

[54] **REFRIGERATOR EVAPORATOR CONSTRUCTION**
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[58] Field of Search **62/275, 276, 524, 526, 62/426, 419**

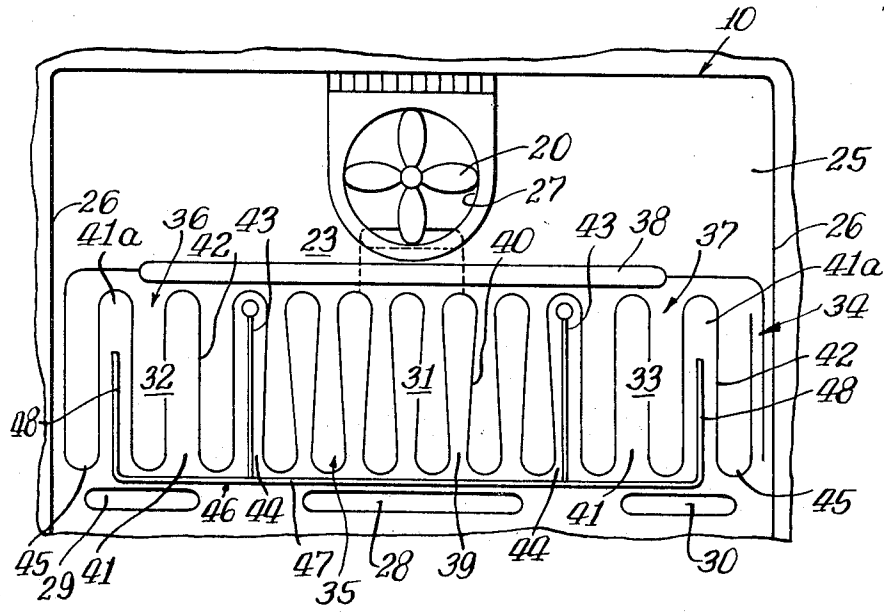
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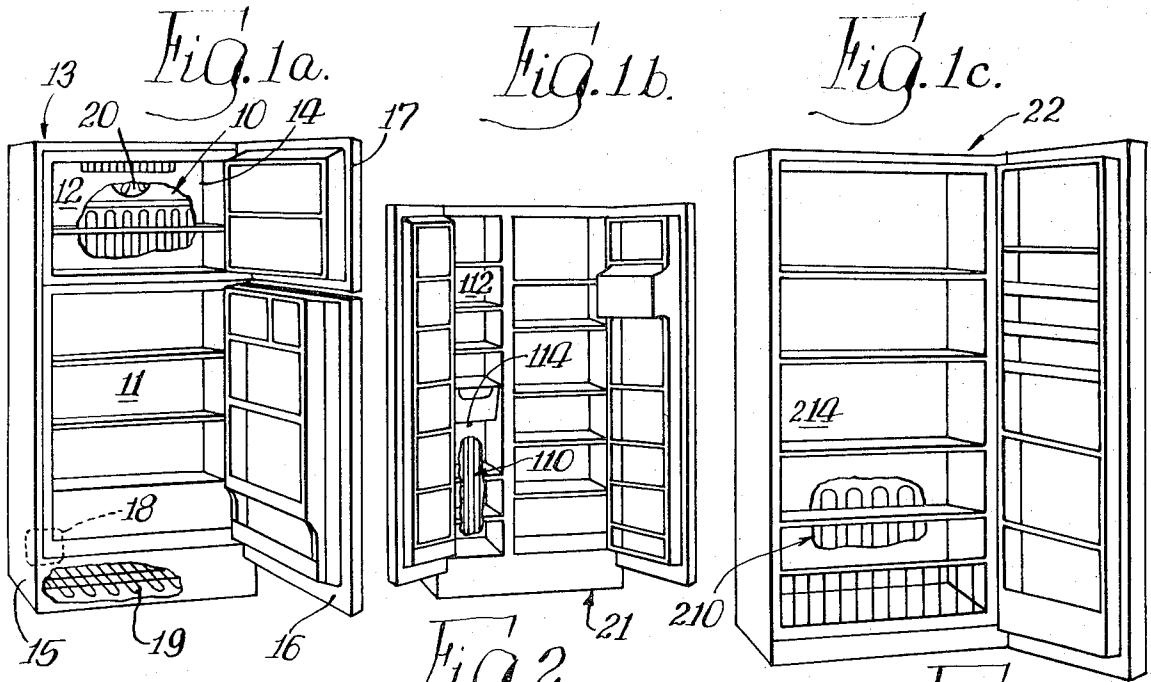
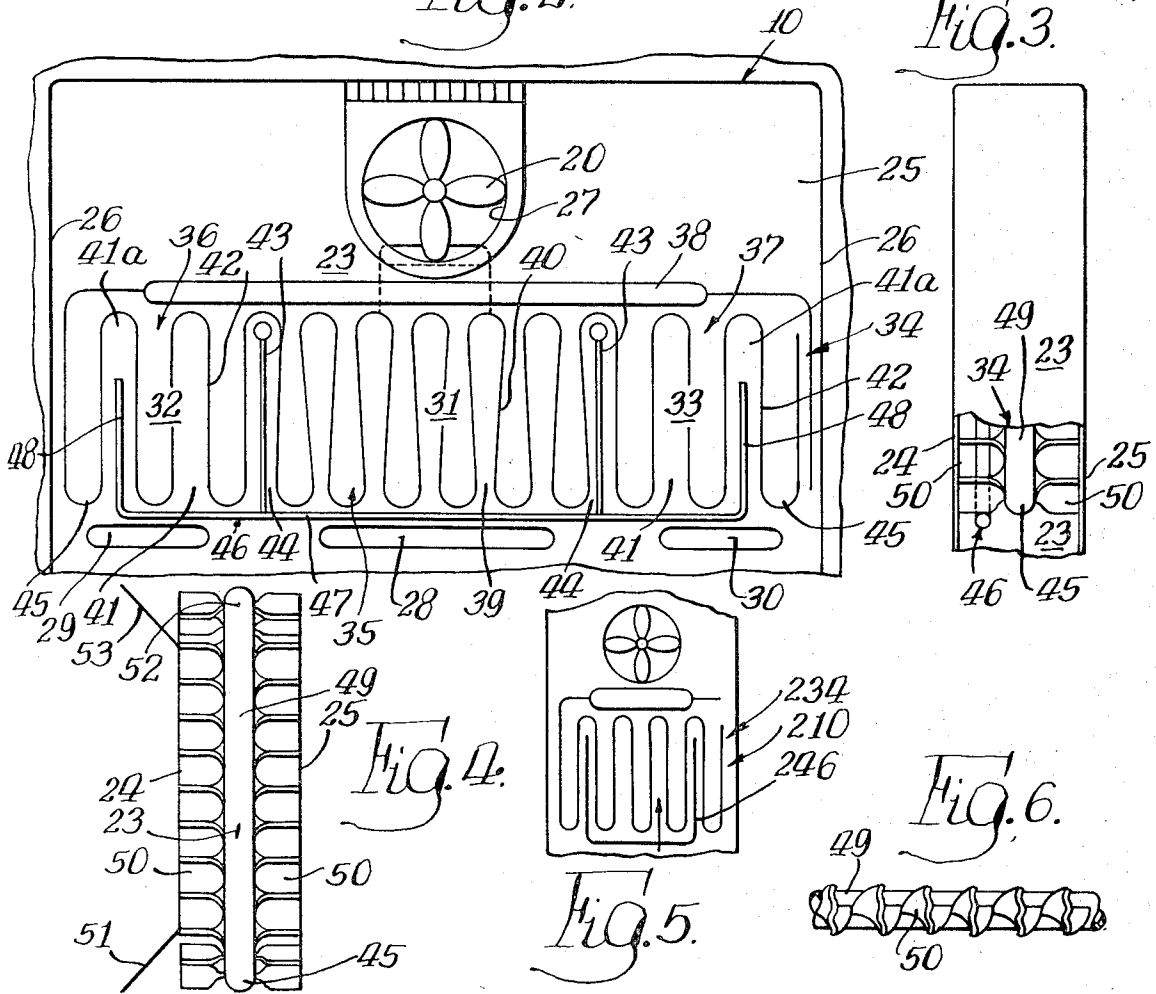
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Primary Examiner—William J. Wye
Attorney, Agent, or Firm—Hofgren, Wegner, Allen, Stellman & McCord

[57] **ABSTRACT**
A refrigerator evaporator construction arranged to provide extended operation between defrosting requirements. The evaporator is defined by different portions having different width passes and the air flow from different portions of the refrigerator is correlated with the width of the passes to provide minimum blocking of the passes by frost buildup. The evaporator defines vertically extending passes and a defrost heater is provided extending upwardly into selected passes providing for facilitated installation and removal. The evaporator enclosure is arranged to define means for bypassing air around a lower end portion of the evaporator in the event of blockage thereof by frost buildup.

17 Claims, 8 Drawing Figures





REFRIGERATOR EVAPORATOR CONSTRUCTION

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to refrigeration apparatus, particularly evaporator apparatus for use therein.

2. Description of the Prior Art

In conventional evaporator structures as used in refrigerators, such as in combination freezer-refrigerator apparatuses, air is circulated to the freezer and refrigerator compartments by means of a blower or fan which further flows the air in heat exchange relationship with an evaporator. The evaporator is conventionally provided as a serpentine coil having the turns thereof extending perpendicular to the air flow to provide maximum scrubbing action for maximum heat transfer from the air to the refrigerant within the tube. The increased heat transfer efficiency permits such an evaporator to be made with relatively few bends, thereby effectively minimizing the cost. An improved form of the tube for use in such an evaporator is formed with an integral fin to provide increased surface area for improved heat exchange efficiency. One form of such an integral fin construction is shown in the G. R. Shockley United States letters Patent 3,333,317. As disclosed therein, the oppositely projecting fin portions may be formed into turned spaced elements which extend transversely to the longitudinal extent of the tube. An evaporator utilizing such turned fins is further illustrated in United States letters Patent 3,678,698 of Gelbard et al., In the Kleist United States letters Patent 2,875,595, a refrigerating unit is illustrated having vertically extending air passages defined by cold plates. Within each plate is positioned an evaporator coil.

SUMMARY OF THE INVENTION

The present invention comprehends an improved evaporator apparatus for use in a refrigeration system having means defining a freezer chamber and an above-freezing refrigerator chamber, and air moving means for flowing air through the chamber. The apparatus includes enclosure means defining a heat exchange space having an outlet and first and second inlets spaced from the outlet, the air moving means causing circulation of air (a) from said freezer chamber through the first inlet, through a first portion of the space to the outlet, and back to the freezer chamber, and (b) from the refrigerator chamber through the second inlet, through a second portion of the space to the outlet, and back to the refrigeration chamber, and a serpentine tube evaporator in the space having a first portion in the first portion of the space and defining relatively closely spaced turns defining narrow passes extending in the direction of air flow between the first inlet and the outlet, and a second portion in the second portion of the space and defining relatively widely spaced turns defining wider passes extending in the direction of air flow between the second inlet and the outlet.

The evaporator tube may be provided with integral fins turned to extend transversely to the longitudinal extent of the tube. The evaporator is confined between front and rear walls of the enclosure means with the distal ends of the fins abutting the walls whereby all the air flowing through the evaporator between the walls is directed against the fins and tube for maximum efficiency of heat transfer. The confinement of the evapo-

rator assures that air flows over at least one portion of the tube in passing from the inlet to the outlet of the space.

As the vertical passes open automatically downwardly, an improved simplified defrost heater construction may be utilized therewith having portions projecting upwardly into one or more downwardly opening passes. The heater may be disposed forwardly of the lower end of the evaporator tube portion subjacent the forwardly projecting fins for improved heating of the evaporator in the defrost operation. Such defrost heater construction permits facilitated installation and removal effectively minimizing the cost of the apparatus while yet providing improved defrost heating operation. Baffle means may be provided in preselected passes of the evaporator between portions having different pass widths for dividing the evaporator into different portions. In the illustrated embodiment, the evaporator is divided into a first portion having relatively narrow passes for flow of freezer compartment air therethrough and a second portion having relatively wide passes for flow of refrigerator compartment air therethrough. As the refrigerator compartment air is relatively moist as compared to the freezer compartment air, the wide passes of the second portion minimize blockage of the air flow as a result of frost buildup. In the illustrated embodiment, two wide pass portions of the evaporator are provided, one at each of the opposite sides of a central narrow pass portion.

To further extend the operating time of the apparatus between required defrosting operations, means are provided for bypassing the air around the lower end of the evaporator in the event the lower end is blocked by frost buildup. More specifically, the bypass means comprises outwardly extended portions of one of the confining walls of the enclosure permitting air to flow around the lower end of the evaporator into an upwardly adjacent portion. The amount of bypassing is effectively minimized to assure effectively maximum flow of air in heat transfer association with the evaporator in the normal operation thereof.

The invention further comprehends providing a widening of the air flow space adjacent the upper end of the evaporator for maintained high efficiency of air flow therethrough.

BRIEF DESCRIPTION OF THE DRAWING

Other features and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawing wherein:

FIG. 1a is a perspective view of refrigeration apparatus with portions broken away to illustrate an evaporator construction embodying the invention;

FIG. 1b is a perspective view of a side-by-side freezer-refrigerator apparatus provided with an evaporator construction embodying the invention;

FIG. 1c is a perspective view of an upright freezer having a portion broken away to illustrate a modified form of evaporator construction embodying the invention;

FIG. 2 is a vertical section illustrating the evaporator construction;

FIG. 3 is a side view of the evaporator with a portion broken away to facilitate illustration of the invention;

FIG. 4 is a vertical section of the evaporator illustrating means for bypassing the air around the lower and upper ends thereof;

FIG. 5 is a schematic front view of a modified form of evaporator construction embodying the invention as utilized in the upright freezer of FIG. 1c; and

FIG. 6 is a fragmentary front view of a portion of the evaporator tube and fin construction.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the exemplary embodiment of the invention as disclosed in the drawing, an evaporator construction generally designated 10 is provided for use in refrigerating air circulated to an above-freezing refrigeration compartment 11 and a below-freezing freezer compartment 12 of a refrigerator 13. As shown in FIG. 1a, the evaporator apparatus may be provided in the rear wall 14 of the cabinet 15 defining compartments 11 and 12. The compartments may be closed respectively by doors 16 and 17. The refrigeration apparatus may include a conventional compressor 18 and condenser 19 connected to the evaporator 10 in the normal manner to provide refrigerant fluid thereto for cooling air flowed in heat exchange relationship therewith. In the illustrated embodiment, air is circulated by means of a fan 20 mounted in wall 14 above the evaporator. As shown in FIG. 1b, in a side-by-side freezer-refrigerator generally designated 21, the evaporator construction generally designated 110 is mounted in the rear wall 114 of the freezer compartment 112. As shown in FIG. 1c, in an upright freezer apparatus generally designated 22, a modified form of evaporator construction generally designated 210 is mounted in the rear wall 214.

As illustrated more specifically in FIGS. 2 and 3, evaporator construction 10 is provided in a space generally designated 23 bounded by front wall 24, rear wall 25, and side walls 26. Air is flowed through space 23 by the fan 20, being delivered to the fan through an outlet 27 at the upper end of space 23 and to the space 23 through a first inlet 28 communicating with freezer compartment 12, and a pair of second inlets 29 and 30 communicating with refrigeration compartment 11. The air thusly passed through space 23 is flowed there-through in three separate portions, namely, a first portion flowing from inlet 28 through a first portion 31 of the space to outlet 27, a second portion flowing from inlet 29 through a second portion 32 of the space to outlet 27, and a third portion flowing from inlet 30 through a third portion 33 of space 23 to outlet 27. Extending fully across the space 23 defined by portions 31, 32 and 33, is a serpentine tube evaporator generally designated 34 defined by a first portion 35 in space portion 31, a second portion 36 in space portion 32 and a third portion 37 in space portion 33. The evaporator may be provided with an accumulator 38 extending across the upper end of space portions 31, 32 and 33.

As best seen in FIG. 2, the evaporator portion 35 defines a plurality of relatively narrow passes 39 between the vertically extending turns 40 thereof. Evaporator portions 36 and 37 define a plurality of relatively wide passes 41 between the vertically extending turns 42 thereof.

The evaporator portion 35 may be effectively separated from evaporator portions 36 and 37 by vertically extending baffles 43 extending vertically through

passes 44 at the opposite sides of evaporator portion 35. Thus, freezer air delivered through inlet 28 flows upwardly through the relatively narrow passes 39 of evaporator portion 35 to the outlet 27. As the freezer air is relatively dry, minimum frosting occurs between the turns 40 of evaporator portion 35 and extended operation of the apparatus may be effected without the necessity of defrosting the evaporator portion 35. However, the relatively moist air from refrigerator compartment 11 tends to deposit frost on the turns 42 of the evaporator portions 36 and 37 in flowing from inlets 29 and 30 to the outlet 27. As the passes 41 are relatively wide, a relatively long period of time is required for the frost to completely bridge the passes at the lower end turns 45 of the evaporator portions 36 and 37, thereby similarly permitting relatively long operation of the refrigeration apparatus and requiring defrosting thereof. The baffles 43 effectively preclude spillover of the moist air from evaporator portions 36 and 37 into space 31 and guide the air effectively in three separate paths to the outlet 27.

The vertical arrangement of the passes 39 and 41 permits the use of a simplified economical radiant defrost heater 46 which includes a horizontal lower portion 47 and upturned end portions 48. The horizontal portion extends subjacent the lower end turns of the evaporator coils 40 and 42 and the end portions 48 project upwardly into downwardly opening passes 41a of the evaporator portions 36 and 37 spaced inwardly from the side walls 26 of the enclosure. This disposition of the heater portions 48 prevents excessive heating of the cabinet wall and effectively prevents damage to gaskets and plastic materials in the wall when the radiant heater is operated. As shown in FIG. 3, the heater 46 is disposed forwardly of the lower end turn of the evaporator coil 34 to permit the radiant heat to pass freely upwardly without interference by the coils in the defrosting operation. The heater may also be installed on the rear side of the lower end turns, although this installation is more difficult to remove for servicing.

More specifically, as shown in FIGS. 3, 4 and 6, the evaporator coil 34 is defined by a metal tube 49 provided with integral fins 50 which are turned transversely to the longitudinal extent of the tube 49. The fins project forwardly and rearwardly from the tube 49 in space 23 between front wall 24 and the rear wall 25 so that the evaporator 34 extends fully across the space, causing all of the air flowing upwardly there-through to be directed in heat exchange relationship with the finned evaporator.

As discussed above, the relatively wide passes 41 permit the evaporator to function for an extended period of time before frost blocks up the passes between the lower end turns 45 of the tube portion 49. To further extend the period of operation before defrosting of the evaporator is required, means are provided to permit a portion of the air to bypass the lower end turns when they become fully blocked by the collected frost. Thus, as shown in FIG. 4, the front wall 24 includes a forwardly turned lower portion 51 extending upwardly to a short distance above the lower end turns whereby a portion of the flowed air may be directed into the space 23 at a point above the lower end turns. Normally, the upwardly flowed air passes upwardly through the downwardly opening passes and crosses the tube 49 at least once in moving to the exit 27. The provision of the outwardly turned portion 51 permits air to flow over

the end turn bends 45 so as to reach the fins even if the end turns 45 are blocked by frost. Further, air is permitted to flow directly upwardly through the vertical pass and flow back outwardly under the upper end turns 52 by means of a turned upper end portion 53 of wall 24. Thus, even if the lower end turns of the evaporator are completely blocked by frost, air may continue to be passed upwardly through the evaporator for extended functioning thereof.

As shown in FIG. 5, the evaporator construction 210 may be vertically elongated to permit use of a U-shaped defrost heater 246 similar to heater 46 described above. As only freezer air is being circulated in freezer 22, the passes may be of equal width. In the embodiment of FIG. 5, the construction may also include two layers of coils placed one behind the other. This provides for a deeper coil which is more efficient than a single layer with extended fins. The evaporator 234 provides improved air flow as discussed above by providing a smaller air flow pressure drop as compared with conventional horizontal coil evaporators and provides for greater air flow for an improved airwide heat transfer coefficient. Resultingly, evaporator 234 requires less defrosting than the conventional horizontal tube evaporators and, thus, evaporator 234 functions in a similar manner to evaporator 34.

As the evaporator fins abut the front and rear walls, the forwardly flowed air is caused to have heat transfer association with the evaporator throughout substantially the entire height thereof. As the defrosting of the evaporator is limited to the lower end turns, the improved heat transfer association is obtained while yet extended operation time between defrosting cycles is provided. The evaporator construction of the present invention is extremely simple and economical while yet providing the highly desirable features discussed above.

The foregoing disclosure of specific embodiment is illustrative of the broad inventive concepts comprehended by the invention.

Having described the invention, the embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a refrigeration system having means defining a freezer chamber and an above-freezing refrigerator chamber, and air moving means for flowing air through said chambers, evaporator apparatus comprising:

enclosure means defining a heat exchange space having an outlet and first and second inlets spaced from said outlet, said air moving means causing circulation of air (a) from said freezer chamber through said first inlet, through a first portion of said space to said outlet, and back to said freezer chamber, and (b) from said refrigerator chamber through said second inlet, through a second portion of said space to said outlet, and back to said refrigerator chamber; and

a serpentine tube evaporator in said space having a first portion in said first portion of said space and defining relatively closely spaced turns defining narrow passes extending in the direction of air flow between said first inlet and said outlet, and a second portion in said second portion of said space and defining relatively widely spaced turns defining wider passes extending in the direction of air flow between said second inlet and said outlet.

2. The refrigeration system of claim 1 wherein said evaporator is provided with integral fins.

3. The refrigeration system of claim 1 wherein said evaporator is provided with integral fins turned transversely to the tube longitudinal extent.

4. The refrigeration system of claim 1 wherein baffle means are provided separating said first and second space portions.

5. The refrigeration system of claim 1 wherein said inlets are substantially spaced.

6. The refrigeration system of claim 1 wherein a third inlet is provided oppositely of said second inlet relative to said first inlet for conducting air from said refrigerator chamber through a third portion of said space to said outlet and said evaporator includes a third portion disposed in said third portion of said space.

7. The refrigeration system of claim 1 further including defrost heater means extending to between said spaced turns of said second evaporator portion from the upstream end thereof.

8. The refrigeration system of claim 1 wherein said space defining means includes front and rear walls and said evaporator is provided with integral fins turned transversely to the tube longitudinal extent to abut said walls.

9. The refrigeration system of claim 1 wherein said space defining means includes front and rear walls and said evaporator is provided with integral fins turned transversely to the tube longitudinal extent to abut said walls, at least one of said walls defining means for bypassing air around the upstream end of said turns in the event said end is blocked by frost.

10. The refrigeration system of claim 1 wherein the evaporator tube defines vertically extending passes.

11. The refrigeration system of claim 1 wherein the evaporator tube defines vertically extending passes and said enclosure means is arranged to confine the flowed air to require the air to pass around at least one portion of the tube while flowing upwardly from the inlet to the outlet through said space.

12. In a refrigeration system having means defining a freezer chamber, and air moving means for flowing air through said chamber, evaporation apparatus comprising:

enclosure means defining a heat exchange space having an outlet means and inlet means spaced below said outlet means, said air moving means causing circulation of air from said inlet means through said spaces to said outlet; a serpentine tube evaporator in said space defining vertical passes extending in the direction of air flow upwardly from said inlet means to said outlet means, and fins formed integrally with the evaporator tube and turned transversely to the longitudinal extent of the tube; and

means for causing the flowed air to bypass the lower end of the tube evaporator as a result of frost buildup blocking the passes thereat.

13. The refrigeration system of claim 12 wherein said enclosure means includes a rear wall and a front wall, said fins extending forwardly and rearwardly from said tube into abutment with said walls whereby said air flow is confined to flow against said tube and fins in passing the evaporator.

14. The refrigeration system of claim 12 further including means for causing the air to bypass the upper end of the evaporator.

15. The refrigeration system of claim 12 further including a defrost heater forwardly of the lower end of the evaporator and subjacent the forwardly extending fins.

16. The refrigeration system of claim 12 further having means defining an above freezing refrigerator chamber, and said apparatus further including said

tube evaporator defining different width vertical passes.

17. The refrigeration system of claim 16 further including vertical baffle means disposed in a vertical pass between portions of the evaporator having different width passes.

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