



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
11.02.2004 Bulletin 2004/07

(51) Int Cl.7: **F25B 43/00, F25B 13/00**

(21) Application number: **03102266.8**

(22) Date of filing: **23.07.2003**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IT LI LU MC NL PT RO SE SI SK TR
 Designated Extension States:
AL LT LV MK

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(30) Priority: **05.08.2002 LU 90945**

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(54) **Bidirectional receiver dryer**

(57) The present method relates to a bidirectional receiver dryer (10) comprising a housing (11), a first drying chamber (12) and a second drying chamber (14) within the housing (11), a partition wall (16) arranged in the housing (11) for separating the first and second drying chambers (12, 14), and an expansion device (28) flu-

idly connected between the first and second drying chambers (12, 14). The partition wall (16) is arranged so as to be able to increase the size of one of the drying chambers while at the same time decreasing the size of the other drying chamber, one of the drying chambers having its size increased at the expense of the other.

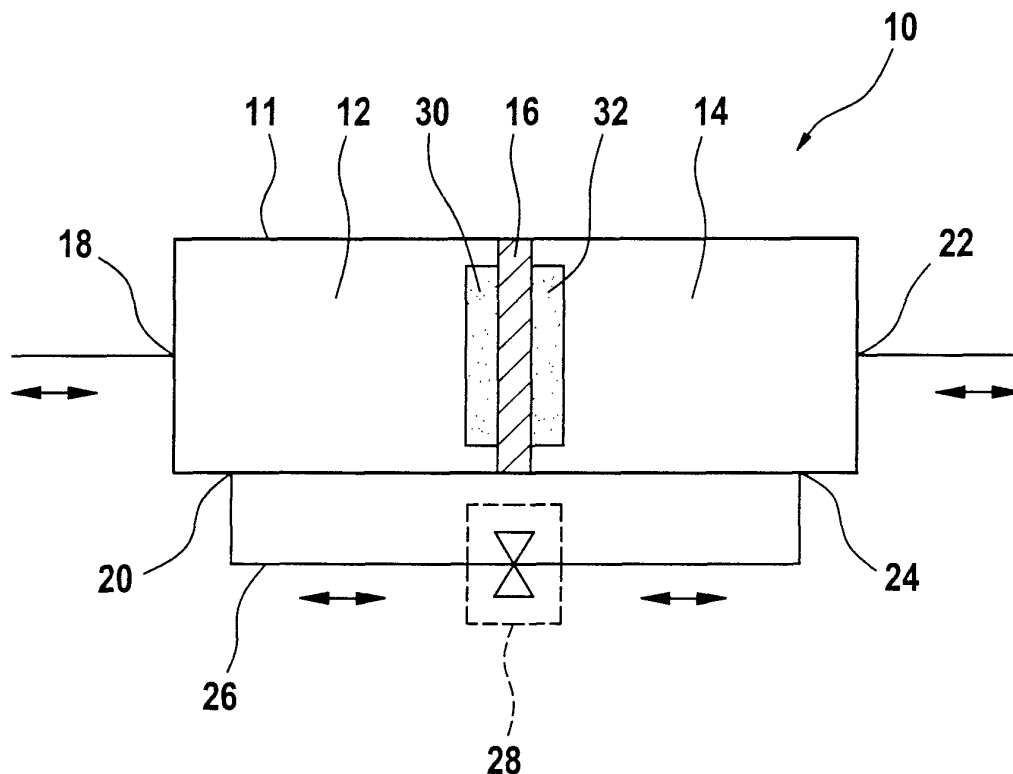


Fig. 1

Description

Field of the invention

[0001] The present invention generally relates to a bidirectional receiver dryer, in particular for use in a reversible air conditioning system.

Background of the invention

[0002] In a typical air conditioning system, a refrigerant in a vapor state is compressed by a compressor unit driven by a motor. The compressed refrigerant, at high temperature and pressure, enters a condenser where heat is removed from the compressed refrigerant and the refrigerant changes to a liquid state. The refrigerant then travels through a receiver dryer to an expansion device. The expansion device throttles the refrigerant as the refrigerant flows through an orifice, which causes the refrigerant to change phase from liquid to a saturated liquid/vapor mixture. The mixture then enters an evaporator, where heat is drawn from the environment, thus cooling the environmental air and causing the refrigerant to change to a vapor state. The low-pressure refrigerant flow from the evaporator returns to the suction side of the compressor to begin the cycle anew.

[0003] Receiver dryer devices, in particular for use in automobile air conditioning units, are well known in the state of the art. They are generally located between the condenser and the expansion device and ensure that only liquid refrigerant is fed to the expansion device.

[0004] In some automotive vehicles, e.g. in vehicles powered by traction motors supplied with electrical power from onboard fuel cells or batteries or in vehicles with advanced diesel engines, the internal combustion engine cannot be relied upon to provide the heat necessary for heating the passenger compartment of the vehicle in cold climate conditions. It has therefore been proposed to operate the air conditioning system as a heat pump, by reversing the flow of refrigerant. To operate the air conditioning system as a heat pump, a reversing valve can be provided and the flow is diverted such that the original evaporator becomes the condenser, the original condenser becomes the evaporator and the flow of refrigerant through the system is reversed. However, as the condenser can now also be located on the other side of the expansion device, a further receiver dryer device must be provided on the other side of the expansion device. This further receiver dryer unfortunately uses up valuable space and the whole system becomes heavier and more expensive.

[0005] There was hence a need for a single receiver dryer that would be positioned between the condenser and the expansion device whether the system was used for cooling or for heating.

[0006] Such a receiver dryer has been disclosed in US-5,832,741 to Hutchison et al. This receiver dryer comprises a drying chamber for removing moisture from

the refrigerant and a bypass chamber for bypassing the drying chamber. The receiver dryer further comprises four ports, two circuit ports and two expansion device ports. The two circuit ports are connected to the evaporator and condenser respectively and the two expansion device ports are connected to the expansion device. Whatever mode the system is operated in, the refrigerant first flows via one of the circuit ports into the drying chamber of the receiver dryer, where it passes through the desiccant material and moisture is removed from the refrigerant. The refrigerant is then led via the first of the expansion device ports out of the receiver dryer and to the expansion device, where it expands. The refrigerant is then led from the expansion device into the bypass chamber of the receiver dryer via the second of the expansion device ports. The refrigerant finally leaves the receiver dryer via the other of the circuit ports. The flow of refrigerant within the receiver dryer is controlled by means of a rather complex arrangement of check valves. Four ball valves are arranged between the two circuit ports to direct the flow of refrigerant either through the drying chamber or through the bypass chamber. This complex arrangement of check valves makes the receiver dryer rather difficult to assemble and therefore also more expensive.

Object of the invention

[0007] The object of the present invention is to provide a bidirectional receiver dryer of simpler design.

Summary of the invention

[0008] This object is achieved by a bidirectional receiver dryer according to claim 1, wherein the receiver dryer comprises a housing, a first drying chamber and a second drying chamber within the housing, a partition wall arranged in the housing for separating the first and second drying chambers, and an expansion device fluidly connected between the first and second drying chambers. The partition wall is arranged so as to be able to increase the size of one of the drying chambers while at the same time decreasing the size of the other drying chamber, one of the drying chambers having its size increased at the expense of the other.

[0009] The receiver dryer according to the invention has one drying chamber arranged either side of the expansion device. Whichever mode the air conditioning system is operated in, the refrigerant always flows through one drying chamber, through the expansion device and then through the other drying chamber. There is therefore no need to provide the receiver dryer with any check valves to direct the flow of refrigerant through the receiver dryer. The present receiver dryer is therefore simpler in design and can be more cheaply produced. The absence of check valves also increases the reliability of the receiver dryer as there are fewer elements that can break down.

[0010] Furthermore, due to the fact that the partition wall allows the drying chambers to be adapted in size and that one of the drying chambers has its size increased at the expense of the other, a more compact receiver dryer can be achieved. While the drying chamber upstream of the expansion device needs to have a certain size in order to be able to receive the refrigerant therein, the drying chamber downstream of the expansion device can be considerably smaller. Instead of arranging two drying chambers of certain size in the receiver dryer, the present invention proposes to provide a partition wall, which allows the drying chambers to vary in size. As the size of the drying chamber upstream of the expansion device is increased, the size of the other drying chamber is decreased by approximately the same amount.

[0011] When the air conditioning system is operated in a first mode, a first of the drying chambers is increased in size so as to receive the refrigerant therein. At the same time, the second of the drying chambers is reduced in size and has no other function than allow the passage of the refrigerant. When the air conditioning system is operated in a second mode and the flow of refrigerant is reversed, the second of the drying chambers is increased in size so as to receive the refrigerant therein. At the same time, the first of the drying chambers is reduced in size and has no other function than allow the passage of the refrigerant. As only the drying chamber upstream of the expansion device is large, the overall size of the receiver dryer is reduced. In fact, the present bidirectional receiver dryer can be designed to be only marginally bigger than a conventional unidirectional receiver dryer with a single drying chamber. An air conditioning system comprising the present receiver dryer allows the operation in two different modes, i.e. heating and cooling, without the need for any check valves.

[0012] It should also be noted that the drying chambers of the present receiver dryer are bidirectional, i.e. the refrigerant can flow through the drying chambers in either direction. This is in contrast to the drying chamber of US-5,832,741, which is unidirectional and where the refrigerant always flows from one of two inlet ports to an outlet port.

[0013] Preferably, the partition wall is a sliding piston wherein stop elements are advantageously arranged in the first and second drying chambers so as to limit the movement of the sliding piston. Indeed, the ports of each drying chamber should remain open, and a passage should be maintained between the ports of each drying chamber so that refrigerant can flow through the drying chambers. The stop elements can also provide additional sealing between the drying chambers. The partition wall can however also be e.g. an elastic membrane.

[0014] The partition wall is advantageously operated by means of the pressure difference between the two drying chambers. The pressure of the refrigerant in the drying chamber upstream of the expansion device is

higher than the pressure of the refrigerant in the drying chamber downstream of the expansion device. Therefore, the partition wall can be moved, under influence of this pressure difference, so as to increase the size of the drying chamber upstream of the expansion device at the expense of the drying chamber downstream of the expansion device. There is therefore no need to provide separate drive or control means for the sliding piston and the receiver dryer is more reliable. The receiver dryer can also be produced more cheaply. It is however not excluded to operate the partition wall mechanically by providing drive or control means. Such control means can e.g. be useful if the pressure difference between the two drying chambers is not sufficient to move the partition wall.

[0015] The receiver dryer preferably further comprises a first circuit port and a first expansion device port in connection with the first drying chamber; and a second circuit port and a second expansion device port in connection with the second drying chamber. The expansion device is then preferably arranged between the first expansion device port and the second expansion device port. This allows the expansion device to be arranged outside of the receiver dryer whereby it becomes more accessible for maintenance or replacement. It is however not excluded to provide an expansion device within the partition wall between the two drying chambers.

[0016] The expansion device is preferably a thermal expansion valve. Advantageously, the thermal expansion valve is a needle valve, so that it is bidirectional. The expansion device can also be an electronic expansion valve.

[0017] The receiver dryer is preferably arranged in an air conditioning system, wherein a refrigerant circulates in the system. The refrigerant used is e.g. R-12, R-134a, R-152 or CO₂. Any other suitable refrigerant can however also be used.

[0018] Desiccant material is preferably arranged in the drying chambers for removing moisture from the refrigerant. The desiccant material can e.g. be covering the circuit ports or the evaporation device ports, or it can be located on the partition wall.

[0019] Advantageously, at least one filter, e.g. a mesh filter, is arranged in said drying chambers. Such a filter can e.g. be associated with the evaporation device ports, so as to prevent any debris from reaching the evaporation device and thereby damaging the latter. Filters can also be associated with the circuit ports, so as to prevent any debris from entering the receiver dryer. Preferably however, the debris is allowed to enter, but prevented from leaving, the receiver dryer. The debris in the system can thereby be trapped inside the drying chambers of the receiver dryer, rather than elsewhere in the system. In order to trap the debris inside the drying chambers, moveable filters are associated with the circuit ports. The moveable filters are arranged so as to cover, resp. uncover, the first, resp. second, circuit ports depending on the direction of flow of the refrigerant. De-

bris can thereby easily enter a drying chamber of the receiver dryer. When the flow of refrigerant is reversed, the debris in the drying chamber is prevented from leaving the drying chamber by means of the moveable filter which now covers the circuit port associated with that drying chamber. The desiccant material can e.g. act as moveable filter for preventing debris from leaving the drying chambers.

[0020] The present invention also proposes an air conditioning system comprising a receiver dryer as described here above.

Brief description of the drawings

[0021] The present invention will be more apparent from the following description of a not limiting embodiment with reference to the attached drawings, wherein

Fig.1 schematically illustrates a bidirectional receiver dryer according to the invention;

Fig.2 schematically illustrates a first embodiment an air conditioning system comprising the receiver dryer of Fig.1, wherein the air conditioning system operates in cooling mode;

Fig.3 schematically illustrates the air conditioning system of Fig.2 operating in heating mode;

Fig.4 schematically illustrates a second embodiment an air conditioning system comprising the receiver dryer of Fig.1, wherein the air conditioning system operates in cooling mode;

Fig.5 schematically illustrates the air conditioning system of Fig.4 operating in heating mode;

Fig.6 schematically illustrates a preferred embodiment of the receiver dryer of Fig.1; and

Fig.7 schematically illustrates another preferred embodiment of the receiver dryer of Fig. 1.

Detailed description of a preferred embodiment

[0022] Fig.1 shows a receiver dryer 10 comprising a housing 11 in which are arranged: a first drying chamber 12, a second drying chamber 14 and a partition wall 16 for separating the two drying chambers 12, 14. The receiver dryer 10 comprises a first circuit port 18 for leading refrigerant from a first heat exchanger (not shown) into the first drying chamber 12 and a first expansion device port 20 for leading the refrigerant out of the first drying chamber 12. The receiver dryer 10 comprises a second circuit port 22 for leading refrigerant from a second heat exchanger (not shown) into the second drying chamber 14 and a second expansion device port 24 for leading the refrigerant out of the second drying chamber

14.

[0023] The first and second expansion device ports 20, 24 are connected to one another by means of a fluid line 26 comprising an expansion device 28 between the first and second expansion device ports 20, 24. The refrigerant always flows through one of the drying chambers 12, 14 then through the expansion device 28 and finally through the other of the drying chambers 12, 14.

[0024] The partition wall 16 is arranged in the housing 11 in such a way that the size of the drying chambers 12, 14 can be increased and decreased respectively. One of the drying chambers 12, 14 can be increased in size at the expense of the other drying chamber 12, 14. Indeed, while the drying chamber upstream of the expansion device 28 needs to be of certain size to allow storage of refrigerant, the drying chamber downstream of the expansion device 28 can be much smaller. By using such a partition wall 16, the sizes of the drying chambers 12, 14 can be adjusted depending on which mode the air conditioning system is operated in. The partition wall 16 can e.g. be a sliding piston, which moves such as to increase the size of one drying chamber, thereby decreasing the size of the other drying chamber. The operation of the moving partition wall can be controlled by means of the pressure difference in the two drying chambers 12, 14. The pressure in the drying chamber upstream of the expansion device is always higher than the pressure in the drying chamber downstream of the expansion device. The partition wall is therefore moved so as to increase the drying chamber upstream of the expansion device and decrease the size of the drying chamber downstream of the expansion device by the same amount. The receiver dryer according to the invention is of similar size to a conventional receiver dryer having only one drying chamber.

[0025] Fig.2 shows the receiver dryer 10 of Fig.1 mounted in an air conditioning system 40 operating in cooling mode. The system 40 comprises a compressor 42, a four-way valve 44, a first heat exchanger 46, the receiver dryer 10, the expansion device 28 and a second heat exchanger 48. The different elements 42, 46, 10, 28, 48 are connected by fluid pipes and form a closed circuit wherein a refrigerant can circulate.

[0026] The refrigerant exits the compressor 42 under high pressure for the four-way valve 44, which determines the direction of the refrigerant in the circuit. In cooling mode, i.e. when the inside compartment of a vehicle is to be cooled, the refrigerant exits the four-way valve 44 for the first heat exchanger 46, where it is condensed. The condensed refrigerant then enters the first drying chamber 12 of the receiver dryer 10 via the first circuit port 18. The pressure in the first drying chamber 12 is higher than the pressure in the second drying chamber 14. The partition wall 16 has therefore been displaced so as to increase the size of the first drying chamber 12 and decrease the size of the second drying chamber 14. The refrigerant collects in the first drying chamber 12 and moisture is removed from the refrigerant.

ant by means of the desiccant material 30 arranged in the first drying chamber 12. The refrigerant leaves the first drying chamber 12 via the first expansion device port 20 for the expansion device 28, where the refrigerant expands and drops in pressure. From the expansion device 28, the refrigerant flows through the second drying chamber 14 of the receiver dryer 10 for the second heat exchanger 48 where it evaporates. The refrigerant then flows back to the four-way valve 44 and through sensing means 50 of the expansion device 28 where the temperature and pressure of the refrigerant are sensed. Sensing can be relayed to the expansion device electronically or by way of a sensing bulb. The refrigerant then finally flows back to the compressor 42.

[0027] Fig.3 shows the receiver dryer 10 of Fig.1 mounted in the air conditioning system 40 operating in heating mode.

[0028] In heating mode, i.e. when the inside compartment of a vehicle is to be heated, the refrigerant exits the four-way valve 44 for the second heat exchanger 48, where it is condensed. The condensed refrigerant then enters the second drying chamber 14 of the receiver dryer 10 via the second circuit port 22. The pressure in the second drying chamber 14 is higher than the pressure in the first drying chamber 12. The partition wall 16 has therefore been displaced so as to increase the size of the second drying chamber 14 and decrease the size of the first drying chamber 12. The refrigerant collects in the second drying chamber 14 and moisture is removed from the refrigerant by means of the desiccant material 32 arranged in the second drying chamber 14. The refrigerant leaves the second drying chamber 14 via the second expansion device port 24 for the expansion device 28, where the refrigerant expands and drops in pressure. From the expansion device 28, the refrigerant flows through the first drying chamber 12 of the receiver dryer 10 for the first heat exchanger 48 where it evaporates. The refrigerant then flows back to the four-way valve 44 and through sensing means 50 of the expansion device 28 where the temperature and pressure of the refrigerant are sensed. The refrigerant then finally flows back to the compressor 42.

[0029] It should further be noted that the expansion device 28 is preferably a thermal expansion valve of needle type. Such a thermal expansion valve comprises sensing means 50 for detecting the pressure and temperature of the refrigerant exiting the four-way valve 44 for the compressor 42. The detected pressure and temperature is used to regulate the thermal expansion valve.

[0030] A second embodiment of an air conditioning system is shown in Figs 4 and 5. The system 40' comprises a compressor 42, a four-way valve 44, a first heat exchanger 46, the receiver dryer 10, the expansion device 28, a second heat exchanger 48 and a third heat exchanger 52. The different elements 42, 46, 10, 28, 48, 52 are connected by fluid pipes and form a closed circuit wherein a refrigerant can circulate. The second and third

heat exchangers 48, 52 are arranged in parallel between the receiver dryer 10 and the compressor 42. Valves 54, 56 are arranged in the circuit in order to direct the refrigerant either through the second or third heat exchanger 48, 52 depending on the mode of operation of the air conditioning system 40'.

[0031] In Fig.4, the air conditioning system 40' is shown operating in cooling mode. The refrigerant leaves the receiver dryer 10 via the second circuit port 22. A check valve 54 mounted upstream of the second heat exchanger 48 prevents the refrigerant from flowing into the second heat exchanger 48. A solenoid valve 56 is opened to allow the refrigerant to flow into the third heat exchanger 52 where it evaporates. From the third heat exchanger 52, the refrigerant flows back to the compressor 42 via the sensing means 50 of the expansion device 28. When the system is operated in cooling mode, the second heat exchanger 48 is not used; no refrigerant flows through it.

[0032] In Fig.5, the air conditioning system 40' is shown operating in heating mode. The refrigerant leaves the compressor 42 and is directed by the four-way valve 44 into the second heat exchanger 48 where it condenses. From the second heat exchanger 48, the refrigerant flows through the check valve 54 to the receiver dryer 10. The solenoid valve 56 is now closed to prevent the refrigerant from flowing to the third heat exchanger 52. When the system is operated in heating mode, the third heat exchanger 52 is not used; no refrigerant flows through it.

[0033] In the air conditioning system 40', the second heat exchanger 48 always operates as condenser and the third heat exchanger 52 always operates as evaporator. The air conditioning system 40' allows to eliminate flash fogging.

[0034] Figs 6 and 7 show preferred embodiments of the receiver dryer 10. In Fig.6, the desiccant material 30, 32 is mounted on either side of the partition wall 16. Refrigerant entering the first drying chamber 12 through the first circuit port 18 is dried by means of the desiccant material 30. When leaving the first chamber 12 through the first expansion device port 20, the refrigerant passes through a mesh filter 58 associated with the first expansion device port 20. Any debris in the refrigerant is thereby collected in the first drying chamber 12. The refrigerant then flows through the expansion device 28 towards the second expansion device port 24 and into the second drying chamber 14. The desiccant material 32 is arranged on the partition wall 16 in such a way that it covers the second circuit port 22. The refrigerant flowing through the second drying chamber 14 has to flow through the desiccant material 32 before leaving the second drying chamber 14. The desiccant material acts as filter and any debris contained in the second drying chamber 14 is prevented from flowing into the circuit via the second circuit port 22. A further mesh filter 60 is associated with the second expansion device port 24 to collect debris in the second drying chamber 14 when the

flow of refrigerant is reversed. It will be understood that, when the flow of refrigerant is reversed, the desiccant material 30 covers the first circuit port 18.

[0035] In the embodiment of Fig.7, the desiccant material 30, 32 is not arranged on the partition wall 16, but is pivotably arranged so as to cover the first and second circuit ports 18, 22 respectively. The desiccant material 30, 32 is pivotably mounted at pivots 62, 64 so as to allow the desiccant material 30, 32 to uncover the first or second circuit port 18, 22 depending on the direction of flow of the refrigerant. In Fig.7, the refrigerant flow forces the desiccant material 30 to uncover the first circuit port 18, so that the refrigerant can easily flow into the first drying chamber 12. The desiccant material 32 in the second drying chamber 14 is forced against the second circuit port 22 thereby covering the latter and preventing debris from leaving the second drying chamber 14 through the second circuit port 22. When the flow of refrigerant is reversed, the desiccant material 32 uncovers the second circuit port 22 and the desiccant material 30 covers the first circuit port 18.

[0036] The embodiments shown in Figs 6 and 7 allow trapping debris in the first and second drying chambers 12, 14, thereby removing debris from the rest of the circuit.

List of reference numerals

[0037]

10 receiver dryer
11 housing
12 first drying chamber
14 second drying chamber
16 partition wall
18 first circuit port
20 first expansion device port
22 second circuit port
24 second expansion device port
26 fluid line
28 expansion device
30 desiccant material
32 desiccant material
40 air conditioning system

42 compressor
44 four-way valve
5 46 first heat exchanger
48 second heat exchanger
50 sensing means
10 52 third heat exchanger
54 check valve
15 56 solenoid valve
58 mesh filter
60 mesh filter
20 62 pivot
64 pivot
25

Claims

1. Bidirectional receiver dryer comprising:

30 a housing;
a first drying chamber and a second drying chamber within said housing;
35 a partition wall arranged in said housing for separating said first and second drying chambers, said partition wall being arranged so as to be able to increase the size of one of the drying chambers while at the same time reducing the size of the other drying chamber, one of the drying chambers having its size increased at the expense of the other; and
40 an expansion device fluidly connected between said first and second drying chambers.
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2. Receiver dryer according to claim 1, wherein said partition wall is a sliding piston.

50 **3. Receiver dryer according to claim 1, wherein said partition wall is an elastic membrane.**

4. Receiver dryer according to claim 2, wherein said receiver dryer comprises
55 a first stop element in said first drying chamber; and a second stop element in said second drying chamber.

5. Receiver dryer according to any one of the previous claims, wherein the size of the drying chambers is determined by the pressure difference between the first and second drying chambers. 5
6. Receiver dryer according to any one of the previous claims, further comprising:
 - a first circuit port and a first expansion device port in connection with said first drying chamber; and 10
 - a second circuit port and a second expansion device port in connection with said second drying chamber; 15
 - said expansion device being arranged between said first expansion device port and said second expansion device port. 20
7. Receiver dryer according to any one of the previous claims, wherein said expansion device is a thermal expansion valve or an electronic expansion valve.
8. Receiver dryer according to any one of the previous claims, wherein said receiver dryer is arranged in an air conditioning system, wherein a refrigerant circulates in said system, the refrigerant being R152, R134a, R12, CO₂. 25 30
9. Receiver dryer according to any one of the previous claims, wherein desiccant material is arranged in said drying chambers.
10. Receiver dryer according to any one of the previous claims, wherein a filter is arranged in said drying chambers. 35
11. Air conditioning system comprising a receiver dryer according to any one of claims 1 to 10. 40

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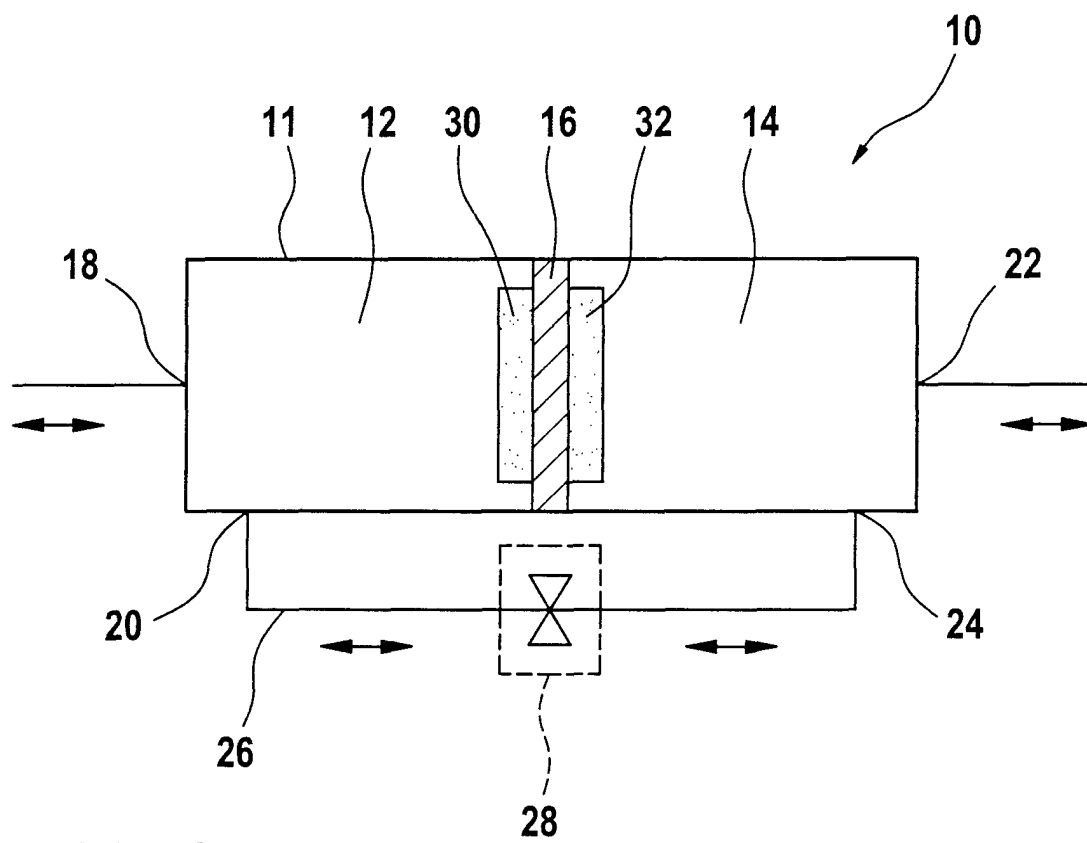
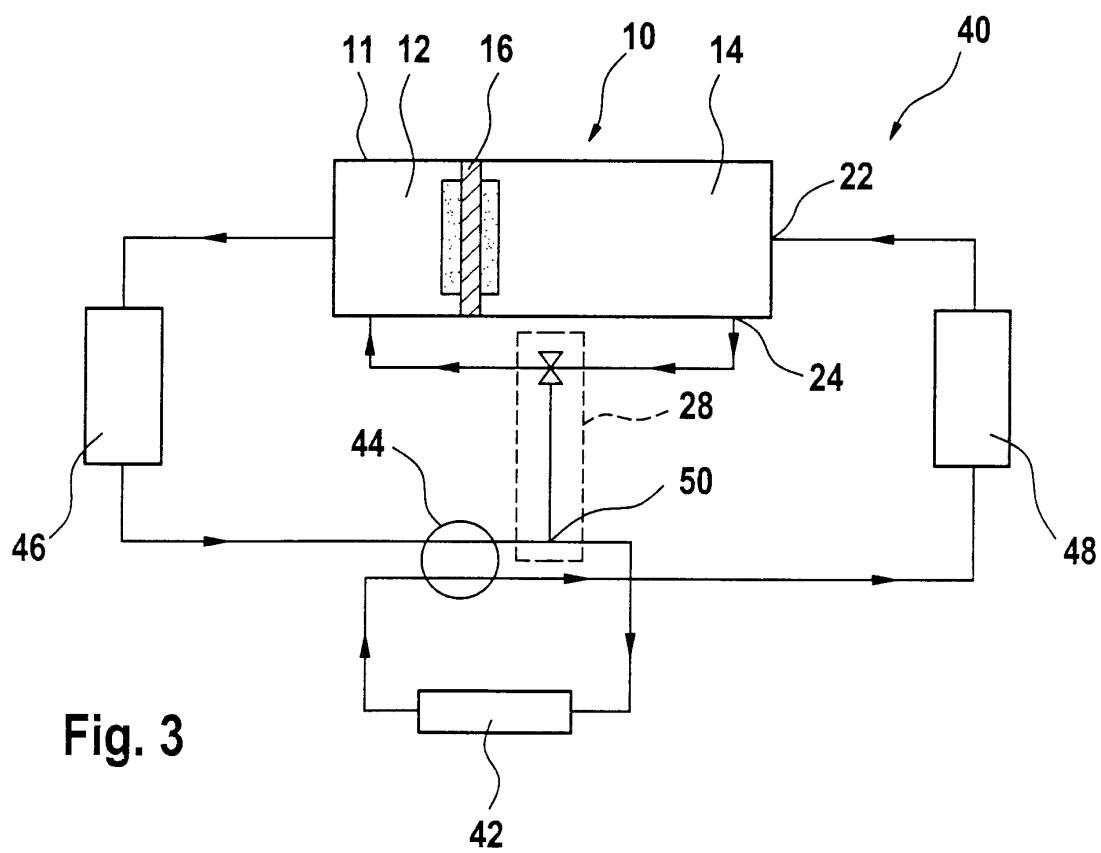
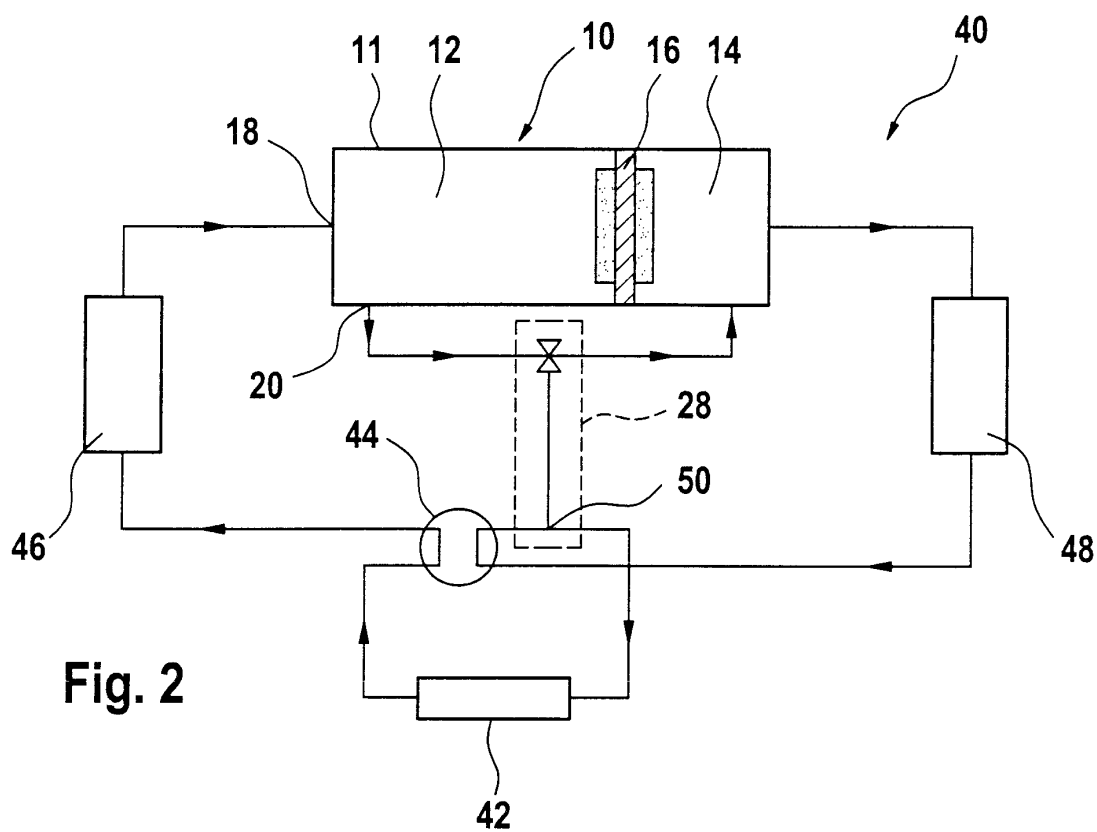
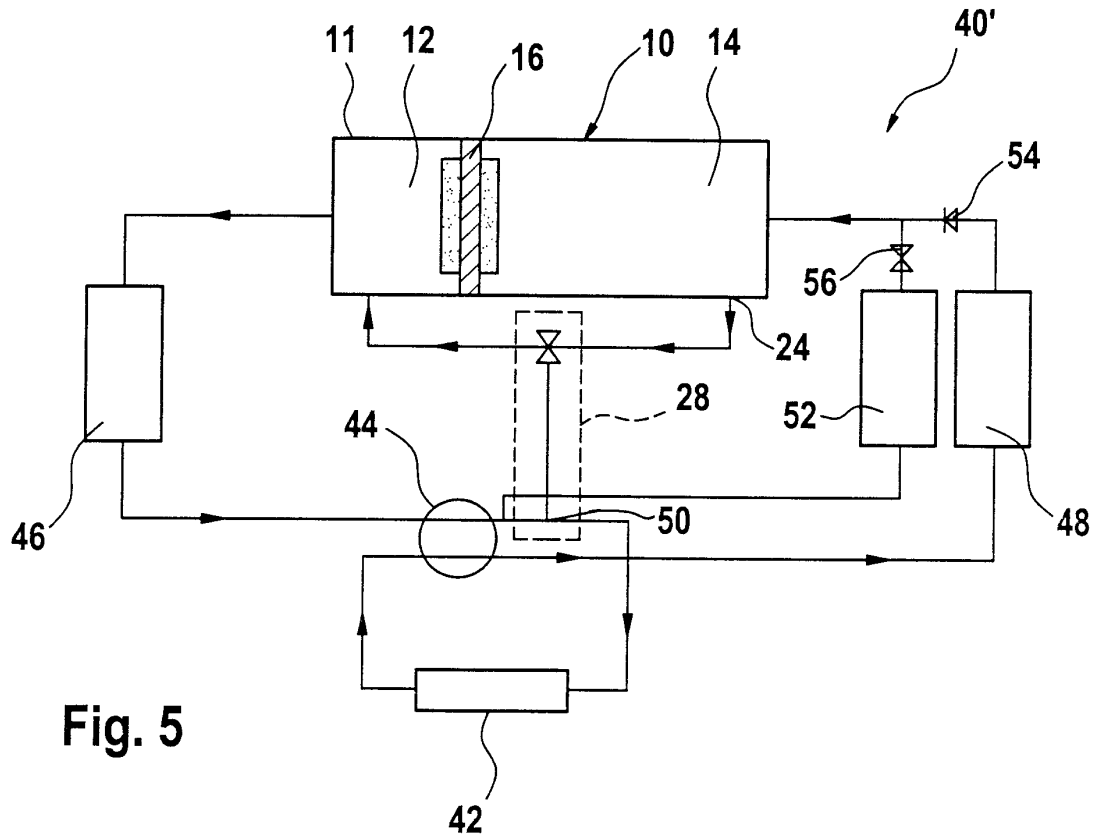
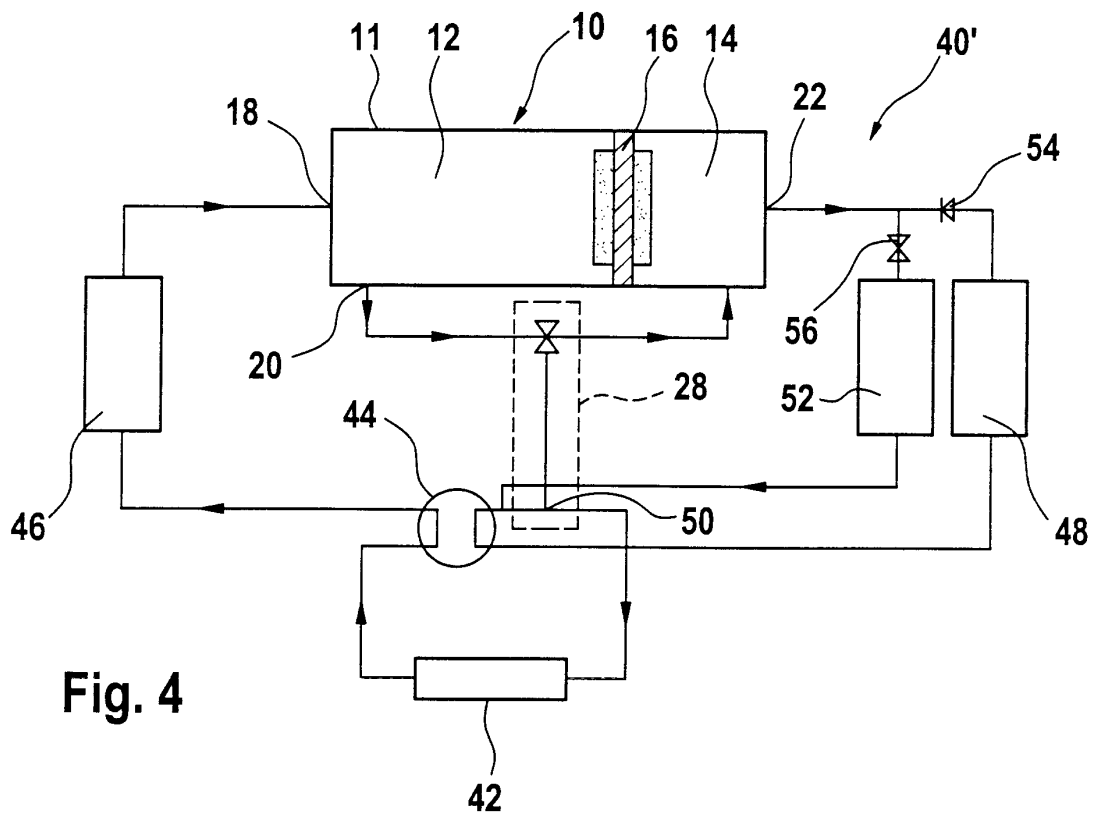


Fig. 1





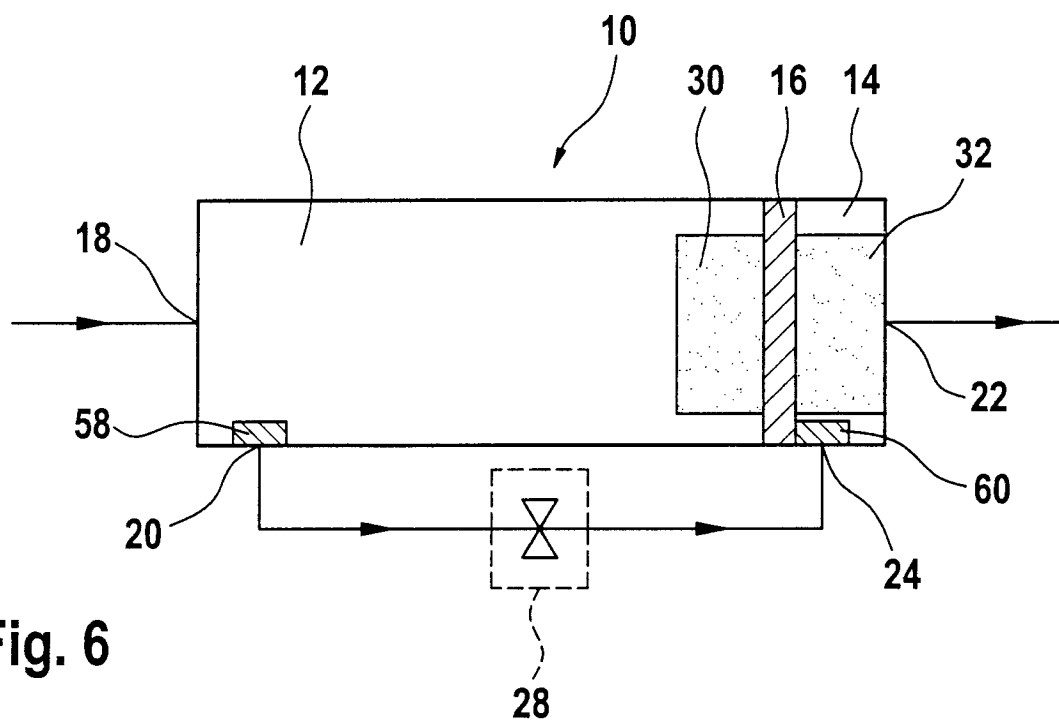


Fig. 6

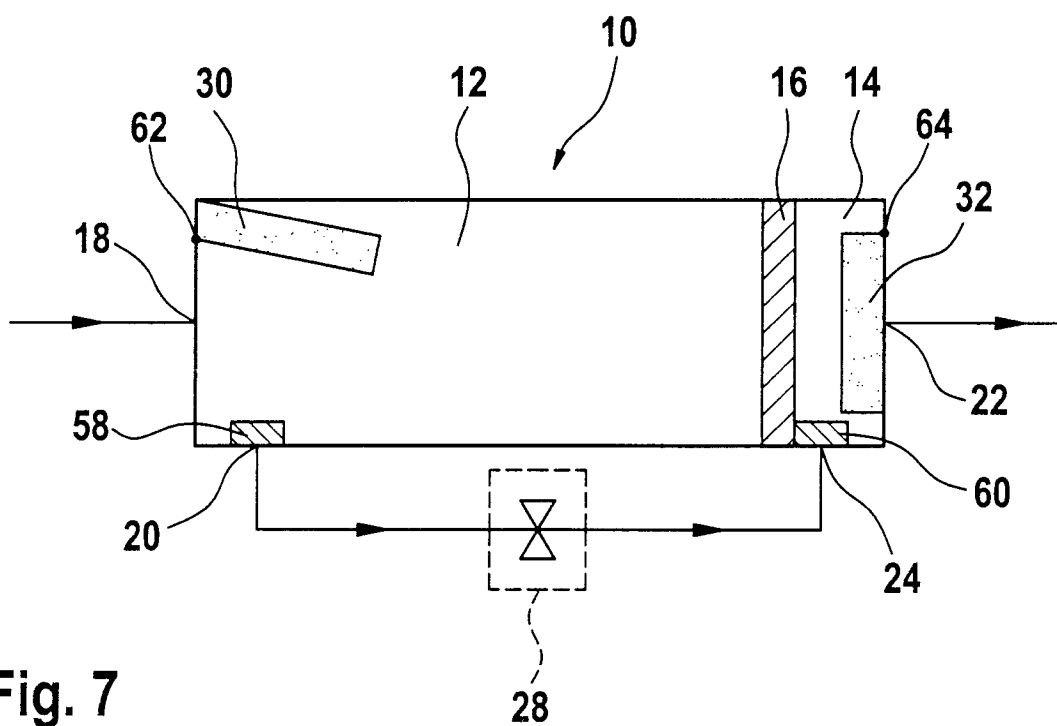


Fig. 7



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Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 10 2266

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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