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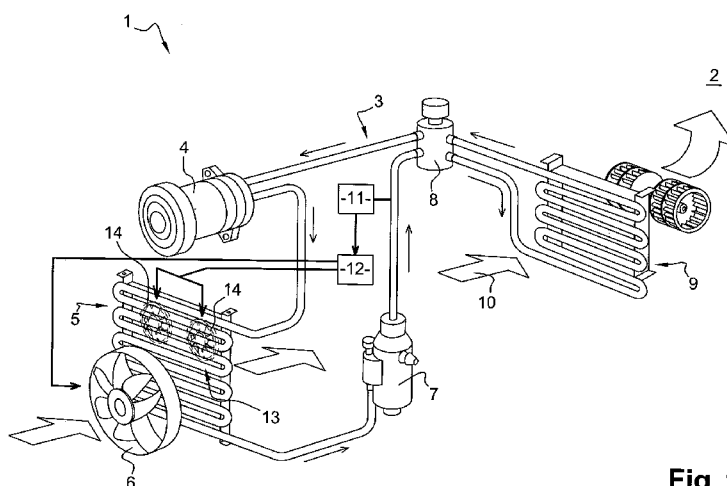


Fig. 1

(57) Abstract: The air conditioning system (1) comprises: a refrigerant circuit (3) carrying a refrigerant in a loop successively through a compressor (4), a condenser (5), an expander (8) and an evaporator (9) capable of cooling an air flow (10) directed to-
wards the cabin (2); a sensor (11) of an operating parameter of the refrigerant; a shared main cooling system (6) and an auxiliary cooling system (13) both capable of providing additional cooling to the refrigerant flowing in the condenser (5). In case said operat-
ing parameter reaches a predetermined auxiliary threshold, the auxiliary cooling system (13) is put into operation before said operat-
ing parameter reaches the main threshold and the main cooling system (6) is put into operation.

METHOD FOR IMPROVING THE EFFICIENCY OF AN AIR CONDITIONING SYSTEM FOR A CABIN OF A VEHICLE

Field of the invention

5

The present invention relates to a method for improving the efficiency of an air conditioning system for a cabin of a vehicle, especially an industrial vehicle.

10

Technological background

An air conditioning system has been a standard feature in vehicles for many years.

Such a system typically comprises a refrigerant circuit carrying a refrigerant in a loop. Conventionally, the refrigerant in gaseous phase is compressed into a high pressure gas in a compressor which is driven by the vehicle engine or by a dedicated motor. At the output of the compressor, the refrigerant is hot due to the compression. The refrigerant is then carried towards a condenser, which may be located in the front of the vehicle or at any other location where it may be contacted by a flow of external ambient air, and in which the refrigerant is cooled down and condensed into a liquid, while remaining at a high pressure. The condenser is essentially a heat exchanger between the refrigerant, at high pressure, and the external ambient air.

The refrigerant in liquid phase, but at high pressure, is then expanded in an expander where its temperature drops dramatically, and it is then carried towards an evaporator where it is evaporated into a gas before entering the compressor again. The evaporation of the refrigerant in the evaporator is used to cool an air flow directed towards the cabin, in order to lower the cabin temperature. The evaporator is essentially a heat exchanger between the refrigerant, at low pressure, and the air which is to be blown inside the cabin.

Of course, various types of air conditioning systems are based on this principle, but the various elements can vary from one embodiment to another. For example, the expander may be a mere calibrated orifice fluid passage, a variable section orifice fluid passage, or can be a thermostatic expansion valve. In the former two cases, the system may further comprise an

accumulator between the evaporator and the compressor, and in the latter case, the system may further comprise a receiver dryer between the condenser and the expander.

5 In some operating conditions, the condenser cannot remove enough calories from the refrigerant, which means that the air conditioning system cannot provide the expected cooling effect. This can happen when the outside temperature is high or when the vehicle has stopped or is moving at low speed, for example in a city.

10 In such cases, it is desirable both to maintain the air conditioning system operative in order to keep the comfort of the driver to a satisfactory level, and to ensure the refrigerant operating parameters remain at acceptable levels so as to avoid damaging the refrigerant circuit.

One solution to improve the system efficiency is to arrange a fan close to the condenser. In case further cooling of the refrigerant is needed, the fan can be put into operation in order to blow a higher flow rate of external ambient air onto the condenser, therefore improving the thermal exchange with the refrigerant.

20 Such a fan can be the same fan as the one used to cool the vehicle engine, said fan being for example driven by said engine through a clutch coupling. As this fan is primarily designed to cool the engine, it is dimensioned to be capable of creating an air flow which is quite high, therefore requiring a fairly high power.

25 The consequences of such an arrangement are the following. First of all, the engine fan is greatly over dimensioned with respect to the needs of the air conditioning system. Besides, there may occur a need to put the fan into operation for improving the air conditioning system efficiency while the engine does not require additional cooling at the same time.

30 Therefore, improving the air conditioning system efficiency with such a conventional disposition results in too much power required and an increased fuel consumption.

It therefore appears that, from several standpoints, there is room for improvement in air conditioning system for vehicles.

Summary

It is an object of the present invention to provide a method for improving the efficiency of an air conditioning system for a cabin of a vehicle which can overcome the drawbacks encountered in conventional methods for operating air conditioning systems.

Another object of the present invention is to provide a method which makes it possible to substantially maintain the cooling effect in some critical operating conditions of the engine without entailing a too high increase of fuel consumption.

The invention relates to a method for improving the efficiency of an air conditioning system for a cabin of a vehicle, said system comprising:

- a refrigerant circuit carrying a refrigerant in a loop successively through a compressor, a condenser, an expander and an evaporator capable of cooling an air flow directed towards the cabin;
- a sensor of an operating parameter of the refrigerant;
- a shared main cooling system capable of providing additional cooling to the refrigerant flowing in the condenser;

According to the invention, the method comprises:

- monitoring said operating parameter;
- in case said operating parameter reaches a predetermined main threshold, putting the main cooling system into operation;
- providing an auxiliary cooling system distinct from the main cooling system and capable of providing additional cooling to the refrigerant flowing in the condenser;
- in case said operating parameter reaches a predetermined auxiliary threshold, putting the auxiliary cooling system into operation before said operating parameter reaches the main threshold.

Thus, the method according to the invention allows prioritizing the use of the auxiliary cooling system over the main cooling system.

As the main cooling system is shared, i.e. used by other components such as, for example, the engine radiator, it can be typically dimensioned according to the most demanding component which is generally not the condenser of the refrigerant circuit. Therefore, the operation of such a main cooling system involves quite high fuel consumption and, in most cases, it is not necessary to provide so much cooling to the condenser.

By putting the auxiliary cooling system into operation as a priority, the invention makes it possible to delay the starting up of the main cooling system or even to avoid it to some extent, which avoids energy unnecessary consumption by said main system.

5 Advantageously, the auxiliary threshold is close enough to the main threshold in order to avoid putting the auxiliary cooling system into operation when no additional cooling is really required for the refrigerant flowing in the condenser. However, the auxiliary threshold is also far enough from the main threshold to allow time for the auxiliary cooling system to bring the operating
10 parameter back to an acceptable value before the main cooling system is put into operation.

 If the auxiliary cooling system is not sufficient to provide the needed cooling, the operational parameter may reach the main threshold, and, as a consequence, the main cooling system may be put into operation. Said
15 main cooling system can be designed with several increasing operating levels, which means that the higher level is not necessarily reached from the beginning. This further helps reducing the fuel consumption.

 If the operational parameter later comes back to an acceptable value, i.e. when no additional cooling of the refrigerant flowing in the condenser
20 is needed, then the main cooling system can be turned off if its operation is not otherwise necessary for the other component with which it is shared.

 Therefore, the invention makes it possible to keep the air conditioning system in use by temporarily increasing the efficiency of the condenser, thanks to a smart use of the auxiliary cooling system, without
25 entailing a high increase of fuel consumption due to the operation of the main cooling system.

 These and other features and advantages will become apparent upon reading the following description in view of the drawing attached hereto representing, as non-limiting examples, embodiments of an air conditioning
30 system and the method for improving its efficiency, according to the invention.

Brief description of the drawings

35 The following detailed description of several embodiments of the invention is better understood when read in conjunction with the appended

drawings, it being however understood that the invention is not limited to the specific embodiments disclosed.

Figure 1 is a schematic representation of an air conditioning system according to a first embodiment of the invention, where the method involves an auxiliary cooling system using ambient air;

Figure 2 is a schematic representation of an air conditioning system according to a second embodiment of the invention, where the method involves an auxiliary cooling system using the condensation fluid which appears at the evaporator;

Figure 3 and 4 are schematic representations of the air conditioning system of Figure 2, showing more specifically the way how the condensation fluid is brought into thermal contact with the refrigerant flowing in the condenser, respectively according to a first and a second variants of the second embodiment.

Detailed description of the invention

As this is illustrated in Figures 1 and 2, an air conditioning system 1 for a cabin 2 of a vehicle first comprises a refrigerant circuit 3 which carries a refrigerant in a loop.

In the refrigerant circuit 3, the refrigerant, as a low pressure gas, enters a compressor 4 driven by the vehicle engine or by a dedicated motor. After the compressor 4, the high pressure and high temperature gaseous refrigerant is directed towards a condenser 5 which may be located in the front of the vehicle, and in which the refrigerant is condensed into a high pressure liquid. In this embodiment, the refrigerant flows towards a receiver dryer 7 and then flows through an expander 8, which is here embodied as a thermal expansion valve. In the expander 8, the high pressure liquid is expanded, so that its pressure is lowered, thereby considerably reducing its temperature. The low pressure refrigerant then enters an evaporator 9 where it is evaporated into a low pressure gas. Said gaseous refrigerant then flows back towards the compressor 4. At the evaporator 9, the evaporation of the refrigerant is used to cool an air flow 10 which is conveyed towards the cabin 2 for example with the help of a blower. Conversely, the air flow heats the refrigerant, thereby promoting its evaporation.

In order to improve the condenser efficiency, there is provided a shared main cooling system capable of providing additional cooling to the refrigerant flowing in the condenser 5. In the illustrated embodiments, said shared main cooling system comprises a fan 6 driven by the engine of the vehicle or by a separate motor, this fan 6 being provided close to the condenser 5. The shared main cooling system can be controlled to be operative or non-operative. For example in the case of a fan driven by the engine, a clutch coupling may be provided and can be uncoupled to stop driving the fan when no additional cooling is necessary, or coupled when the airflow created by the fan is needed.

The air conditioning system 1 also comprises at least one sensor for sensing at least one operating parameter of the refrigerant, preferably one or several parameters representative of the capacity of said refrigerant to cool the air flow 10. In concrete terms, the operating parameter can be the pressure of the refrigerant in the refrigerant circuit 3, preferably when said refrigerant is in liquid phase. In this embodiment, a pressure sensor 11 is provided in the circuit 3 between the receiver dryer 7 and the expander 8. The sensor could also be provided between the condenser 5 and the receiver-dryer 7.

Alternatively, the operating parameter could be the refrigerant temperature.

A controller 12 is coupled to the sensor 11 of the operating parameter. Said controller 12 is capable of monitoring the operational parameter and, as a consequence, to control directly or indirectly both the main cooling system, here the operation of fan 6, and an auxiliary cooling system 13 which is distinct from the main cooling system and capable of providing additional cooling to the refrigerant flowing in the condenser 5. In practice, in case the operating parameter reaches a predetermined main threshold, the main cooling system 6 is put into operation. But before that, in case said operating parameter reaches a predetermined auxiliary threshold, the auxiliary cooling system 13 is put into operation before said operating parameter reaches the main threshold.

For example, if the operating parameter is the refrigerant pressure as described above, the auxiliary threshold is lower than the main threshold. If the refrigerant is R134A fluid, the main threshold can be set to around 24 bar, while the auxiliary threshold can be around 16 bar.

The auxiliary cooling system 13 can be dedicated to the cooling of the refrigerant flowing in the condenser 5. Alternatively, it could be shared with another component.

According to an advantageous implementation of the invention, the auxiliary cooling system 13 can use a power source or a cold source which can be stored. As a result, said power source or cold source can be used only when needed, which results in a reduction of the energy required for the functioning of the system. This also makes it possible to save this power source or cold source, to ensure some of it is substantially always available when an additional cooling is required.

In concrete terms, the power source can be electricity stored in batteries while the cold source can be a liquid such as water stored in a tank.

The method according to the invention is particularly advantageous in case the auxiliary cooling system 13 uses a power source or a cold source which is produced intermittently. This can be electricity, which can typically be produced only when the vehicle is in motion, and which can be produced at almost no energy cost when the vehicle is decelerating, or a fluid, for example the condensate water which may appear at the evaporator under certain conditions when the air conditioning system is in operation.

Since this power source of cold source is produced, it can be envisaged that no initial amount of said source is provided. However, said production can be too low to allow a continuous use of said source. Therefore, a smart use of this source is necessary to ensure some of it is substantially always available when an additional cooling is required.

A first embodiment of the invention will now be described with reference to Figure 1.

According to this embodiment, the auxiliary cooling system 13 uses external ambient air as a cold source.

In practice, the auxiliary cooling system can comprise at least one auxiliary fan 14 facing the condenser 5. In the illustrated example, two auxiliary fans 14 are provided. It may also be envisaged to arrange more auxiliary fans 14.

When the operating parameter or parameters, such as the pressure detected by the sensor 11, reaches the predetermined auxiliary threshold, the controller 12 controls the operation of the motor (not shown) which drives said fans 14. If this is not sufficient and the operating parameter

reaches the main threshold, the fan 6 – or more generally the main cooling system – is turned on. The fan 6 can be driven at only a portion of its maximum capacity, for example about 50% of its maximum capacity, thereby avoiding a too high fuel consumption which might not be needed to achieve the expected cooling effect. When the main cooling system is operative, the auxiliary cooling system may be stopped. In such a case the auxiliary cooling system 6 can be made operative again upon extreme conditions, so that the additional cooling actions of both the main and the auxiliary system are added.

Figures 2, 3 and 4 show a second embodiment of an air conditioning system 1 according to the invention.

According to this embodiment, the auxiliary cooling system 13 uses a cooling fluid as a cold source, the method comprising bringing said fluid in thermal contact with the refrigerant flowing in the condenser 5. Said cooling fluid could be water for example. Therefore, the refrigerant is cooled and condensed in the condenser 5 both by means of ambient air and by means of the cooling fluid.

Advantageously, there may be provided a tank 15 for storing said cooling fluid and a pipe 16 for carrying said fluid from the tank 15 towards the condenser 5, said pipe 16 being equipped with a valve 17 located downstream from the tank 15 and controlled by the controller 12 coupled to the sensor 11 of the operating parameter. As described below, the tank 15 can be fed during the operation of the system with fluid produced on-board the vehicle, such as with condensate water. Alternatively or in combination, it could also be filled with fluid from time to time, for example at each time fuel is added to the fuel tank.

Especially when it is provided to fill the tank with fluid produced on-board the vehicle, an overflow duct 18 is preferably provided from said tank 15 towards a point of the pipe 16 downstream of the valve 17, so as to form a valve bypass so that the excess cooling fluid can be directed towards the condenser 5 whatever the operating parameter.

The thermal contact between the cooling fluid and the refrigerant can be achieved by providing a condenser 5 in the form of a three-fluid heat exchanger with the refrigerant as a first fluid, ambient air as a second fluid, and the cooling fluid as a third fluid, or by spraying said cooling fluid onto the condenser 5.

In the embodiment illustrated in the figures, the auxiliary cooling system 13 can use the condensation fluids which may appear at the evaporator 9 in use as a cold source.

To this end, the air conditioning system 1 can comprise a collector 19 for collecting the condensation fluids which may appear on the evaporator 9 in use. The collected condensation fluids can be received in the tank 15 and then be carried towards the condenser 5 by the pipe 16.

The condensation fluid primarily comprises water which is condensed on the evaporator because the air which comes into contact with the evaporator is cooled and thereby loses part of its ability to carry water vapor. Said pipe 16 can also carry cold air. Presence of air may derive from the fact the pipe 16 originates near the evaporator, where air may be slightly pressurized due to the blower of the air conditioning system.

The flow of condensation fluids in the pipe 16 may result from the slight overpressure at the evaporator 9, from gravity, and/or through the provision of a pump located for example in the pipe 16.

A significant advantage of this embodiment is that the invention makes use of the condensation fluids which would otherwise be lost, knowing that the volume of water which is condensed per hour can be quite high, especially in hot and humid countries.

According to a first variant of this second embodiment, the thermal contact between the condensation fluids and the refrigerant is achieved by providing a condenser 5 in the form of a three-fluid heat exchanger with the refrigerant as a first fluid, ambient air as a second fluid, and the condensation fluids as a third fluid. Such a condenser can be similar to the heat exchanger shown in document JP-61059188.

In practice, the condenser 5 can have a substantially parallelepiped shape. It can include a plurality of parallel conduits extending from a refrigerant inlet to a refrigerant outlet, said conduits extending between the vertical edges of the condenser 5. Furthermore, a side chamber may be located on each side of the conduits, preferably close to the corresponding vertical edge, the chambers being in fluid communication with the conduits.

According to an implementation, at least one of the conduits comprises an inner fluid passage in which the condensation fluids – or more generally the cooling fluid – can flow and an outer fluid passage substantially coaxial with the inner fluid passage and in which the refrigerant can flow. The

inner and outer fluid passages are separated by a continuous wall of the material of which the conduits are made, for example a metal such as aluminium. The inner and outer fluid passages are therefore fluid tight with respect one to the other. Air circulates around the outer surface of the conduit.

- 5 The outer fluid passage can be formed of a plurality of separate holes which extend axially, and which are arranged substantially all around the inner fluid passage.

In figure 3 are schematically illustrated three successive conduits 20 forming a serpentine path between an inlet 21 and an outlet 22, with the condensation fluids flowing in one direction in a conduit 20 and flowing in the opposite direction in the adjacent conduit 20. Of course, more successive conduits can be provided in the condenser 5.

This implementation of a condenser 5 is very efficient since it ensures a thermal transfer between the refrigerant and the condensation fluids along the whole length of the conduits 20.

In another implementation (not shown), the condenser 5 can further comprise an additional conduit in which the condensation fluids can flow, said additional conduit being located in at least one side chamber. The additional conduit can have a U shape extending along the whole height of the side chamber.

The condensation fluids are thereby heated by the refrigerant at the condenser 5. Due to this heating, at least part of the condensation water may be transformed into water vapor. This water vapor will eventually mix with air carried by the collecting pipe so as to form heated humidified air. The condensation fluids heated at the condenser 5 are rejected by a conduit 23 equipped with a sensor 24 capable of detecting water and coupled to the controller 12.

Alternatively, according to an implementation not shown, at least part of the condensation water heated and vaporized at the condenser 5 could be carried by a return pipe to the cabin 2, in order to humidify the cabin 2. As shown in figure 3, the cabin 2 includes at least one air duct 25 comprising openings 26 by which air can enter the cabin 2. An air conditioner 27 coupled to the evaporator 9 is provided inside the cabin 2 or in an engine compartment to send cooled air into said air duct 25. The return pipe preferably delivers at least part of the heated condensation water to the duct 25.

One advantage of this implementation is that the condensation fluids are canalized, and that this minimizes the amount of water being rejected on the ground, which can generate rust on the parts of the vehicle on which said water streams, and marks on the ground.

5 In practice, the operation of the system can be as follows. When the refrigerant pressure detected by the sensor 11 reaches the auxiliary threshold, for example around 16 bar, the controller 12 causes the valve 17 to open, thereby bringing some cooling fluid towards the condenser 5. As a consequence, the refrigerant pressure drops, or at least rises more slowly,
10 which avoids or delays putting the fan 6 into operation. After the pressure has decreased the controller 12 causes the valve 17 to shut. Hence, the tank 5 can be filled again, and only ambient air is used to cool the refrigerant flowing in the condenser 5.

According to a second variant of the second embodiment, the
15 thermal contact between the cooling fluid (here the condensation fluids) and the refrigerant fluid is achieved by spraying said cooling fluid onto the condenser 5, as illustrated in figure 4.

The condenser 5 can be of the conventional type, i.e. without specific arrangement of the conduits to form a passage for the condensation
20 fluids.

The downstream end of pipe 16 can be equipped with several nozzles 28 designed to spray droplets of cooling fluid onto the condenser 5 in order to provide additional cooling of the refrigerant. The droplets can be sprayed directly onto the condenser 5 or in an air flow directed towards the
25 condenser 5.

As previously described, the spraying is not continuous but occurs only when the operating parameter has reached the auxiliary threshold and the valve 17 has been opened. This allows the tank 15 to be filled when no additional cooling is needed, so that some cooling fluid is available for spraying
30 when necessary.

Thanks to the invention, the efficiency of the air conditioning system can be greatly improved. Therefore, the system can provide enough cooled air in the cabin even during hot days or when the vehicle is moving at low speeds. The invention makes it possible to achieve this effect without
35 requiring the main fan to rotate during long periods, and therefore contributes to reduce the fuel consumption. Moreover, by improving the system efficiency, the

invention also makes it possible to reach more quickly the target temperature inside the cabin.

The invention provides an air conditioning system which will be capable of producing enough cooling efficiency even with refrigerants
5 conforming to future regulations, which may be less effective.

Of course, the invention is not restricted to the embodiments described above by way of non-limiting examples, but on the contrary it encompasses all embodiments thereof.

CLAIMS

1. A method for improving the efficiency of an air conditioning system (1) for a cabin (2) of a vehicle, said system (1) comprising:

5 - a refrigerant circuit (3) carrying a refrigerant in a loop successively through a compressor (4), a condenser (5), an expander (8) and an evaporator (9) capable of cooling an air flow (10) directed towards the cabin (2);

 - a sensor (11) of an operating parameter of the refrigerant;
10 - a shared main cooling system (6) capable of providing additional cooling to the refrigerant flowing in the condenser (5);

the method comprising:

 - monitoring said operating parameter;
 - in case said operating parameter reaches a predetermined
15 main threshold, putting the main cooling system (6) into operation;

characterized in that the method comprises:

 - providing an auxiliary cooling system (13) distinct from the main cooling system (6) and capable of providing additional cooling to the refrigerant flowing in the condenser (5);
20 - in case said operating parameter reaches a predetermined auxiliary threshold, putting the auxiliary cooling system (13) into operation before said operating parameter reaches the main threshold.

2. The method according to claim 1, characterized in that the
25 operating parameter is the pressure of the refrigerant in the refrigerant circuit (3), preferably when said refrigerant is in liquid phase.

3. The method according to claim 1 or claim 2, characterized in that the shared main cooling system comprises a fan (6) driven by the engine
30 of the vehicle.

4. The method according to any one of claims 1 to 3, characterized in that the auxiliary cooling system (13) is dedicated to the cooling of the refrigerant flowing in the condenser (5).

5. The method according to any one of claims 1 to 4, characterized in that the auxiliary cooling system (13) uses a power source or a cold source which can be stored.

5 6. The method according to any one of claims 1 to 5, characterized in that the auxiliary cooling system (13) uses a power source or a cold source which is produced intermittently.

7. The method according to any one of claims 1 to 6,
10 characterized in that the auxiliary cooling system (13) uses ambient air as a cold source.

8. The method according to claim 7, characterized in that the
15 auxiliary cooling system comprises at least one auxiliary fan (14) facing the condenser (5).

9. The method according to any one of claims 1 to 6,
characterized in that the auxiliary cooling system (13) uses a cooling fluid as a cold source, the method comprising bringing said fluid in thermal contact with
20 the refrigerant flowing in the condenser (5).

10. The method according to claim 9, characterized in that it
comprises providing a tank (15) for storing said cooling fluid and a pipe (16) for carrying said fluid from the tank (15) towards the condenser (5), said pipe (16)
25 being equipped with a valve (17) located downstream from the tank (15) and controlled by a controller (12) coupled to the sensor (11) of the operating parameter.

11. The method according to claim 10, characterized in that an
30 overflow duct (18) is provided from said tank (15) towards a downstream point of the pipe (16) so that the excess cooling fluid is directed towards the condenser (5), whatever the operating parameter.

12. The method according to any one of claims 9 to 11,
35 characterized in that the thermal contact between the cooling fluid and the refrigerant is achieved by providing a condenser (5) in the form of a three-fluid

heat exchanger with the refrigerant as a first fluid, ambient air as a second fluid, and the cooling fluid as a third fluid.

13. The method according to any one of claims 9 to 12,
5 characterized in that the thermal contact between the cooling fluid and the refrigerant fluid is achieved by spraying said cooling fluid onto the condenser (5).

14. The method according to any one of claims 9 to 14,
10 characterized in that the auxiliary cooling system (13) uses the condensation fluids which may appear at the evaporator (9) in use as a cold source.

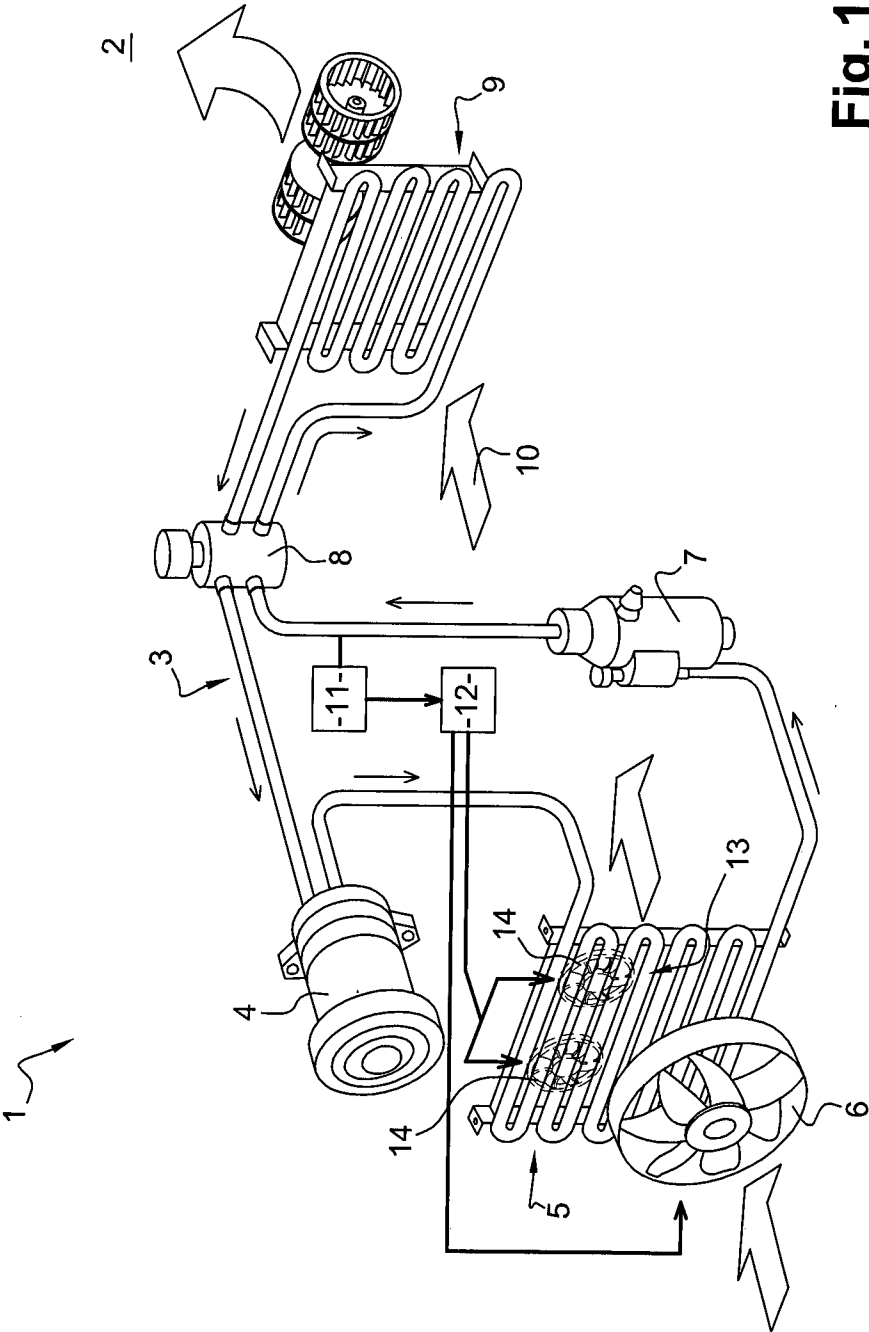
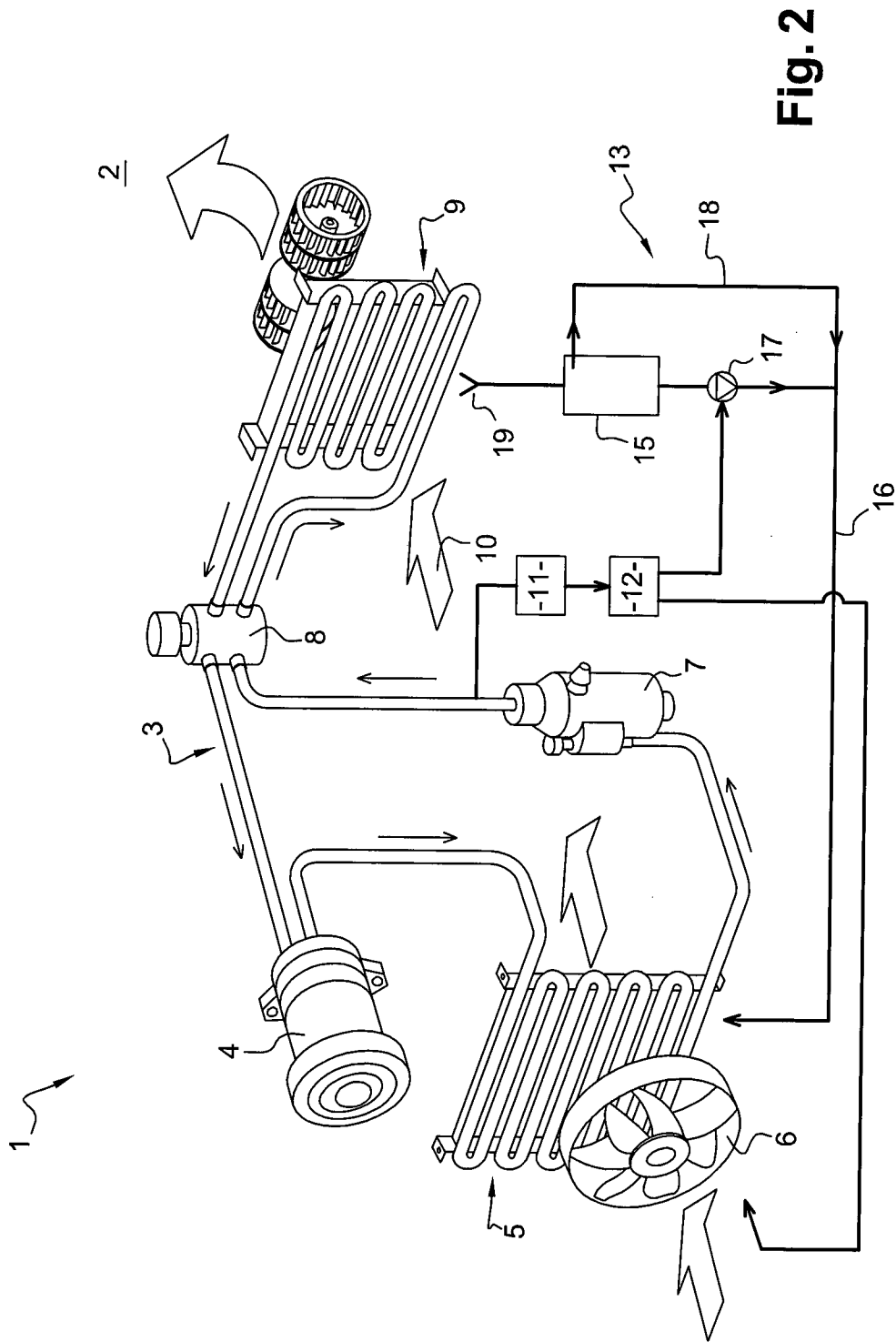


Fig. 1



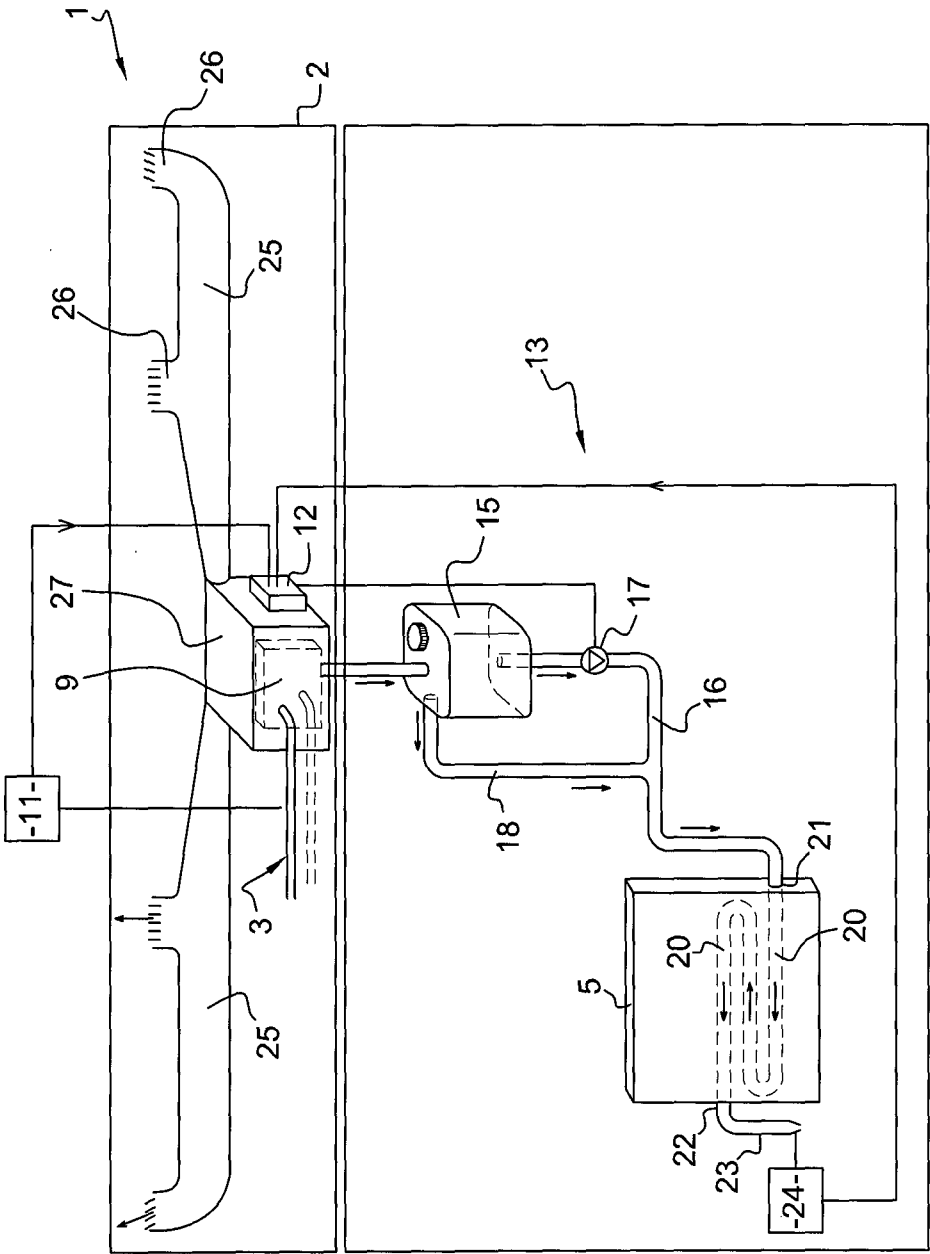


Fig. 3

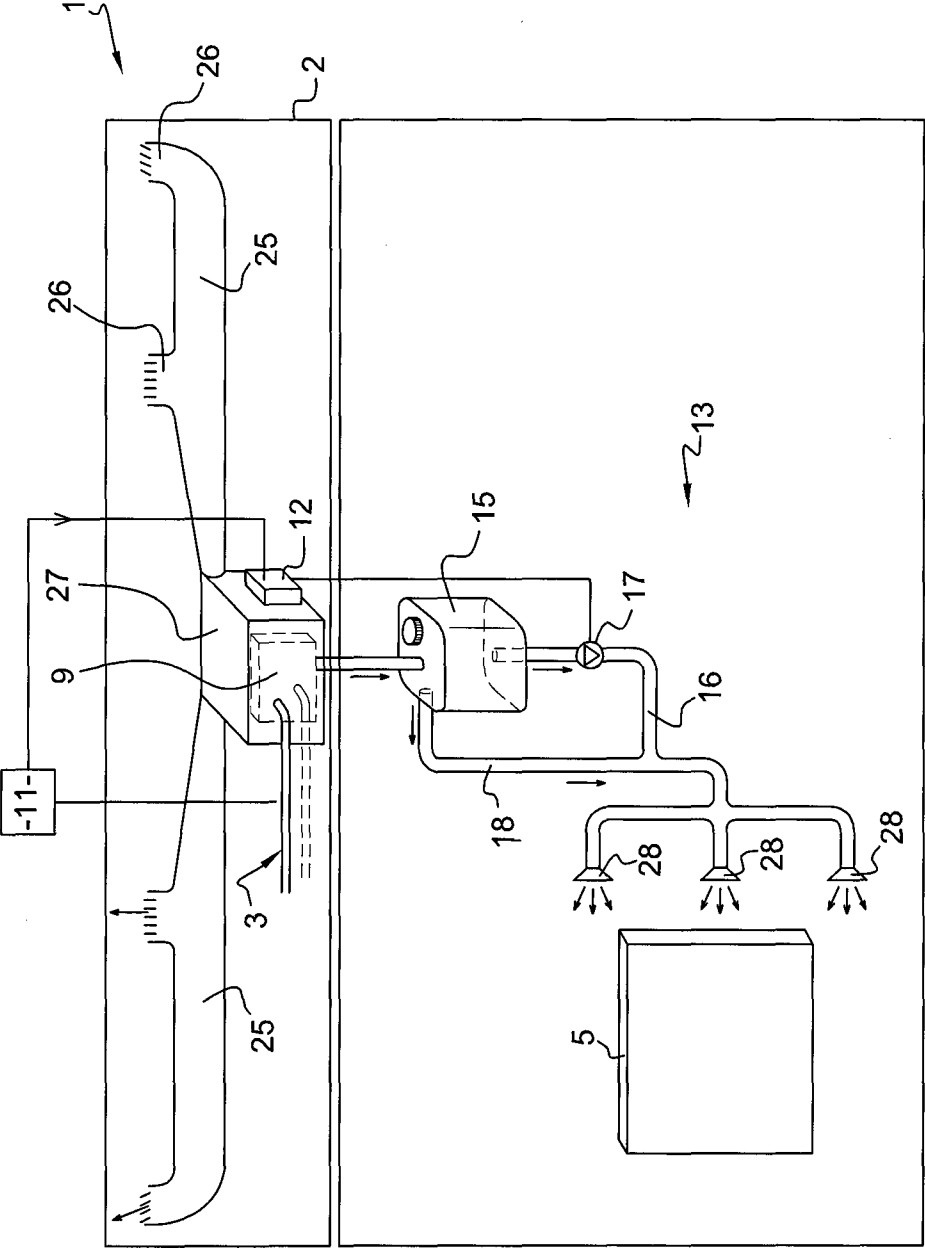


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2011/002496

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60H1/32
ADD.

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)
B60H

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 138 844 A (CLANIN THOMAS J [US] ET AL) 18 August 1992 (1992-08-18) columns 4-5; figure 1 -----	1-4,6-8
X	US 5 385 030 A (KITAGAWA KOICHI [JP] ET AL) 31 January 1995 (1995-01-31) columns 4-6; figure 3 -----	1-4,6-8
X	EP 1 632 373 A1 (BEHR GMBH & CO KG [DE]) 8 March 2006 (2006-03-08) claims; figures 1,7 -----	1-4,6-8
X	US 5 186 242 A (ADACHI TSUNENARI [JP] ET AL) 16 February 1993 (1993-02-16) columns 4-6; figure 1 ----- -/-	1-5, 9-12,14

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

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Date of the actual completion of the international search

17 February 2012

Date of mailing of the international search report

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International application No

PCT/IB2011/002496

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