



(11)

EP 2 963 364 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
06.01.2016 Bulletin 2016/01

(51) Int Cl.:
F25B 43/00 (2006.01) F25B 40/00 (2006.01)

(21) Application number: **15173644.4**

(22) Date of filing: **24.06.2015**

(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:
MA

(71) Applicant: **Eaton Industrial IP GmbH & Co. KG**
12529 Schönefeld (DE)

(72) Inventor: **Kreutz, Marlene**
76199 Karlsruhe (DE)

(74) Representative: **Eaton IP Group**
EMEA
Route de la Longeraie 7
1110 Morges (CH)

(30) Priority: **30.06.2014 GB 201411563**

(54) **ACCUMULATOR FOR AN AIR CONDITIONING SYSTEM**

(57) The invention relates to an accumulator for an air conditioning system, which accumulator comprises:

- a closed container with an inlet and an outlet for supply and discharge of a first medium;
- an accumulating chamber in fluid connection with the inlet and comprising a refrigerant outlet;
- a heat exchanger having a first channel and a second channel for transporting a second medium, the second channel being in heat exchanging contact with the first channel, wherein the first channel is in fluid connection with the refrigerant outlet of the accumulating chamber and the outlet of the container, wherein the container comprises two chambers arranged next to each other under a top wall of the container, a first chamber defining the accumulating chamber and a second chamber accommodating the heat exchanger, wherein the refrigerant outlet of the accumulating chamber is located near the top of the container.

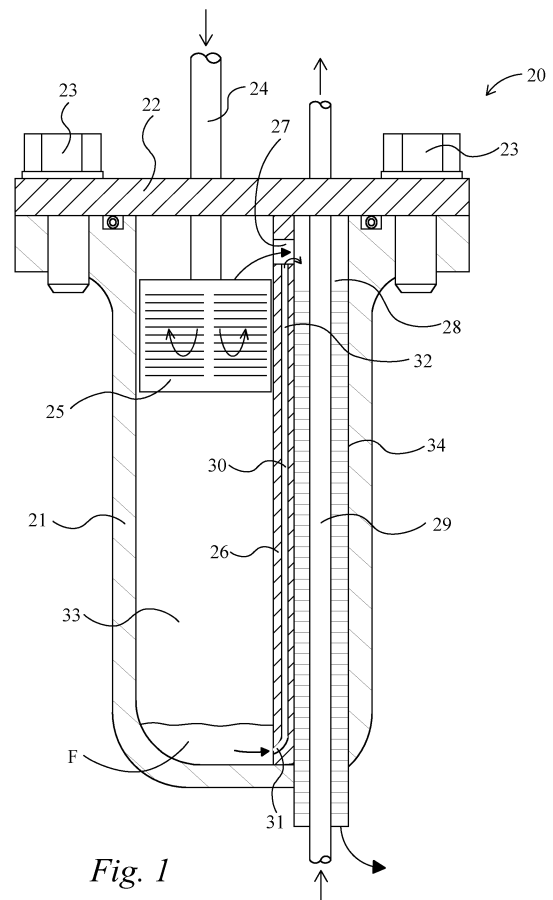


Fig. 1

Description

[0001] The invention relates to an accumulator for an air conditioning system, which accumulator comprises:

- a closed container with an inlet and an outlet for supply and discharge of a first medium;
- an accumulating chamber in fluid connection with the inlet and comprising a refrigerant outlet;
- a heat exchanger having a first channel (low pressure) and a second channel (high pressure) for transporting a second medium, the second channel being in heat exchanging contact with the first channel, wherein the first channel is in fluid connection with the refrigerant outlet of the accumulating chamber and the outlet of the container.

[0002] Such an accumulator is for example known from DE 102006017071.

[0003] An accumulator separates the liquid from the gaseous refrigerant after the refrigerant has passed the expansion and the evaporator means of an air conditioning system. The accumulator is also used as a reservoir for refrigerant during the life time of the system and for balancing the dynamic characteristics of the air conditioning system. The heat exchanger is furthermore used to evaporate any droplets of refrigerant still present. If such refrigerant droplets would continue to the compressor, substantial damage could be done to the compressor.

[0004] In the accumulator can also be integrated a filter dryer as seen in DE 10 2005 009 191 B3. The filter dryer typically also provides drying means for removing any moist from the refrigerant. The accumulator is also a physical separator of the liquid and the gaseous refrigerant. Furthermore, the accumulator collects lubricant transported by the refrigerant and returns the lubricant in a controlled way to the refrigerant to ensure that the lubricant is evenly distributed throughout the air conditioning system.

[0005] The refrigerant used nowadays is for example R134, which is a 1,1,1,2-Tetrafluoroethane based refrigerant. Such a refrigerant is environment unfriendly (GWP = 13000).

[0006] An alternative to R134 is R744, which is carbon dioxide. Carbon dioxide has a high volumetric cooling capacity, which makes it an excellent refrigerant. However, the current air conditioning systems in vehicles designed for R134 using usually have an expansion valve for regulating the superheating after the evaporator and the receiver at the high pressure side behind the condenser. The carbon dioxide air conditioning systems are usually high pressure regulated and have the accumulator on the low pressure side behind the evaporator (US 5245836 A). The accumulator would not be sufficient to ensure that all carbon dioxide is in gas phase before it enters the compressor, as the carbon dioxide cycle will be a high pressure regulated system.

[0007] It is known in the prior art, for example from DE 102006017071, to arrange a heat exchanger at the outlet of the accumulator within the same closed container of the accumulator to ensure that in particular carbon dioxide based refrigerant is fully in gas phase when entering the compressor. In particular the main effect of the heat exchanger will be an increase in the performance of the air conditioning system.

[0008] However, such an accumulator according to DE 102006017071 is difficult or even impossible to mount in an engine compartment of an existing motor vehicle due to the space restrictions. If such an accumulator with additional heat exchanger on top of the accumulating space needs to be mounted in an existing vehicle, the air conditioning system needs to be redesigned to comply with the space restrictions.

[0009] Accordingly it is an object of the invention to provide an accumulator according to the preamble in which the above mentioned disadvantages are reduced or even removed.

[0010] This object is achieved with an accumulator according to the invention, which accumulator is characterized in that the container comprises two chambers arranged next to each other under a top wall of the container, a first chamber defining the accumulating chamber and a second chamber accommodating the heat exchanger, wherein the refrigerant outlet of the accumulating chamber is located near the top of the container.

[0011] Apart from the fact that a more compact design will be obtained that will meet space requirements in the vehicle, the two chamber concept according to the invention also has another advantage. This design will prevent any interaction between the accumulator and the internal heat exchanger. The difference between refrigeration cycles of R134a and CO₂ is that the CO₂ refrigeration cycle also works in the transcritical area for the high pressure side. That means that there is no correlation between temperature and pressure. In CO₂ refrigeration cycles there is intent to adjust the high pressure, for R134a refrigeration cycles the pressure is determined by the temperature. The high pressure regulation of the CO₂ cycle generates the optimum Coefficient of Performance (COP) for each load point. As there is no interaction between the heat exchanger and the accumulator, and the heat exchanger does not evaporate liquid refrigerant that is stored in the accumulator, the heat exchanger will not evaporate too much refrigerant and the optimum COP can be reached.

[0012] The two chambers are created by an internal wall of the container. Near the top of the container, an orifice is provided. This orifice forms the outlet of the accumulator for gaseous refrigerant and at the same time an inlet to the heat exchanger in the second chamber.

[0013] In another embodiment of the accumulator according to the invention a passage (or capillary tube) extends in the internal wall of the container from the bottom zone of the first chamber of the container to the orifice

near the top of the container.

[0014] When the first medium (gaseous refrigerant) flows through the orifice between the first chamber and the second chamber, the pressure will be a bit lower in the second chamber than the pressure in the first chamber of the container. Due to the Venturi principle any (liquid) lubricant, such as for instance oil, present at the bottom of the container will be sucked through the passage and into the gas flow of the first medium of the accumulator. To increase that effect, the diameter of the accumulator inlet is preferably larger than the diameter of the orifice between the two chambers.

[0015] The capillary tube is implemented in the wall between the two chambers: the oil carryover will take less space. The intent of the capillary tube is to suck oil. In the ideal case it would only suck oil and no liquid refrigerant, but this cannot be prevented. Due to the two chamber design according to the invention, the heat exchanger will evaporate only the sucked liquid refrigerant in the second chamber, and not any liquid refrigerant stored in the accumulating chamber. The main task of the heat exchanger is to increase the performance of the total refrigeration cycle.

[0016] The heat exchanger can be of any known type. Advantageously, the heat exchanger comprises one or more heat exchanging elements which together with the internal wall of the second chamber form the heat exchanger. The heat exchanging elements can comprises any of the following: straight or coiled tube heat exchanger element, brush-type heat exchanger element, and/or multi-port extruded heat exchanger element (also known as MPE heat exchanger).

[0017] In an embodiment of the invention the first channel of the heat exchanger is formed between the wall of the second chamber and the external wall of the heat exchanger element. The second channel (high pressure) is formed by the heat exchanger element itself. Compared to an R134a air conditioning system, there is no correlation in a carbon dioxide system between the temperature and the pressure at the high pressure side. This allows for optimization of the pressure to achieve the optimum coefficient of performance (COP) for each load point. To this end it is necessary to prevent interaction between the heat exchanger and the accumulator, which would otherwise lead to additional evaporation of liquid refrigerant in the accumulator. By arranging the heat exchanger in a separate chamber, and by arranging the second (high pressure) channel within the first channel, the high pressure side is shielded from the accumulator.

[0018] The heat exchanger element comprising the first channel could be made from a composite material, which will further isolate the second channel from the accumulator. It will also simplify the manufacture of such a first tube.

[0019] In a preferred embodiment of the accumulator according to the invention, the heat exchanger element is provided with a plurality of heat conducting elements, preferably extending substantially radially between the

outer surface of the heat exchanger element and the wall of the first channel. These heat conducting elements will improve enhance heat improvement.

[0020] As the first medium or refrigerant is substantially in gas phase when passing the heat exchanger, the heat conducting elements extending into the first channel through which the refrigerant flows do not provide too much pressure lose, while the plurality of elements provide a large heat conducting surface, such that any liquid droplets of the refrigerant are easily heated in the heat exchanger into the gas phase by the second medium.

[0021] As is generally known from the prior art, filter means can be arranged in connection with the inlet of the accumulator for filtering the first medium entering the container.

[0022] The filter means could furthermore comprise drying means for drying the first medium.

[0023] With the filter means any water or other particles are filtered out from the refrigerant, to prevent wear to the air conditioning system by the water and particles.

[0024] The closed container could be provided with a drain plug at the bottom of the container for serviceability.

[0025] The invention also relates to an air conditioning system comprising a refrigerant loop in which are arranged in succession, in flow direction, at least a compressor, a gas cooler, expansion means and an evaporator, wherein an accumulator according to the invention is furthermore arranged in the refrigerant loop, wherein the inlet is in fluid connection with the evaporator and the outlet is in fluid connection with the compressor and wherein the second channel is in fluid connection with the gas cooler and the expansion means.

[0026] These and other features of the invention will be elucidated in conjunction with the accompanying drawings.

Figure 1 shows a cross-sectional view of an embodiment of an accumulator according to the invention.

Figure 2 shows a schematic view of an air conditioning system according to the invention.

Figure 3 shows another embodiment of an accumulator according to the invention.

[0027] Figure 1 shows an accumulator 20 for an air conditioning system. The accumulator 20 has a container 21 with a lid 22, which is mounted by bolts 23 to the container 21. The closed container 21, 22 is shown generally semi- oblong shaped but can have any shaped adapted to the manufacturing method used and/or vehicle space available.

[0028] An inlet pipe 24 extends through the lid 22 and is connected to a filter dryer 25. Through the inlet a low pressure first medium, such as a refrigerant is supplied to a first chamber 33 of the closed container 21, 22. When the first medium exits the filter dryer 25, the gas part of the first medium will rise towards the top of the accumu-

lator 20, while any liquid particles will fall down, due to gravity, and are collected at the bottom (indicated as a fluid level F in Fig. 1). In an air conditioning system, this fluid F will mainly consist of liquid refrigerant and a smaller amount of oil. The first chamber 33 defines thus an accumulating chamber.

[0029] The gas part of the first medium will rise to the top of the container 2 to exit the accumulating chamber 33 and enter a second chamber 34 of the closed container 21, 22 which accommodates a heat exchanger.

[0030] A separation wall 26 is vertically arranged in the container 21. This separation wall 26 divides the container into the two chambers 33, 34. An orifice 27 is arranged in the separation wall 26 near the top of the closed container 21, 22. Through this orifice 27 gaseous medium will enter a space 28 between the wall of the second chamber 34 and the separation wall 26. This space 28 forms part of the heat exchanger. The space 28 forms a first channel for the first medium. The other part of the heat exchanger is formed by a tube 29 that runs from the outside of the container 21 through the second chamber 34 and exits the container 21 again to the outside. This tube forms a second channel for a second medium. This medium is preferably the same refrigerant as the gaseous first medium flowing in the space 28, but at high pressure. The heat exchange ensures that any possible liquid in the space 28 is evaporated before it exits the accumulator 20.

[0031] The tube 29 may be provided on its outer surface with a plurality of heat conducting elements (as shown in the figure), but a plain tube could also be used (not shown). Alternatively other type of heat exchangers can be accommodated in the second chamber 34, such as for instance: heat exchanging elements manufactured from multi-port extruded elements, or coiled heat exchanging elements.

[0032] Furthermore, a passage 30 is provided in the separation wall 26 having an inlet opening 31 at the bottom and an outlet opening 32 at the top. The outlet opening 32 exits in the orifice 27 of the separation wall 26. The passage 30 acts as a capillary tube for transporting liquid medium consisting of liquid refrigerant and lubricant to the orifice 27. Due to a Venturi effect the liquid refrigerant will be sucked into the passage 30 and brought by the gaseous medium via the heat exchanger back into the air-conditioning circuit.

[0033] Figure 2 shows a schematic view of an air conditioning system 40 of the invention. The air conditioning system 40 has a refrigerant loop 41. This refrigerant loop 41 is a tube and/or hose through which a suitable refrigerant flows. The refrigerant loop 41 has in succession and in flow direction, a compressor 42, a gas cooler 43, expansion means 44 and an evaporator 45, similar to a conventional air conditioning system.

[0034] To ensure that all refrigerant coming from the evaporator 45 is in gas phase before it enters the compressor 42, the loop 41 according to the invention is provided with an accumulator with an integrated heat ex-

changer 46 according to the invention, such as for example shown in figure 1.

[0035] The (low pressure) refrigerant coming from the evaporator 45 enters the accumulator 46 and runs through a first channel 38 (see figure 1) and then exits the accumulator with integrated heat exchanger 46 towards the compressor 42.

[0036] The refrigerant coming from the gas cooler 43 and running to the expansion means 44, which typically has a high temperature and a high pressure, is guided through the heat exchanger of the accumulator 46 to ensure that the low pressure refrigerant does not contain any liquid particles, which could damage the compressor 42. This refrigerant will also contain the recovered lubricant (e.g. oil) from the accumulator that is needed for lubrication of the compressor 42.

[0037] Figure 3 shows another embodiment of the accumulator according to the invention. This accumulator doesn't have any bolts or sealing. There is a cover at the top and at the bottom of the container 21. The container is formed with two separate chambers 33, 34. The chambers are divided by an internal wall 33 of the container 21. The outlet 27 of the accumulating chamber 33 is located near the top of the container. The inlet pipe 24 with attached the filter dryer 25 and the heat exchanger element 35 are inserted in their respective chambers 33, 34. The container is subsequently closed by attaching the lids 22 on both sides of the container 21.

Claims

1. Accumulator for an air conditioning system, which accumulator comprises:

- a closed container with an inlet and an outlet for supply and discharge of a first medium;
- an accumulating chamber in fluid connection with the inlet and comprising a refrigerant outlet;
- a heat exchanger having a first channel and a second channel for transporting a second medium, the second channel being in heat exchanging contact with the first channel, wherein the first channel is in fluid connection with the refrigerant outlet of the accumulating chamber and the outlet of the container, **characterized in that** the container comprises two chambers arranged next to each other under a top wall of the container, a first chamber defining the accumulating chamber and a second chamber accommodating the heat exchanger, wherein the refrigerant outlet of the accumulating chamber is located near the top of the container.

2. Accumulator according to claim 1, wherein the two chambers are divided by an internal wall of the container.

3. Accumulator according to claim 2, wherein an orifice is provided in the internal wall near the top of the container.
4. Accumulator according claim 3, wherein a passage extends in the internal wall of the container from the bottom zone of the first chamber of the container to the orifice. 5
5. Accumulator according to claim 3 or 4, wherein the diameter of the orifice is smaller than the diameter of the inlet of the container. 10
6. Accumulator according to any of the preceding claims, wherein the heat exchanger comprises one of the following heat exchanger elements: brush-type heat exchanger, multi-port extruded (MPE) heat exchanger or coiled tube heat exchanger. 15
7. Accumulator according to claim 6, the first channel of the heat exchanger is formed between a wall of the second chamber and the external wall of the heat exchanger element. 20
8. Air conditioning system comprising a refrigerant loop in which are arranged in succession, in flow direction, at least a compressor, a gas cooler, expansion means and an evaporator, **characterized in that** an accumulator according to any of the preceding claims is furthermore arranged in the refrigerant loop, wherein the inlet is in fluid connection with the evaporator and the outlet is in fluid connection with the compressor and wherein the second channel is in fluid connection with the gas cooler and the expansion means. 25
30
35

40

45

50

55

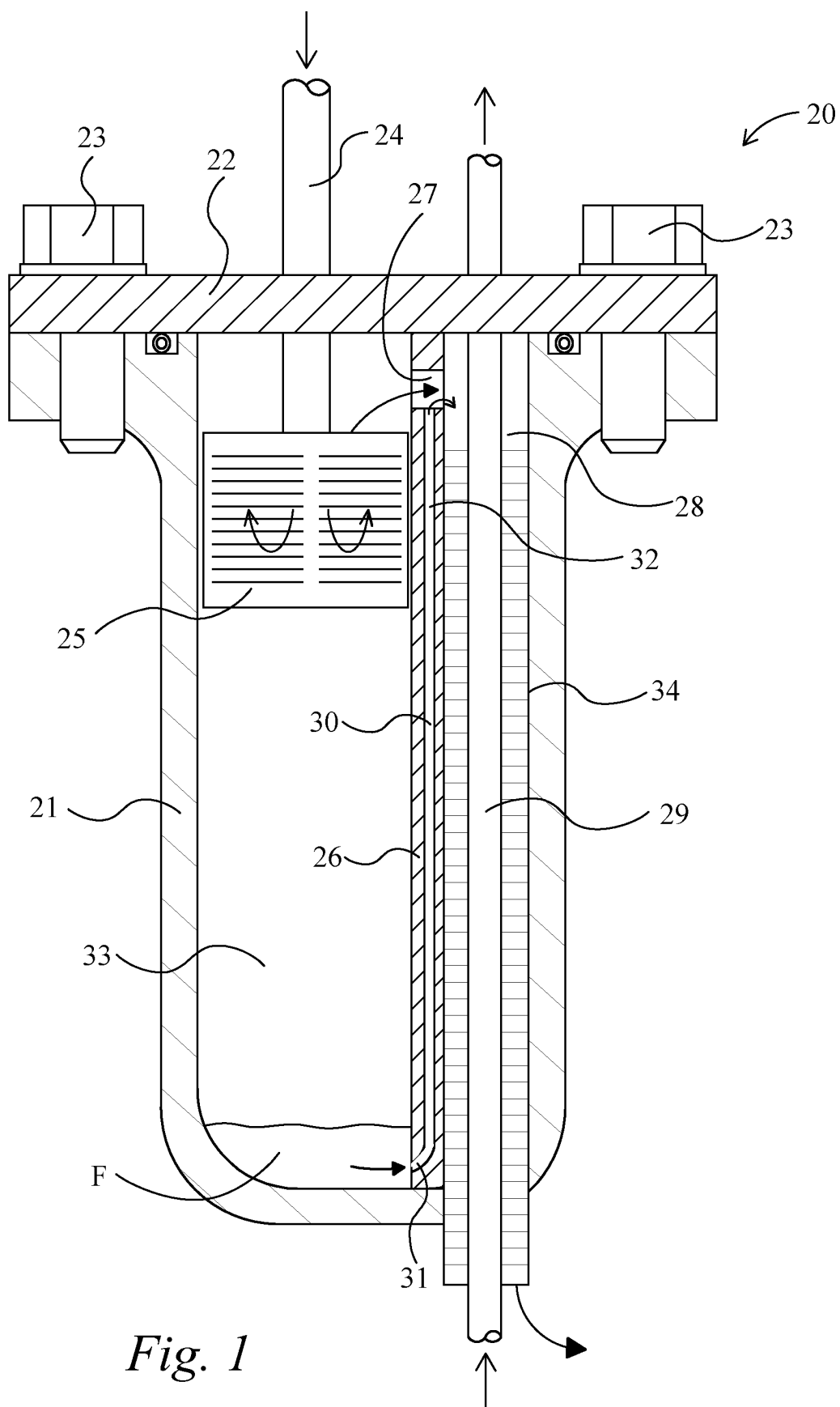


Fig. 1

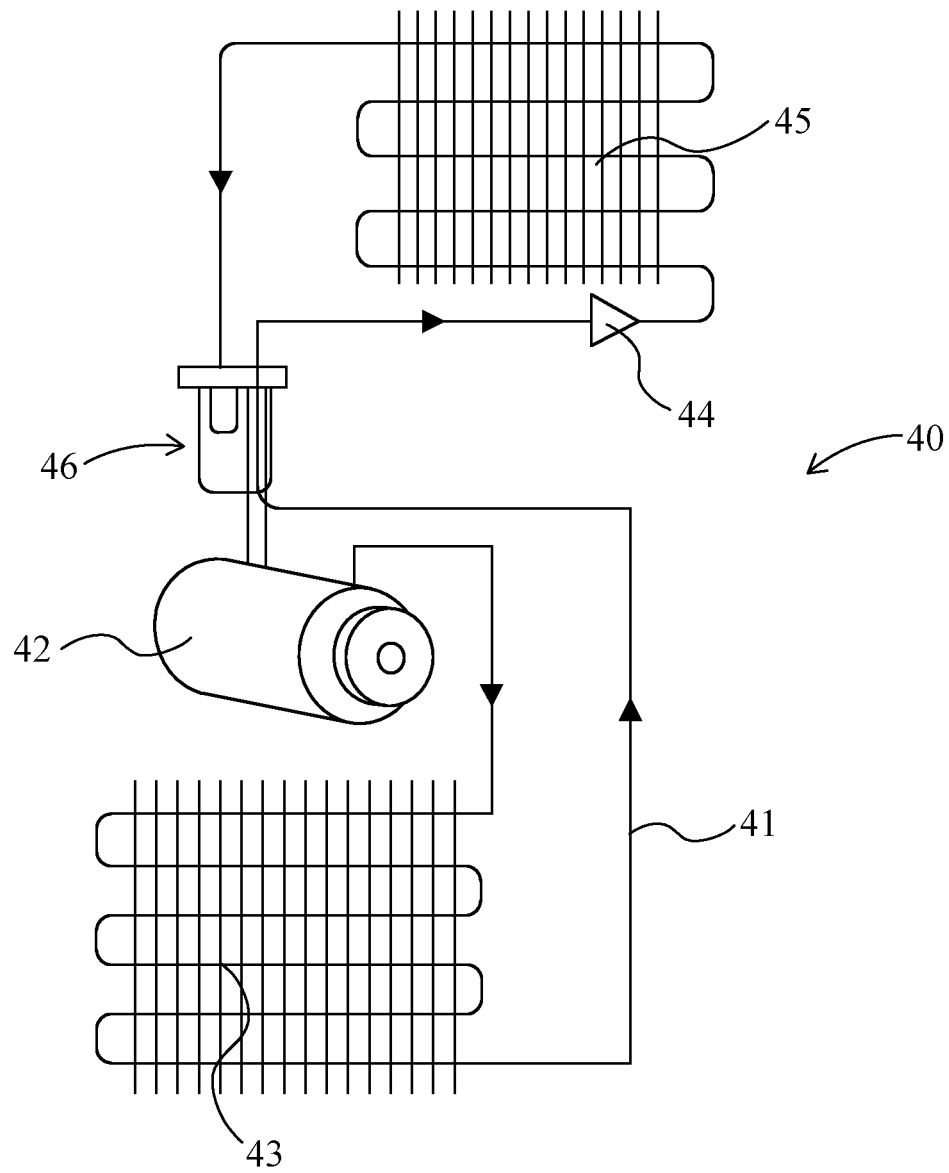


Fig. 2

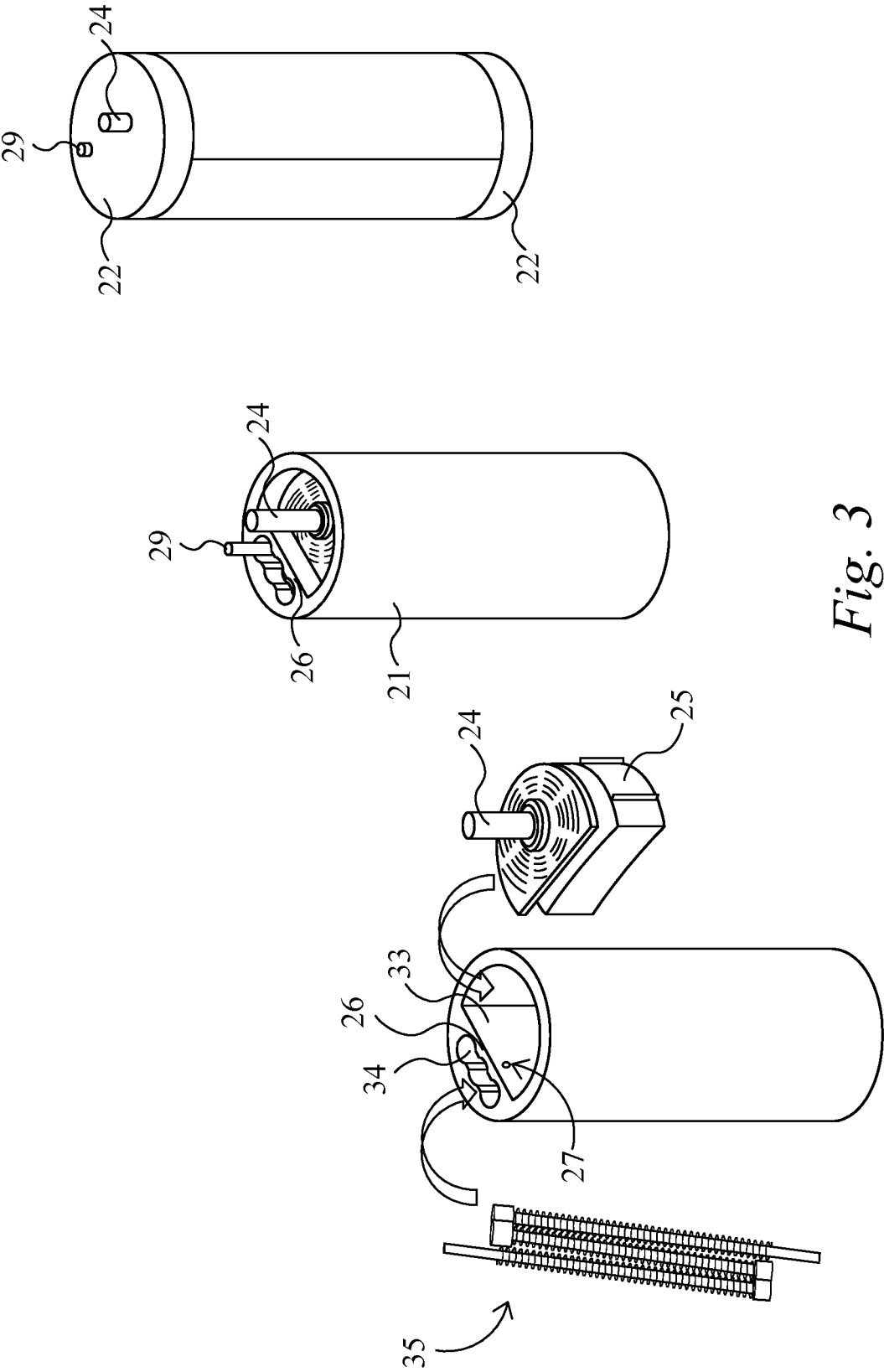


Fig. 3



EUROPEAN SEARCH REPORT

Application Number
EP 15 17 3644

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 198 08 893 A1 (BEHR GMBH & CO [DE]) 9 September 1999 (1999-09-09)	1-3,5-8	INV. F25B43/00
Y	* column 4, line 18 - column 6, line 22; figures 1,2 *	4	F25B40/00

X	EP 1 845 320 A2 (BEHR GMBH & CO KG [DE]) 17 October 2007 (2007-10-17)	1,2,5-8	
Y	* the whole document *	4	

X	EP 2 199 709 A2 (VALEO SYSTEMES THERMIQUES [FR]) 23 June 2010 (2010-06-23)	1,2,6-8	
	* the whole document *		

X	EP 2 199 708 A1 (VALEO SYSTEMES THERMIQUES [FR]) 23 June 2010 (2010-06-23)	1,8	
	* paragraphs [0049] - [0065]; figures 1,2 *		

X	GB 934 490 A (DENCO MILLER LTD) 21 August 1963 (1963-08-21)	1,8	
	* the whole document *		

The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC) F25B
Place of search Munich		Date of completion of the search 20 October 2015	Examiner Ritter, Christoph
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	

1

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 15 17 3644

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.

20-10-2015

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 19808893 A1	09-09-1999	NONE	
EP 1845320 A2	17-10-2007	DE 102006017071 A1 EP 1845320 A2	11-10-2007 17-10-2007
EP 2199709 A2	23-06-2010	CN 101799232 A EP 2199709 A2 FR 2940418 A1 JP 5497419 B2 JP 2010169387 A US 2010155012 A1	11-08-2010 23-06-2010 25-06-2010 21-05-2014 05-08-2010 24-06-2010
EP 2199708 A1	23-06-2010	AT 530865 T CN 101762131 A EP 2199708 A1 ES 2375917 T3 FR 2940419 A1 JP 5421091 B2 JP 2010143574 A US 2010155017 A1	15-11-2011 30-06-2010 23-06-2010 07-03-2012 25-06-2010 19-02-2014 01-07-2010 24-06-2010
GB 934490 A	21-08-1963	NONE	

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- DE 102006017071 [0002] [0007] [0008]
- DE 102005009191 B3 [0004]
- US 5245836 A [0006]