



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**28.07.2021 Bulletin 2021/30**

(51) Int Cl.:  
**F25B 39/04 (2006.01)**

(21) Application number: **20461504.1**

(22) Date of filing: **22.01.2020**

(84) Designated Contracting States:  
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**  
Designated Extension States:  
**BA ME**  
Designated Validation States:  
**KH MA MD TN**

- **GLUCHOWSKI, Marek**  
**32 050 Skawina (PL)**
- **OCHALA, Wojciech**  
**32 050 Skawina (PL)**

(74) Representative: **Bialkowski, Adam**  
**Valeo Systèmes Thermiques**  
**Industrial Property Department**  
**ZA L'Agiot**  
**8 rue Louis Lormand**  
**CS 80517 LA VERRIERE**  
**78322 Le Mesnil Saint Denis Cedex (FR)**

(71) Applicant: **Valeo Autosystemy SP. Z.O.O.**  
**32-050 Skawina (PL)**

(72) Inventors:  
• **JUGOWICZ, Andrzej**  
**32 050 Skawina (PL)**

(54) **A HEAT EXCHANGER WITH HORIZONTALLY POSITIONED RECEIVER DRIER**

(57) A heat exchanger includes a first section (110), a second section (120) and a receiver drier (130). The first section (110) includes a first set of tubes (112) arranged substantially horizontally, wherein edges of the first set of tubes (112) define a first air-inlet surface (X). The second section (120) includes a second set of tubes (122), wherein edges of the second set of tubes (122) define a second air-inlet surface (Y). The receiver drier

(130) is disposed parallel with respect to the first set of tubes (112) and configures fluid communication between the first section (110) and the second section (120). The first air-inlet surface (X) and the second air-inlet surface (Y) do not overlap when viewed in a direction perpendicular to the first air inlet surface (X) and when viewed in a direction perpendicular to the second air-inlet surface (Y).

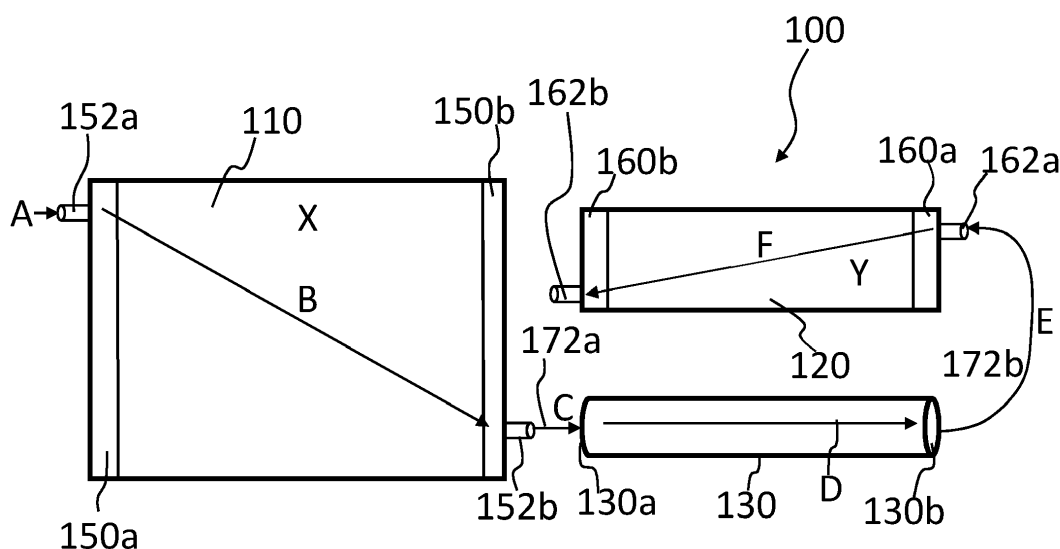


FIG. 6a

## Description

**[0001]** The present invention relates to a heat exchanger, more particularly, the present invention relates to a condenser with a horizontally positioned receiver drier for a vehicle Heating Ventilation and Air-conditioning unit.

**[0002]** Conventional air conditioning system for example for a vehicle cabin includes a condenser, an evaporator, an expansion device, a compressor and a heater. The compressor pumps refrigerant gas up to a high pressure and temperature. Thereafter, refrigerant gas enters the condenser, where refrigerant gas rejects heat energy to external ambient (through ambient air or a specific low temperature coolant circuit), is cooled, and condenses into liquid phase. Thereafter, the expansion valve regulates refrigerant liquid to flow at proper rate, reducing pressure of the refrigerant liquid due expansion of the refrigerant liquid, and finally, the cooled liquid refrigerant flows to the evaporator, where the cooled liquid refrigerant is evaporated. As the liquid refrigerant evaporates, the refrigerant extracts or absorbs heat energy from air inside an enclosure to be conditioned, specifically, the vehicle cabin in case of a vehicle air conditioning system and the refrigerant returns to the compressor, and the above cycle repeats. In the process, the heat is extracted from inside the vehicle cabin and is rejected outside the vehicle cabin, resulting in cooling of air inside the vehicle cabin.

**[0003]** Generally, the conventional air conditioning system configured with an expansion valve is also configured with a receiver drier that is disposed in a high-pressure section of the air conditioning system, usually located between a condenser and the expansion valve in the air conditioning loop. Generally, a conventional heat exchanger, particularly, the condenser is configured with the receiver drier along an outlet side of the condenser, particularly, along a length of an outlet collector of a pair of collectors of the condenser. The receiver drier includes a tubular casing in the form of an airtight container with an inlet and an outlet. The inlet receives liquid refrigerant along with some uncondensed refrigerant, debris and incompressible moisture, if any, from a first pass defining a condensing section of the condenser via a first portion of the outlet collector. Whereas, the outlet delivers the liquid refrigerant from which incompressible moisture and debris is removed, to a second pass defining the sub-cooling section of the condenser via a second section of the outlet collector.

**[0004]** However, there are various drawbacks associated with a condenser of such conventional configuration. Particularly, the conventional condenser with a receiver drier thereof disposed along a collector is bulky. The conventional condenser with the receiver drier thereof disposed along the collector is generally secured to the collector and as such fails to provide flexibility of adjusting position of the receiver drier based on packaging constraints. The conventional condenser with the receiver

drier thereof disposed along the collector faces packaging issues due to limited space in a front of the vehicle, the packaging issue is further aggravated in case the vehicle is an electric vehicle, in which the front portion of the electric vehicle is utilized as utility such as for example, a cargo-space or in case the condenser includes two separate cores disposed in a co-planar, non-overlapping configuration to achieve better heat exchange.

**[0005]** Accordingly, there is a need for a condenser with a receiver drier that can be positioned with respect to collectors of the condenser, to attain a compact configuration and enable packaging thereof in a limited space in front of a vehicle. Further, there is a need for the condenser with the receiver drier that provides flexibility of adjusting position of the receiver drier based on packaging constraints.

**[0006]** An object of the present invention is to provide a condenser with a receiver drier that can be positioned with respect to collectors of the condenser, to enable packaging thereof in a limited space in front of a vehicle.

**[0007]** Another object of the present invention is to provide a condenser with a receiver drier that obviates the drawbacks associated with the conventional condenser with a receiver drier thereof disposed vertically along a collector.

**[0008]** Yet another object of the present invention is to provide a condenser with a receiver drier that provides flexibility of adjusting position of the receiver drier based on packaging constraints.

**[0009]** In the present description, some elements or parameters may be indexed, such as a first element and a second element. In this case, unless stated otherwise, this indexation is only meant to differentiate and name elements, which are similar but not identical. No idea of priority should be inferred from such indexation, as these terms may be switched without betraying the invention. Additionally, this indexation does not imply any order in mounting or use of the elements of the invention.

**[0010]** A heat exchanger is disclosed in accordance with an embodiment of the present invention. The heat exchanger includes a first section, a second section and a receiver drier. The first section includes a first set of heat exchange tubes that are arranged horizontally, wherein edges of the first set of heat exchange tubes define a first air-inlet surface. The second section includes a set of heat exchange tubes, wherein edges of the second set of heat exchange tubes define a second air-inlet surface. The receiver drier is disposed parallel with respect to the first set of heat exchange tubes and configures fluid communication between the first section and the second section. The first air inlet surface and the second air inlet surface do not overlap when viewed in a direction perpendicular to the first air inlet surface and when viewed in a direction perpendicular to the second air-inlet surface.

**[0011]** The first section and the second section are co-planar with respect to each other, are connecting a pair of common collectors and are defined by at least one

baffle disposed inside each of the pair of common collectors.

**[0012]** Generally, the receiver drier is disposed either one of in-front and behind the first section and the second section.

**[0013]** Alternatively, the receiver drier is disposed along and adjacent to a longitudinal side of either one of the first section and the second section.

**[0014]** Specifically, the receiver drier connects the pair of common collectors with a first inlet and a second inlet formed on same side of the heat exchanger and on different sides of the baffle, the first inlet and the second inlet supplies fluid to the first section and the second section respectively.

**[0015]** Further, the heat exchanger includes

- a first connecting line in the form of a flexible conduit that configures connection between a first outlet formed on the outlet collector and the receiver drier; and
- a second connecting line in the form of a flexible conduit that configures connection between the receiver drier and the second inlet formed on the inlet collector.

**[0016]** Alternatively, the heat exchanger includes,

- a first connecting line in the form of channels formed on at least one of the outlet collector and the receiver drier, the channels form connection between the first outlet formed on outlet collector and the receiver drier; and
- a second connecting line in form of channels formed on at least one of the receiver drier and the inlet collector, the channels form connection between the receiver drier and the second inlet formed on the inlet collector.

**[0017]** In accordance with another embodiment of the present invention, the first section and the second section are separate cores arranged in non-overlapping configuration with respect to each other, each of the first section and the second section is configured with a separate pair of first pair of collectors and a second pair of collectors respectively for heat exchange fluid.

**[0018]** Specifically, the first section and the second section are separate cores that are arranged in co-planar configuration with respect to each other.

**[0019]** Generally, the receiver drier is disposed either one of in-front and behind the first section and the second section.

**[0020]** Alternatively, the receiver drier is disposed between the first section and the second section.

**[0021]** Otherwise, the receiver drier is disposed along and adjacent to either one of the longitudinal sides of at least one of the first section and the second section.

**[0022]** Specifically, the receiver drier connects the first outlet collector of a first pair of collectors to the second

inlet collector of the second pair of collectors.

**[0023]** Further, the heat exchanger includes :

- a first connecting line in the form of a first flexible conduit that configures connection between a first outlet formed on the first outlet collector and the receiver drier;
- a second connecting line in the form of a second flexible conduit configures connection between the receiver drier and the second inlet formed on the second inlet collector.

**[0024]** Alternatively, the heat exchanger includes,

- a first connecting line in form channels formed on at least one of the first outlet collector and the receiver drier, the channels configures connection between the first outlet formed on the first outlet collector and the receiver drier; and
- a second connecting line in form of channels formed on at least one of the receiver drier and the second inlet collector, the channels configures connection between the receiver drier and the second inlet formed on second inlet collector.

**[0025]** Other characteristics, details and advantages of the invention can be inferred from the description of the invention hereunder. A more complete appreciation of the invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying figures, wherein:

**FIG.1a** and **FIG.1b** illustrate a schematic representation of a condenser in accordance with an embodiment of the present invention, wherein condensing and sub-cooling sections are co-planar with respect to each other;

**FIG. 2a** and **FIG. 2b** illustrate a schematic representation of a condenser in accordance with another embodiment of the present invention, wherein condensing and sub-cooling sections are co-planar with respect to each other but arranged differently than arrangement illustrated in **FIG.1a** and **FIG.1b**;

**FIG. 3** illustrates a schematic representation of a condenser in accordance with yet another embodiment of the present invention, wherein condensing and sub-cooling sections are co-planar with respect to each other and a receiver drier is arranged either in front or behind of the condensing and sub-cooling sections;

**FIG. 4** illustrates a schematic representation of a

condenser in accordance with still another embodiment of the present invention, wherein condensing and sub-cooling sections are co-planar with respect to each other but arranged differently than arrangement illustrated in **FIG. 3**;

**FIG. 5a** illustrates a schematic representation of a condenser in accordance with yet another embodiment of the present invention;

**FIG. 5b** illustrates an isometric view of the condenser of **FIG. 5a**;

**FIG. 6a** illustrates a schematic representation of a condenser in accordance with yet another embodiment of the present invention, wherein the receiver drier is arranged differently than the arrangement thereof illustrated in **FIG. 5a** and **FIG. 5b**;

**FIG. 6b** illustrates an isometric view of the condenser of **FIG. 6a**;

**FIG. 7** illustrates a schematic representation of a condenser in accordance with yet another embodiment of the present invention, wherein the receiver drier is arranged differently than the arrangement thereof illustrated in **FIG. 5a**, **FIG. 5b** and **FIG. 6a**, **6b**; and

**FIG. 7b** illustrates an isometric view of the condenser of **FIG. 7a**.

**[0026]** It must be noted that the figures disclose the invention in a detailed enough way to be implemented, said figures helping to better define the invention if needs be. The invention should however not be limited to the embodiment disclosed in the description.

**[0027]** The present invention envisages a heat exchanger or a condenser that includes a first condenser section, a second condenser section and a receiver drier. The first section includes a first set of heat exchange tubes that are arranged substantially horizontally, wherein edges of the first set of heat exchange tubes define a first air-inlet surface. The second section includes second set of heat exchange tubes, wherein edges of the second set of heat exchange tubes define a second air inlet surface. The receiver drier is disposed parallel with respect to the first set of heat exchange tubes and configures fluid communication between the first section and the second section. The first air-inlet surface and the second air-inlet surface do not overlap when viewed in a direction perpendicular to the first air-inlet surface and when viewed in a direction perpendicular to the second air-inlet surface. However, the present invention is also applicable for any heat exchanger configured with an element that is required to be in fluid communication with and positioned horizontally with respect to the heat exchange tubes of the heat exchanger to address packaging is-

sues.

**[0028]** **FIG. 1a** illustrates a schematic representation of a heat exchanger, particularly, a condenser **100** for an air conditioning system for a vehicle. The condenser **100** is generally disposed at a front portion of the vehicle. The condenser **100** includes a first condenser section or a condensing section **110** defining a first pass and a second condenser section or a sub cooling section **120** defining a second pass and a receiver drier **130**. The first condensing section **110** and the sub-cooling section **120** includes a first set of heat exchange tubes **112** and a second set of heat exchange tubes **122** respectively. At least the first set of heat exchange tubes **112** are arranged substantially horizontally. The receiver drier **130** is disposed horizontally and parallel with respect to at least one of the first set of heat exchange tubes **112** and the second set of heat exchange tubes **122** and configures fluid communication there between. More specifically, the receiver drier **130** is disposed horizontally and parallel to the set of heat exchange tubes of either the first pass and the second pass that are disposed horizontally.

**[0029]** In accordance with an embodiment of the present invention, the condensing section **110** and the sub-cooling section **120** are co-planar with respect to each other. Further, the condensing section **110** and the sub-cooling section **120** are connecting a pair of common collectors **140a**, **140b** and are defined by at least one baffle **142a**, **142b** disposed inside each of the pair of common collectors **140a**, **140b**. More specifically, a first baffle **142a** disposed inside and dividing interior of an inlet collector **140a** of the pair of common collectors **140a**, **140b** into a first portion **144a** and a second portion **146a**. Similarly, a second baffle **142b** disposed inside and dividing an interior of an outlet collector **140b** of the pair of common collectors **140a**, **140b** into a first portion **144b** and a second portion **146b**. The first portion **144a** of the inlet collector **140a** receives vapour refrigerant from a first inlet **114a** along a flow direction as depicted by arrow **A** and distributes the vapour refrigerant to the first set of heat exchange tubes **112**. In case fluid flow through the condensing section **110** is I-flow, the vapour refrigerant is condensed as the vapour refrigerant flows through the heat exchange elements of the condensing section **110** along flow direction depicted by the arrow **B**. Although, in the accompanying drawings and corresponding description the refrigerant flow through the condensing section **110** is depicted and described to be as I-flow. However, refrigerant flow through the condensing section **110** is not limited to I-flow and the flow through the condensing section **110** can be U-flow or any other flow instead of I-flow. The condensed refrigerant egressing the condensing section **110** is collected by the first portion **144b** of the outlet collector **140b**.

**[0030]** The condensed refrigerant, including some refrigerant vapours and incompressible moisture, if any, egresses through the first portion **144b** of the outlet collector **140b** through a first outlet **114b** and enters an inlet **130a** to the receiver drier **130** by flowing along flow di-

rection depicted by arrow **C**. More specifically, a first connecting line in form of a first flexible conduit **172a** connects the first outlet **114b** formed on the first portion **144b** of the outlet collector **140b** to the inlet **130a** to the receiver drier **130**. As the condensed refrigerant passes through the receiver drier **130** along flow direction depicted by arrow **D**, the incompressible moisture and debris are removed. The condensed refrigerant with moisture and debris removed therefrom, egresses through an outlet **130b** of the receiver drier **130** and enters the sub-cooling section **120** by flowing along flow direction depicted by arrow **E**. More specifically, a second connecting line in form of a second flexible conduit **172b** connects the outlet **130b** of the receiver drier **130** to a second inlet **124a** formed on the second portion **146a** of the inlet collector **140a**. In accordance with an embodiment of the present invention, the first and the second connecting lines between the receiver drier **130** and the first outlet **114b** and the second inlet **124a** can be incorporated into at least one of the inlet collector **140a**, the outlet collector **140b** and the receiver drier **130**. Specifically, the first and the second connecting lines may be formed as inner channels or side channels, for example formed on walls of at least one of the inlet collector **140a**, the outlet collector **140b** and the receiver drier **130**. More specifically, the first and the second connecting lines may be coextruded on walls of at least one of the inlet collector **140a**, the outlet collector **140b** and the receiver drier **130**. The second portion **146a** of the inlet collector **140a** distributes the refrigerant with moisture and debris removed therefrom to the sub-cooling section **120**. In the sub-cooling section **120**, the condensed refrigerant is sub-cooled and the sub-cooled refrigerant is collected in the second portion **146b** of the outlet collector **140b**. The sub cooled refrigerant collected in the second portion **146b** of the outlet collector **140b** egresses through a second outlet **124b**.

**[0031]** FIG. 1a - FIG. 4 depict different positions of the receiver drier **130** with respect to the condensing section **110** and the sub-cooling section **120**, wherein the condensing section **110** and the sub-cooling section **120** are arranged in different configurations with respect to each other. Particularly, in some cases as illustrated in FIG. 1a, FIG. 1b and FIG. 3, the condensing section **110** is disposed at the bottom, whereas in other cases as illustrated in FIG. 2a, FIG. 2b and FIG. 4, the sub-cooling section **120** is disposed at the bottom.

**[0032]** Specifically, the FIG. 1a and FIG. 1b illustrate schematic representations of the condenser **100** in accordance with different embodiments, wherein the condensing section **110** and the sub-cooling section **120** are co-planar with respect to each other. The receiver drier **130** can be disposed along and adjacent to a longitudinal side of either one of the condensing section **110** and the sub-cooling section **120**. More specifically, as illustrated in FIG. 1a and FIG. 1b, the sub-cooling section **120** is disposed at the top and the receiver drier **130** is disposed along and adjacent to the longitudinal side of either one of the condensing section **110** and the sub-cooling sec-

tion **120** respectively.

**[0033]** Further, the FIG. 2a and FIG. 2b illustrate schematic representations of the condenser **100** in accordance with still different embodiments of the present invention, wherein the condensing section **110** and the sub-cooling section **120** are co-planar with respect to each other. More specifically, as illustrated in FIG. 2a and FIG. 2b, the sub-cooling section **120** is disposed at bottom and the receiver drier **130** is disposed along and adjacent to the longitudinal side of either one of the condensing section **110** and the sub-cooling section **120** respectively.

**[0034]** Furthermore, FIG. 3 and FIG. 4 illustrate schematic representations of the condenser **100** in accordance with yet different embodiments of the present invention, wherein the condensing section **110** and sub-cooling section **120** are co-planar with respect to each other. The receiver drier **130** can be disposed either one of in-front or behind at least one of the condensing section **110** and the sub-cooling section **120**. More specifically, as illustrated in FIG. 3, the sub-cooling section **120** is disposed at the top and the receiver drier **130** is disposed in-front of the condensing section **110** disposed at the bottom. However, the receiver drier **130** can also be disposed behind the condensing section **110**. Further, as illustrated in FIG. 4, the sub-cooling section **120** is disposed at the bottom and the receiver drier **130** is disposed in-front of the condensing section **110** that is disposed at the top. However, the receiver drier **130** can also be disposed behind the condensing section **110**. In accordance with another embodiment of the present invention, the receiver drier **130** can be disposed either in front or behind the sub-cooling section **120** instead of the condensing section **110**.

**[0035]** The first outlet **114b** formed on the first portion **144b** of the outlet collector **140b** is connected to the inlet **130a** to the receiver drier **130** via the first flexible conduit **172a**. In accordance with an embodiment of the present invention, the connection between ends of the first flexible conduit **172a** and the first outlet **114b** formed on the first portion **144b** of the outlet collector **140b** and the inlet **130a** to the receiver drier **130** is a removable connection. Similarly, the outlet **130b** of the receiver drier **130** is connected to the second inlet **124a** formed on the second portion **146a** of the inlet collector **140a** via the second flexible conduit **172b**. The connection between ends of the second flexible conduit **172b** and the second inlet **124a** formed on the second portion **146a** and the outlet **130b** of the receiver drier **130** is a removable connection. With such configuration, the receiver drier **130** connects the pair of common collectors **140a**, **140b**, with the first and second inlets **114a**, **124a** supplying fluid to the condensing section **110** and the sub-cooling section **120** formed on the same side of the condenser **100** respectively and on either sides of the baffle **142a**. Instead of flexible conduit **172a** connecting the first outlet **114b** to the inlet **130a** of the receiver drier **130** and the second flexible conduit **172b** connecting the outlet **130b** of the

receiver drier **130** to the second inlet **124a**, rigid pipes can be used to form such connections. Such configuration provides flexibility of adjusting position of the receiver drier **130** based on packaging constraints. Such configuration ensures compact configuration and convenient packaging thereof in a limited space without interfering with operation of other elements disposed adjacent to the condenser **100**. Further, such configuration enables quick, convenient replacement or removal of the receiver drier **130** for easy serviceability, as the receiver drier **130** can be replaced or removed for servicing without dismounting the whole condenser assembly.

**[0036]** FIGS. 5a - FIG. 5b illustrates the condenser **100** in an accordance with a different embodiment of the present invention. The condenser **100** includes a first condenser section or a condensing section **110** defining a first pass, a second condenser section or a sub-cooling section **120** defining a second pass and the receiver drier **130**. The condensing section **110** and the sub cooling section **120** are formed as separate cores. The condensing section **110** includes a first set of heat exchange elements, particularly, heat exchange tubes **112** disposed between a first pair of collectors **150a** and **150b**. The first set of heat exchange tubes **112** are arranged substantially horizontally, wherein edges of the first set of heat exchange tubes define a first air-inlet surface X. Similarly, the sub-cooling section **120** includes a second set of heat exchange elements, particularly, heat exchange tubes **122** disposed between a second pair of collectors **160a** and **160b**, wherein edges of the second set of heat exchange tubes define a second air-inlet surface Y. The first pair of collectors **150a** and **150b** are disposed at opposite lateral sides of the first core defining the condensing section **110**, whereas the second pair of collectors **160a** and **160b** is disposed at opposite lateral sides of the second core defining the sub-cooling section **120**. The receiver drier **130** includes a tubular casing **132**, the inlet **130a**, the outlet **130b**, a desiccant material, a filter and a suction tube held inside the tubular casing **132**. As the internal details of the receiver drier **130** and the elements held inside the receiver drier **130** are not within the scope of the present invention, they are hence not shown in the accompanying drawings and are not described in details in the forthcoming description.

**[0037]** Again referring to FIG. 5a and FIG. 5b, a first inlet collector **150a** of the first pair of collectors **150a** and **150b** distributes refrigerant vapour to the first set of heat exchange tubes **112** of the first core defining the condensing section **110**. Whereas a first outlet collector **150b** of the first pair of collectors **150a** and **150b** collects refrigerant from the first set of heat exchange tubes **112** of the first core defining the condensing section **110**. Similarly, a second inlet collector **160a** of the second pair of collectors **160a** and **160b** distributes condensed refrigerant to the second set of heat exchange tubes **122** of the second core defining the sub-cooling section **120**. Whereas a second outlet collector **160b** of the second pair of collectors **160a** and **160b** collects sub-cooled re-

frigerant from the second set of heat exchange tubes **122** of the second core **120** defining the sub-cooling section **120**. At least the first pair of collectors **150a** and **150b** are arranged substantially vertically. Generally, the first core defining the condensing section **110** and the second core defining the sub-cooling section **120** both are disposed at a front of the vehicle and both directly receive the ram air. Specifically, the first air-inlet surface (X) and the second air-inlet surface (Y) do not overlap when viewed in a direction perpendicular to the first air-inlet surface (X) and when viewed in a direction perpendicular to the second air-inlet surface (Y). More specifically, the first core defining the condensing section **110** and the second core defining the sub-cooling section **120** are so arranged with respect to each other such that refrigerant flow through the condensing section **110** and the sub-cooling section **120** is series flow, whereas air flow through the condensing section **110** and the sub-cooling section **120** is parallel flow. The condenser with first core defining the condensing section **110** and the second core defining the sub-cooling section **120** disposed non-overlapping configuration with respect to each other exhibits improved heat exchange efficiency as compared to condenser with the first core and the second core disposed in overlapping configuration, due to both cores in the non-overlapping configuration being directly exposed to air. Specifically, condenser with the first core and the second core disposed in overlapping configuration exhibit reduced heat exchange efficiency as the first core acts as a barrier to air flow to the second core placed behind the first core in the overlapping configuration. However, condenser disposed at front of the vehicle, with non-overlapping cores occupies comparatively more space in lateral direction of the vehicle as compared to condenser with overlapping cores and cause packaging issues for the other elements such as the receiver drier **130**. Accordingly, there is a need for arranging the receiver drier **130** in compact configuration to address the packaging issues. Also, such configuration of the first core and the second core disposed in non-overlapping configuration with respect to each other enables compact packaging of the cores along longitudinal direction of the vehicle. Further, such configuration of the first core and the second core disposed in non-overlapping configuration with respect to each other enables mounting of both cores in the left and right wheelbases of the vehicle or generally apart from each other along the width of the vehicle.

**[0038]** The first core defining the condensing section **110** receives refrigerant vapours and delivers condensed refrigerant along with some incompressible moisture and uncondensed refrigerant and debris, if any, to the inlet **130a** to the receiver drier **130**. The receiver drier **130** is disposed horizontally and parallel to the first set of heat exchange tubes **112** to address the packaging issue arising due to the first core and the second core arranged in non-overlapping configuration with respect to each other. The receiver drier **130** removes incompressible moisture and debris from the refrigerant vapours passing there

through and separates the condensed refrigerant from the vapour refrigerant. The second core defining the sub-cooling section **120** is disposed downstream of and is connected to the outlet **130b** of the receiver drier **130** in the fluid flow direction. The receiver drier **130** is generally connected to the second core defining the sub-cooling section **120** by brackets or support elements. The second core defining the sub-cooling section **120**, sub-cools the condensed refrigerant from the first core defining the condensing section **110** from which incompressible moisture and uncondensed refrigerant is removed by the receiver drier **130**. The first core defining the condensing section **110** and the second core defining the sub-cooling section **120** may be connected to each other to impart strength to the overall structure. In one embodiment, the first core and the second core are connected by brackets or support elements. In accordance with another embodiment, the first core and the second core are independently mounted on vehicle frame. However, the present invention is not limited to any particular configuration and placement of the second core defining the sub-cooling section **120** with respect to the first core defining the condensing section **110**, as far as the first air-inlet surface (X) and the second air-inlet surface (Y) do not overlap when viewed in a direction perpendicular to the first air-inlet surface (X) and when viewed in a direction perpendicular to the second air-inlet surface (Y). The air flow through the condensing section **110** and the sub-cooling section **120** is parallel flow, particularly, both the condensing section **110** and the sub-cooling section **120** directly receives the ram air.

**[0039]** The first core defining the condensing section **110** receives the refrigerant vapour from the first inlet collector **150a**. The first inlet collector **150a** includes a first inlet **152a** configured thereon and in fluid communication therewith. The first inlet **152a** supplies refrigerant vapour to the first inlet collector **150a**. More specifically, referring to the **FIG. 5a**, the refrigerant vapour enters the first inlet collector **150a** from the first inlet **152a** along a flow direction depicted by arrow **A**. Thereafter, the first inlet collector **150a** in conjunction with corresponding header distributes the vapour refrigerant in the first core defining the condensing section **110**. In case fluid flow through the first core defining the condensing section **110** is I-flow, the vapour refrigerant is condensed as the vapour refrigerant flows through the heat exchange elements of the core defining the condensing section **110** along flow direction depicted by the arrow **B**. Although, in the accompanying drawings and corresponding description, the refrigerant flow through the heat exchange elements of the core defining the condensing section **110** is depicted and described as I-flow. However, refrigerant flow through the core defining the condensing section **110** is not limited to I-flow and the flow through the core defining the condensing section **110** can be U-flow or any other flow instead of I-flow. As the vapour refrigerant flows through the first set of heat exchange tubes **112** of the first core defining the condensing section **110** as de-

picted by arrow **B**, the air flows past the and outside heat exchange tubes **112** and the vapour refrigerant flowing inside the heat exchange tubes **112** is condensed. The condensed refrigerant egressing the first core defining the condensing section **110** is collected by the first outlet collector **150b**. The first outlet collector **150b** includes a first outlet **152b** configured thereon and in fluid communication therewith. The condensed refrigerant, including some refrigerant vapours, debris and incompressible moisture, if any egresses through the first outlet **152b** and enters the inlet **130a** to the receiver drier **130** as depicted by the arrow **C**. More specifically, the first outlet **152b** is connected to the inlet **130a** to the receiver drier **130** via the first flexible conduit **172a** and the condensed refrigerant, along with some incompressible moisture, debris and uncondensed refrigerant vapours, if any flows from the first outlet **152b** to the inlet **130a** to the receiver drier **130** as depicted by arrow **C**. Thereafter, the condensed refrigerant along with some incompressible moisture and uncondensed refrigerant vapours flows through the receiver drier **130** in flow direction depicted by arrow **D** and incompressible moisture and debris are removed from the condensed refrigerant as it flows through the receiver drier **130**. The condensed refrigerant with moisture and debris removed therefrom egresses the receiver drier **130** and enters the sub cooling section **120** by flowing along flow direction depicted by arrow **E**. More specifically, the second inlet collector **160a** includes a second inlet **162a** formed thereon and in fluid communication therewith and a second connecting line in form of a second flexible conduit **172b** connects the outlet **130b** of the receiver drier **130** to the second inlet **162a**. The second inlet collector **160a** distributes the condensed refrigerant with moisture and debris removed therefrom to the sub-cooling section **120**. In the sub-cooling section **120**, the condensed refrigerant is sub cooled. The sub-cooled refrigerant is collected in the second outlet collector **160b**. The sub cooled refrigerant collected in the second outlet collector **160b** egresses through a second outlet **162b** of the second outlet collector **160b**. In accordance with an embodiment of the present invention, the first and the second connecting lines between the receiver drier **130** and the first outlet **152b** formed on the first outlet collector **150b** and the second inlet **162a** formed on the second inlet collector **160a** can be incorporated into at least one of the first outlet collector **150b**, the second inlet collector **160a**, and the receiver drier **130**. Specifically, the first and the second connecting lines may be formed as inner channels or side channels, for example formed on walls of at least one of first outlet collector **150b**, the second inlet collector **160a** and the receiver drier **130**. More specifically, the first and the second connecting lines may be coextruded on walls of at least one of the first outlet collector **150b**, the second inlet collector **160a** and the receiver drier **130**. In accordance with another embodiment, the receiver drier **130** can be disposed either in front or behind the first and the second cores defining the condensing section **110** and

the sub-cooling section **120** respectively.

**[0040]** Also, in accordance with another embodiment of the present invention, the receiver drier **130** can be disposed along and adjacent to the longitudinal side of at least one of the first and the second cores defining the condensing section **110** and the sub-cooling section **120** respectively.

**[0041]** **FIG. 5a** illustrates a schematic representation of the condenser **100** in accordance with yet another embodiment of the present invention, wherein the separate cores defining the condensing section **110** and the sub-cooling section **120** are coplanar and are disposed side-by-side with respect to each other, whereas, the receiver drier **130** is disposed along and adjacent to a first longitudinal side of the core defining the sub-cooling section **120**. In another embodiment, the separate cores defining the condensing section **110** and the sub-cooling section **120** are coplanar, disposed side by side and abutting each other. **FIG. 5b** illustrates an isometric view of the condenser **100** with separate cores defining the condensing section **110** and the sub-cooling section **120** coplanar and are disposed side-by-side with respect to each other with the receiver drier **130** disposed along and adjacent to the first longitudinal side of the core defining the sub-cooling section **120**.

**[0042]** **FIG. 6a** illustrates a schematic representation of the condenser **100** in accordance with still another embodiment of the present invention, wherein the separate cores defining the condensing section **110** and the sub-cooling section **120** are coplanar and disposed side-by-side with respect to each other, whereas, the receiver drier **130** is disposed along and adjacent to a second longitudinal side of the core defining the sub-cooling section **120**. The first and the second longitudinal sides of the core defining the sub-cooling section **120** are disposed opposite to each other. **FIG. 6b** illustrates an isometric view of the condenser **100** with cores defining the condensing section **110** and the sub-cooling section **120** disposed co-planar and side-by-side with respect to each other, whereas the receiver drier **130** is disposed along and adjacent to the second longitudinal side of the core defining the sub-cooling section **120**.

**[0043]** **FIG. 7a** illustrates a schematic representation of the condenser **100** in accordance with still another embodiment of the present invention, wherein the separate cores defining the condensing section **110** and the sub-cooling section **120** are coplanar and disposed side-by-side with respect to each other, whereas, the receiver drier **130** is disposed between the cores defining the condensing section **110** and the sub-cooling section **120**. **FIG. 7b** illustrates an isometric view of the condenser **100** with cores defining the condensing section **110** and the sub-cooling section **120** disposed co-planar and side-by-side with respect to each other, whereas the receiver drier **130** is disposed between the cores defining the condensing section **110** and the sub-cooling section **120**.

**[0044]** Several modifications and improvement might be applied by the person skilled in the art to the heat

exchanger or a condenser **100** as defined above and such modifications and improvements will still be considered within the scope and ambit of the present invention, as long as the heat exchanger or the condenser includes a first section, a second section and a receiver drier. The first section includes a first set of heat exchange tubes that are arranged substantially horizontally, wherein edges of the first set of heat exchange tubes define a first air-inlet surface. The second section includes a second set of heat exchange tubes, wherein edges of the second set of heat exchange tubes define a second air inlet surface. The receiver drier is disposed parallel with respect to the first set of heat exchange tubes and configures fluid communication between the first section and the second section. The first air-inlet surface and the second air-inlet surface do not overlap when viewed in a direction perpendicular to the first air-inlet surface and when viewed in a direction perpendicular to the second air-inlet surface.

**[0045]** In any case, the invention cannot and should not be limited to the embodiments specifically described in this document, as other embodiments might exist. The invention shall spread to any equivalent means and any technically operating combination of means.

## Claims

### 1. A heat exchanger (100) comprising:

- a first section (110) comprising a first set of heat exchange tubes (112) that are arranged substantially horizontally, wherein edges of the first set of heat exchange tubes (112) define a first air-inlet surface (X) ;
- a second section (120) comprising a second set of heat exchange tubes (122), wherein edges of the second set of heat exchange tubes (122) define a second air-inlet surface (Y);
- a receiver drier (130) disposed parallel with respect to the first set of heat exchange tubes (112) and adapted to configure fluid communication between the first section (110) and the second section (120),

**characterized in that** the first air-inlet surface (X) and the second air-inlet surface (Y) do not overlap when viewed in a direction perpendicular to the first air-inlet surface (X) and when viewed in a direction perpendicular to the second air-inlet surface (Y).

### 2. The heat exchanger (100) as claimed in the previous claim, wherein the first section (110) and the second section and (120) are coplanar with respect to each other, are connecting a pair of common collectors (140a) and (140b) and are defined by at least one baffle (142a,142b) disposed inside each of the pair of common collectors (140a) and (140b).

3. The heat exchanger (100) as claimed in any of the previous claims, wherein the receiver drier (130) is disposed either one of in-front and behind the first section (110) and the second section (120). 5
4. The heat exchanger (100) as claimed in any of the claim 2, wherein the receiver drier (130) is disposed along and adjacent to a longitudinal side of either one of the first section (110) and the second section (120). 10
5. The heat exchanger (100) as claimed in claim 2, wherein the receiver drier (130) is adapted to connect the pair of common collectors (140a) and (140b) with a first inlet (114a) and a second inlet (124a) formed on same side of the heat exchanger (100) and on different sides of the baffle (142a), the first inlet (114a) and the second inlet (124a) adapted to supply fluid to the first section (110) and the second section (120) respectively. 15  
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6. The heat exchanger (100) as claimed in the previous claim, further comprising: 25
  - a first connecting line in the form of a flexible conduit (172a) adapted to configure connection between a first outlet (114b) formed on the outlet collector (140b) and the receiver drier (130); and
  - a second connecting line in the form of a flexible conduit (172b) adapted to configure connection between the receiver drier (130) and the second inlet (124a) formed on the inlet collector (140a). 30
7. The heat exchanger (100) as claimed in claim 6 comprising 35
  - a first connecting line in the form of channels formed on at least one of the outlet collector (140b) and the receiver drier (130) and adapted to configure connection between the first outlet (114b) formed on the outlet collector (140b) and the receiver drier (130); 40
  - a second connecting line in form of channels formed on at least one of the receiver drier (130) and the inlet collector (140a) and adapted to configure connection between the receiver drier (130) and the second inlet (124a) formed on the inlet collector (140a). 45
8. The heat exchanger (100) as claimed in claim 1, wherein the first section (110) and the second section (120) are separate cores that are arranged in non-overlapping configuration with respect to each other, each of the first section (110) and the second section (120) is configured with a separate first pair of collectors (150a) and (150b) and a second pair of collectors (160a) and (160b) respectively for heat exchange fluid. 50  
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9. The heat exchanger (100) as claimed in claim 1, wherein the first section (110) and the second section (120) are separate cores that are arranged in co-planar configuration with respect to each other.
10. The heat exchanger (100) as claimed in any of the previous claim, wherein the receiver drier (130) is disposed either one of in-front and behind the first section (110) and the second section (120).
11. The heat exchanger (100) as claimed in claim 8, wherein the receiver drier (130) is disposed between the first section (110) and the second section (120).
12. The heat exchanger (100) as claimed in claim 8, wherein the receiver drier (130) is disposed along and adjacent to either one of the longitudinal sides of at least one of the first section (110) and the second section (120).
13. The heat exchanger (100) as claimed in claim 8, wherein the receiver drier (130) is adapted to connect the first outlet collector (150b) of the first pair of collectors (150a) and (150b) to the second inlet collector (160a) of the second pair of collectors (160a) and (160b).
14. The heat exchanger (100) as claimed in the previous claim further comprising: 30
  - a first connecting line in the form of flexible conduit (172a) adapted to configure connection between a first outlet (152b) formed on the first outlet collector (150b) and the receiver drier (130); and
  - a second connecting line in the form flexible conduit 172b) adapted to configure connection between the receiver drier (130) and the second inlet (162a) formed on the second inlet collector (160a). 35
15. The heat exchanger (100) as claimed in the claim 13, further comprising: 40
  - a first connecting line in form channels formed on at least one of the first outlet collector (150b) and the receiver drier (130) and adapted to configure connection between the first outlet (152b) formed on the first outlet collector (150b) and the receiver drier (130); and
  - a second connecting line in form channels formed on at least one of the second inlet collector (160a) and the receiver drier (130) adapted to configure connection between the receiver drier (130) and the second inlet (162a) formed the second inlet collector (160a). 45

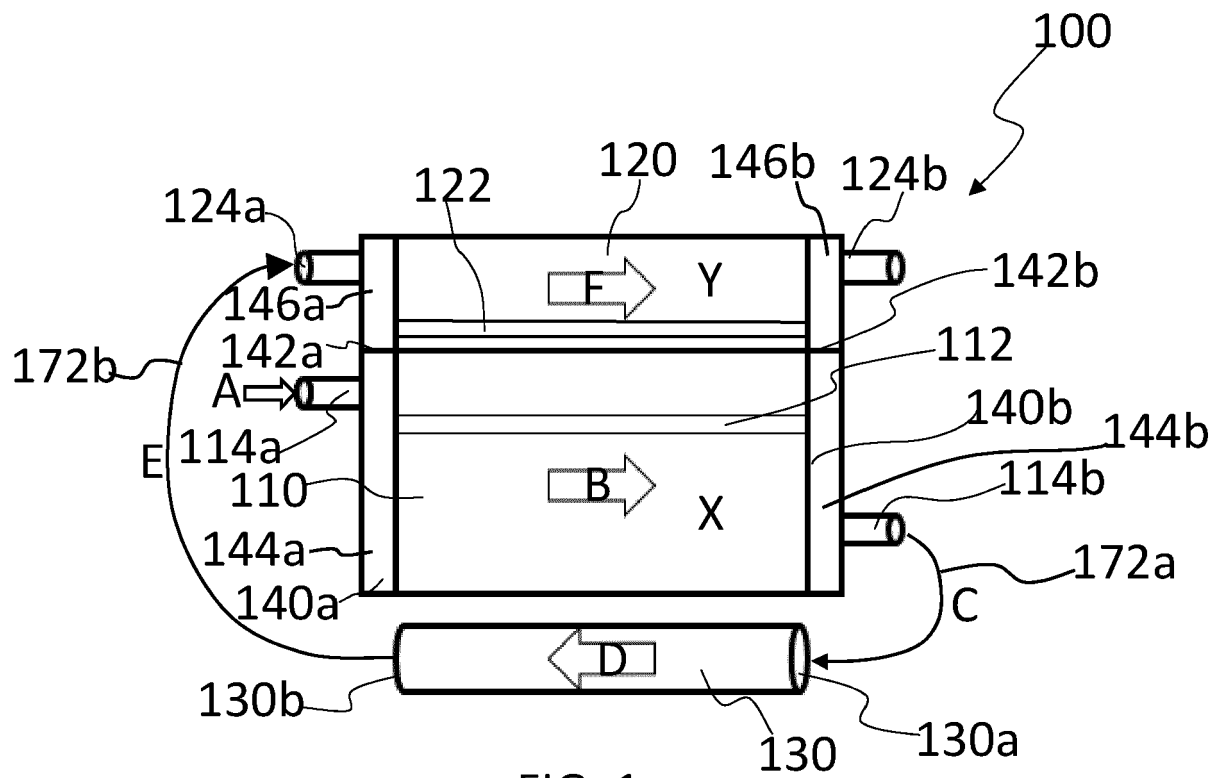


FIG. 1a

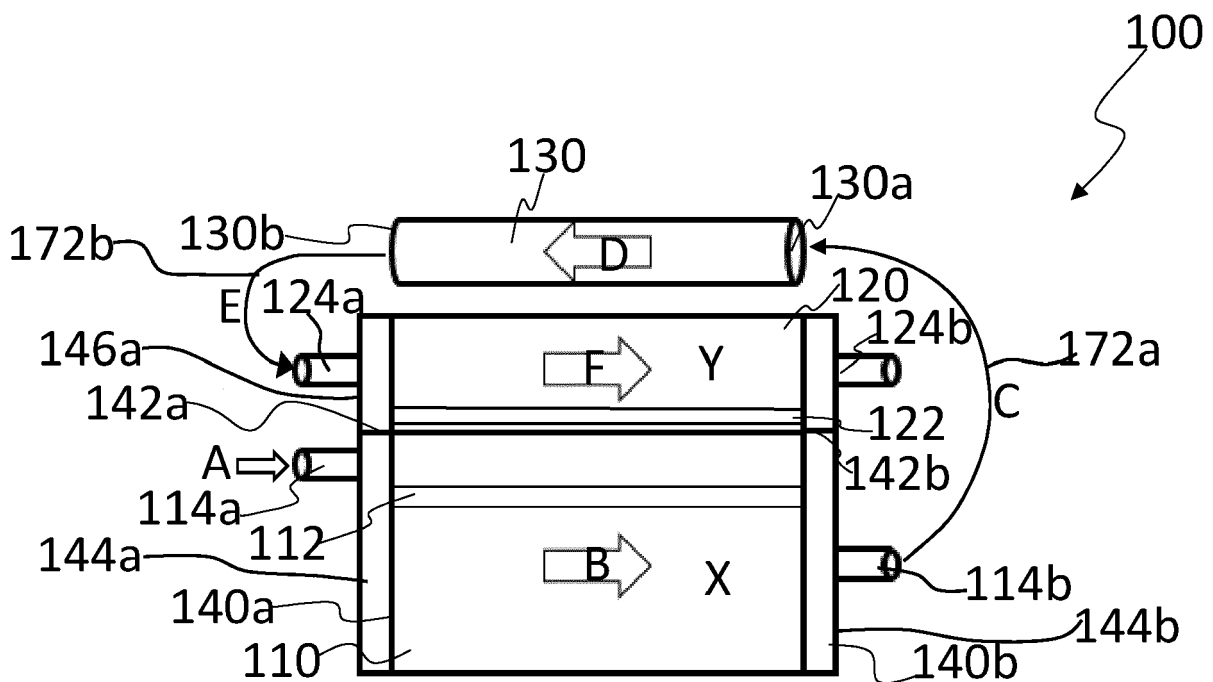


FIG. 1b

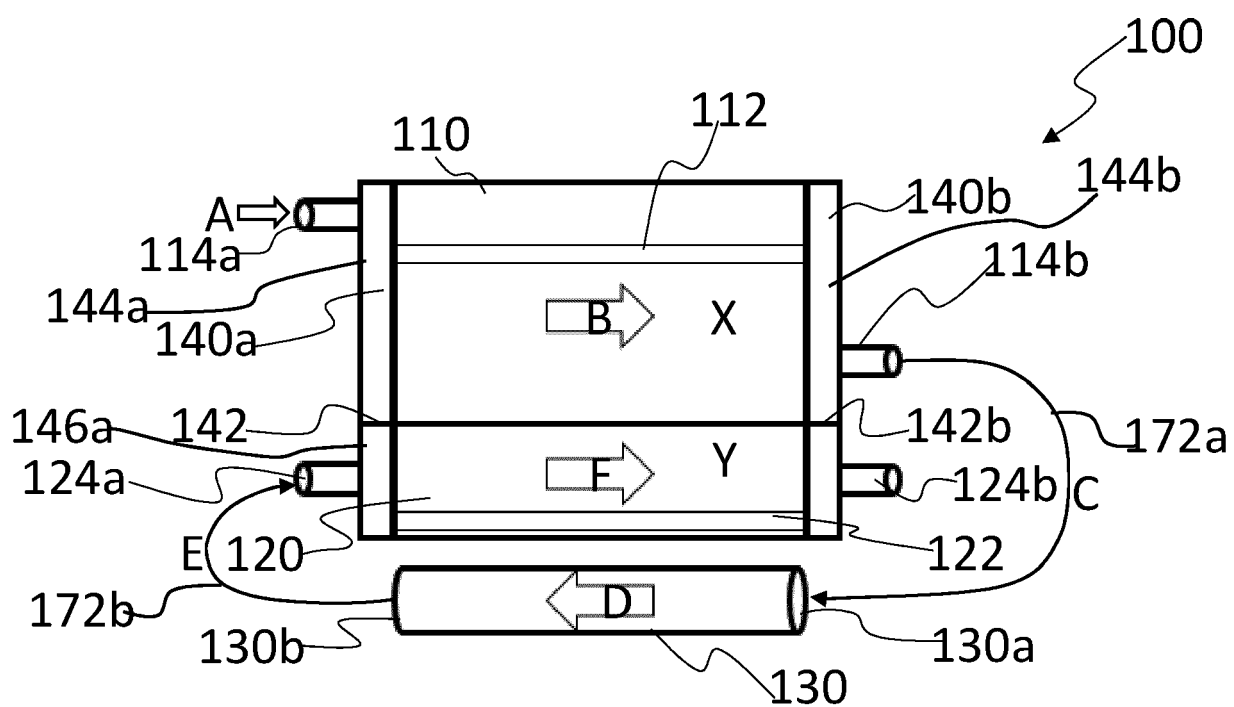


FIG. 2a

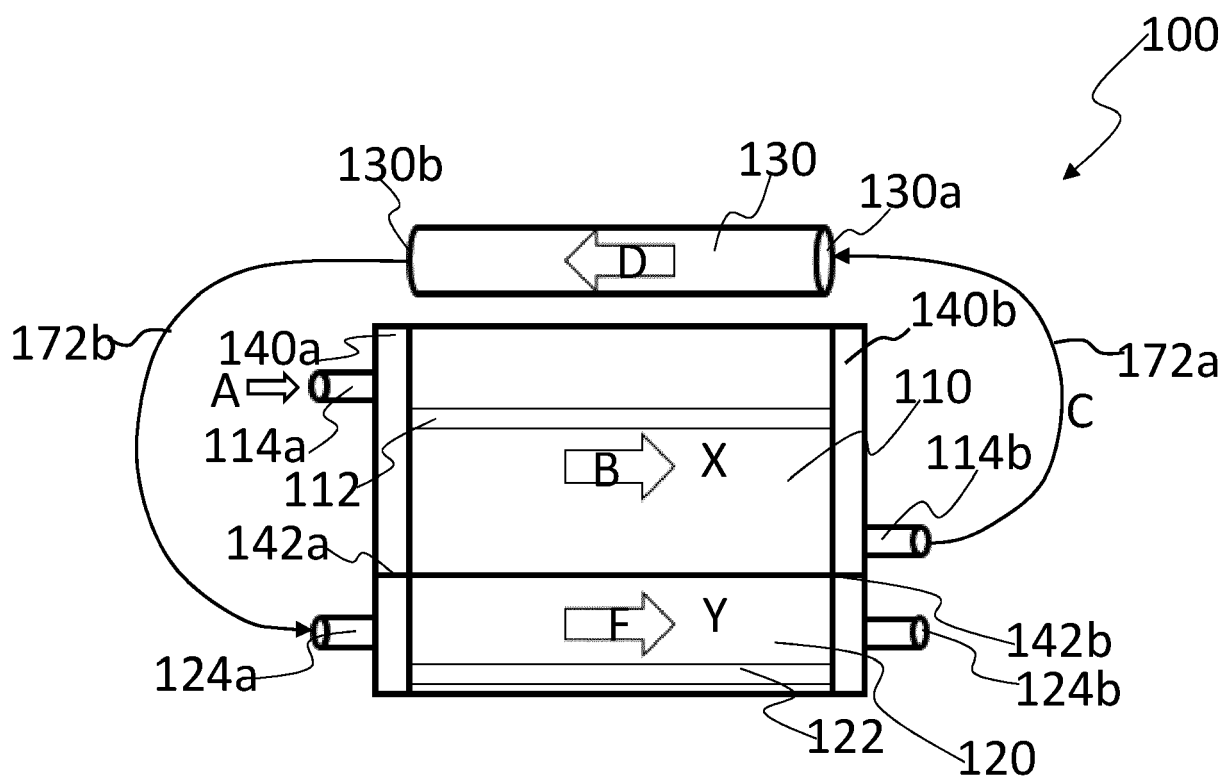


FIG. 2b

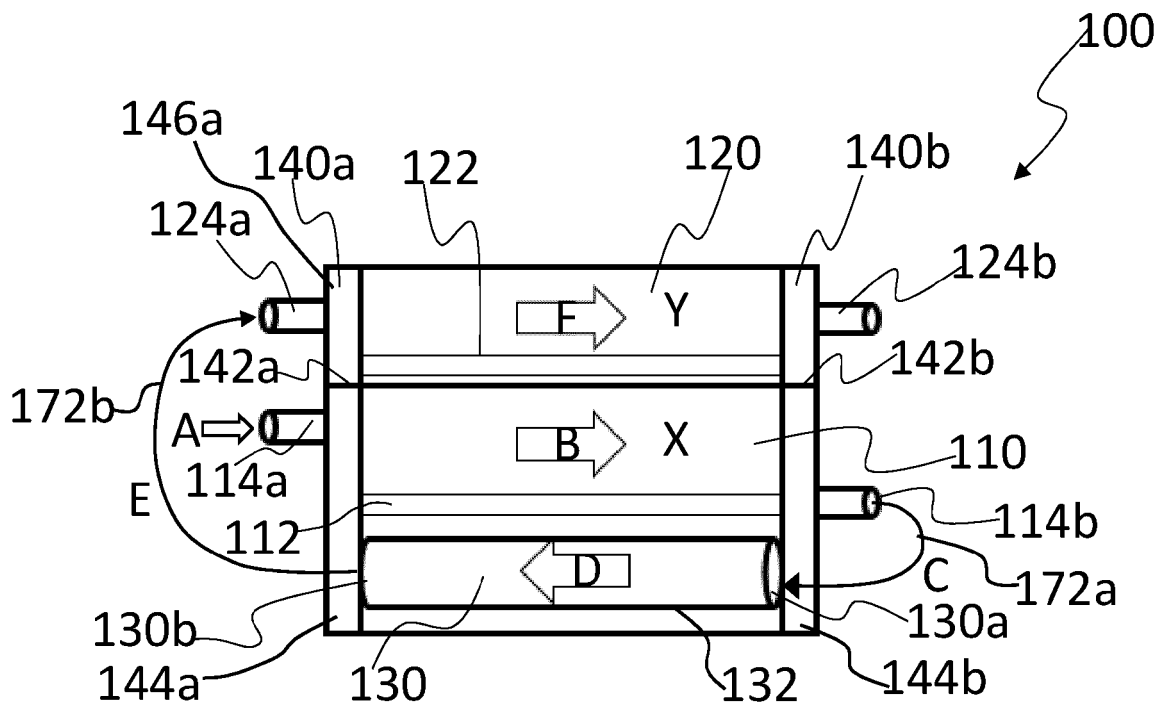


FIG. 3

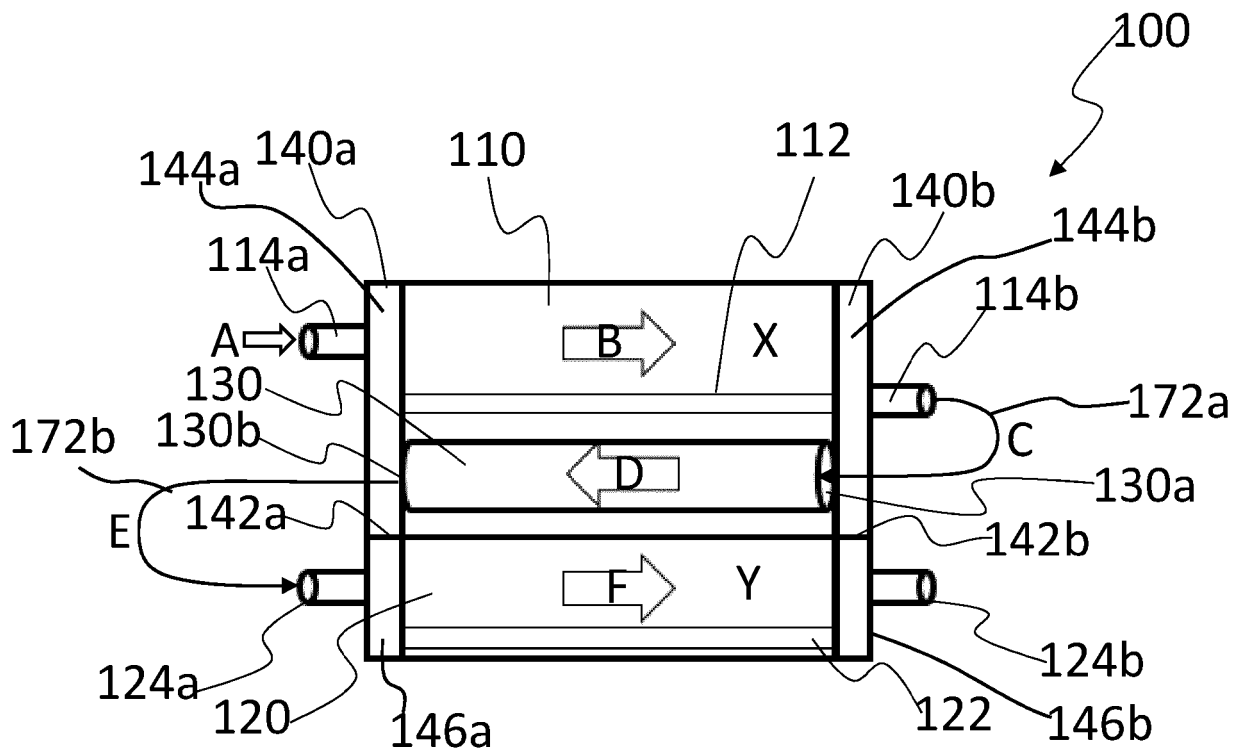


FIG. 4

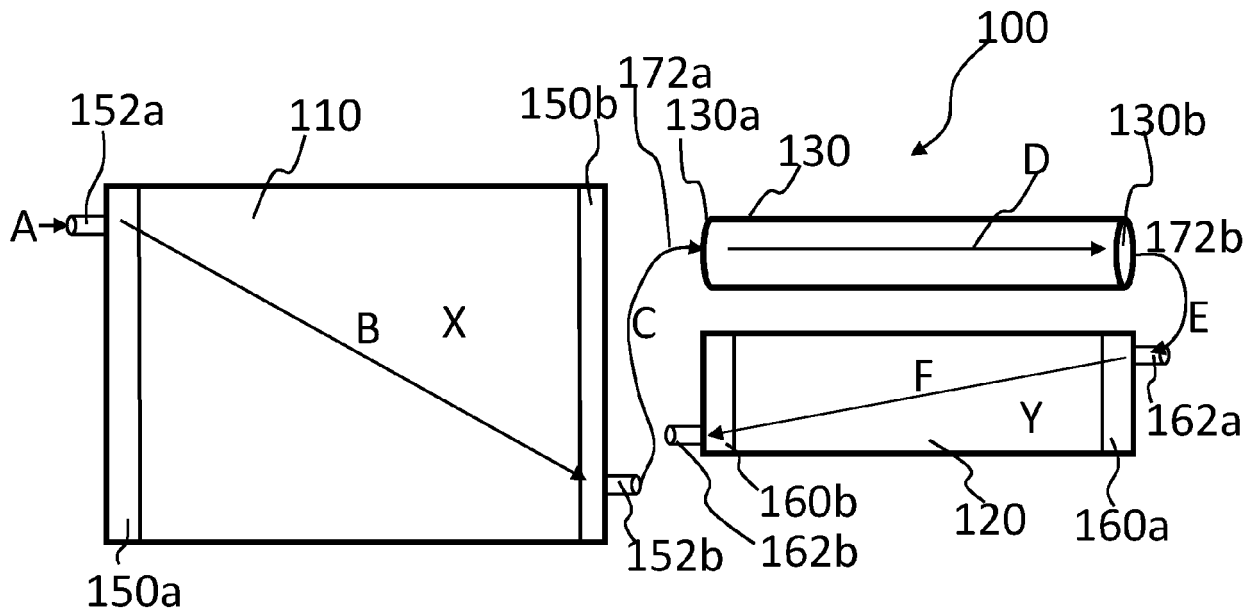


FIG. 5a

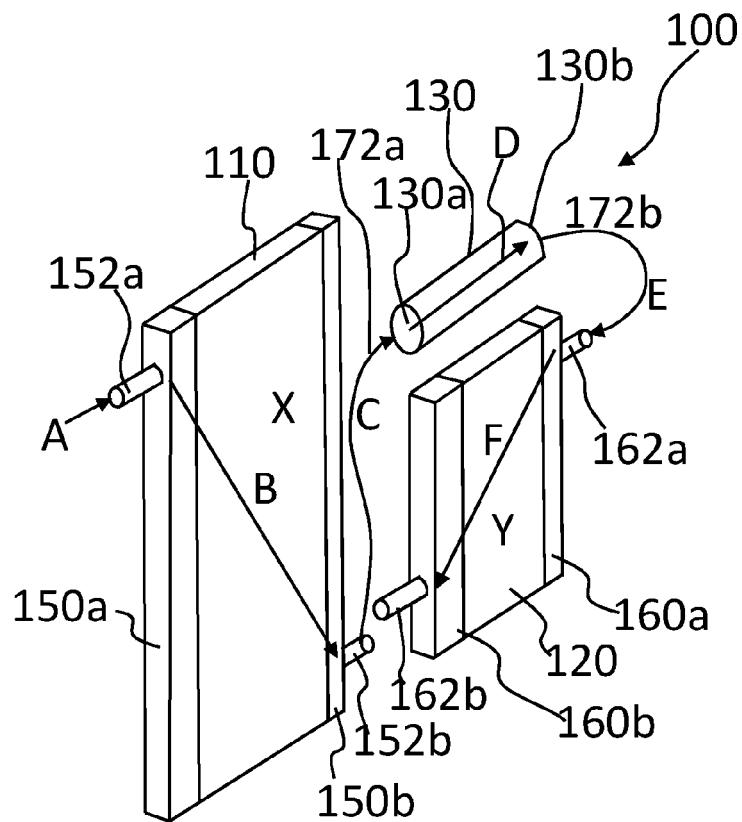


FIG. 5b

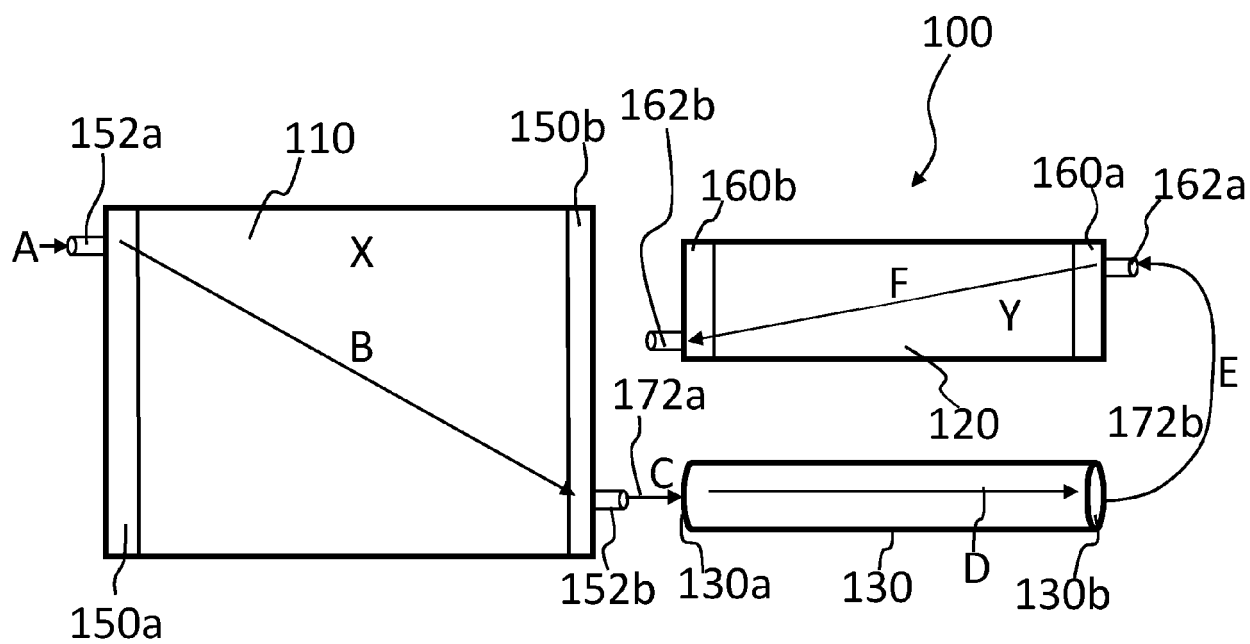


FIG. 6a

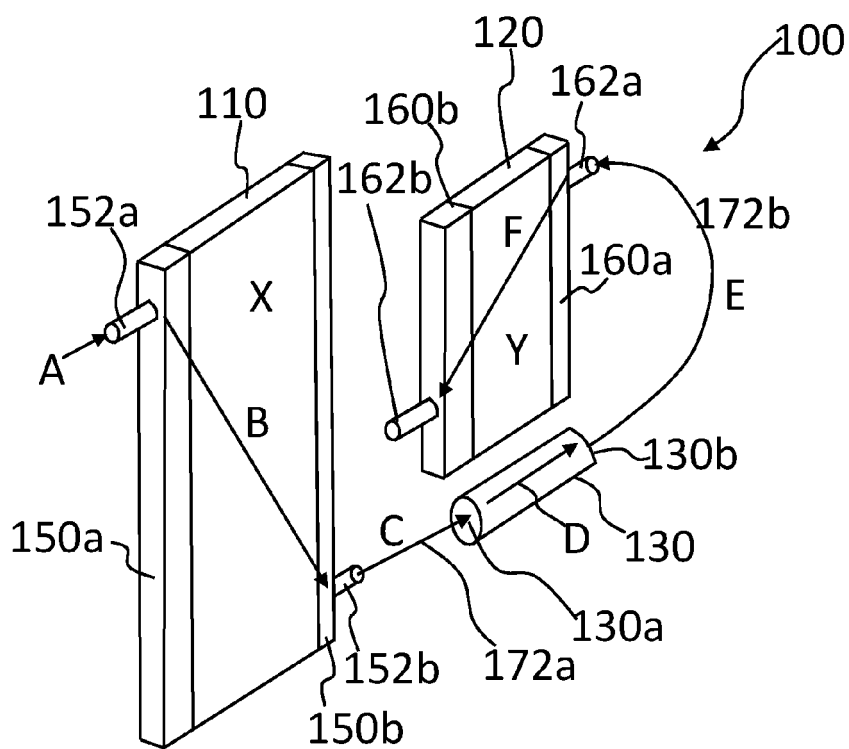
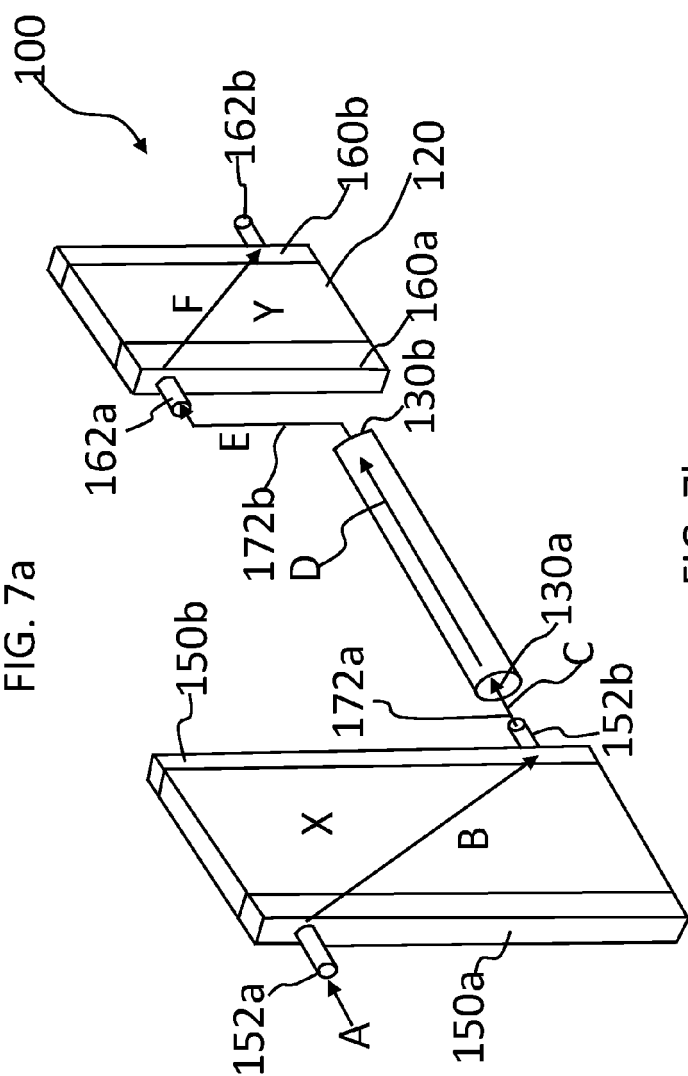
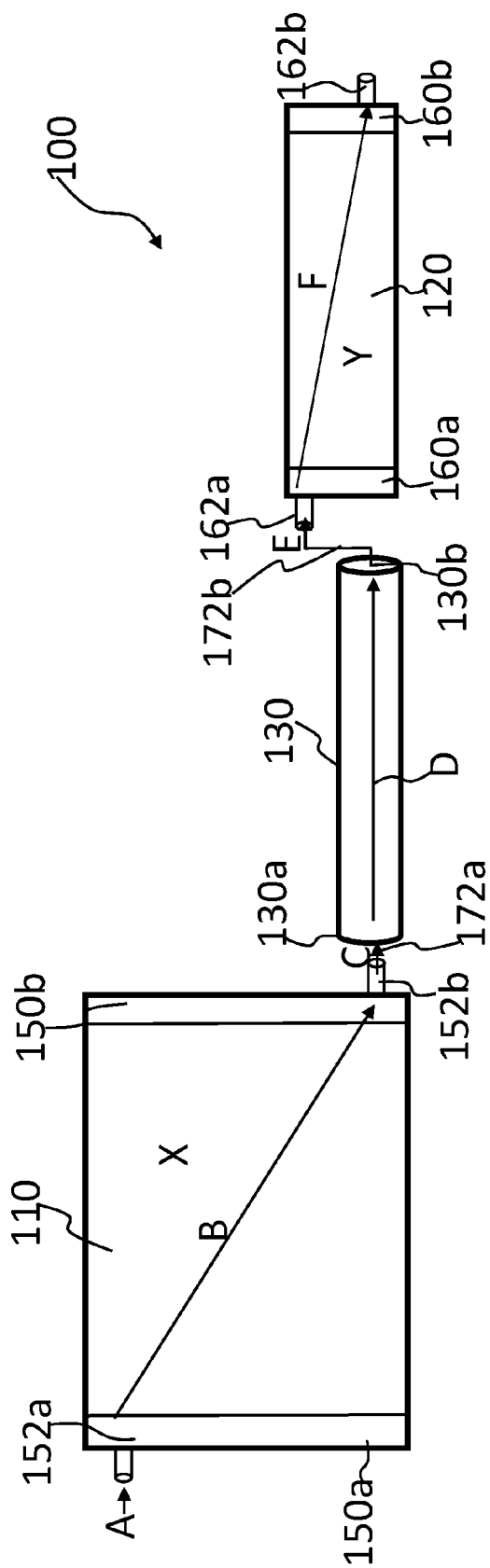


FIG. 6b





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| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                    |                                                                                                   |                                                                                                                                                                                                                                                                              |                                                    |
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| The present search report has been drawn up for all claims                                                                                                                                                                                             |                                                                                                   |                                                                                                                                                                                                                                                                              |                                                    |
| Place of search<br><b>Munich</b>                                                                                                                                                                                                                       |                                                                                                   | Date of completion of the search<br><b>24 June 2020</b>                                                                                                                                                                                                                      | Examiner<br><b>Mellado Ramirez, J</b>              |
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