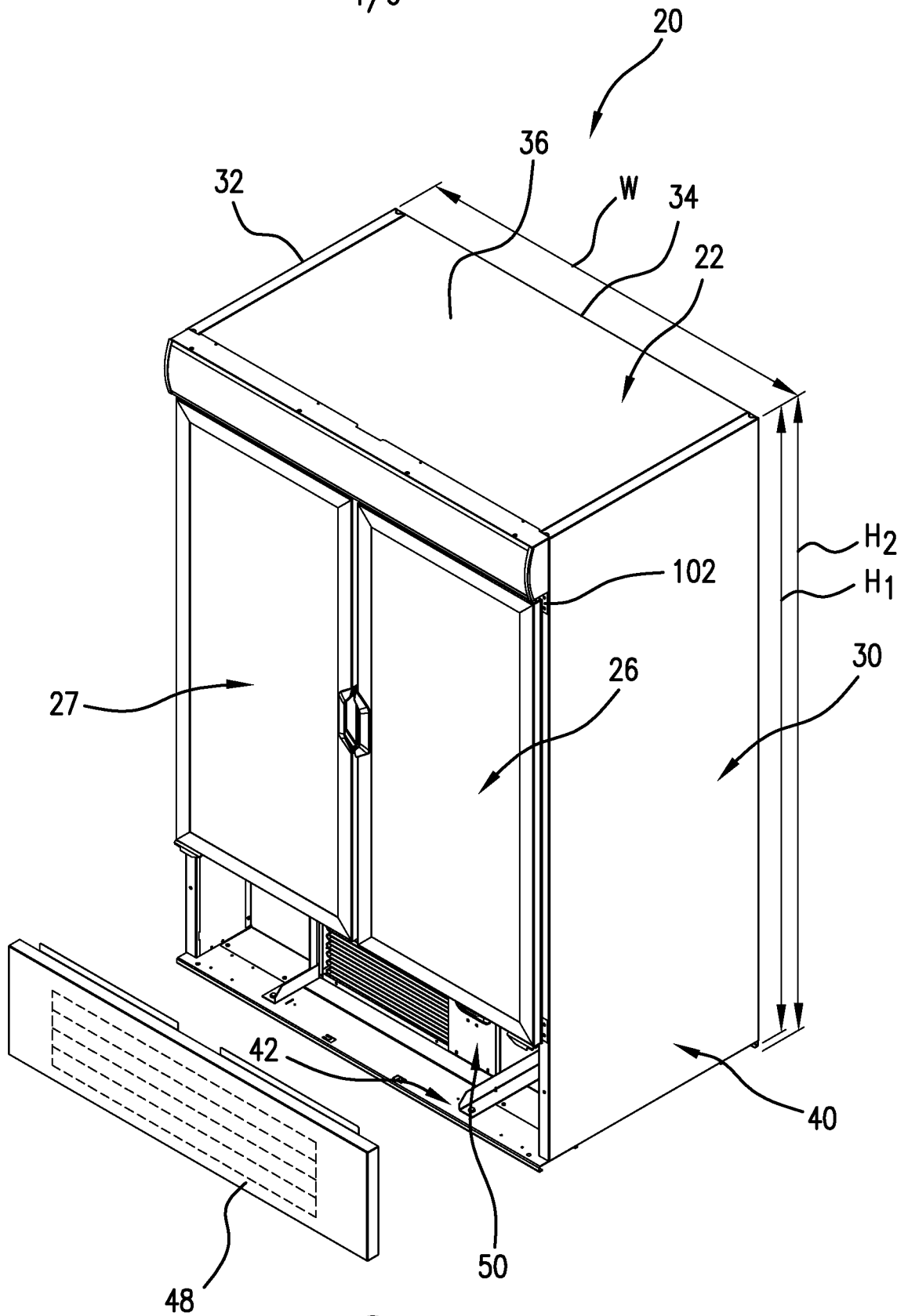


FIG. 1

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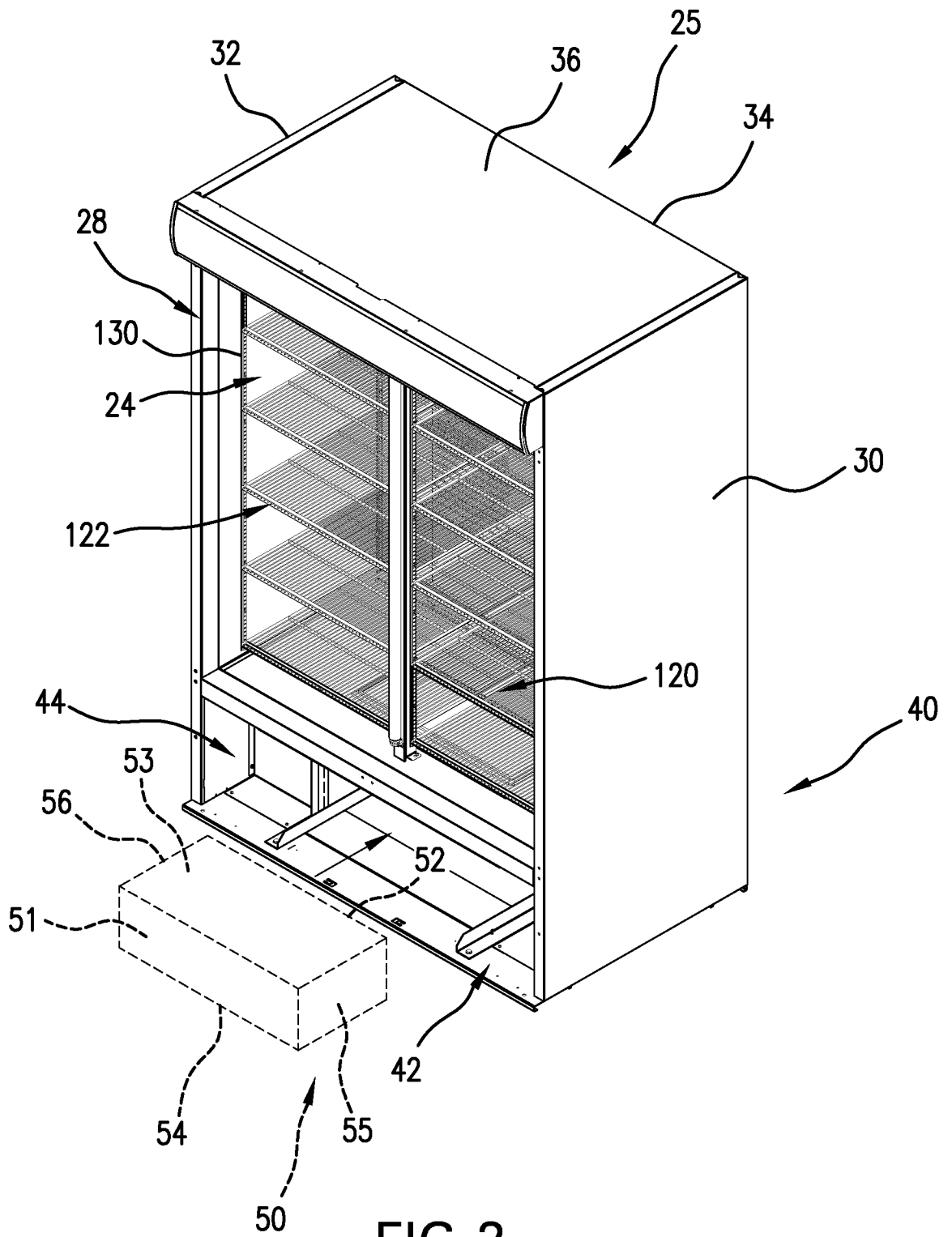


FIG. 2

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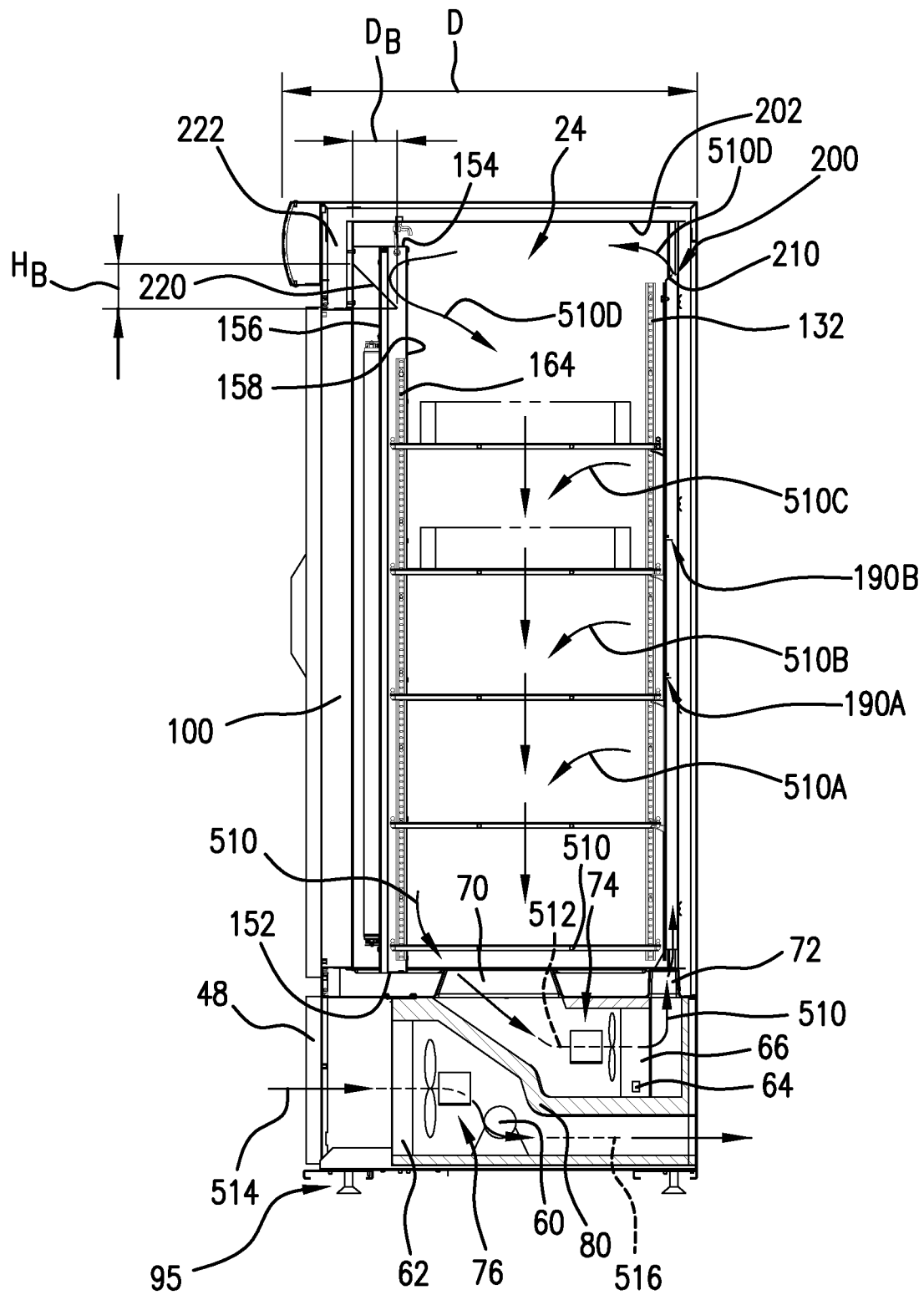


FIG.3

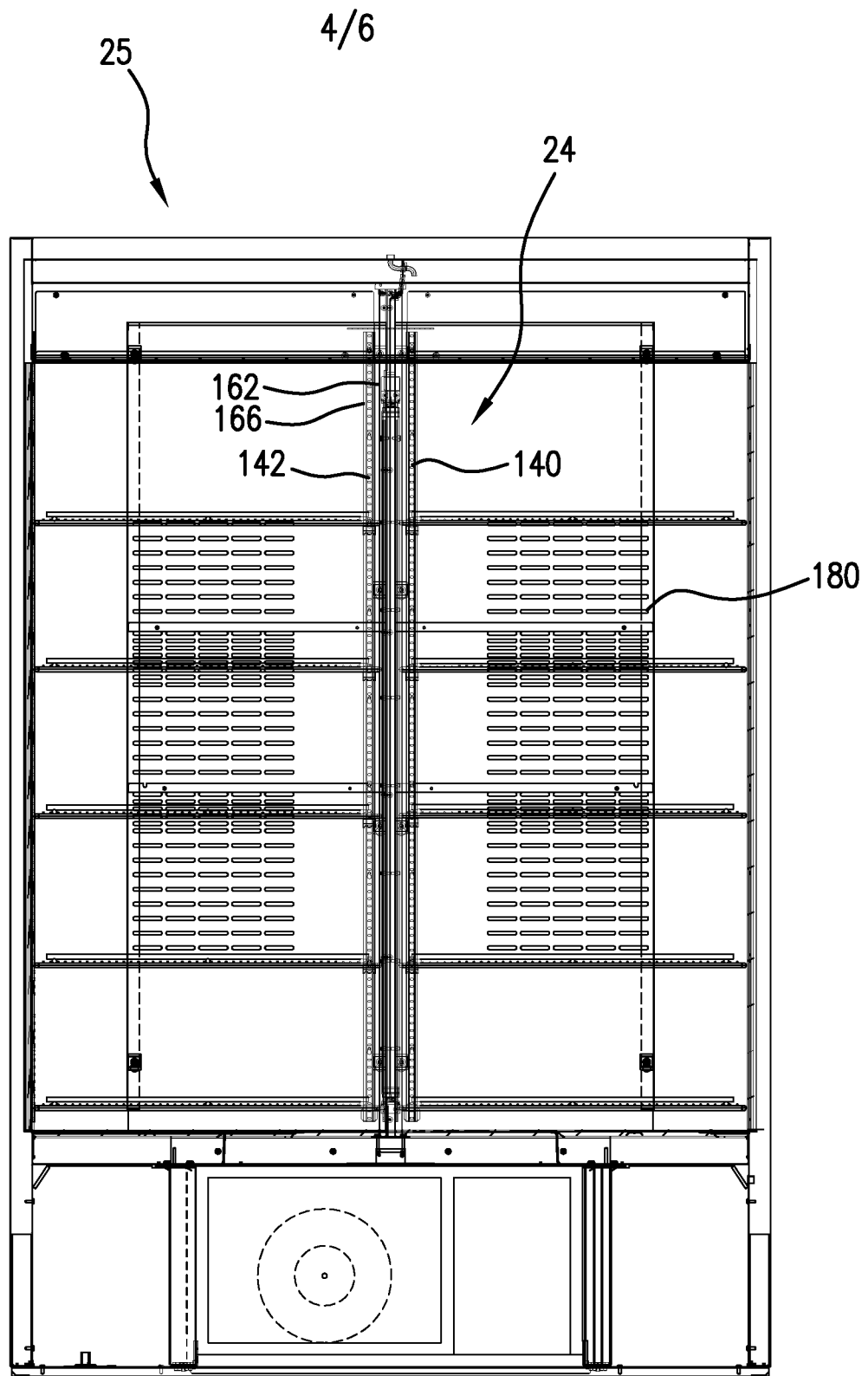


FIG.4

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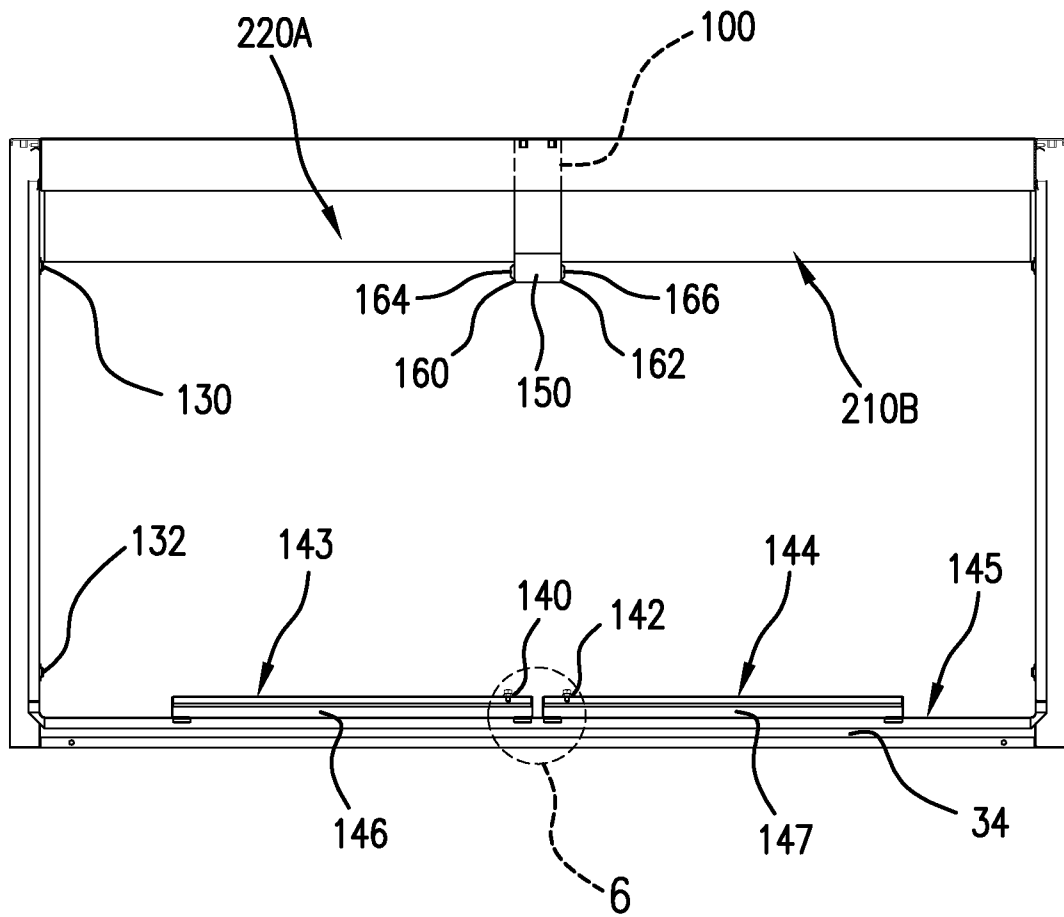


FIG. 5

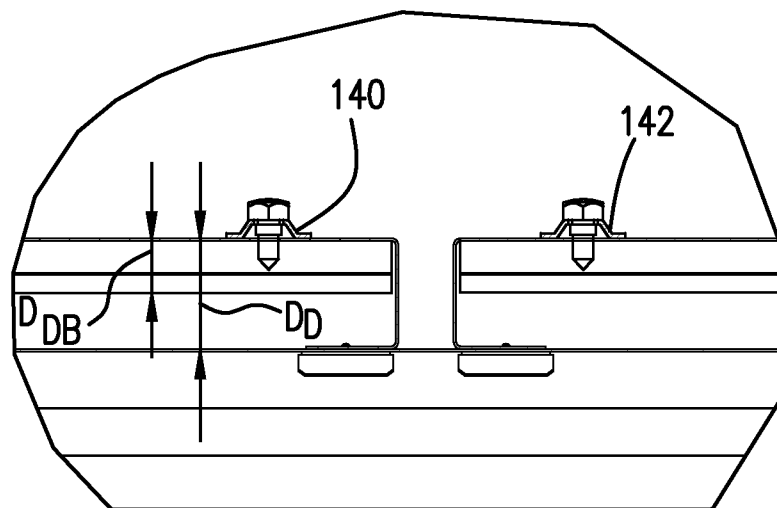


FIG. 6

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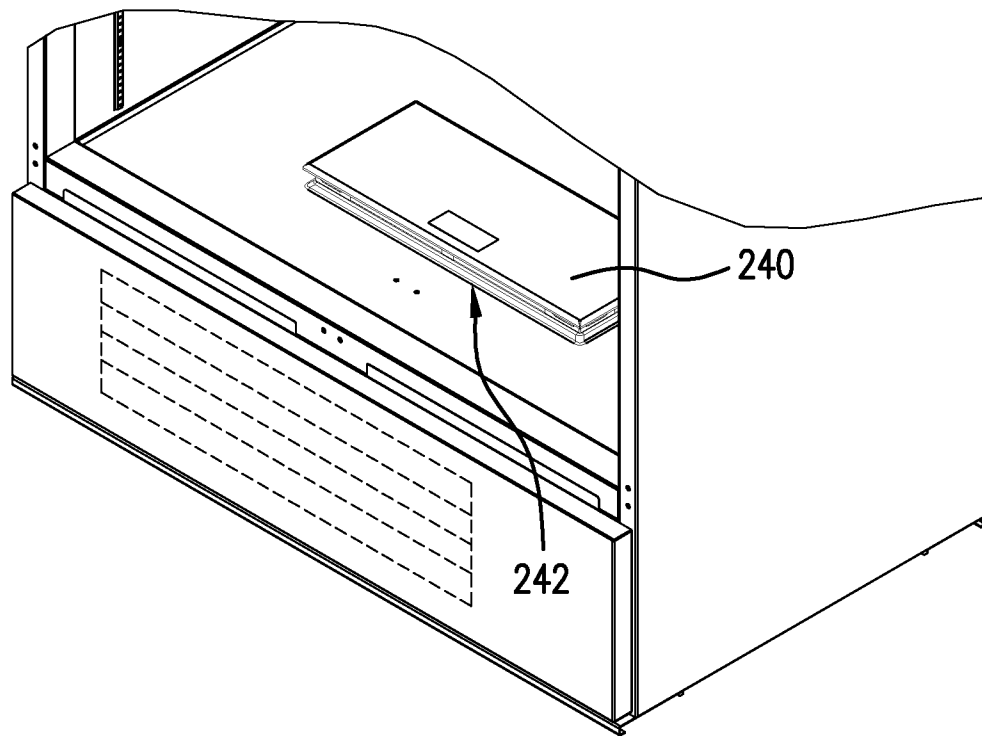


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2007/085075**A. CLASSIFICATION OF SUBJECT MATTER****A47F 3/04(2006.01)i, F25D 11/00(2006.01)i**

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 8: A47F3/04, F25D11/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models since 1975
Japanese utility models and applications for utility models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKIPASS (KIPO internal) & keywords: "refrigerated", "show", "case" and "duct"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6701736 B1 (JOHNSON, T.) 9 MAR. 2004 See figure 1 and column 2, line 57 - column 3, line 37	1-23
Y	KR 200395162 Y1 (SEIDAE IND. CORP.) 7 SEP. 2005 See figure 2 and page 3, lines 4 - 30	1-23
A	JP 2005312586 A (FUJITSU ELEC. CORP.) 10 NOV. 2005 See the whole document	1-23

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

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29 APRIL 2008 (29.04.2008)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2007/085075

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