(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 855 101 A1

(12) EUROPEAN PATENT APPLICATION

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

(21) Application number: **20461505.8**

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

(51) Int Cl.:
F28D 1/04 *(2006.01)* ***F28D 1/053*** *(2006.01)*
F28F 9/26 *(2006.01)* ***F25B 39/04*** *(2006.01)*
F25B 40/02 *(2006.01)* ***B60H 1/00*** *(2006.01)*

(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

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

(72) Inventors:
- **JUGOWICZ, Andrzej**
  32 050 SKAWINA (PL)
- **OCHALA, Wojciech**
  32 050 SKAWINA (PL)
- **GLUCHOWSKI, Marek**
  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)

(54) A HEAT EXCHANGER WITH HORIZONTALLY POSITIONED RECEIVER DRIER

(57) The condenser includes a first and a second core and a receiver drier, the first and the second cores include a first and a second pair of collectors respectively for heat exchange fluid, wherein at least the first pair of collectors are arranged substantially vertically. The receiver drier includes a tubular casing, an inlet and an outlet port, a desiccant section and a suction tube. The inlet and outlet ports are configured at opposite lateral ends of the tubular casing. The desiccant section is configured between the lateral ends of the tubular casing. The suction tube configures fluid communication between the desiccant section and the outlet port. The receiver drier is disposed horizontally, wherein the suction tube is configured to enable receiving of the fluid from a lower portion of the tubular casing along the vertical direction and upstream of the suction tube in direction of fluid flow in the receiver drier.

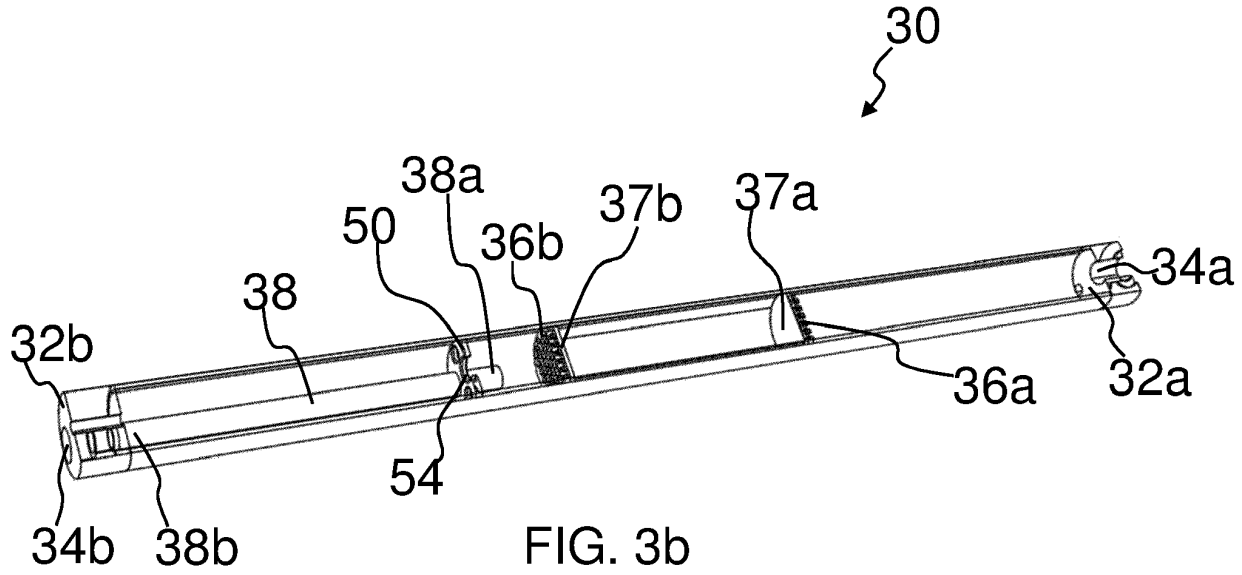

FIG. 3b

EP 3 855 101 A1

Description

[0001] The present invention relates to a heat exchanger with a receiver drier, more particularly, the present invention relates to a heat exchanger with a receiver drier that is horizontally positioned with respect to the heat exchanger 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 its pressure due its expansion, 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 returns to the compressor, and the above cycle repeats. In the process, the heat extracted from inside the vehicle cabin and rejected to outside vehicle cabin, results 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 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 section 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 with such configuration of the receiver drier. Particularly, the condenser with such conventional configuration of receiver drier is bulky and 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. Certain prior art discloses condenser with receiver drier that is orthogonally and horizontally disposed with respect to the collectors that are laterally disposed. However, such condenser exhibits reduced performance in case vehicle is subjected to angular displacement, for example, when one side of the vehicle is elevated due to vehicle traversing or parked on an inclined / uneven road or with one side thereof on a pavement or raised area. Specifically, in case of the conventionally known condenser configured with horizontally disposed receiver drier, angular displacement of the vehicle detrimentally affects refrigerant supply to a sub-cooling section of the condenser. More specifically, in case of the conventionally known condenser, configured with horizontally disposed receiver drier, the refrigerant supply to the sub-cooling section is insufficient in case of angular displacement of the vehicle. Further, the conventional receiver drier fails to prevent refrigerant vapour from reaching the sub-cooling section of the condenser along with the condensed refrigerant, thereby adversely affecting the efficiency and performance of the condenser.

[0005] Accordingly, there is a need for a condenser with receiver drier that can be configured horizontally 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 a condenser with horizontally positioned receiver drier that ensures high efficiency and performance of the condenser by supplying liquid refrigerant to a sub-cooling section of the condenser and preventing refrigerant vapour from reaching the sub-cooling section along with the condensed refrigerant. Further, there is a need for a condenser with horizontally positioned receiver drier that ensures high efficiency and performance of the condenser by ensuring sufficient supply of the condensed refrigerant to a sub-cooling section of the condenser, irrespective of the angular displacement of the vehicle. Specifically, there is need for a condenser with a horizontally positioned receiver drier that mitigates any impact of angular displacement of the vehicle on supply of condensed refrigerant to the sub-cooling section of the condenser and as such on performance of the condenser.

[0006] An object of the present invention is to provide a condenser with a receiver drier that can be horizontally 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 conventional condenser with horizontally positioned receiver drier.

[0008] Still another object of the present invention is to provide a condenser with a horizontally positioned receiver drier that ensures high efficiency and performance of the condenser by preventing refrigerant vapour from reaching a sub-cooling section along with the condensed refrigerant.

[0009] Another object of the present invention is to pro-

vide a condenser with a horizontally positioned receiver drier that ensures sufficient supply of the condensed refrigerant to a sub-cooling section of the condenser, irrespective of the angular displacement of the vehicle.

[0010] Yet another object of the present invention is to provide a condenser with a horizontally positioned receiver drier that mitigates any impact of angular displacement of the vehicle on performance of the condenser.

[0011] 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.

[0012] A heat exchanger to be mounted on a vehicle is disclosed in accordance with an embodiment of the present invention. The heat exchanger includes a first core, a second core and a receiver drier. The first core and the second core includes a first pair of collectors and a second pair of collectors respectively for heat exchange fluid. At least the first pair of collectors being arranged substantially vertically. The receiver drier is inter-positioned fluidly between the cores and includes, a tubular casing, an inlet port, an outlet port, a desiccant section and a suction tube. The inlet port and the outlet port are configured at opposite lateral ends of the tubular casing. The desiccant section is configured between the lateral ends and receives desiccant material therein. The suction tube configures fluid communication between the desiccant section and the outlet port. The receiver drier is disposed horizontally. The suction tube is configured to enable receiving of the fluid from a lower portion of the tubular casing defined below a central axis O of the tubular casing and upstream of the suction tube in direction of fluid flow in the receiver drier.

[0013] Generally, the second core is disposed parallel to and behind the first core.

[0014] Specifically, the desiccant section is defined between a pair of perforated end plates received in the tubular casing, the pair of perforated end plates permit ingress, egress and fluid flow through the desiccant section.

[0015] Also, the outlet port is in fluid communication with and supplies condensed refrigerant egressing the tubular casing to the second core through a jumper line.

[0016] Generally, the desiccant material is silica gel.

[0017] Further, the heat exchanger includes at least one restraining element received inside the tubular casing and downstream of the desiccant section in a fluid flow direction inside the receiver drier to position and maintain the suction tube below the central axis O of the tubular casing.

[0018] Specifically, the at least one restraining element is provided with either one of an aperture and a cut-out to receive the suction tube to position and maintain the suction tube below the central axis O of the tubular casing.

[0019] Further, the at least one restraining element is provided with at least one opening to permit fluid flow across the at least one restraining element.

[0020] Preferably, the desiccant section with desiccant material received therein is positioned between filtering pads and corresponding perforated plates positioned inside the tubular casing.

[0021] In accordance with an embodiment of the present invention, the desiccant material is in the form of a desiccant bag retained inside the tubular casing between a distal end of the desiccant section and at least one of a filter body and a first lateral end of the pair of lateral ends with at least a portion of the desiccant bag received in the desiccant section.

[0022] Specifically, an inlet to the suction tube facing the desiccant section is disposed along rotation centre of the vehicle, at the lower portion of the tubular casing to receive the fluid inside the suction tube irrespective of vehicle orientation.

[0023] Generally, the inlet to the suction tube is provided with a nozzle of reduced dimension compared to rest of the suction tube to promote suction of the fluid inside the suction tube.

[0024] 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 illustrates an isometric front view of a condenser with a receiver drier horizontally positioned with respect to collectors of the condenser that are substantially vertical, in accordance with an embodiment of the present invention;

FIG. 1b illustrates an isometric rear view of the condenser with the receiver drier of **FIG. 1a**;

FIG. 2a illustrates an isometric view of the receiver drier of **FIG 1b;**

FIG. 2b illustrates another isometric view of the receiver drier of **FIG 1b;**

FIG. 3a illustrates a sectional view depicting internal details of the receiver drier of **FIG 2b;**

FIG. 3b illustrates another sectional view depicting internal details of the receiver drier of **FIG 2b;**

FIG 4 illustrates an exploded view of the receiver drier of **FIG. 2b;**

FIG. 5 illustrates an isometric view of a suction tube along with a retraining element in accordance with an embodiment of the present invention;

FIG. 6 illustrates a desiccant section defined between a pair of perforated end plates in accordance with an embodiment of the present invention; and

FIG. 7 illustrates an isometric sectional view depicting internal details of a receiver drier in accordance with yet another embodiment of the present invention, wherein desiccant material is received inside a desiccant bag and at least a portion of the desiccant bag is received in the desiccant section; and

FIG. 8 illustrates an exploded view of the receiver drier of **FIG. 7.**

[0025] 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.

[0026] Forthcoming description explains the present invention with example of a condenser with a receiver drier configured horizontally and orthogonally with respect to collectors of the condenser, wherein horizontal configuration of the receiver drier addresses packaging issues associated with packaging of condenser-receiver drier assembly in a limited space in front of the vehicle. The receiver drier includes a tubular casing, wherein inlet and outlet ports configured on the tubular casing are strategically configured with respect to each other to prevent refrigerant vapour from egressing the receiver drier and reaching a sub-cooling section of the condenser along with condensed refrigerant. The receiver drier also includes a suction tube that is so positioned and maintained with respect to a cross section of the tubular casing that sufficient condensed refrigerant is supplied to a sub-cooling section of the condenser irrespective of the angular displacement of the vehicle. However, the present invention is also applicable for any other device configured on a vehicle and that is required to be disposed horizontally to address packaging issues that is required to efficiently separate vapour from liquid-vapour mixture received therein and that ensures sufficient supply of separated liquid without vapours to a next element of a system of which the device is a part of irrespective of the angular displacement of the vehicle.

[0027] **FIG. 1a** illustrates an isometric front view of a heat exchanger, particularly, a condenser **100** for an air conditioning system for a vehicle. The condenser includes a receiver drier **30** horizontally positioned with respect to a first pair of collectors **10a, 10b** and a second pair of collectors **20a** and **20b** of the condenser **100,** in accordance with an embodiment of the present invention. At least one of the pair of collectors being arranged substantially vertically. The condenser **100** includes a first core **110,** a second core **120** and the receiver drier **30.** The first core **110** is configured with the first pair of collectors **10a** and**10b** for distributing and collecting the refrigerant through heat exchange elements of the first core **110.** The second core **120** is configured with the second pair of collectors **20a** and **20b** for distributing and collecting the refrigerant through heat exchange elements of the second core **120.** At least the first pair of collectors **10a** and **10b** are arranged substantially vertically. Generally, the second core **120** is disposed parallel to and behind the first core **110** to impart compact configuration to the condenser **100** and address packaging issues. Specifically, the first core **110** is disposed at a front of the vehicle and is the first to come in contact with the ram air and the second core **120** is disposed behind, particularly, downstream of the first core **110** in ram air flow direction depicted by arrows **R.** The first core **110** receives refrigerant vapours and delivers condensed refrigerant along with some incompressible moisture and uncondensed refrigerant, if any, whereas the second core **120** is disposed downstream of and is connected to outlet of the receiver drier **30.** The second core **120** sub-cools the condensed refrigerant from the first core **110** from which incompressible moisture and uncondensed refrigerant is removed by the receiver drier **30.** However, the present invention is not limited to any particular configuration and placement of the second core **120** with respect to the first core **110,** as far as cores are arranged in compact configuration to address packaging issues and the second core **120** sub-cools the condensed refrigerant that is separated by passing through the receiver drier **30.** The receiver drier **30** includes a tubular casing **32,** an inlet port **34a**, an outlet port **34b**, a desiccant section **36** and a suction tube **38.**

[0028] The first pair of collectors **10a** and **10b** are disposed at lateral sides of the first core **110,** whereas the second pair of collectors **20a** and **20b** is disposed at lateral sides of the second core **120.** The first core **110** receives refrigerant vapour from a first inlet collector **10a** of the first pair of collectors **10a** and **10b.** The first inlet collector **10a** includes a first inlet block **12a** configured thereon and in fluid communication therewith. The first inlet block **12a** supplies refrigerant vapour to the first inlet collector **10a.** More specifically, referring to the **FIG.1a,** the refrigerant vapour enters the first inlet collector **10a** from the first inlet block **12a** as illustrated by arrow **A.** Thereafter, the first inlet collector **10a** in conjunction with corresponding header distributes the vapour refrigerant in the first core **110.** As the vapour refrigerant flows through the heat exchange elements of the first core **110** as depicted by the arrow **B,** the vapour refrigerant is condensed. The condensed refrigerant egressing the first core **110** is collected by a first outlet collector **10b**. The first outlet collector **10b** includes a first outlet block **12b** configured thereon and in fluid communication therewith. The condensed refrigerant, including some refrigerant vapours and incompressible moisture, if any egresses through the first outlet block **12b** as depicted by the arrow

C. Thereafter, the condensed refrigerant along with some incompressible moisture and uncondensed refrigerant vapours, if any enters the tubular casing **32** of the receiver drier **30** through the inlet port **34a** configured on a corresponding lateral end **32a** closing the end of the tubular casing **32** and in flow direction depicted by arrow **E.** The first outlet block **12b** is in fluid communication with the inlet port **34a** and the condensed refrigerant, along with some incompressible moisture and uncondensed refrigerant vapours flows from the first outlet block **12b** to the inlet port **34a** as depicted by arrow **D**. The fluid flow from the first outlet block **12b** to the inlet port **34a** is depicted by arrows **C, D** and **E**.

[0029] Referring to **FIG. 1b,** the tubular casing **32** includes the lateral ends **32a** and **32b** that at closed at the extreme ends. The tubular casing **32** may include lateral end plates for closing the opposite lateral ends **32a** and **32b** or the opposite lateral ends **32a** and **32b** are closed ends. The condensed refrigerant, along with some incompressible moisture and refrigerant vapours, if any enters the tubular casing **32** of the receiver drier **30** and passes there through as depicted by the arrow F. Inside the receiver drier **30,** desiccant material held in the desiccant section **36** absorbs the incompressible moisture to prevent damage to critical elements such as compressor disposed downstream of the condenser **100** due to moisture reaching the critical elements. Further, referring to the **FIG. 2a** and **FIG. 2b,** the inlet port **34a** and the outlet port **34b** are configured respectively above and below a central axis **O** of the tubular casing **32.** Specifically, the central axis **O** of the horizontally disposed tubular casing **32** is defined as axis extending along axial length of the tubular casing **32** and passing through a centre of cross section of the tubular casing **32.** More specifically, in case the tubular casing **32** is of circular cross section, the central axis **O** pass through the centre of circular cross section of the tubular casing **32.** With such configuration, liquid refrigerant egresses out of the receiver drier **30** and is transferred to the second core **120** for sub-cooling thereof, while vapour refrigerant is prevented from egressing the receiver drier **30** and reaching the second core **120.** The internal details of the receiver drier **30** as well as configuration of the desiccant section **36,** the strategic placement of the inlet port **34a** and the outlet port **34b** is elaborately defined in the forthcoming description. The condensed refrigerant with incompressible moisture and vapour refrigerant removed therefrom in the receiver drier **30** is transferred to a second inlet block **22a** configured on a second inlet collector **20a** of the second pair of collectors **20a** and **20b** via a jumper line **40** as depicted by arrow **G.** The second inlet block **22a** is in fluid communication with the second inlet collector **20a** and supplies the condensed refrigerant to the second inlet collector **20a**. The second inlet collector **20a** distributes the condensed refrigerant received thereby to the second core **120.** As the condensed refrigerant passes through the second core along arrow **H,** the condensed refrigerant is sub-cooled. The sub-cooled refrigerant is collected in a second outlet collector **20b** of the second pair of collectors **20a** and **20b**. The second outlet collector **20b** includes a second outlet block **22b** configured thereon and in fluid communication therewith. The sub-cooled refrigerant egresses the second outlet block **22b** along arrow **I** as illustrated in the **FIG. 1b.**

[0030] The receiver drier **30** is disposed horizontally and orthogonality with respect to the first pair of collectors **10a** and **10b.** Such configuration of the receiver drier **30** enables packaging of the condenser **100** along with the receiver drier **30** in a limited space in front of the vehicle. **FIG. 2a** and **FIG 2b** depicts isometric views the tubular casing **32** of the receiver drier **30.** The tubular casing is generally of a one-piece configuration. The lateral ends **32a** and **32b** of the tubular casing **32** can be closed by using lateral end plates. However, the present invention is not limited to any particular configuration of the tubular casing **32.** The inlet port **34a** and the outlet port **34b** are configured at the opposite lateral ends **32a** and **32b** of the tubular casing **32.** The inlet port **34a** and the outlet port **34b** are configured respectively above and below the central axis **O** of the tubular casing **32.** More specifically, the condensed refrigerant being heavier, settles at the bottom of the tubular casing **32** and egresses through the outlet port **34b** that is disposed below the central axis **O** and closer to the bottom of the tubular casing **32.** Such configuration provides easy escape of the condensed refrigerant from the outlet port **34b**. Whereas the vapour refrigerant being lighter remains at the top of the tubular casing **32** away from the outlet port **34b** and as such is retained inside the tubular casing **32** and separates out from the condensed refrigerant. With such configuration, only liquid refrigerant egresses from the receiver drier **30** to be transferred to the second core **120** for sub-cooling thereof, while vapour refrigerant is prevented from egressing the receiver drier **30** and reaching the second core **120.** Such configuration effective separation of the liquid refrigerant and the vapour refrigerant.

[0031] **FIG 3a** and **FIG 3b** illustrate sectional views depicting internal details of the receiver drier **30.** The desiccant section **36** is configured between the lateral ends **32a** and **32b** and receives desiccant material that absorbs moisture from the refrigerant passing there through. In accordance with an embodiment of the present invention, the desiccant section **36** is centrally disposed between the lateral ends **32a** and **32b** of the tubular casing **32.** In accordance with an embodiment, the desiccant material is silica gel. However, the present invention is not limited to any particular desiccant material received in the desiccant section **36** as far as the desiccant material is capable of absorbing moisture from the condensed refrigerant passing there through. The desiccant section **36** is defined between a pair of perforated end plates **36a** and **36b** received in the tubular casing **32.** The perforated end plates **36a** and **36b** respectively permit ingress of the refrigerant into the desiccant section **36** and egress of refrigerant from the desiccant

section **36** after passing through the desiccant material held in the desiccant section **36.** In a preferred embodiment of the present invention as illustrated in **FIG. 3a-FIG. 4,** the desiccant section **36** with the desiccant material received therein is positioned between filtering pads **37a** and **37b** and the perforated plates **36a** and **36b** received inside the tubular casing **32.** The filtering pads **37a** and **37b** perform filtering action and allow fluid flow there through but retain the desiccant material therebetween. In one embodiment of the present invention, the desiccant section **36** can be in form of polyester bag filled with desiccant material and tightly gripped inside the tubular casing **32.** In accordance with an embodiment as illustrated in **FIG. 7** and **FIG. 8**, the desiccant material is in received in a desiccant bag **41.** The desiccant bag **41** is retained inside the tubular casing **32** between a distal end of the desiccant section **36** and at least one of a filter body **60** and a first lateral end **32a** of the pair of lateral ends **32a** and **32b** with at least a portion of the desiccant bag **41** received in the desiccant section **36.** In one embodiment, the desiccant bag **41** is connected to the filter body **60** by gluing or mechanical connection means **64.** In another embodiment, the desiccant bag **41** is not connected to the filter body **60** and is pushed inside the tubular casing **32** by the filter body **60.** The filter body **60** receives a filter element **62 that** perform filtering action. At least one of the perforated end plates **36a** and **36b** include an aperture to allow entry and receiving of at least a portion of the desiccant bag **41** in the desiccant section **36.** However, the present invention is not limited to any particular configuration of the desiccant section **36** and placement of the desiccant section **36** inside the tubular casing **32** as far as the desiccant section **36** is capable of receiving the desiccant material therein and cause the condensed refrigerant to compulsorily flow through the desiccant material held therein.

[0032] The suction tube **38** configures fluid communication between the desiccant section **36** and the outlet port **34b.** More specifically, the suction tube **38** is positioned in such a manner that one end of the suction tube **38,** particularly, an inlet **38a** of the section tube **38** is either facing or abutting against the perforated end plate **36b** through which the condensed refrigerant egresses the desiccant section **36.** Specifically, the inlet **38a** to the suction tube **38** that is proximal to and facing the desiccant section **36** is disposed along rotation centre of the vehicle, at the lower portion of the tubular casing and receives the fluid inside the suction tube **38** irrespective of vehicle orientation. In addition or alternatively, the inlet 38a may be placed in the middle between the opposite lateral ends **32a** and **32b** of the tubular casing **32.** In accordance with an embodiment of the present invention, the suction tube **38** and accordingly, the inlet **38a** is of oval or circular cross section. In accordance with an embodiment of the present invention, the inlet **38a** to the suction tube **38** is provided with a nozzle of reduced dimension compared to rest of the suction tube **38** to promote suction of the fluid inside the suction tube **38.** Whereas, the other end of the suction tube **38,** particularly an outlet **38b** of the suction tube **38** is connected to the outlet port **34b.** The suction tube **38** is positioned and maintained below the central axis O of the tubular casing **32.** The suction tube **38** is configured to enable receiving of the fluid from a lower portion of the tubular casing **32** with respect to and below the central axis O of the tubular casing **32.** Specifically, the receiver drier **30** includes at least one restraining element **50** received inside the tubular casing **32** and downstream of the desiccant section **36** in fluid flow direction inside the receiver drier, to position and maintain the suction tube **38** below the central axis **O** of the tubular casing **32. FIG. 5** illustrates an isometric view of the suction tube **38** along with the at least one retraining element **50.** The at least one restraining element **50** is in the form of a planar element received inside the tubular casing **32** and configured with an aperture or a cut out portion **52** that receives the suction tube **38** to position and maintain the suction tube **38** below the central axis **O** of the tubular casing **32.** Further, the at least one restraining element **50** is provided with at least one opening **54** to permit fluid flow across the at least one restraining element **50.** However, the present invention is not limited to any particular configuration of the at least one restraining element **50** as far as the at least one restraining element **50** is capable of positioning and maintaining the suction tube **38** below the central axis **O** of the tubular casing **32. FIG 4** illustrates an exploded view of the receiver drier **30.**

[0033] The condensed refrigerant from which moisture and debris is removed in the receiver drier **30** and flowing through the suction tube **38** egresses the receiver drier **30** from the outlet port **34b.** The outlet port **34b** is in fluid communication with and supplies condensed refrigerant egressing the tubular casing **32** to the second core **120** through the jumper line **40.**

[0034] With such configuration, the condensed refrigerant is separated and the suction tube **38** receives condensed refrigerant irrespective of the angular position of the vehicle. As the inlet **38a** to the suction tube **38** is at the lowest point, the suction tube **38** receives condensed refrigerant in all conditions, such configuration ensures supply of the condensed refrigerant to the suction tube **38** in all conditions, and ultimately to the second core **120** in which the condensed refrigerant is sub-cooled. Specifically, such configuration of the suction tube **38** ensures sufficient supply of the refrigerant to the sub-cooling section of the condenser **100,** irrespective of the angular displacement of the vehicle. More specifically, such configuration of the suction tube **38** mitigates any impact of angular displacement of the vehicle on performance of the condenser.

[0035] Several modifications and improvement might be applied by the person skilled in the art to the heat exchanger, particularly condenser as defined above and such modifications and improvements will still be considered within the scope and ambit of the present invention, as long the heat exchanger includes a first core, a second

core, and a receiver drier. The first core includes a first pair of collectors for collecting and distributing the heat exchange fluid. Similarly, the second core includes a second pair of collectors for collecting and distributing the heat exchange fluid. The receiver drier is inter-positioned fluidly between the first and the second cores and include a tubular casing, an inlet port, an outlet port, a desiccant section and a suction tube. The inlet port and the outlet port are configured at opposite lateral ends of the tubular casing. The desiccant section is configured between the lateral ends and includes desiccant material. The suction tube configures fluid communication between the desiccant section and the outlet port. The receiver drier is disposed horizontally and the suction tube is configured to enable receiving of the fluid from a lower portion of the tubular casing defined below a central axis O of the tubular casing and upstream of the suction tube in direction of fluid flow in the receiver drier.

[0036] 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) for a vehicle, the heat exchanger (100) comprising:

   • a first core (110) and a second core (120) comprising a first pair of collectors (10a) and (10b) and a second pair of collectors (20a) and (20b) respectively for heat exchange fluid; at least the first pair of collectors (10a) and (10b) being arranged substantially vertically,
   • a receiver drier (30) inter-positioned fluidly between the cores (110) and (120), the receiver drier (30) comprising:

      ◦ a tubular casing (32);
      ◦ an inlet port (34a) and an outlet port (34b) configured at opposite lateral ends (32a) and (32b) of the tubular casing (32);
      ◦ a desiccant section (36) configured between the lateral ends (32a) and (32b) and adapted to receive desiccant material; and
      ◦ a suction tube (38) adapted to configure fluid communication between the desiccant section (36) and the outlet port (34b),

   characterized in that the receiver drier (30) is disposed horizontally, wherein the suction tube (38) is configured to enable receiving of the fluid from a lower portion of the tubular casing (32) defined below a central axis O of the tubular casing (32) and upstream of the suction tube (38) in direction F of fluid flow in the receiver drier (30).

2. The heat exchanger (100) as claimed in the previous claim, wherein the second core (120) is disposed parallel to and behind the first core (110).

3. The heat exchanger (100) as claimed in any of the preceding claims, wherein the desiccant section (36) is defined between a pair of perforated end plates (36a) and (36b) received in the tubular casing (32), wherein the pair of perforated end plates (36a) and (36b) are adapted to permit ingress, egress and fluid flow through the desiccant section (36).

4. The heat exchanger (100) as claimed in any of the preceding claims, wherein the outlet port (34b) is in fluid communication with and adapted to supply condensed refrigerant egressing the tubular casing (32) to the second core (120) through a jumper line (40).

5. The heat exchanger (100) as claimed in any of the preceding claims, wherein the desiccant material is silica gel.

6. The heat exchanger (100) as claimed in any of the preceding claims, further comprising at least one restraining element (50) adapted to be received inside the tubular casing (32) and downstream of the desiccant section (36) in fluid flow direction inside the receiver drier (30) to position and maintain the suction tube (38) below the central axis O of the tubular casing (32).

7. The heat exchanger (100) as claimed in the previous claim, wherein the at least one restraining element (50) is provided with either one of an aperture and a cut-out (52) adapted to receive the suction tube (38) to position and maintain the suction tube (38) below the central axis O of the tubular casing (32).

8. The heat exchanger (100) as claimed in claim 6 or 7, wherein the at least one restraining element (50) is provided with at least one opening (54) to permit fluid flow across the at least one restraining element (50).

9. The heat exchanger (100) as claimed in any of the preceding claims, wherein the desiccant section (36) with desiccant material received therein is positioned between filtering pads (37a) and (37b) and corresponding perforated plates (36a) and (36b) positioned inside the tubular casing (32).

10. The heat exchanger (100) as claimed in any of the preceding claims, wherein the desiccant material is in the form of a desiccant bag (41) retained inside the tubular casing (32) between a distal end of the desiccant section (36) and at least one of a filter body

(60) and a first lateral end (32a) of the pair of lateral ends (32a) and (32b) with at least a portion of the desiccant bag (41) received in the desiccant section (36).

11. The heat exchanger (100) as claimed in any of the preceding claims, wherein an inlet (38a) to the suction tube (38) facing the desiccant section (36) is disposed along rotation centre of the vehicle, at the lower portion of the tubular casing (32) and is adapted to receive the fluid inside the suction tube (38) irrespective of vehicle orientation.

12. The heat exchanger (100) as claimed in the previous claim, wherein the inlet (38a) to the suction tube (38) is provided with a nozzle of reduced dimension compared to rest of the suction tube (38) to promote suction of the fluid inside the suction tube (38).

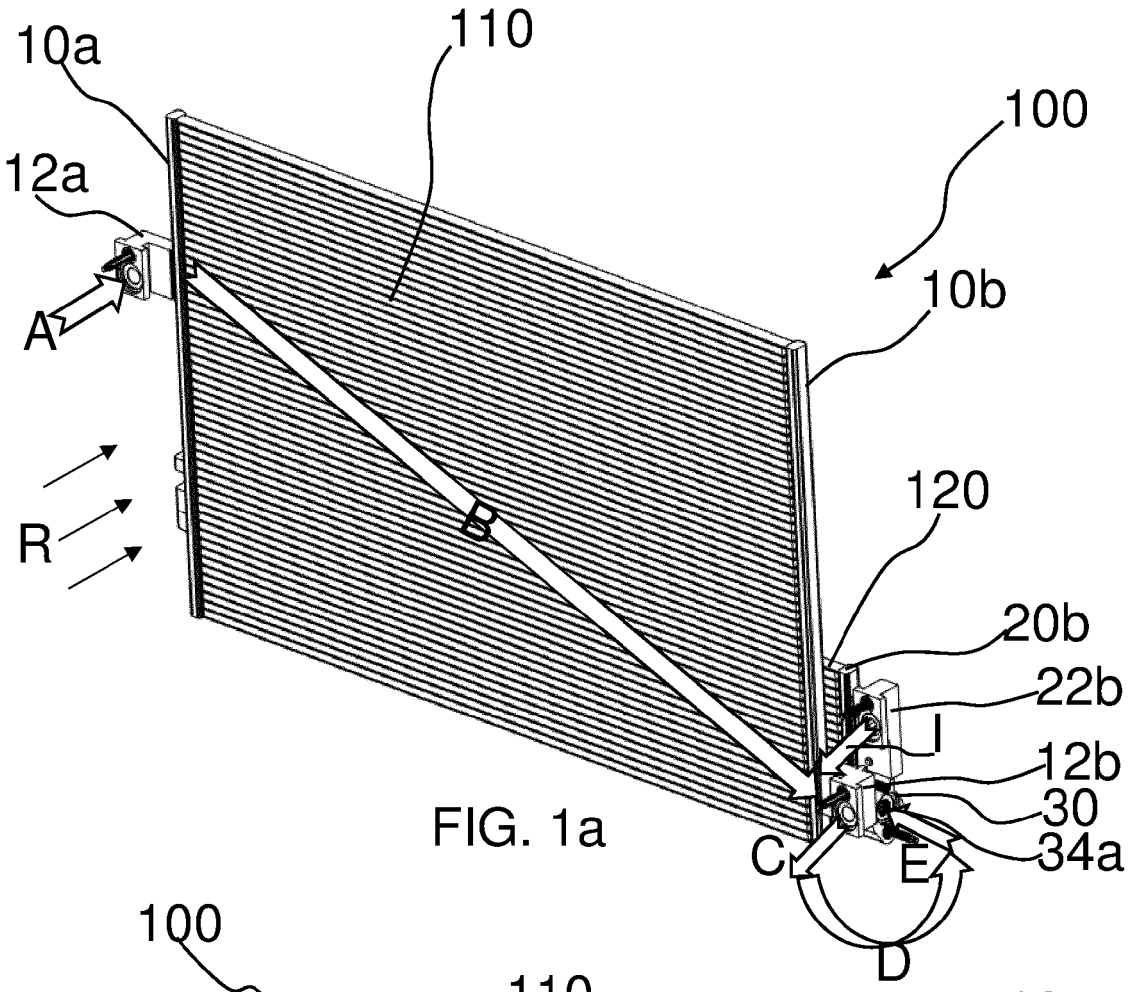
10a
110
100
12a
10b
A
B
R
120
20b
22b
I
12b
30
34a
C
E
D

FIG. 1a

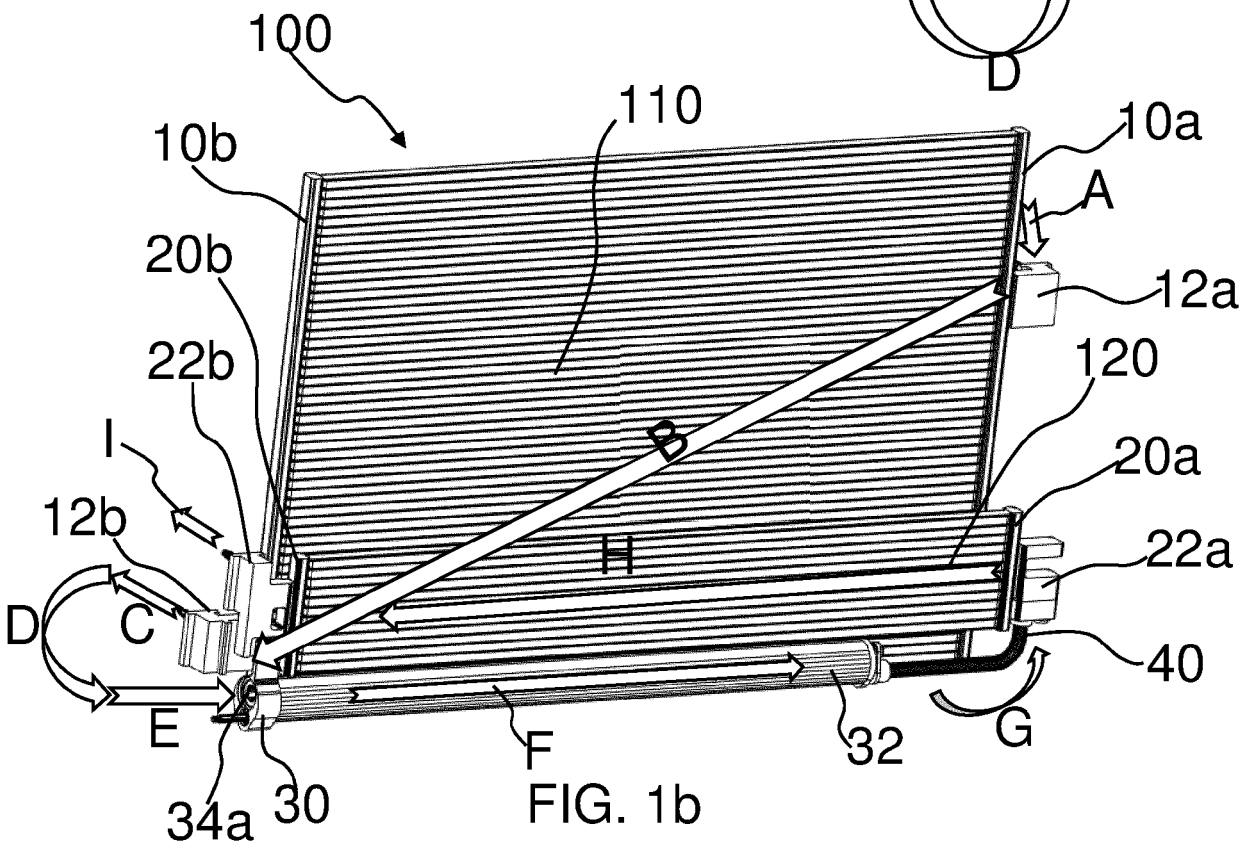
100
110
10b
10a
A
20b
12a
22b
120
I
B
20a
12b
H
22a
D
C
40
E
F
32
G
34a
30

FIG. 1b

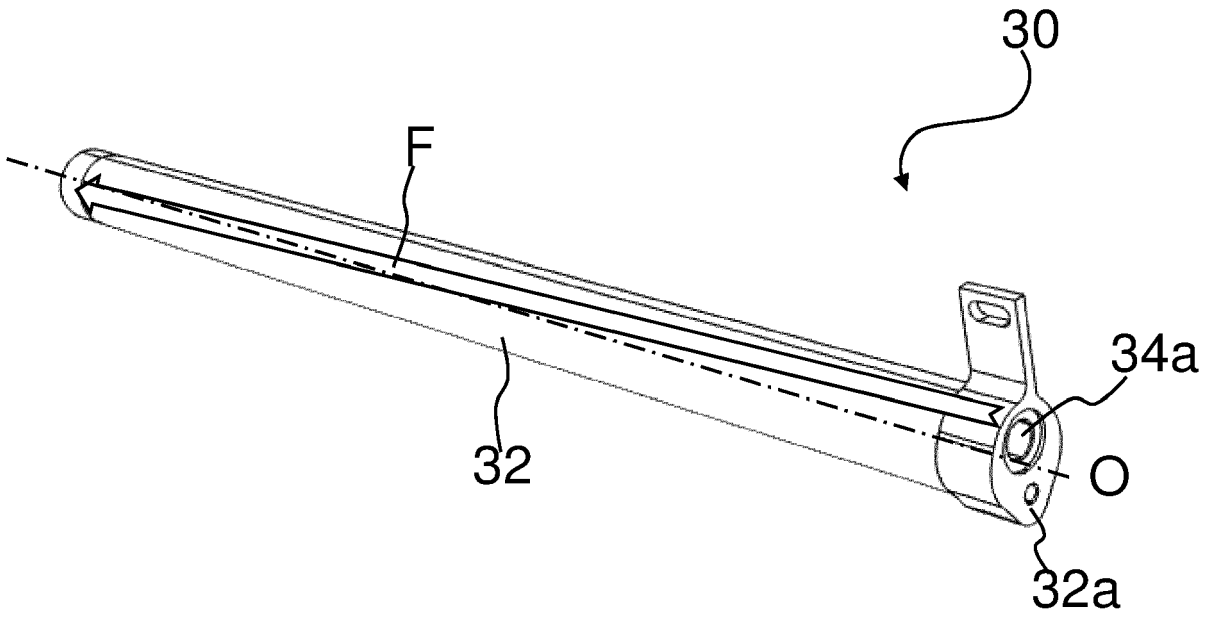

FIG. 2a

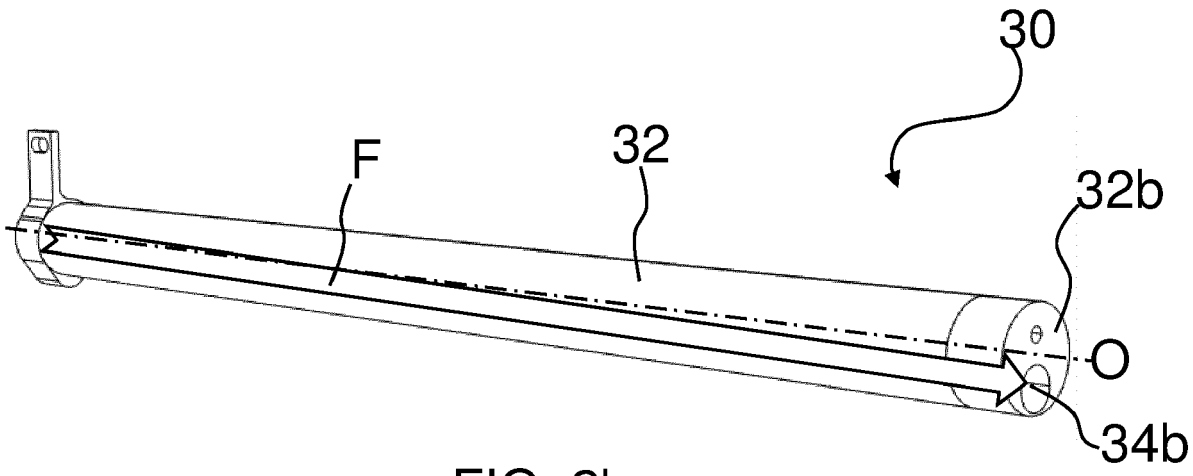

FIG. 2b

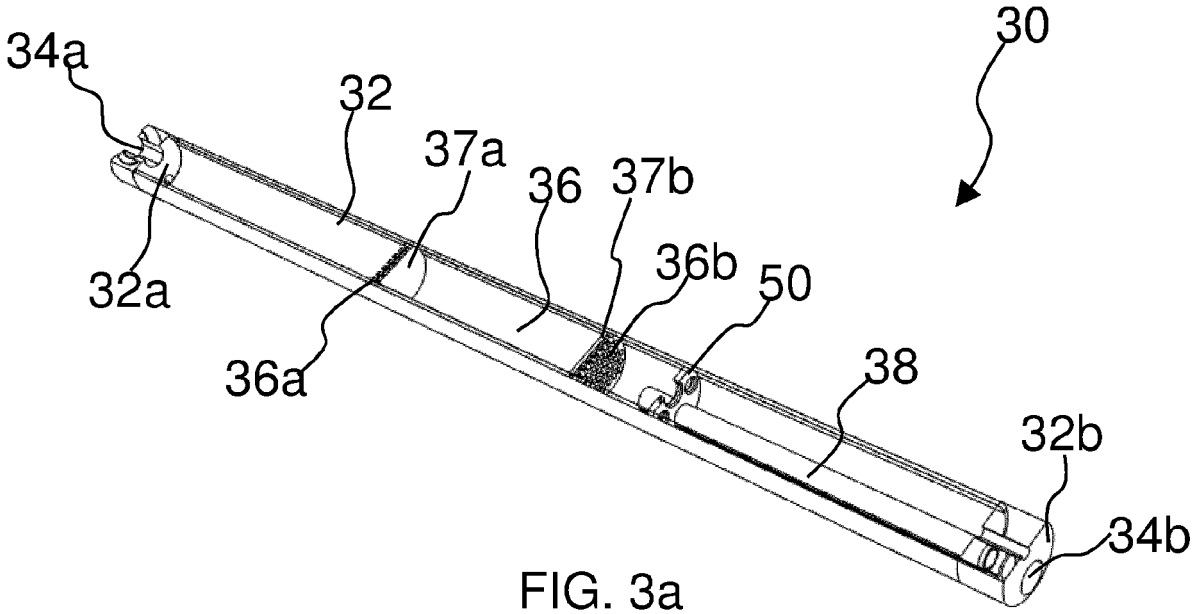
34a
32
37a
36
37b
30
32a
36b
50
36a
38
32b
34b

FIG. 3a

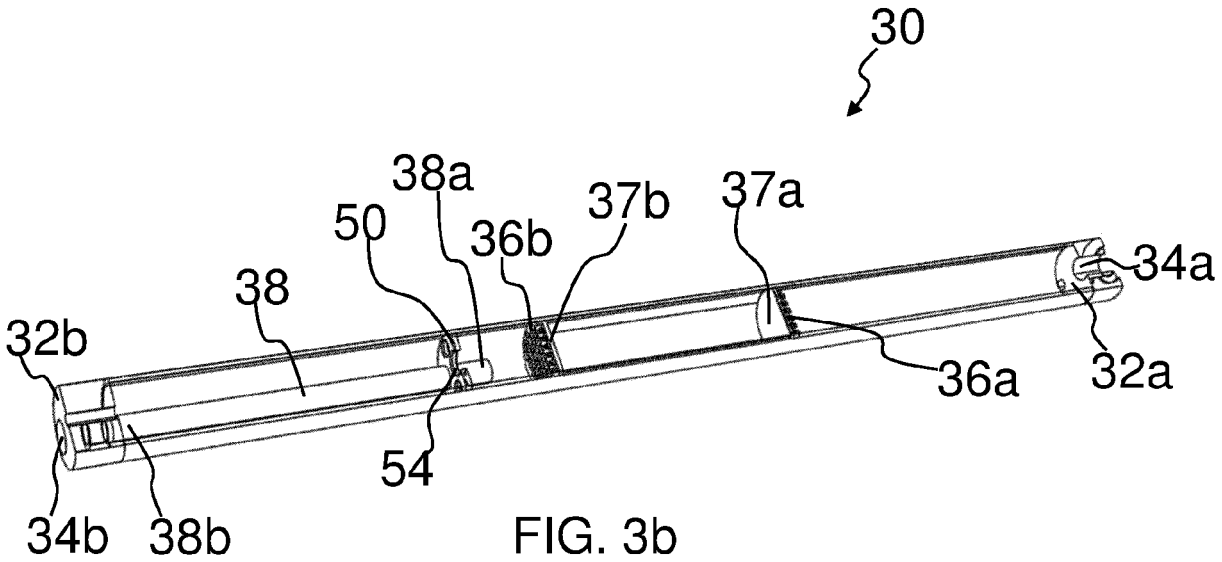
30
38a
37b
37a
50
36b
34a
38
32b
36a
32a
54
34b
38b

FIG. 3b

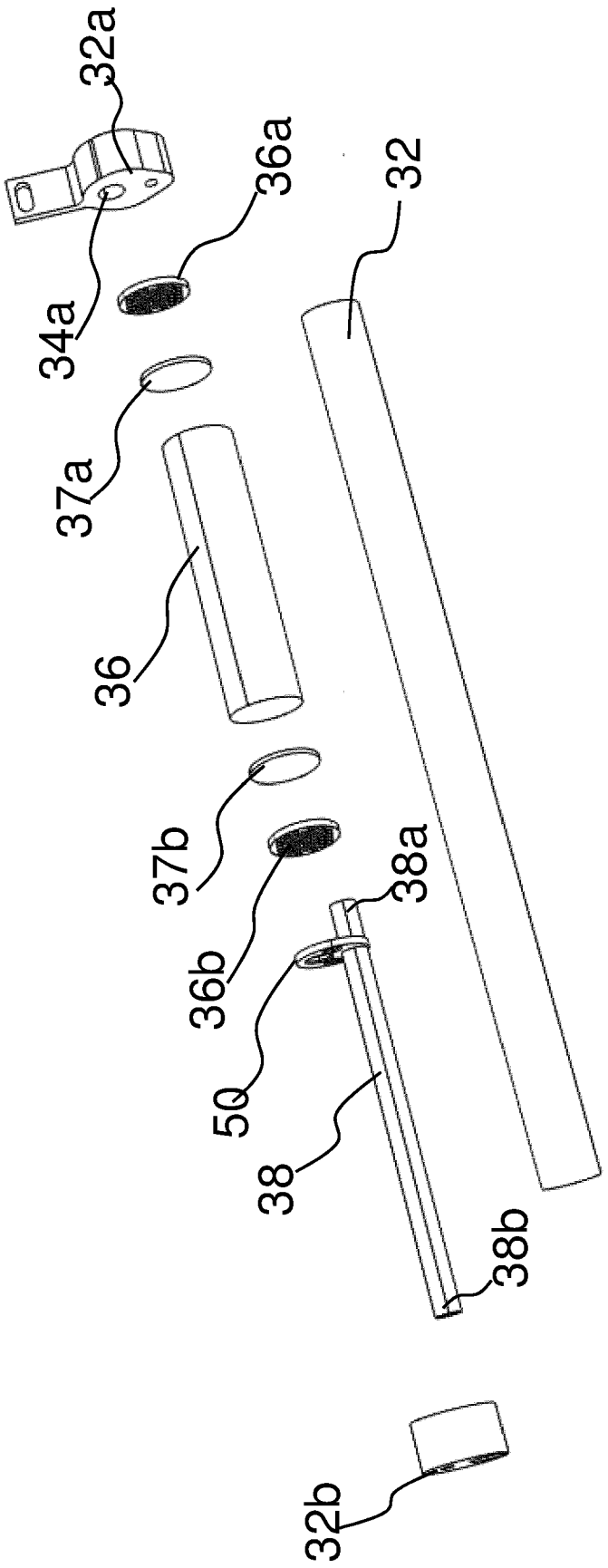

FIG. 4

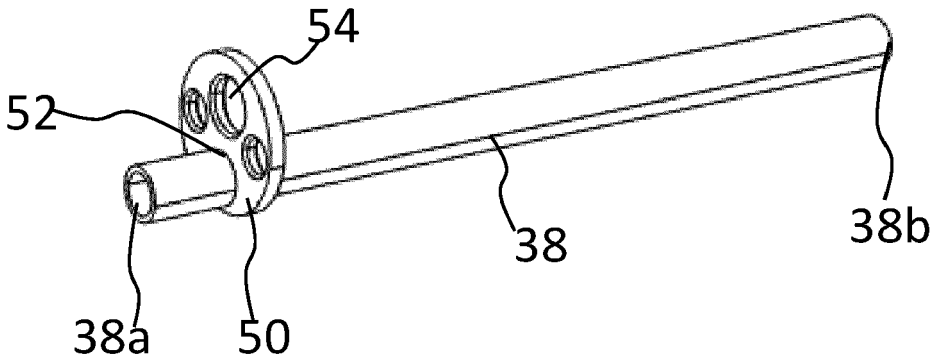

FIG. 5

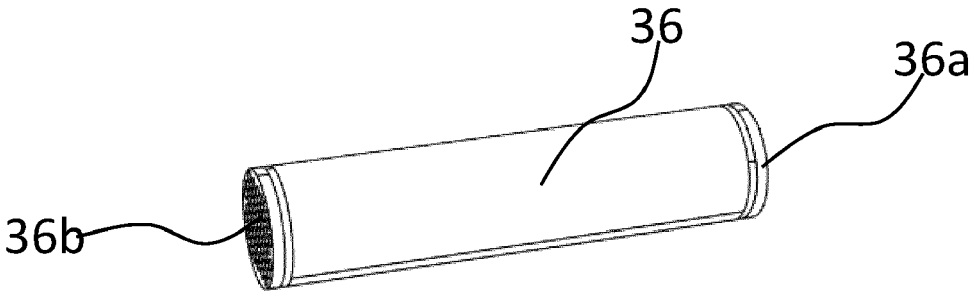

FIG. 6

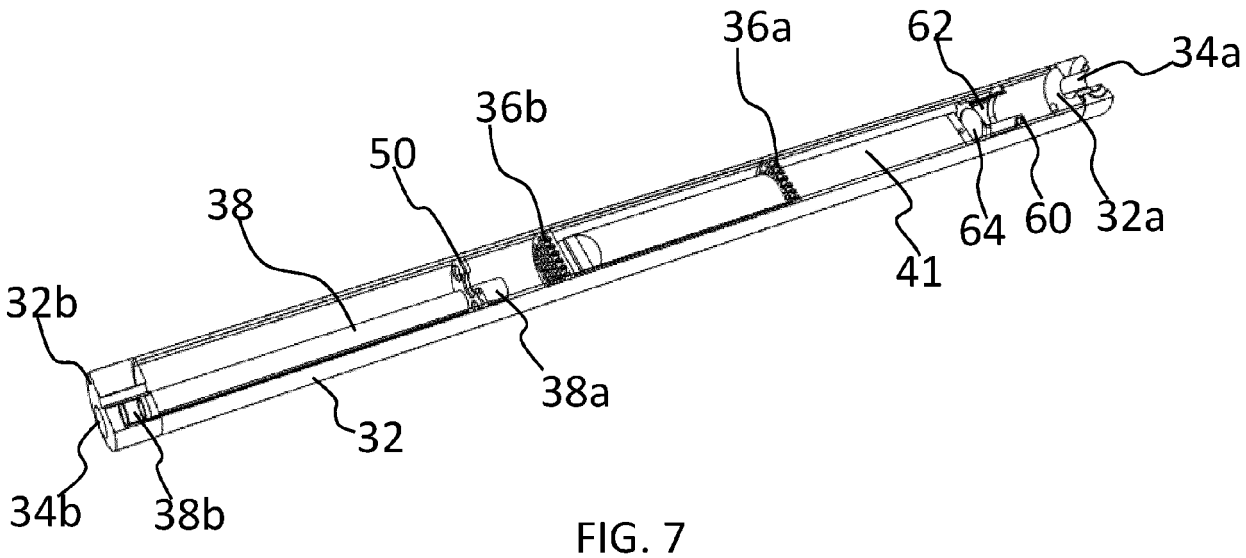

FIG. 7

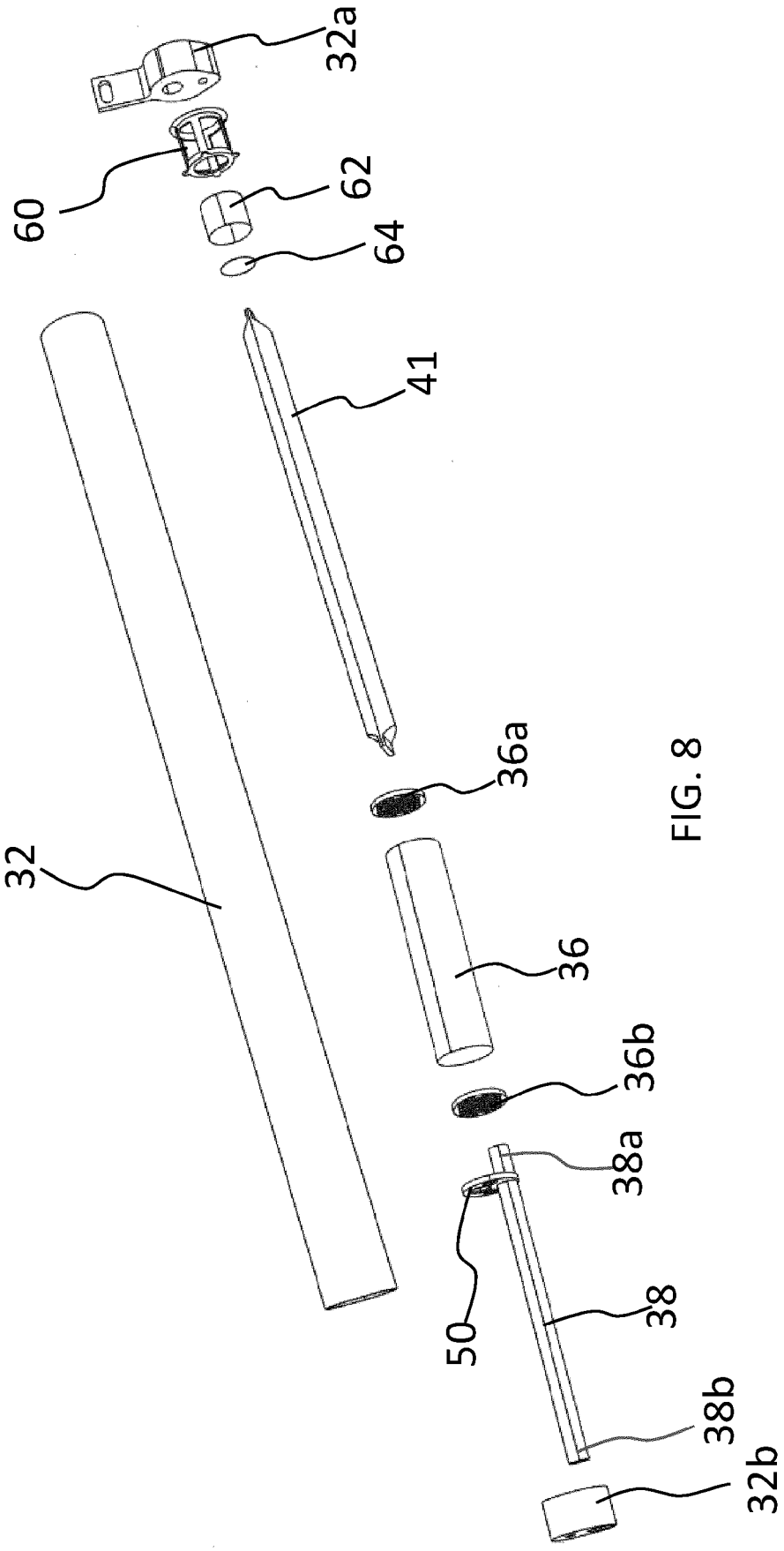

FIG. 8

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 20 46 1505

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	EP 2 835 608 A1 (VALEO AUTOSYSTEMY SP ZOO [PL]) 11 February 2015 (2015-02-11)	1-11	INV. F28D1/04
A	* paragraph [0001] * * paragraph [0017] - paragraph [0026] *	12	F28D1/053 F28F9/26 F25B39/04
Y	DE 196 45 502 A1 (VOLKSWAGEN AG [DE]) 28 May 1997 (1997-05-28)	1-11	F25B40/02 B60H1/00
A	* the whole document *	12	
A	EP 1 505 358 A2 (BEHR GMBH & CO KG [DE]) 9 February 2005 (2005-02-09) * paragraph [0001] - paragraph [0004]; figures 1,2,6 * * paragraph [0007] - paragraph [0008] *	1	
A	JP H11 257799 A (SANDEN CORP) 24 September 1999 (1999-09-24) * abstract; figures 1, 4 *	1,3,5,9, 10	
A	EP 1 202 007 A1 (SKG ITALIANA SPA [IT]) 2 May 2002 (2002-05-02) * figures 1, 3; example 1 * * paragraph [0012] - paragraph [0013] * * paragraph [0018] - paragraph [0019] *	1-5,9,10	
A	JP 2008 151420 A (SHOWA DENKO KK) 3 July 2008 (2008-07-03) * abstract; figure 2 * * paragraph [0047] - paragraph [0048] *	3-9	
A	DE 10 2004 022714 A1 (BEHR GMBH & CO KG [DE]) 15 December 2005 (2005-12-15) * the whole document *	1-9	
A	DE 102 26 851 A1 (BAYERISCHE MOTOREN WERKE AG [DE]) 8 January 2004 (2004-01-08) * paragraphs [0007] - [0021]; figures 2,3 *	1,2	
	-/--		

TECHNICAL FIELDS SEARCHED (IPC)
F28D
F28F
F25B
B60H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	25 June 2020	Leclaire, Thomas

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 20 46 1505

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	DE 101 04 374 A1 (BEHR GMBH & CO [DE]) 8 August 2002 (2002-08-08) * paragraphs [0001], [0004], [0005], [0011] - [0013]; figures 1, 2 *	1,2	

TECHNICAL FIELDS SEARCHED (IPC)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	25 June 2020	Leclaire, Thomas

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 20 46 1505

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

25-06-2020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2835608 A1	11-02-2015	NONE	
DE 19645502 A1	28-05-1997	DE 19645502 A1	28-05-1997
		DE 19655397 B4	29-07-2010
EP 1505358 A2	09-02-2005	AT 442558 T	15-09-2009
		DE 10336621 A1	10-03-2005
		EP 1505358 A2	09-02-2005
JP H11257799 A	24-09-1999	NONE	
EP 1202007 A1	02-05-2002	EP 1202007 A1	02-05-2002
		US 2002046571 A1	25-04-2002
JP 2008151420 A	03-07-2008	NONE	
DE 102004022714 A1	15-12-2005	AT 543063 T	15-02-2012
		DE 102004022714 A1	15-12-2005
		EP 1745255 A1	24-01-2007
		US 2008156012 A1	03-07-2008
		WO 2005108896 A1	17-11-2005
DE 10226851 A1	08-01-2004	NONE	
DE 10104374 A1	08-08-2002	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82