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(54) Title: A HEATING, VENTILATION, AND AIR CONDITIONING (HVAC) SYSTEM FOR A VEHICLE

(57) Abstract: This disclosure relates to a heating, ventilation, and air conditioning (HVAC) system (100) for a vehicle. The HVAC system (100) may include a heating and cooling assembly (101) configured to receive unconditioned air, and convert the unconditioned air into conditioned air. The heating and cooling assembly (101) may include one or more Peltier elements (102), each of the one or more Peltier elements (102) comprising a first side (104) configured to be a cold side, and a second side (106), configured to be a hot side. The HVAC system (100) may further include a flap assembly (112) configured to shift between a first plurality of positions, to selectively cause to emit, in the cabin of the vehicle, conditioned air, wherein the conditioned air comprises a portion of cold air and a portion of hot air, corresponding to the positions of the flap assembly (112).

FORM 2

THE PATENTS ACT 1970

(39 OF 1970)

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The Patent Rules, (200)3

Complete Specification

(See Section 10 and Rule 13)

1. TITLE OF THE INVENTION

A Heating, Ventilation and Air Conditioning (HVAC) System for a Vehicle

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3. PREAMBLE TO THE DESCRIPTION

COMPLETE

The following specification particularly describes the invention and the manner in which it is performed**.**

DESCRIPTION

Technical Field

[001] This disclosure relates generally to a heating, ventilation, and air conditioning (HVAC) system, and particularly to a Peltier effect-based HVAC system for a vehicle.

Background

[002] Climate inside a vehicle may be controlled via a heating, ventilation, and air conditioning (HVAC) system, where heating and cooling of air may be done by means of a coolant and a refrigerant. The coolant and refrigerant flow inside tubes of a heating core and an evaporator, respectively.

[003] In order to perform cooling, air may be cooled via the evaporator which works on the principle of a refrigeration cycle. To perform these functions, a compressor is required. As it will be appreciated by those skilled in the art, the compressor may consume as much as 25% of energy produced by an engine of the vehicle. In order to perform heating, the coolant which cools the engine of the vehicle, may be used. The coolant which is circulated around the engine to absorb the engine's heat, is later passed through the heating core. This heating core is then used to it heat incoming air. For example, air is sucked inside the vehicle from atmosphere via a blower, and is then passed through the evaporator core and the heater core. Some flaps guide the hot or cold air (i.e. conditioned air) to a region of the vehicle, such as near feet, near windshield for defrosting, etc.

[004] The conventional HVAC systems are complex and include a large number of components, which make the system costly and prone to frequent wear and tear. Further, electric vehicles may not use the coolant. As such, a separate provision for heating may be required.

BRIEF DESCRIPTION OF THE DRAWINGS

[005] The accompanying drawings, which are incorporated in and constitute a part of this disclosure, illustrate exemplary embodiments and, together with the description, serve to explain the disclosed principles.

[006] **FIG. 1** illustrates a front view of a heating and cooling assembly of a HVAC system, in accordance with an embodiment of the present disclosure.

[007] **FIG. 2** illustrates a perspective view of a HVAC system for a vehicle, in accordance with an embodiment of the present disclosure.

[008] **FIGs. 3A-3C** illustrate a flap assembly in a first position, a second position, and an intermediary position, respectively, in accordance with some embodiment of the present disclosure.

[009] **FIG. 4** illustrates a front view of a gear assembly, in accordance with an embodiment of the present disclosure.

[010] **FIGs. 5A-5B** illustrate a top view and a perspective view, respectively, of a HVAC system with a flap assembly in a first position, in accordance with an embodiment of the present disclosure.

[011] **FIGs. 6A-6B** illustrate a top view and a perspective view, respectively, of a HVAC system with a flap assembly in a second position, in accordance with an embodiment of the present disclosure.

DETAILED DESCRIPTION

[012] Exemplary embodiments are described with reference to the accompanying drawings. Wherever convenient, the same reference numbers are used throughout the drawings to refer to the same or like parts. While examples and features of disclosed principles are described herein, modifications, adaptations, and other implementations are possible without departing from the spirit and scope of the disclosed embodiments. It is intended that the following detailed description be considered as exemplary only, with the true scope and spirit being indicated by the following claims.

[013] Referring now to FIG. 1, a front view of a heating and cooling assembly 101 is illustrated, in accordance with an embodiment of the present disclosure. The heating and cooling assembly 101 may be configured to receive unconditioned air and further configured to emit conditioned air (cold air or hot air) in a cabin of a vehicle.

[014] The heating and cooling assembly 101 may include one or more Peltier elements 102A, 102B, 102C, 102D (also, collectively referred to as Peltier elements 102). Each of the Peltier elements 102 may include a first side 104A, 104B, 104C, 104D (also, collectively referred to as first sides 104) and a second side 106A, 106B, 106C, 106D (also, collectively referred to as second sides 106). Each of the first sides 104 may be configured to be a cold side and each of the second sides 106 may be configured to be a hot side.

[015] In some embodiments, the Peltier elements 102 may be arranged adjacent to each other. Further, a first side 104 of each of the Peltier elements 102 may face a first side of an adjacent Peltier element to define a cold zone. For example, the first side 104B of the Peltier element 102B may face the first side 104C of the adjacent Peltier element 102C to define a cold zone 110. Similarly, the second side 106A of the Peltier element 102A may face the second side 106B of the adjacent Peltier element 102B to define a hot zone 108.

[016] It may be understood that the unconditioned air may be sucked in the vehicle using a blower (not shown in FIG. 1). A portion of the unconditioned air may be converted into cold air upon contacting the first sides 104 of the Peltier elements 102 (i.e. upon passing through cold zones). Similarly, another portion of the unconditioned air may be converted into hot air upon contacting the second sides 106 of the Peltier elements 102 (i.e. upon passing through hot zones).

[017] Referring now to FIG. 2, a perspective view of a HVAC system 100 for a vehicle is illustrated, in accordance with an embodiment of the present disclosure. The HVAC system 100 may include the heating and cooling assembly having the Peltier elements, for example the Peltier element 102B, the Peltier element 102C (not shown in FIG. 2), and the Peltier element 102D. The HVAC system 100 may further include a flap assembly 112 having flaps 114A, 114B, 114C, and so on (also collectively, referred to as flaps 114). It may be noted that the flaps 114 may be made of an adiabatic material, i.e. the flaps 114 may not allow heat or matter to pass across.

[018] As shown in the FIG. 2, the Peltier element 102B may include the first side 104B, and the Peltier element 102D may include the first side 104D (each of the first side 104B and the first side 104D being a cold side). It may be noted that view of the Peltier element 102C positioned between the Peltier element 102B and the Peltier element 102D may be blocked by the flap 114B. It may be

further noted that a first side 104C (not shown in FIG. 2) of the Peltier element 102C (not shown in FIG. 2) may face towards the first side 104D of the Peltier element 102D, to define a cold zone 110 between the Peltier element 102C and the Peltier element 102D. Similarly, a second side 106C (not shown in FIG. 2) of the Peltier element 102C (not shown in FIG. 2) may face towards the second side 106B of the Peltier element 102B, to define a hot zone 108 between the Peltier element 102C and the Peltier element 102B.

[019] The HVAC system 100 may further include a blower 116. As mentioned earlier, the blower 116 may suck air from the atmosphere (unconditioned air) into the HVAC system 100. The blower 116 may throw this unconditioned air on the heating and cooling assembly of the HVAC system 100. It may be noted that the unconditioned air may come in contact with the first sides 104 of each of the Peltier elements 102 and the second sides 106 of each of the Peltier elements 102. A portion of the unconditioned air may be converted into cold air upon contacting the first sides 104 (i.e. upon entering the cold zone 110). Similarly, another portion of the unconditioned air may be converted into hot air upon contacting the second sides 106 of the Peltier elements 102 (i.e. upon entering the hot zone 108).

[020] The flap assembly 112 may be configured to shift into a first plurality of positions with respect to the Peltier elements 102. By way of shifting the position, the flap assembly 112 may cause to selectively emit, in the cabin of the vehicle, a portion of volume of the cold air and a portion of volume of the hot air. It may be noted that these portions may depend on the position of the flap assembly 112, or in other words, the position of flaps 114 with respect to the Peltier elements 102.

[021] It may be noted that the flaps 114 may be configured to slide into a first plurality of positions with respect to the Peltier elements 102, to selectively interrupt passage of cold air from the cold zones (e.g. 110) and hot air from the hot zones (e.g. 108) into the cabin of the vehicle. For example, the first plurality of positions may include a first position, a second position, and a second plurality of intermediary positions. The flap assembly 112 and the flaps 114 are further explained in detail, in conjunction with FIGS. 3-4.

[022] Referring now to FIG. 3A, 3B, and 3C, the flap assembly 112 in the first position, the second position, and an intermediary first position, respectively, is illustrated, in accordance with an embodiment of the present disclosure. Referring to FIG. 3A, in the first position, the flaps 114 of the

flap assembly 112 may completely interrupt passage of hot air from the hot zones. For example, the flap 114A may interrupt passage of hot air from the hot zone 108 (not shown in FIG. 3A). However, the flap assembly 112 allows cold air from the cold zones 110 (for example, cold zone 110) to flow through uninterruptedly and pass into the cabin of the vehicle.

[023] Referring to FIG. 3B, in the second position, the flaps 114 of the flap assembly 112 may completely interrupt passage of cold air from the cold zones. For example, the flap 114A may interrupt passage of cold air from the cold zone 110 (not shown in FIG. 3B). However, the flap assembly 112 may allow hot air from the hot zones 108 (for example, hot zone 108) to pass uninterruptedly into the cabin of the vehicle.

[024] Referring to FIG. 3C, in the intermediary position, the flaps 114 of the flap assembly 112 may partially interrupt passage of cold air and hot air from the cold zones and the hot zones, respectively. For example, the flap 114A and flap 114B may partially interrupt passage of cold air from the cold zone 110 and partially interrupt passage of hot air from the hot zone 108. As a result, a mixture of hot air and cold may into the cabin of the vehicle.

[025] It may be noted that, in some embodiments, the flap assembly 112 may be caused to shift into the first plurality of positions, by a gear assembly 124. The gear assembly 124 is further explained in detail, in conjunction with FIG. 4.

[026] Referring now to FIG. 4, a front view of the gear assembly 124 is illustrated, in accordance with some embodiments of the present disclosure. In some embodiments, the gear assembly 124 may be rack and pinion based. For example, as shown in FIG. 4, the gear assembly 124 may include a first rack 302 and a second rack 304. The gear assembly may further include a driver gear 308, and a driven gear 310. In some embodiments, the driver gear 308 may be powered to rotate by an electric motor (not shown in FIG. 4). However, in alternate embodiments, the driver gear 308 may as well be manually powered.

[027] The driver gear 308 may be engaged with the first rack 302, and the driven gear 310 may be engaged with the second rack 304. The driver gear 308 may be simultaneously engaged with the driven gear 310. It may be understood that a rotatory motion of the driver gear 308 may translate into rotatory motion of the driven gear 310. The rotatory motion of the driver gear 308 and the driven gear

310 may further translate into liner motion (for example, upwards or downwards) of the first rack 302 and the second rack 304, respectively. The linear motion of the first rack 302 and the second rack 304 may cause the flap assembly 112 to shift between the first plurality of positions.

[028] Returning back to FIG. 2, as mentioned earlier, in the first position, the portion of the hot air emitted may be zero. As shown in FIG. 2, in the first position, the flaps 114 may completely interrupt passage of hot air from each of the hot zones. For example, the flap 114B may block passage of air through the hot zone 108 defined between the Peltier element 102B and the Peltier element 102C. As such, the unconditioned air may get convert into hot air upon entering the hot zone 108. However, the hot air may be trapped in the hot zone 108. It may be noted that in the first position, the cold zones, for example the cold zone 110 defined between the Peltier element 102B and the Peltier element 102C, may not be blocked by the flaps 114. As such, the unconditioned air may be converted into cold air upon entering the cold zone 110. This cold air may then exit from the cold zone 110 into the cabin of the vehicle.

[029] In the second position (not shown in FIG. 2), the portion of the cold air in the conditioned air (i.e. air emitted in the cabin of the vehicle) may be zero. Further, in the second position, the flaps 112 may completely interrupt passage of cold air from each of the cold zones. For example, in the second position, the flap 114B may block passage of cold air through the cold zone 110 defined between the Peltier element 102C and the Peltier element 102D. As such, the conditioned air may get converted into cold air upon entering this cold zone 110, however, this cold air may be trapped in this cold zone 110, due to the flap 114B blocking the cold zone 110. However, in the second position, the hot zones, for example the hot zone 108 defined between the Peltier element 102B and the Peltier element 102C, may not be blocked by any of the flaps 114. As such, the unconditioned air may get converted into hot air upon entering the hot zone 108, and this hot air may then exit from the hot zone 108 into the cabin of the vehicle.

[030] In the second plurality of intermediary positions, the portion of the hot air and the portion of the cold air in the conditioned air may be non-zero. In other words, the flaps 114 may assume infinite number of intermediary positions between the first position and the second position of the flap assembly. In each of these positions, the flaps 114 may partially interrupt passage of cold air from the cold zones and passage of hot air from the hot zones. As such, a mixture of hot and cold air

may be received from the HVAC system 100. The portion of the hot air and the portion of the cold air in the conditioned air may be controlled based on the temperature desired inside the vehicle cabin, by the adjusting the position of the flaps 114.

[031] It may be noted that, in the first position of the flap assembly 112, trapping of the hot air in the hot zones (e.g. hot zone 108) may lead to heat imbalance, as the heat may not escape. As a result, heat in the hot zones may rise gradually, which may affect air-cooling efficiency of the cold zones (e.g. cold zone 110). In order to avoid this heat buildup, the hot air may be bypassed from the hot zones to remove the heat from the HVAC system 100. Similarly, in the second position of the flap assembly 112, cold air may be bypassed from the cold zones.

[032] To this end, the HVAC system 100 may further include a bypass assembly. The bypass assembly may be configured to bypass the hot air trapped in the hot zones when the flaps 114 are in the first position, and further configured to bypass the cold air trapped in cold zones when the flaps 114 are in the second position.

[033] The bypass assembly may include one or more first conduits 118A, 118B, 118C, etc. (also, collectively referred to as first conduits 118) fluidically coupled to the each of the one or more hot zones. It may be understood that the first conduits 118 may be further configured to bypass the hot air trapped in hot zones when the flaps 114 are in the first position. The bypass assembly may further include one or more second conduits 120A, 120B, 120C, etc. (also collectively referred to as second conduits 120) fluidically coupled to the each of the one or more cold zones. Further, the second conduits 120 may be configured to bypass the cold air trapped in the cold zones, when the flaps 114 are in the second position.

[034] The bypass assembly may further include a gate 122 movable between an open position and a closed position. The open position and the closed position of the gate 122 may be synchronized with the first position and the second position of the flap assembly 112. In some embodiments, the gate 122 may be mechanically coupled to the flap assembly 112. As such, the open position of the gate 122 may coincide with the first position of the flap assembly 112. Similarly, the closed position of the gate 122 may coincide with the second position of the flap assembly 112. In the open position, the gate may be configured to direct the unconditioned air towards the one or more first conduits 118,

wherein in the closed position, the gate 122 may be configured to direct the unconditioned air towards the one or more second conduits 120. The bypass assembly is further explained in detail, in conjunction with FIGS. 5A-5B and FIGS. 6A-6B.

[035] Referring now to FIG. 5A-5B, a top view and a perspective view, respectively, of the HVAC system 100 with the flap assembly 112 in the first position, is illustrated, in accordance with an embodiment of the present disclosure. The blower 116 may suck atmospheric air (unconditioned air) inside the HVAC system 100, and may throw a portion of the unconditioned air on the heating and cooling assembly 101. As such, some of this unconditioned air (for example, half of that portion of the unconditioned air) may enter the cold zones and get converted into cold air, and the rest of this unconditioned air may enter the hot zones and may get converted into hot air.

[036] As mentioned earlier, in the first position of the flap assembly 112, the gate 122 may be in the open position, in which the gate 122 may direct a portion of the unconditioned air towards the first conduits 118. Further, in the first position of the flap assembly 112, the flaps 114 may completely interrupt passage of hot air through the hot zones, due to which the hot air may be trapped in the hot zones. As the first conduits 118 are fluidically coupled to the hot zones, the unconditioned air directed towards the hot zones may bypass via the hot zones thereby removing the hot air trapped in the hot zones. Further, since, in the first position, the cold zones are unblocked by the flaps 114, the cold air may exit from the cold zones in the cabin of the vehicle.

[037] Referring now to FIG. 6A-6B, a top view and a perspective view, respectively, of the HVAC system 100 with the flap assembly 112 in the second position is illustrated, in accordance with an embodiment of the present disclosure. In the second position of the flap assembly 112, the gate 122 may be in the closed position. In the closed position, the gate 122 may direct a portion of the unconditioned air towards the second conduits 120. Further, in the second position of the flap assembly 112, the flaps 114 may completely interrupt passage of cold air form the cold zones into the vehicle cabin, due to which the cold air may be trapped in the cold zones. As the second conduits 120 are fluidically coupled to the cold zones, the unconditioned air directed towards the cold zones may bypass via the cold zones thereby removing the cold air trapped in the cold zones. Further, since, in the second position, the hot zones are not blocked by the flaps 114, the hot air may exit from the hot zones in the cabin of the vehicle.

[038] A HVAC system based on reverse Seebeck effect or Peltier effect is disclosed. It will be appreciated that, according to the Peltier effect, when electric current is supplied to a thermoelectric material, one surface of the thermoelectric material develops as hot surface and the other as cold surface. Therefore, the Peltier effect-based HVAC system provides a single stage cooling and heating solution for a vehicle. The Peltier effect-based HVAC system further eliminates requirement of the compressor, and heavy piping channels that are required for the evaporator and the heater. Furthermore, the Peltier effect-based HVAC system provides a light-weight setup that can replace conventional automotive climate control in the vehicles. As the thermoelectric material may withstand up to -15 to 90 °C with a 12V battery supply, and the temperature requirement inside the vehicle is between -1°C to 85°C, the above disclosed HVAC is able to provide sufficient heating and cooling.

[039] It is intended that the disclosure and examples be considered as exemplary only, with a true scope and spirit of disclosed embodiments being indicated by the following claims.

We claim:

1. A heating, ventilation, and air conditioning (HVAC) system (100) for a vehicle, the HVAC system (100) comprising:

a heating and cooling assembly (101) configured to receive unconditioned air, and further configured to convert the unconditioned air into conditioned air, and emit the conditioned air in a cabin of the vehicle, the heating and cooling assembly (101) comprising:

one or more Peltier elements (102), each of the one or more Peltier elements (102)comprising a first side (104) and a second side (106), the first side (104) being configured to be a cold side and the second side (106) being configured to be a hot side, wherein a first portion of the unconditioned air is converted into cold air upon contacting the first side (104) of each of the one or more Peltier elements (102), and wherein a second portion of the unconditioned air is converted into hot air upon contacting the second side (106) of each of the one or more Peltier elements (102); and

a flap assembly (112) configured to shift between a first plurality of positions with respect to the one or more Peltier elements (102), to selectively cause to emit, in the cabin of the vehicle, conditioned air, wherein the conditioned air comprises a portion of cold air and a portion of hot air, corresponding to a position from the first plurality of positions of the flap assembly (112) with respect to the one or more Peltier elements (102).

2. The HVAC system (100) as claimed in claim 1, wherein the one or more Peltier elements (102) are arranged adjacent to each other, and wherein a first side of each of the one or more Peltier element (102) faces a first side of an adjacent Peltier element to define a cold zone, and wherein a second side of each of the one or more Peltier elements (102) faces a second side of an adjacent Peltier elements to define a hot zone.

3. The HVAC system (100) as claimed in claim 2, wherein the flap assembly (112) comprises one or more flaps (114), wherein each of the one or more flaps (114) is configured to slide into a first plurality of positions with respect to each of the one or more Peltier elements (102), to selectively interrupt passage of cold air from each of the cold zones and hot air from each of the hot zones into the cabin of the vehicle.

4. The HVAC system (100) as claimed in claim 3, wherein the first plurality of positions comprises:

a first position in which the portion of the hot air in the conditioned air is zero, and wherein in the first position, each of the one or more flaps (114) completely interrupts passage of hot air from each of the cold zones;

a second position in which the portion of the cold air in the conditioned air is zero, and wherein in the second position, each of the one or more flaps (114) completely interrupts passage of cold air from each of the cold zones; and

a second plurality of intermediary positions in which the portion of each of the hot air and the cold air in the conditioned air is non-zero.

5. The HVAC system (100) as claimed in claim 4, comprising a bypass assembly, wherein the bypass assembly is configured to:

bypass the hot air trapped in each of the hot zones when the one or more flaps (114) are in the first position; and

bypass the cold air trapped in each of the cold zones when the one or more flaps (114) are in the second position.

6. The HVAC system (100) as claimed in claim 5, wherein the bypass assembly comprises:

one or more first conduits (118) fluidically coupled to the each of the one or more hot zones, wherein each of the one or more first conduits (118) is configured to bypass the hot air trapped in each of the hot zones when the one or more flaps (114) are in the first position;

one or more second conduits (120) fluidically coupled to the each of the one or more cold zones, wherein each of the one or more second conduits is (120) configured to bypass the cold air trapped in each of the cold zones when the one or more flaps (114) are in the second position;

a gate (122) movable between an open position and a closed position, wherein in the open position, the gate (122) is configured to direct the unconditioned air in the one or more first conduits (118), and wherein in the closed position, the gate (122) is configured to direct the unconditioned air in the one or more second conduits (120).

7. The HVAC system (100) as claimed in claim 1, wherein the flap assembly (112) comprises a gear assembly (124), wherein the flap assembly (112) is configured to shift into the first plurality of positions via the gear assembly (124).

Dated this 07th of February 2020

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ABSTRACT

A HEATING, VENTILATION, AND AIR CONDITIONING (HVAC) SYSTEM FOR A VEHICLE

This disclosure relates to a heating, ventilation, and air conditioning (HVAC) system (100) for a vehicle. The HVAC system (100) may include a heating and cooling assembly (101) configured to receive unconditioned air, and convert the unconditioned air into conditioned air. The heating and cooling assembly (101) may include one or more Peltier elements (102), each of the one or more Peltier elements (102) comprising a first side (104) configured to be a cold side, and a second side (106), configured to be a hot side. The HVAC system (100) may further include a flap assembly (112) configured to shift between a first plurality of positions, to selectively cause to emit, in the cabin of the vehicle, conditioned air, wherein the conditioned air comprises a portion of cold air and a portion of hot air, corresponding to the positions of the flap assembly (112).

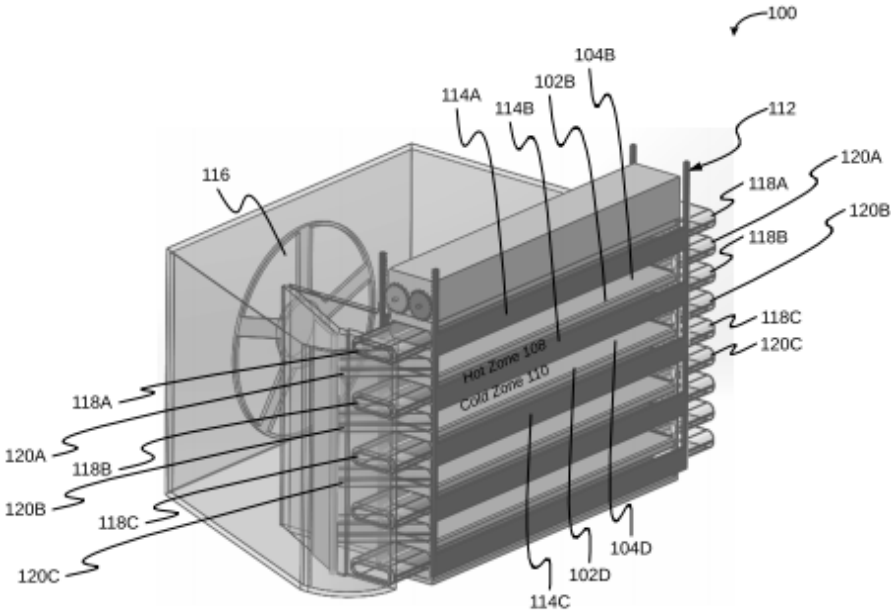

FIG. 2

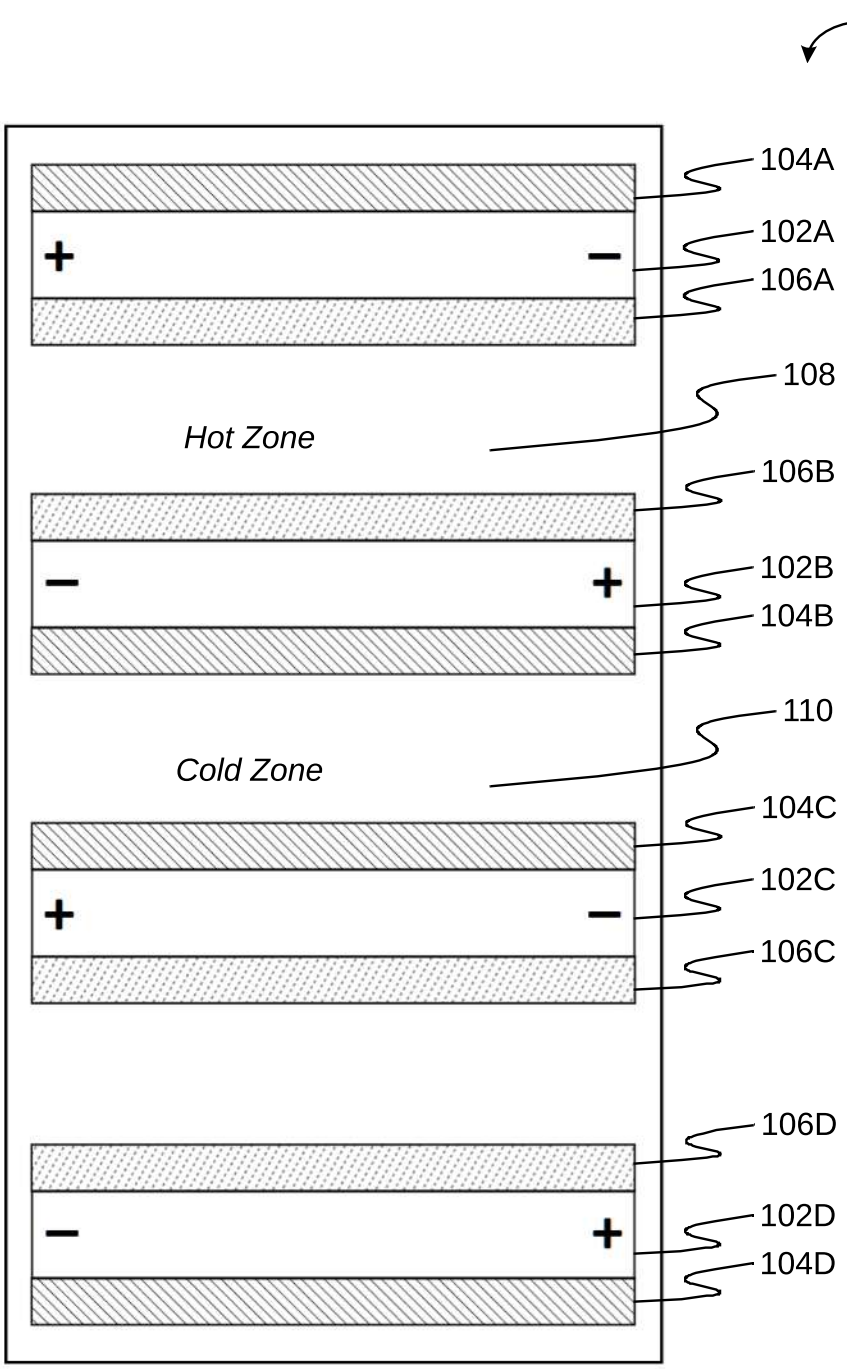

FIG. 1

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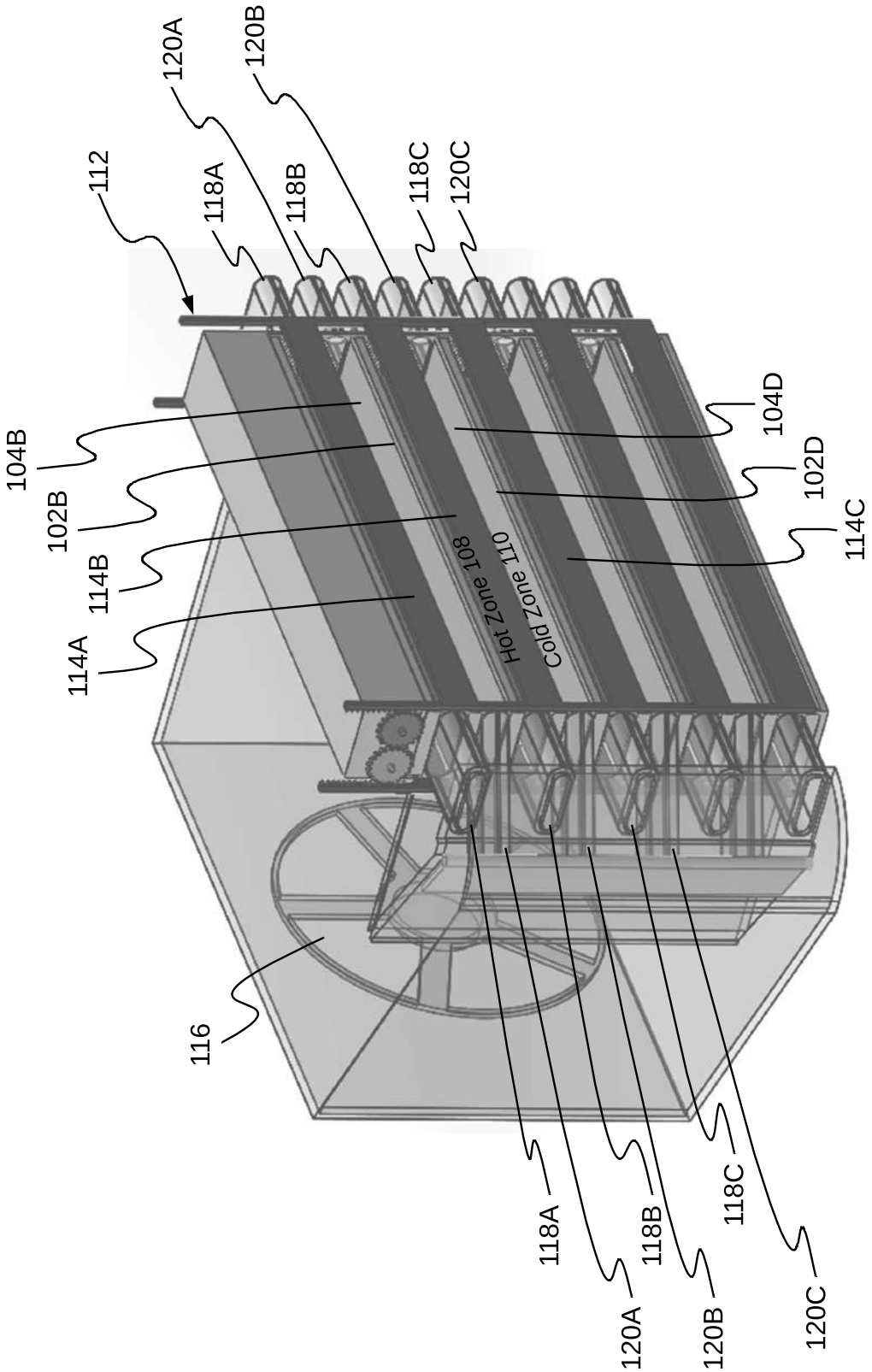

FIG. 2

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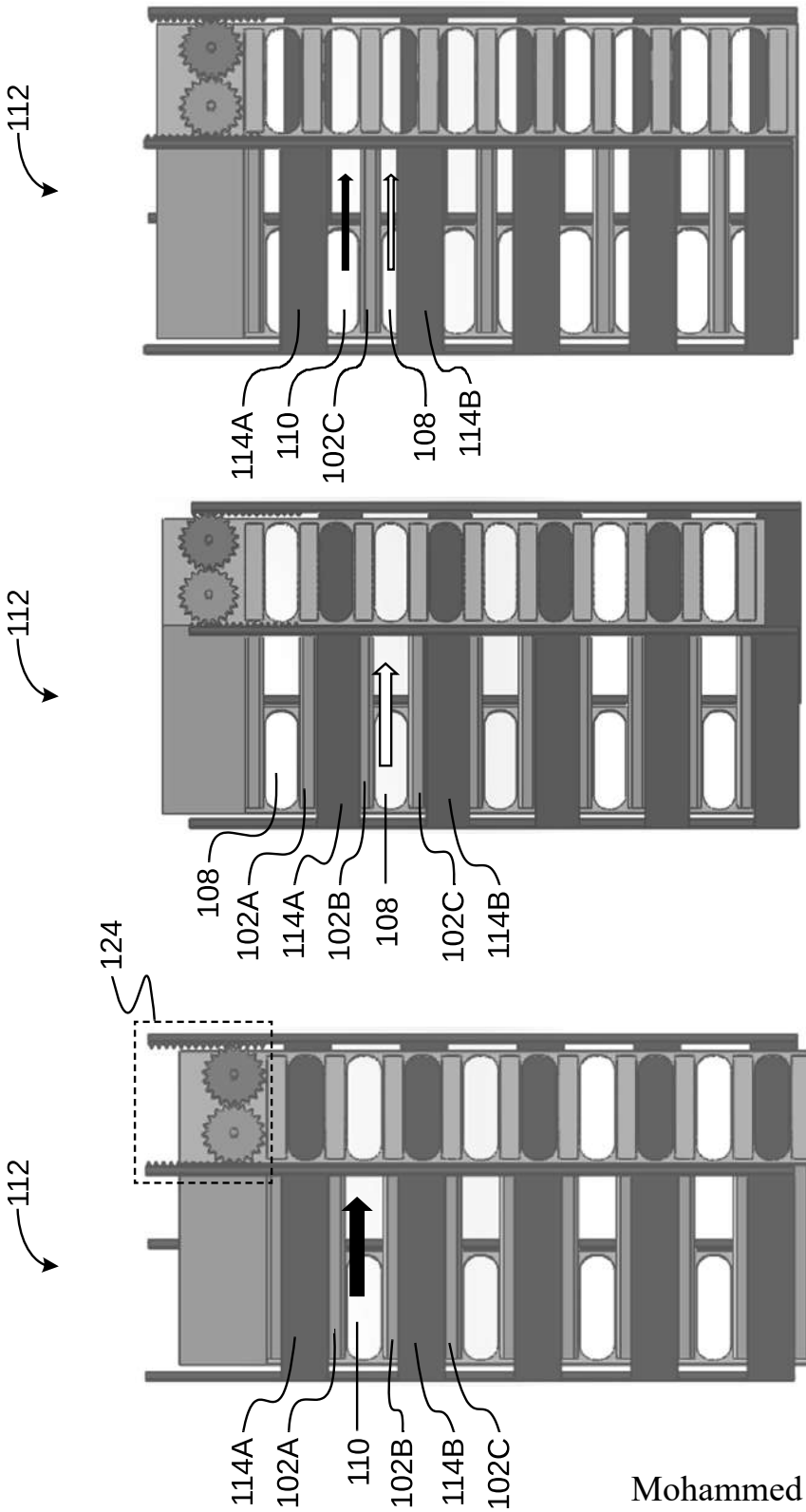

FIG. 3C

FIG. 3B

FIG. 3A

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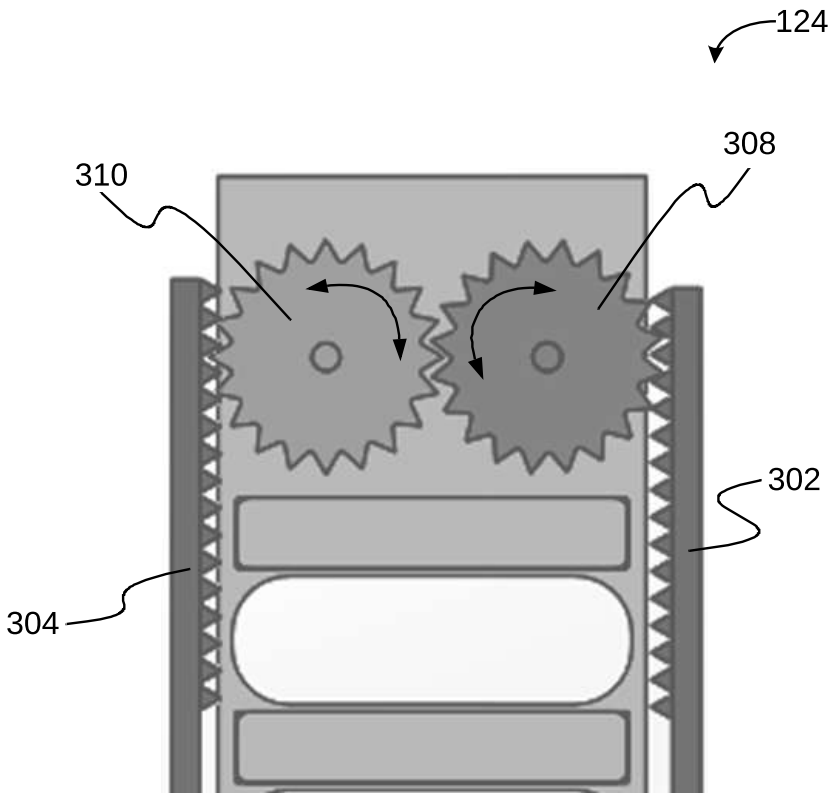

FIG. 4

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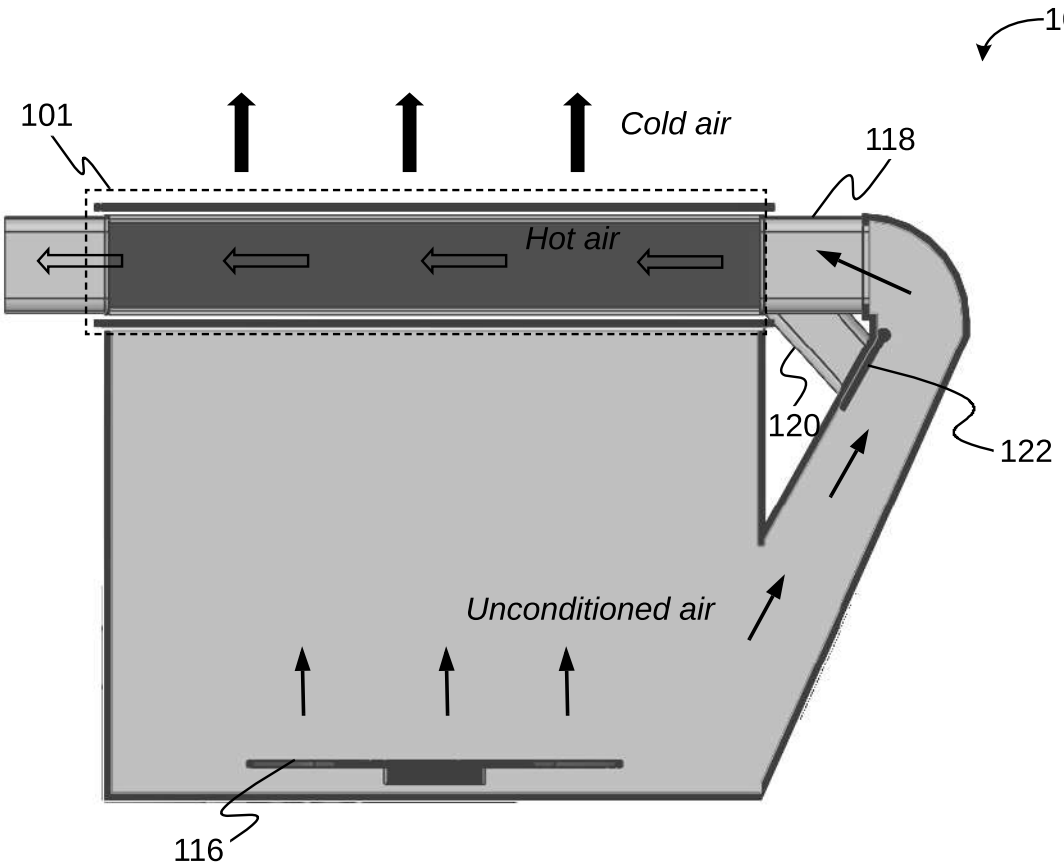

FIG. 5A

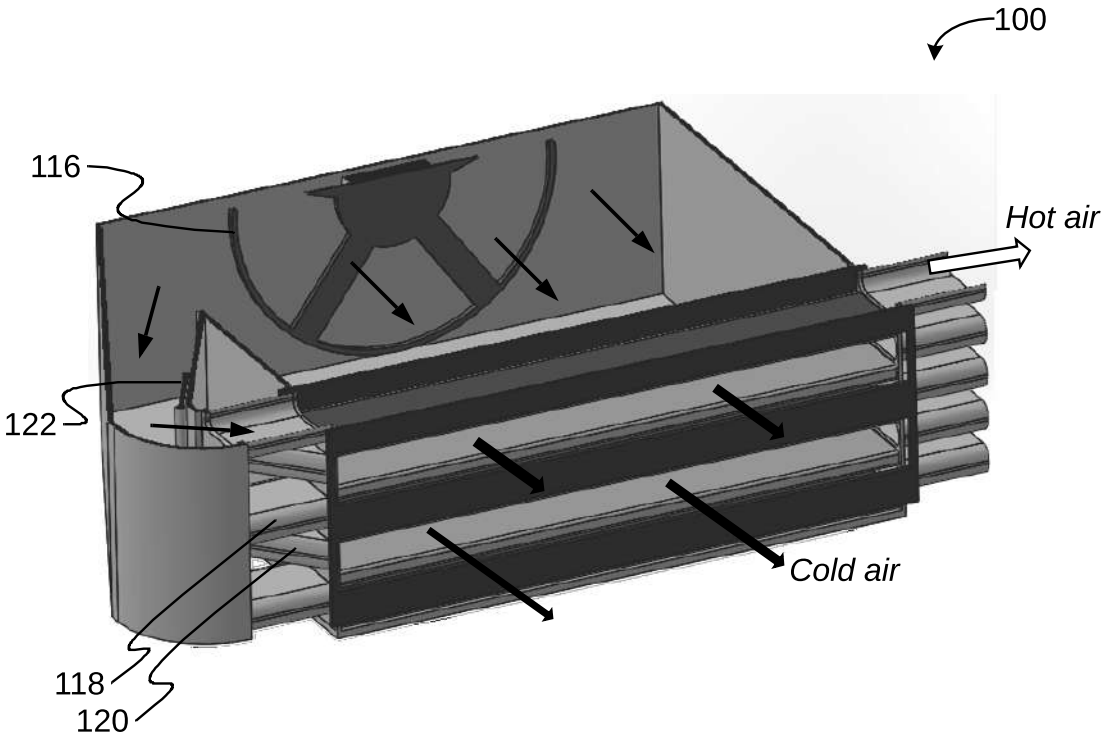

FIG. 5B

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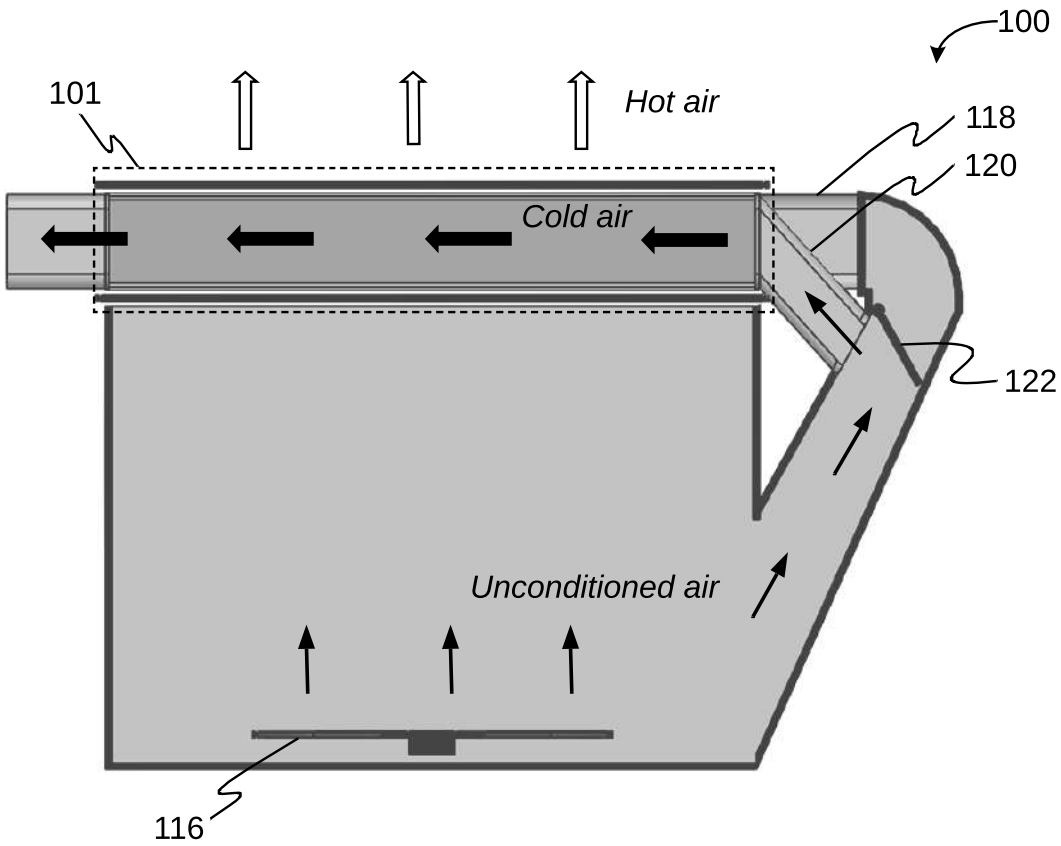

FIG. 6A

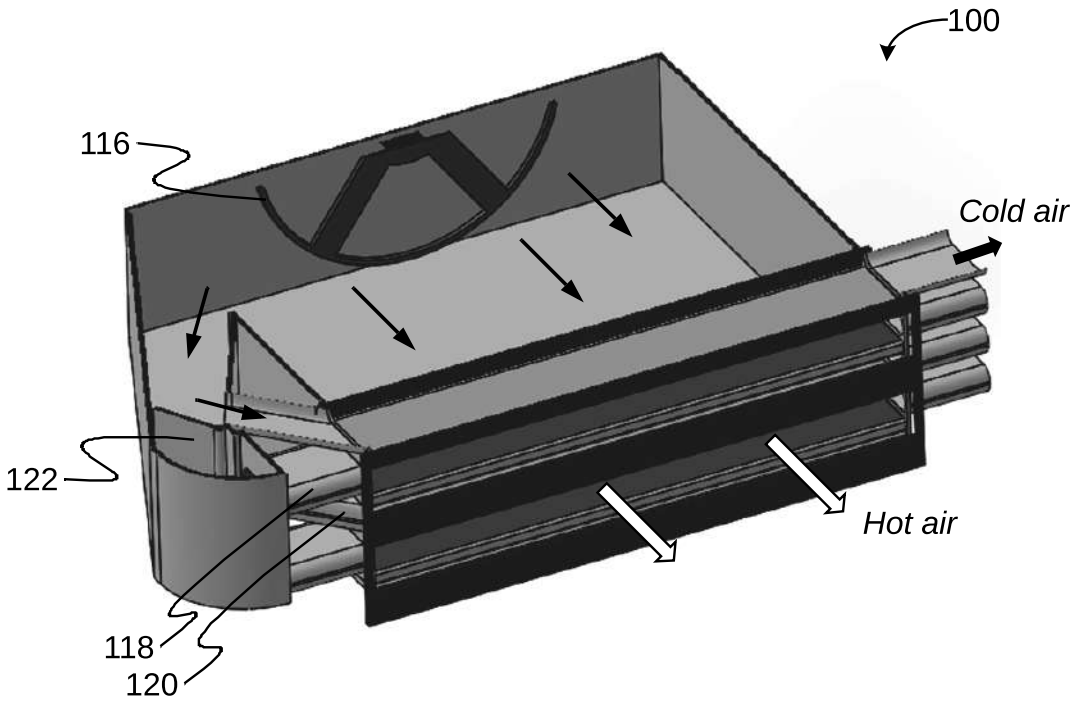

FIG. 6B

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