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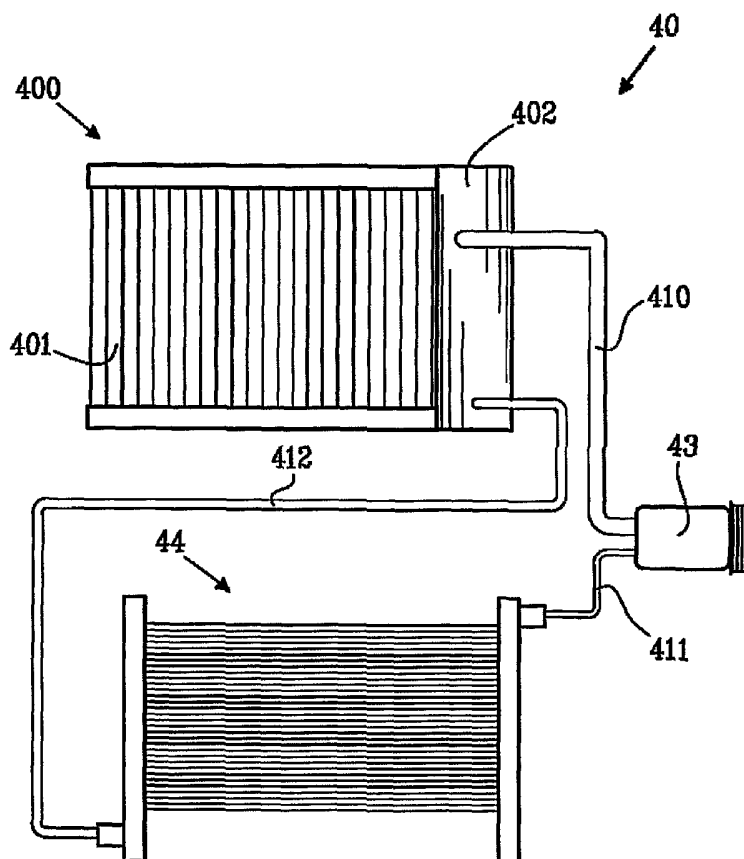
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(54) Title: ARRANGEMENT AND METHOD RELATING TO COOLING SYSTEMS



(57) Abstract: An evaporator for use in a cooling system in a vehicle, characterized in that an accumulator combined with an expansion device tube and heat exchanger is directly attached to the evaporator, together forming an integral unit.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Arrangement and method relating to cooling systems

Field of the invention

- 5 The present invention relates to a cooling system in vehicles and in particular to a cooling system comprising an evaporator with integrated accumulator, sub-cooler, and expansion device tube.

Background of the invention

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It is an increasing demand from regulatory authorities to increase the efficiency of cooling (air conditioning) systems in vehicles and reduce risks for introducing environmentally unfriendly substances outside the closed loop air conditioning system. This demand has been actualized due to growing environmental concerns.

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Conventional cooling systems comprise mainly four major components: an evaporator for absorbing heat from the inside of a vehicle, a condenser for radiating heat from the cooling substance, a compressor for circulating the cooling substance within the system, and an accumulator for storing and drying the cooling substance (depending on the type of cooling system this part is sometimes replaced with a receiver-dryer). The operation of air condition systems are well known in the art.

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In order to control the flow of the liquid entering the evaporator mainly two different components are used: in some systems an orifice tube is used for controlling the flow of the cooling substance and in other systems a thermal expansion valve is used for regulating the flow of the refrigerant substance.

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The operation of a standard air conditioning system may be as follows with an orifice tube/accumulator system as an example:

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1. The compressor pumps the cooling substance around the system, it takes the gas from the low pressure side and outputs higher pressure gas.
2. The cooling substance (in gas phase) enters the condenser which condenses the gas into a liquid phase.
3. An orifice tube reduces the pressure of the liquid and thus lowers the temperature, as may be understood by the well known Carnot cycle.

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4. The cold liquid is entered into an evaporator, and the cold liquid is made to boil by absorbing heat from the vehicle compartment. The vehicle compartment is then cooled (air conditioning).
5. The cooling substance (in gas phase mostly) is outputted from the evaporator and entered into an accumulator, which allows for a controlled delivery of gas to the compressor and at the same time makes sure no cooling substance in liquid phase reaches the compressor. The compressor may be damaged if subjected to cooling substance in liquid phase and/or will operate in a non optimal manner.
6. The process cycle now starts over again.

A normal orifice tube air conditioning system comprises the following components: Compressor, discharge hose assembly, condenser, liquid hose assembly (or assemblies), orifice tube, evaporator tube or hose assembly, evaporator, suction tube or hose assembly, accumulator, suction hose assembly.

In order to increase the efficiency of the air conditioning system it is sometimes suggested to sub-cool the liquid substance from the condenser before entering the evaporator directly or via regulating components. Sub cooling of the liquid cooling substance means cooling of the liquid, at a constant pressure, below the point at which it was condensed. This may be done in a separate heat exchanger exchanging heat between high pressure liquid line between the condenser and orifice tube, and the low pressure gas line between the accumulator and compressor for an orifice tube system.

However, increasing the number of components increases the possibility for faulty connections, more tubes and parts that may brake down, and the number of operation during assembly increases which is time consuming. It is therefore of interest to find solutions where it is possible to combine components.

Summary of the invention

Accordingly the present invention in accordance with a preferred embodiment seeks to mitigate, alleviate or eliminate one or more of the above-mentioned disadvantages singly or in any combination.

A first aspect of the invention is, an accumulator arrangement for use in a cooling system preferably in a vehicle, comprising an outer wall (303), an inlet from a condenser, an outlet to a compressor, and wherein the accumulator arrangement further comprises an expansion device, e.g. an orifice tube, and heat exchanging tube located inside the outer wall.

The accumulator arrangement may further be integrated with an evaporator.

The accumulator arrangement may comprise an outer wall, attached to the evaporator, forming a compartment wherein a tube, for directing cooling substance from a condenser for providing heat exchange between a cooling substance in the tube and the compartment, and an expansion device are located.

The accumulator may further have a desiccant located inside the compartment.

In another aspect of the invention a cooling system for use in a vehicle is provided, comprising:
an evaporator;
a condenser;
a compressor;
an accumulator;
an expansion device; and
a heat exchanger,
wherein the accumulator is integrated with the evaporator, and includes inside a housing the heat exchanger and the orifice tube.

In a third aspect of the invention a method of providing a compact cooling system is provided, preferably for a vehicle, comprising the steps of:
providing an accumulator arrangement comprising an outer wall, an inlet from a condenser, an outlet to a compressor, and wherein the accumulator arrangement further comprises an expansion device and heat exchanging tube located inside the outer wall; and
providing an evaporator,
integrating the accumulator arrangement with the evaporator.

In still another aspect of the invention, a method of assembly of a cooling system, preferably for a vehicle, is provided, comprising the assembly steps of:

assembling an accumulator arrangement comprising an outer wall, an inlet from a condenser, an outlet to a compressor, and wherein the accumulator arrangement further comprises an expansion device and heat exchanging tube located inside the outer wall;

5 assembling an evaporator and the accumulator arrangement, together forming an evaporator arrangement;

connecting the evaporator arrangement to a condenser using a connection;

connecting the condenser to compressor using a connection; and

connecting the compressor to the evaporator arrangement using a connection.

10

The cooling system may be installed in a vehicle.

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

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Brief description of the drawings

In the following the invention will be described in a non-limiting way and in more detail with reference to exemplary embodiments illustrated in the enclosed
20 drawings, in which:

Fig. 1 illustrates schematically a standard well known cooling system according to the known art.

25 Fig. 2 illustrates schematically an evaporator according to the present invention.

Fig. 3 illustrates schematically an accumulator according to the present invention, wherein Fig. 3a schematically shows the present invention from a front view, 3b is a schematic from a side view, and 3c a schematic top view.

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Fig. 4 illustrates schematically a cooling system according to the present invention.

Detailed description of the invention

35 Fig. 1 illustrates a standard cooling system 10 as known in the art. A cooling system 10 may comprise of an evaporator 1 connected to a accumulator 2 in turn connected to a heat exchanger 6 for pre heating of the cooling substance preferably

for reducing the risk of cooling substance in liquid phase reaching a compressor 3. The heat exchanger 6 is further connected to the compressor 3 pumping the cooling substance around the cooling system 10. The compressor 10 is in turn connected to a condenser 4 condensing a high pressure cooling substance in gas phase to a liquid phase. The condenser may be further connected to the heat exchanger 6 for sub cooling of the cooling substance and the heat exchanger 6 is further connected to an expansion device 5, e.g. an orifice tube, reducing the pressure of the liquid, thus lowering the temperature of the cooling substance. The expansion device 5 is connected to the evaporator 1. All the tubes and/or hoses present between the different main components are shown but have not been given numerals.

The present invention combines several of the above described parts as to form a more condense device enabling safer usage, simple assembly, and more cost effective production. Fig. 4 illustrates an example of a cooling system 40 according to the present invention. A device 400 according to the present invention comprises an evaporator 401 with an accumulator 402 combined with an expansion device, e.g. an orifice tube, and a heat exchanger. This device 400 is connected to a compressor 43 which in turn is connected to a condenser 44, and finally the condenser 44 may be connected to the device 400.

Fig. 2 illustrates the combined evaporator 21 and accumulator 22 forming the device 20 according to the present invention. Tubing 23, 24 for connecting a compressor and a condenser are shown in the figure as well. Tube 23 may be connected to the compressor and tube 24 may be connected to condenser.

Figs 3a – 3c shows a schematic of the combined accumulator 302 with internal parts from three different points of view. The combined accumulator 302 is attached to an evaporator 301 and has an external wall 303 protecting parts of the combined accumulator 302 and holding cooling substance. The accumulator 302 further comprises an inlet 304 from the condenser 44 connecting a helical tube 312 for providing heat exchange between cooling substance from the condenser 44 and cooling substance present in the accumulator compartment 325. The cooling substance from the condenser exits through an expansion device 305 into the evaporator 301. The accumulator further comprises a desiccant unit 313 and a tube 311 for removing gas from the accumulator 302 to the compressor 43 through an outlet 317. The desiccant unit 313 is removed through a port 314 when it needs to be changed. The helical tube 312 encircles the desiccant. An outlet 316 from the

evaporator 301 is provided at an upper part of the accumulator 301 and a splash guard is provided above an inlet 321 to the tube 311 connecting to the compressor 43.

- 5 The operation of the combined accumulator 302 and evaporator 301 is as follows: Warm liquid enters from the condenser 44 through the inlet 304 from the condenser and the cooling substance flows through the tube 312 or similar structure containing cooling substance, while in this structure, the cooling substance will be sub cooled before reaching the orifice tube 305. The orifice tube
10 305 decreases the pressure and thus further decreases the temperature of the cooling substance before it enters the evaporator 301 through a tube 315. The evaporator 301 extracts heat from e.g. a vehicle compartment (not shown) and returns cooling substance mainly in gas phase (however, some liquid phase cooling substance may be present) into the accumulator 302 compartment 325 through the
15 outlet 316. The splash guard 320 is provided in order to prevent liquid phase cooling substance to reach the inlet 321 to tube 311.

- In the accumulator compartment 325 the cooling substance is accumulated and dried from moisture through contact with a desiccant 313. Gas phase cooling
20 substance is sucked into an inlet 321 connected to an outlet 317 in turn connected to the compressor. The tubing between the inlet 321 and the outlet 317 is substantially U-shaped in order to collect lubrication residues present in the cooling substance. These lubrication residues are evacuated from the cooling line through an oil return hole 310. The U-shaped tubing 311 is located on one side of the
25 accumulator in order to make room for the desiccant unit 313.

- Since the accumulator compartment 325 is in heat connection with the tubing 312 containing the warm liquid from the condenser, the cooling substance in the compartment 325 will be heated slightly, which reduces the risk of transferring
30 cooling substance in liquid phase to the compressor. The cooling substance is in flow due to the compressor work and therefore there will be a temperature difference between the cooling substance in the compartment 325 and the tubing 312.

- 35 The combined accumulator/heat exchanger/orifice tube assembly 302 may be directly attached to the evaporator 301 or it may be connected to the evaporator through piping and spaced some distance from the evaporator.

Advantages of the present invention as compared to conventional systems are, for example:

- 5 – Reduced number of parts.
- Reduced cost.
- Reduced weight
- Reduced packaging space.
- Reduced number of tube connections.
- 10 – Improved assembly properties in an assembly line.
- Compact system.

Some of these advantages will now be discussed in more detail. Due to the reduced number of parts to assemble, the assembly cost will be reduced, as well as the
15 overall production cost due to reduced number of tubing and material. The reduced number of parts reduces the weight of the system leading to possibly reduced fuel consumption. The improved assembly properties, due to reduced number of components, may for instance be reduced assembly time and improved quality (both assembly and product quality). Since fewer parts are used, the likelihood that
20 they break during use and assembly is reduced and this leads to cost reducing for the end customer.

Fig. 4 illustrates a cooling system 40 for a vehicle according to the present invention. The accumulator 402 may be pre fabricated with the heat exchanger and
25 expansion device located inside the accumulator. The accumulator may also be pre mounted together with an evaporator 401. During an installation procedure the accumulator will be mounted on an evaporator 401, and these units 401, 402 in turn (or the pre mounted combined accumulator/evaporator unit 400) will be mounted in the vehicle together with a condenser 44, a compressor 43, and
30 suitable tubing 410, 411, 412 in order to operatively connect the units together.

The invention has been described in a non-limiting example, for instance the tubing 312 need not be helically formed and the tubing 311 need not to be U-shaped but other shapes may be used, as understood by the person skilled in the art, for
35 solving the same functionality. Other solutions for providing desiccant changing possibilities may be provided, such as a port 314 located on the side or top of the accumulator 302 depending on the shape and location of tubing 312 and 311.

Tubing 312 need not be encircling the desiccant unit 313 but may be located on a side of the accumulator 302.

The wording "tube" and "tubing" refer to transfer means in general and may be for instance tube, pipe, hose, and so on as understood by the person skilled in the art. The cooling substance may be any suitable substance for air conditioning systems e.g. hydro fluorocarbons (HFC), hydro chlorofluorocarbons (HCFC), CO₂, and hydrocarbons (HC).

It should be noted that the word "comprising" does not exclude the presence of other elements or steps than those listed and the words "a" or "an" preceding an element do not exclude the presence of a plurality of such elements. It should further be noted that any reference signs do not limit the scope of the claims, that the invention may be implemented by means of both hardware and software, and that several "means" may be represented by the same item of hardware.

The above mentioned and described embodiments are only given as examples and should not be limiting to the present invention. Other solutions, uses, objectives, connections, and functions within the scope of the invention as claimed in the below described patent claims should be apparent for the person skilled in the art.

Reference signs

1	Evaporator
2	Accumulator
25 3	Compressor
4	Condenser
5	Expansion device
6	Heat exchanger
10	Air condition system
30 20	Evaporator with attached accumulator with combined components
21	Evaporator
22	Accumulator with combined components
23	Tubing to compressor
24	Tubing from condenser
35 301	Evaporator
302	Accumulator with combined components
303	Outer wall of accumulator

	304	Inlet of tubing from condenser
	305	Expansion device
	310	Oil return hole
	311	Tubing for suction gas to compressor
5	312	Tubing for heat exchange of warm liquid from condenser
	313	Desiccant
	314	Port for changing desiccant
	315	Tubing to evaporator
	316	Outlet hole from evaporator into accumulator
10	317	Outlet hole to tubing to compressor
	320	Splash guard
	321	Inlet hole for suction gas to compressor
	325	Accumulator compartment
	40	Air condition system according
15	43	Compressor
	44	Condenser
	400	Evaporator with attached accumulator with combined components
	401	Evaporator
	402	Accumulator with combined components
20	410, 411, 412	Tubing

Claims

1. An accumulator arrangement (302) for use in a cooling system (40) preferably in a vehicle, comprising an outer wall (303), an inlet (304) from a condenser (44), an outlet (317) to a compressor (43), and **characterized in** that said accumulator arrangement (302) further comprises an expansion device (305) and heat exchanging tube (312) located inside said outer wall (303).

5
2. The accumulator arrangement (302) according to claim 1, wherein said accumulator arrangement (302) is integrated with an evaporator (301).

10
3. The accumulator arrangement (302) according to claim 2, wherein said accumulator arrangement (302) comprises an outer wall (302), attached to said evaporator (301), forming a compartment (325) in which a tube (312) for directing cooling substance from a condenser (44) for providing heat exchange between a cooling substance in said tube (312) and said compartment (325) and an expansion device (305) are located.

15
4. The accumulator arrangement according to claim 3, wherein a desiccant (313) is located inside said compartment (325).

20
5. The accumulator arrangement according to claim 1, wherein said expansion device (305) is an orifice tube.

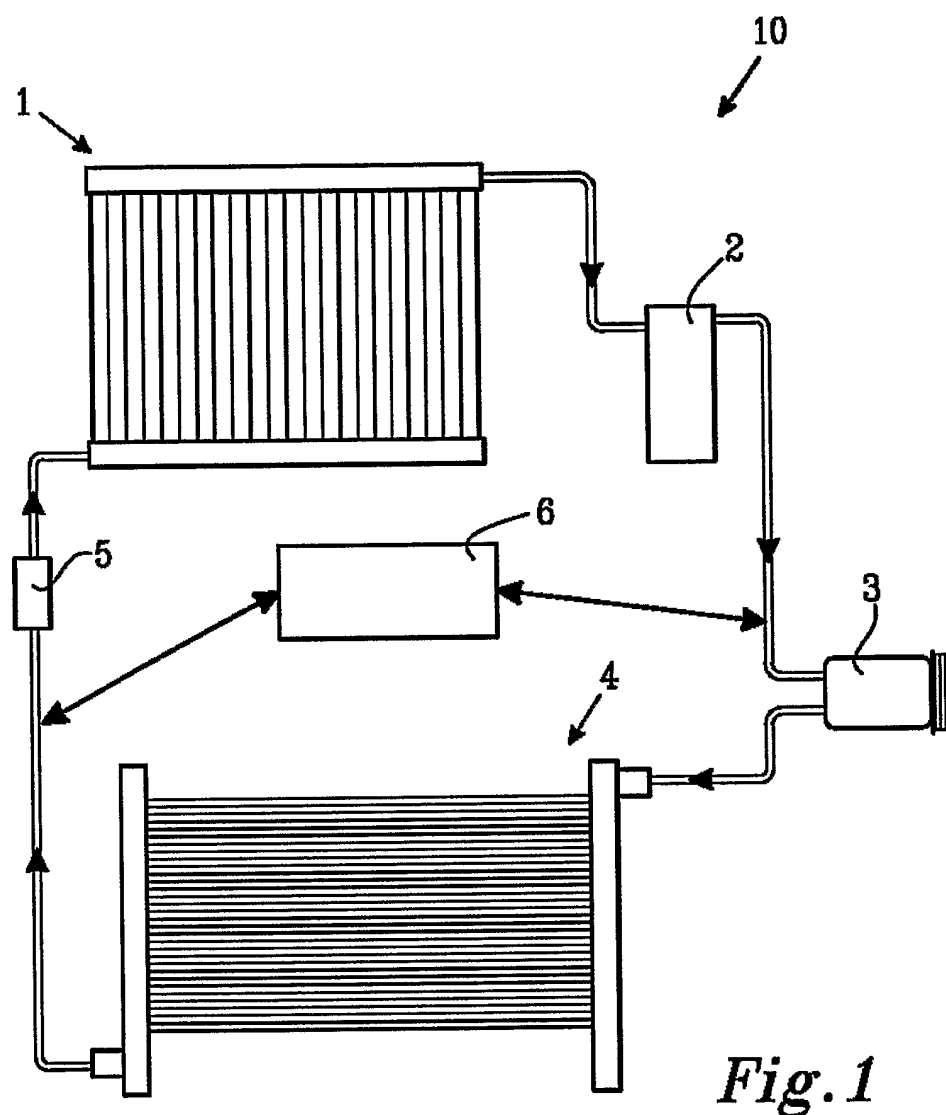
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6. A cooling system (40) for use in a vehicle, comprising:
 - an evaporator (401);
 - a condenser (44);
 - a compressor (43);
 - an accumulator (402);
 - an expansion device (305); and
 - a heat exchanger (312),**characterized in** that said accumulator (402) is integrated with said evaporator (401), and includes inside a housing (303) said heat exchanger (312) and said expansion device (305).

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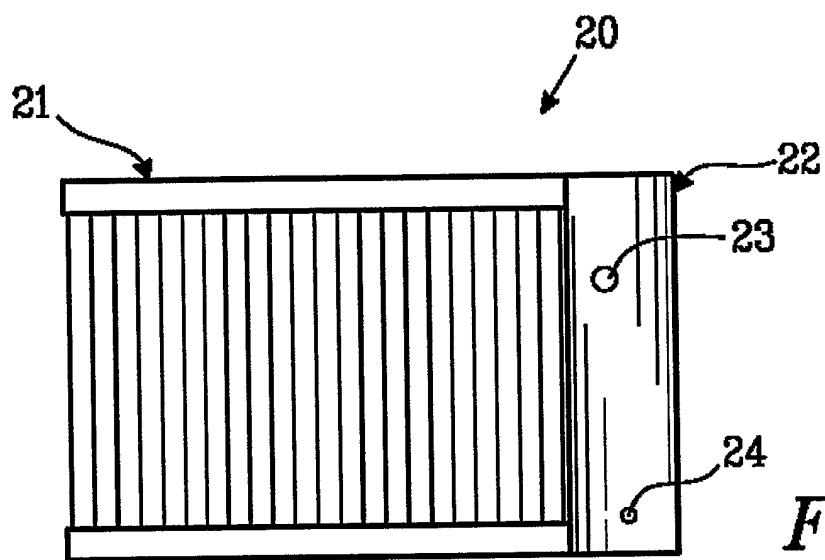
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7. A method of providing a compact cooling system (40), preferably for a vehicle, comprising the steps of:
- providing an accumulator arrangement (302) comprising an outer wall (303), an inlet (304) from a condenser (44), an outlet (317) to a compressor (43), and wherein said accumulator (302) arrangement further comprises an expansion device (305) and heat exchanging tube (312) located inside said outer wall (303); and
 - providing an evaporator (301),
 - integrating said accumulator arrangement (302) with said evaporator (301).
8. A method of assembly of a cooling system (40), preferably for a vehicle, comprising the assembly steps of:
- assembling an accumulator arrangement (402) comprising an outer wall (303), an inlet (304) from a condenser (44), an outlet (317) to a compressor (43), and wherein said accumulator (302) arrangement further comprises an expansion device (305) and heat exchanging tube (312) located inside said outer wall (303);
 - assembling an evaporator (401) and said accumulator arrangement (302), together forming an evaporator arrangement (400);
 - connecting said evaporator arrangement (400) to a condenser (44) using a connection (412);
 - connecting said condenser (44) to compressor (43) using a connection (411); and
 - connecting said compressor (43) to said evaporator arrangement (400) using a connection (410).
9. A vehicle comprising a cooling system (40) according to claim 5.

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*Fig. 1*

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*Fig. 2*

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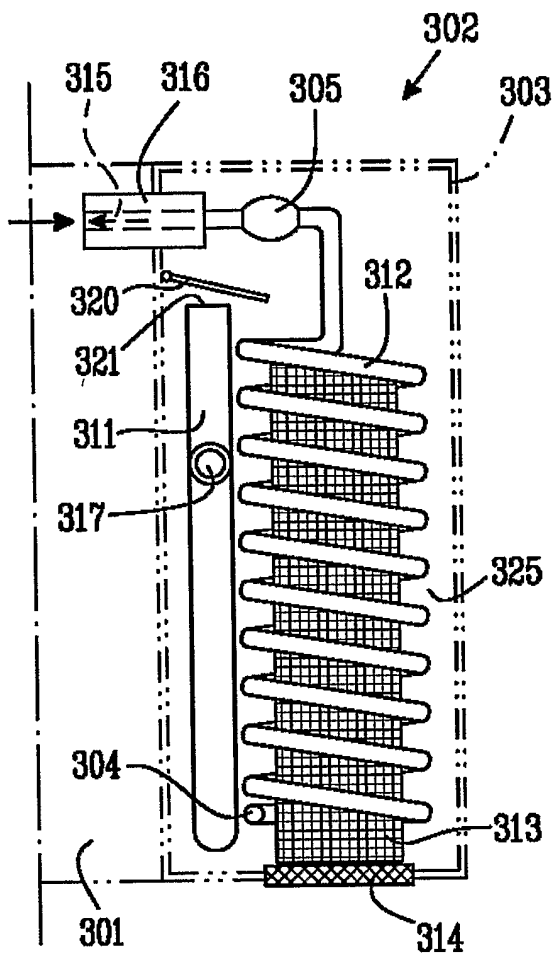


Fig. 3a

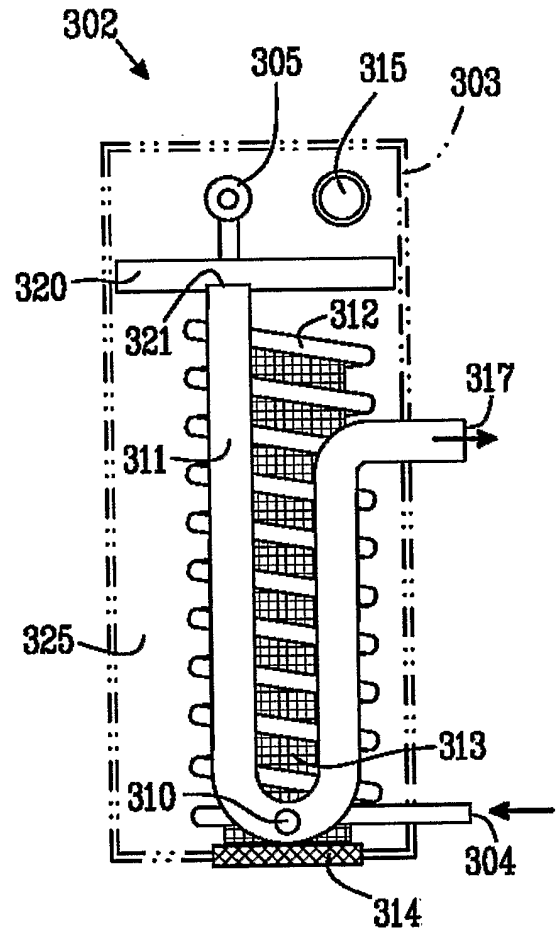


Fig. 3b

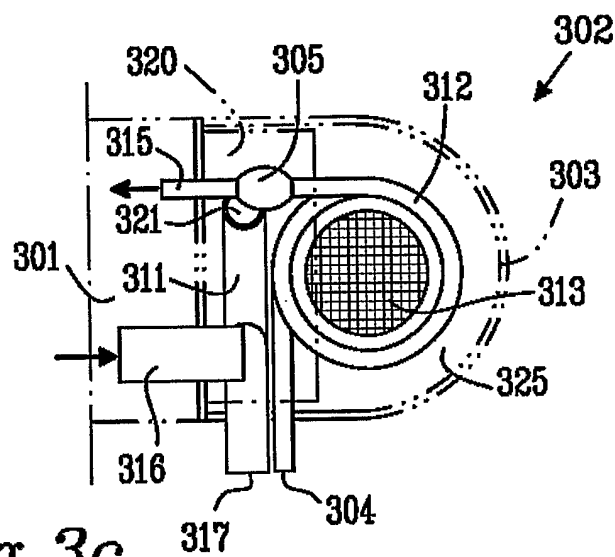
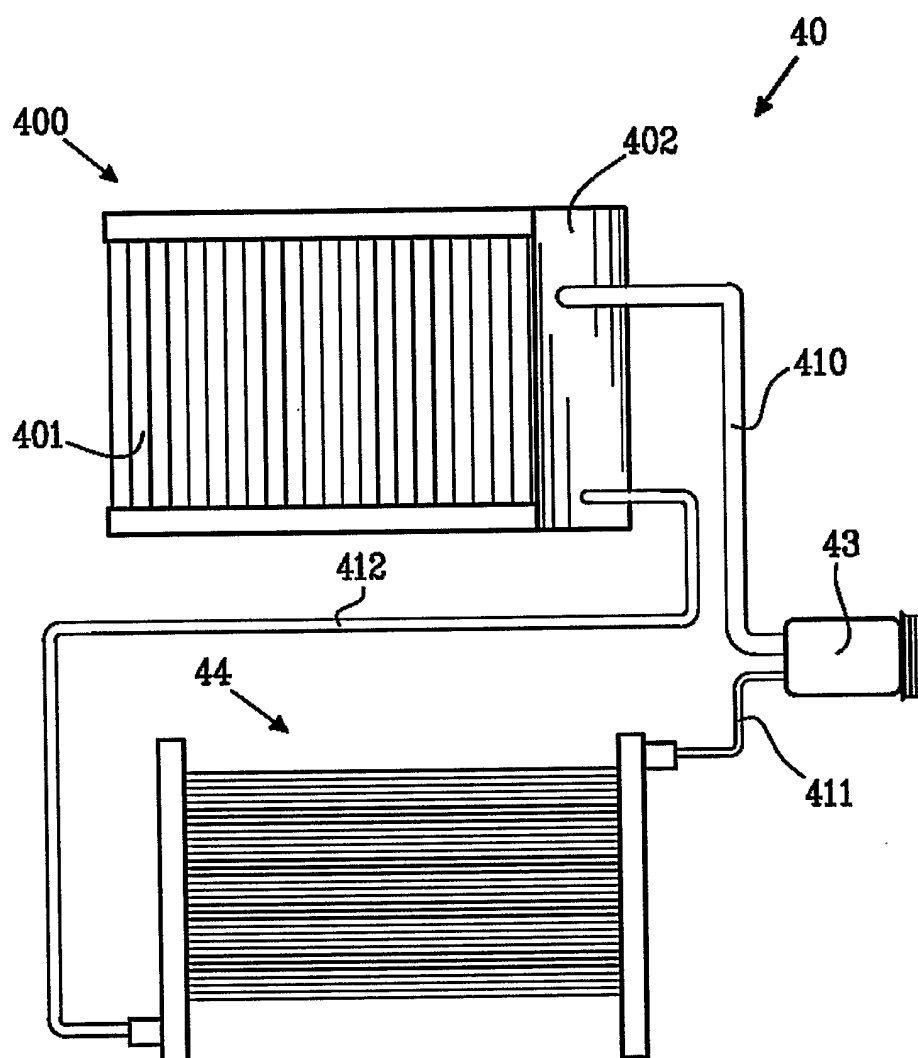


Fig. 3c

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*Fig. 4*

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 2004/001925

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B60H 1/32, F25B 39/02, F25B 40/02, F25B 41/06
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B60H, F25B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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INTERNATIONAL SEARCH REPORT

International application No.

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