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(54) **AIR CONDITIONING DEVICE FOR HEATING, VENTILATION AND/OR AIR CONDITIONING INSTALLATION**

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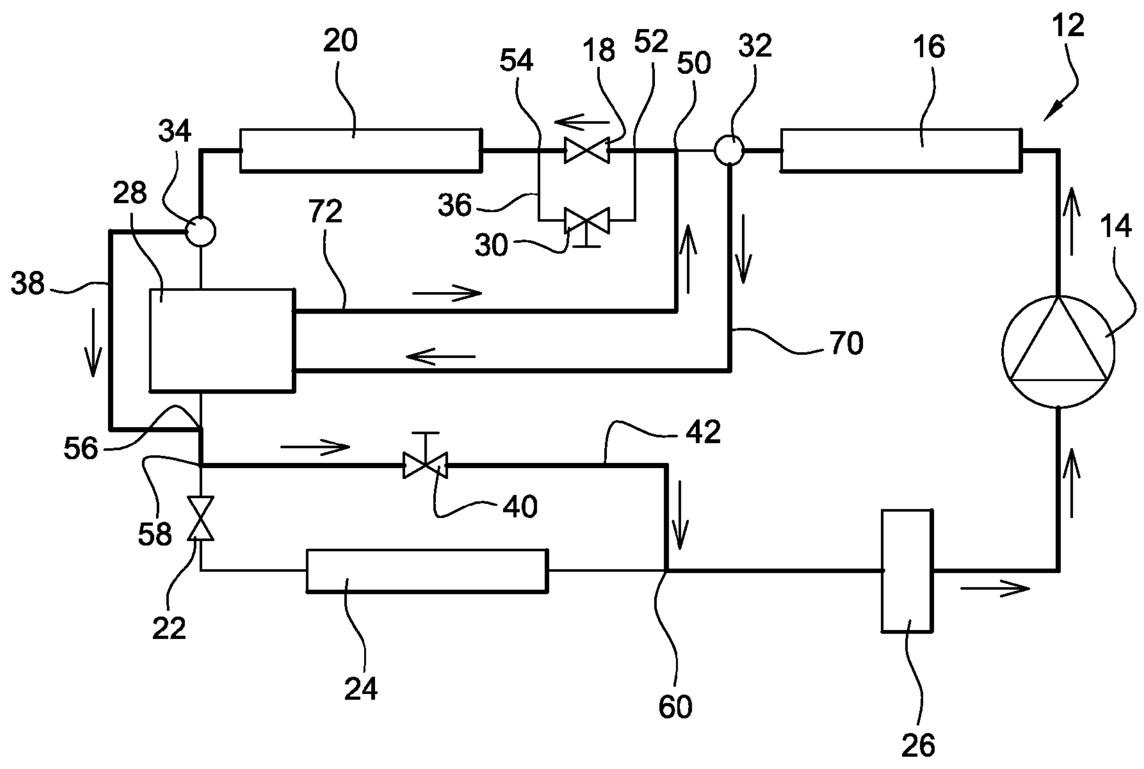
(57) **ABSTRACT**

The invention is related to an AC loop (**12**) for ventilation, heating and/or air conditioning installation comprising, according to the circulation of an refrigerant in the AC loop, at least a compressor (**14**), a first heat exchanger (**16**) for heating an air flow distributed into the passenger compartment, a first expansion device (**18**), an exterior heat exchanger (**20**) and a second heat exchanger (**24**). The AC loop (**12**) comprises a storage device (**28**) connected to the outlet of the first heat exchanger (**16**) and to the outlet of the exterior heat exchanger (**20**).



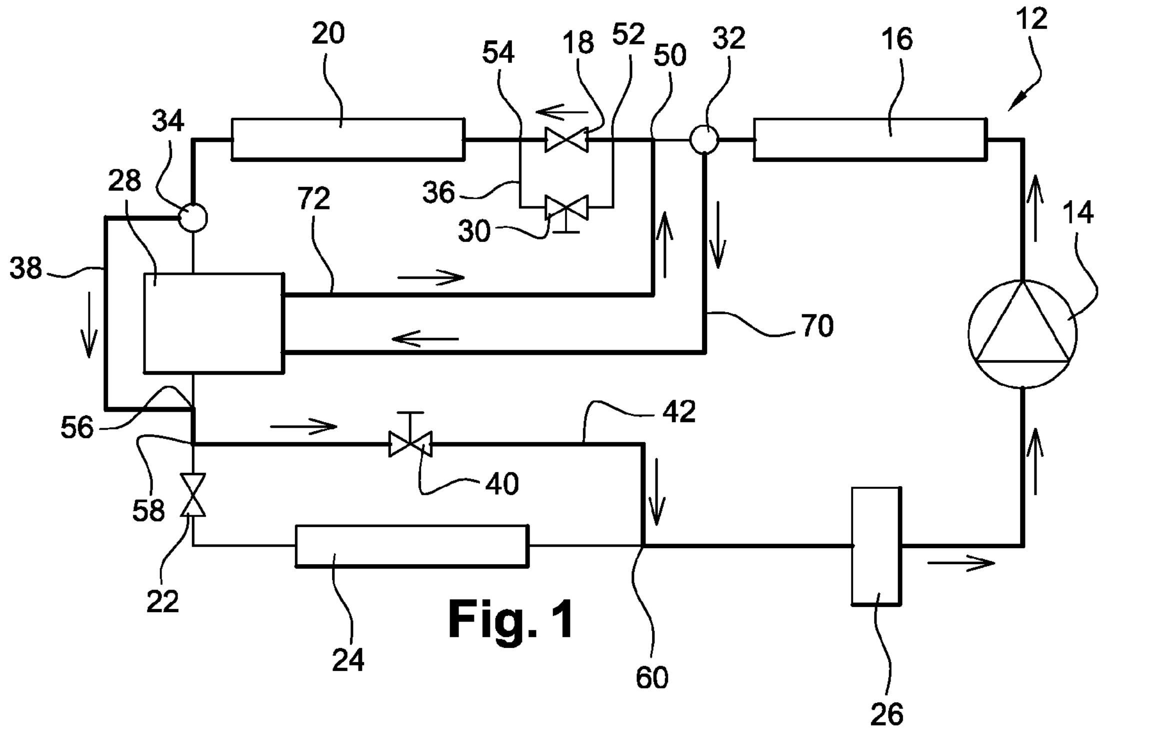

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Fig. 1

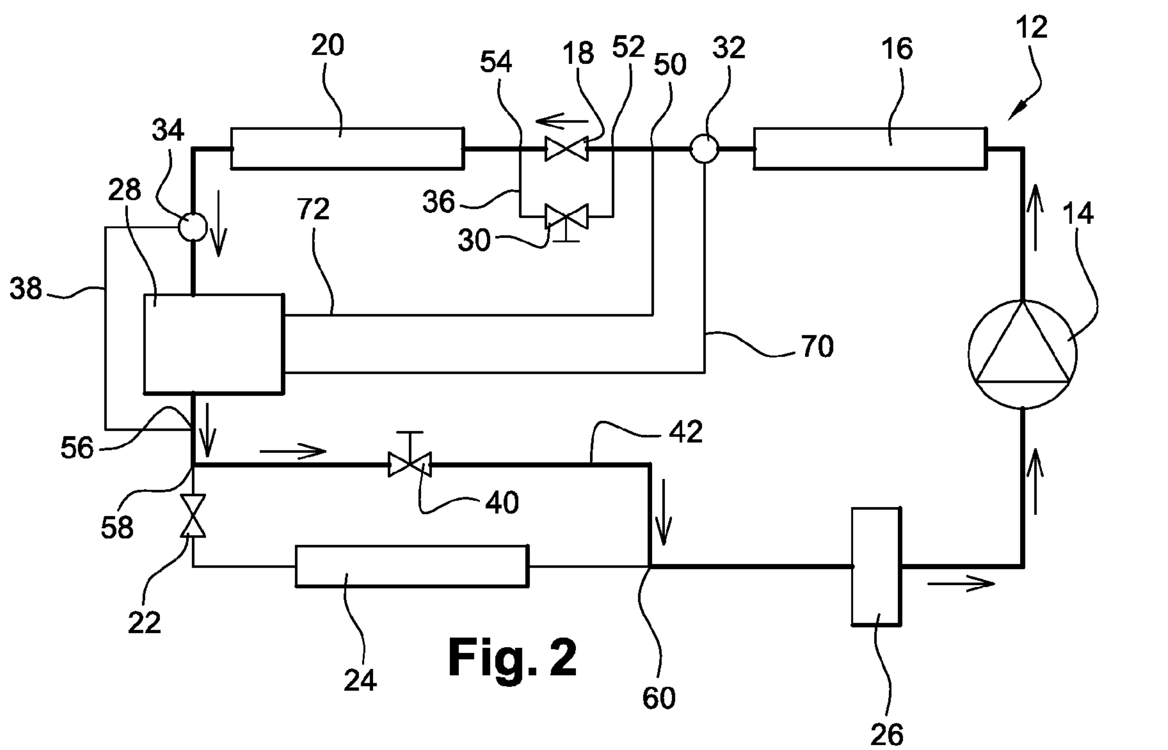
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Fig. 2

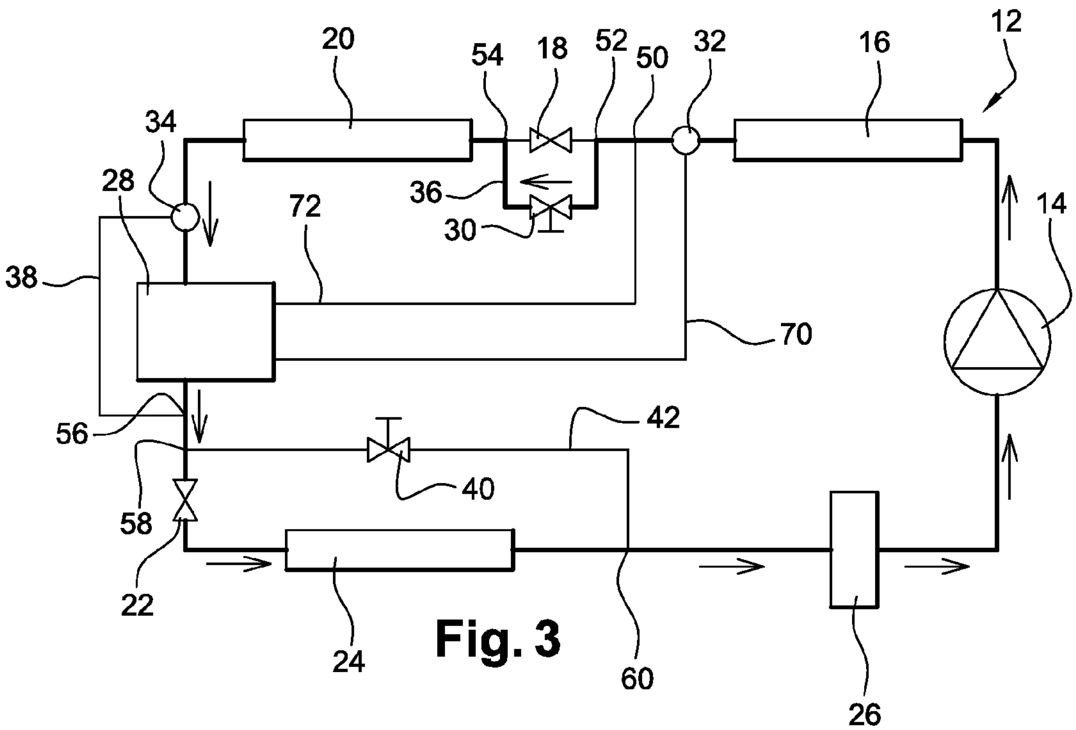
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Fig. 3

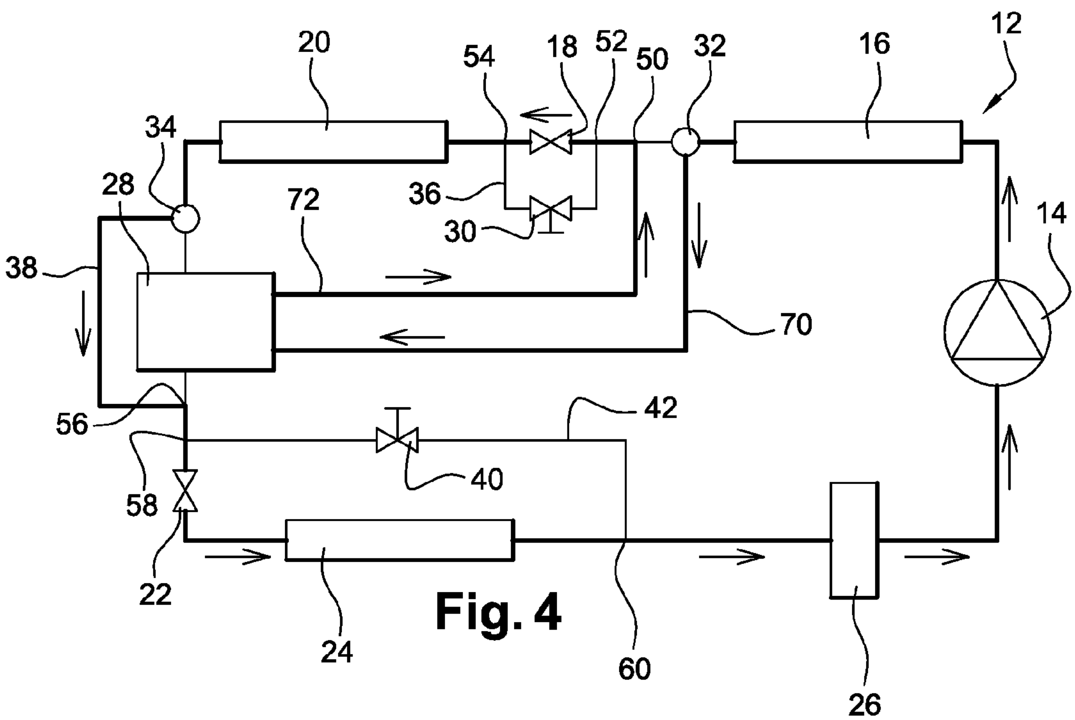
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Fig. 4

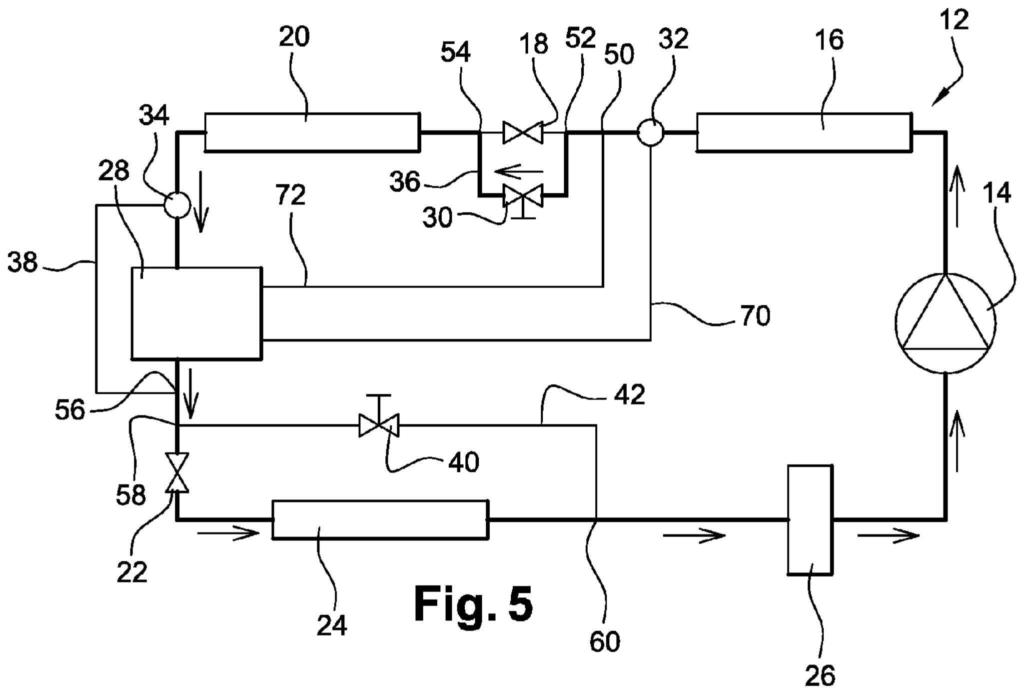
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Fig. 5

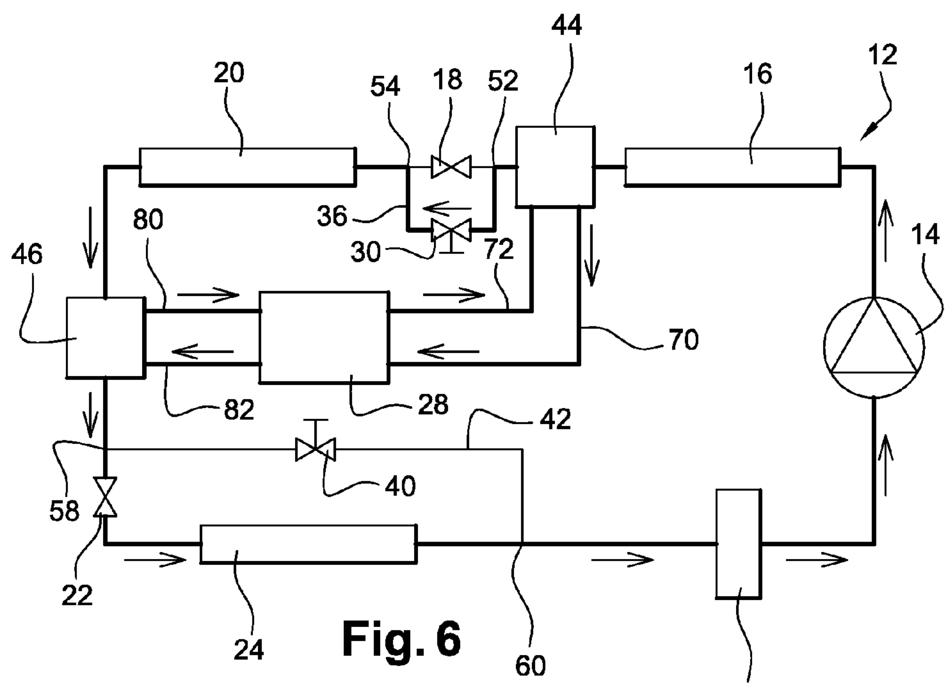
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Fig. 6

AIR CONDITIONING DEVICE FOR HEATING, VENTILATION AND/OR AIR CONDITIONING INSTALLATION

[0001] The invention relates to an air conditioning circuit for a heating, ventilation and/or air conditioning installation.

[0002] Motor vehicles are routinely equipped with a heating, ventilation and/or air conditioning installation to modify the aerothermal parameters of an air flow diffused inside the vehicle interior.

[0003] The heating, ventilation and/or air conditioning installation also comprises an air conditioning circuit with a coolant circulating therein. The coolant is, for example, a hydrofluorocarbon, particularly the coolant known under the reference R134a, or a hydrofluoro-olefin-based compound, particularly the coolant known under the reference HFO1234yf. The present invention is also applicable with any coolants equivalent to those mentioned above. The present invention is also applicable with supercritical fluids, particularly carbon dioxide.

[0004] The air conditioning circuit particularly comprises an external heat exchanger, particularly positioned at the front of the vehicle, for exchanging heat with an air flow external to the vehicle. The external heat exchanger is traversed by the external air flow but is not in contact with the air flow to be diffused in the vehicle interior.

[0005] The external heat exchanger is a heat exchange device extracting heat from the external air flow passing therethrough. However, the efficiency of the external heat exchanger is particularly degraded due to the formation of frost on the inserts arranged in the air flow passage on passing through the external heat exchanger. Frosting may appear when water vapor, present in the surrounding ambient air flow and passing through the external heat exchanger, condenses on the external surfaces of the external heat exchanger and freezes. While slight frost formation is not detrimental to heat exchanges on the external heat exchanger, an accumulation of frost is, on the other hand, particularly harmful and may result in the complete blockage of the external air flow passage via the external heat exchanger. Such frosting induces impaired air conditioning circuit performance.

[0006] As a result, air conditioning circuits must be fitted, almost systematically, with an effective external heat exchanger defrosting system. To solve the defrosting problem, a number of solutions have been proposed.

[0007] A first well-known method is that operating on the basis of "thermodynamic cycle inversion". If defrosting is required, the role of the external heat exchanger is reversed and, as it operates as a gas condenser or cooler, the heat released during the defrosting phase on the external heat exchanger melts the frost.

[0008] A second method is that operating on the basis of "hot gas bypassing". When the need for defrosting is detected, opening a bypass valve enables the compressor to discharge the coolant directly, particularly in the form of "hot" gases, into the external heat exchanger, bypassing part of the air conditioning circuit. The advantages of this method lie in the simplicity of the embodiment of the air conditioning circuit, the lack of heat extraction at the heat source and, in sum, a relatively low energy cost.

[0009] However, such a method only provides a low air conditioning circuit defrosting power and, in some designs, inefficiency. Document US 2007/0137228 discloses such a system and envisages an air conditioning circuit suitable for defrosting at a low ambient temperature. However, the drawback of the device described in this document is a loss of heating capacity during defrosting.

[0010] One aim of the invention is thus that of remedying the abovementioned drawbacks. It thus relates to an air conditioning circuit for a heating, ventilation and/or air conditioning installation. More specifically, the invention relates to an air conditioning circuit for a heating, ventilation and/or air conditioning installation, particularly a motor vehicle interior, comprising at least, according to the direction of closed circuit coolant circulation, a compressor, a first heat exchanger, suitable for heating an air flow to be distributed in the vehicle interior, a first expansion member, an external heat exchanger and a second heat exchanger, suitable for dehumidifying and/or cooling the air flow to be distributed in the vehicle interior. The air conditioning circuit comprises a storage device connected to the outlet of the first heat exchanger, to be able to store the calories from the first heat exchanger in the storage device with a maximum capacity, and connected to the outlet of the heat exchanger, to redistribute the calories via the coolant in the second heat exchanger to defrost same and/or restore the stored energy.

[0011] It is thus possible to defrost or limit the frosting of the external heat exchanger and/or the second heat exchanger by means of the storage device. Indeed, the temperature of the storage device is maintained by the air conditioning circuit while ensuring maximum energy performance. Subsequently, the calories stored are used to defrost the external heat exchanger and/or second heat exchanger by limiting the drop in the air conditioning circuit performance.

[0012] According to one example of an embodiment, the air conditioning circuit comprises a first bypass arm arranged in parallel with the first expansion member.

[0013] Advantageously, the air conditioning circuit comprises a first switching means arranged at the outlet of the first heat exchanger, to control the circulation of the coolant through the storage device. Preferentially, the first switching means is a first "three-way" valve or a first intermediate heat transfer fluid/coolant heat exchanger.

[0014] Alternatively or additionally, the air conditioning circuit comprises a second switching means arranged at the outlet of the external heat exchanger, to control the circulation of the coolant through the storage device or in a bypass arm of the storage device, referred to as the second bypass arm, particularly when the use of the storage device is not intended to favor energy restoration or further cooling of the coolant at the outlet of the external heat exchanger operating as a condenser.

[0015] Preferentially, the second switching means is a second "three-way" valve or a second intermediate heat transfer fluid/coolant heat exchanger. Particularly advantageously, the second bypass arm of the storage device is connected to the second "three-way" valve.

[0016] Moreover, the second intermediate heat transfer fluid/coolant heat exchanger is arranged at the outlet of the external heat exchanger, to enable storage management and/or energy restoration and the high pressure end and/or further cooling at the low pressure end.

[0017] According to further embodiments, the air conditioning circuit comprises a second expansion member. In particular, the second expansion member is controlled such that the coolant pressure at the outlet of the second expansion member is greater than the saturation pressure of the air flow to be distributed in the vehicle interior passing through the second heat exchanger to prevent frosting of the air flow to be distributed in the vehicle interior.

[0018] Preferentially, the air conditioning circuit comprises a third bypass arm arranged in parallel with the second expansion member and/or the second heat exchanger.

[0019] According to various designs, the first switching means and the second switching means are designed such that the coolant from the compressor passes successively through,

- **[0020]** the first heat exchanger, the first bypass pipe, the thermal storage device, the first return pipe, the first expansion member, the external heat exchanger, the second bypass arm and the third bypass arm, or
- **[0021]** the first heat exchanger, the first expansion member, the external heat exchanger, the storage device and the third bypass arm, or
- **[0022]** the first heat exchanger, the first bypass arm, the external heat exchanger, the storage device, the second expansion member and the second heat exchanger, or
- **[0023]** the first heat exchanger, the first bypass pipe, the thermal storage device, the first return pipe, the first expansion member, the external heat exchanger, the second bypass arm, the second expansion member and the second heat exchanger.

[0024] Preferentially, the storage device contains a phase change material having a phase change temperature between 5° C. and 20° C., particularly between 10° C. and 15° C.

[0025] Further features and advantages of the present invention will emerge on reading the following detailed description including examples of embodiments given as a non-limitative illustration with reference to the appended figures, which may serve to complete the comprehension of the present invention and the description of the embodiment thereof, and, if applicable, contribute to the definition thereof, wherein:

[0026] FIG. **1** represents a schematic view of the air conditioning circuit according to a first operating mode, referred to as the "heating—storage mode", wherein the vehicle interior is heated and the energy stored in the storage device is maintained,

[0027] FIG. **2** represents a schematic view of the air conditioning circuit according to a second operating mode, referred to as the "first heating—defrosting mode", wherein the vehicle interior is heated and the external heat exchanger is defrosted using the storage device at the low pressure end of the thermodynamic circuit,

[0028] FIG. **3** represents a schematic view of the air conditioning circuit according to a third operating mode, referred to as the "second heating—defrosting mode", wherein the vehicle interior is heated and the external heat exchanger is defrosted using the storage device at the high pressure end of the thermodynamic circuit,

[0029] FIG. **4** represents a schematic view of the air conditioning circuit according to a fourth operating mode, referred to as the "demisting—defrosting mode", wherein the vehicle interior is demisted and/or frost formation on the external heat exchanger is limited using the storage device,

[0030] FIG. **5** represents a schematic view of the air conditioning circuit according to a fifth mode, referred to as the "cooling mode", wherein the interior is cooled using the storage device, and

[0031] FIG. **6** represents a schematic view of the air conditioning circuit according to an alternative embodiment of the invention comprising a circuit on water.

[0032] FIG. **1** represents schematically an air conditioning circuit **12** according to the invention for a heating, ventilation and/or air conditioning installation.

[0033] The air conditioning circuit **12** enables the circulation of a coolant, particularly a subcritical fluid, such as R134A or equivalent, or a supercritical fluid, such as R744 or carbon dioxide.

[0034] The air conditioning circuit **12** comprises, in particular, in the direction of closed circuit circulation of the coolant, a compressor **14**, suitable for circulating the coolant inside the air conditioning circuit **12**, a first heat exchanger **16**, operating as a condenser **16** and suitable for heating an air flow to be distributed in the vehicle interior, a first expansion member **18**, such as, for example, an electronic expansion valve or a thermostatic expansion valve, an external heat exchanger **20**, a second expansion member **22**, a second heat exchanger **24**, operating as an evaporator **24** and suitable for dehumidifying and/or cooling the air flow to be distributed in the vehicle interior, and an accumulator **26**. At the outlet, the accumulator **26** is connected to the inlet of the compressor **14**.

[0035] The first heat exchanger **16** and the second heat exchanger **24** are placed in an air flow circulation pipe, not shown, opening into various areas of the vehicle interior. The first heat exchanger **16** and the second heat exchanger **24** are suitable for heating and/or cooling the air flow opening into the vehicle interior, particularly in an area arranged for demisting the windshield, a central aeration area and an area for feet.

[0036] The air flow suitable for distribution in the vehicle interior thus passes, in alternation or succession, through the first heat exchanger **16** and/or the second heat exchanger **24**. In particular, according to a particular example of an embodiment, a mixing flap is arranged in the circulation pipe to enable distribution of the air flow between the first heat exchanger **16** and the second heat exchanger **24**. Advantageously, the second heat exchanger **24** is arranged upstream from the first heat exchanger **16**, along the direction of circulation of the air flow in the circulation pipe. Preferentially, the entire air flow passes through the second heat exchanger **24** before passing through and/or bypassing the first heat exchanger **16**.

[0037] Advantageously, according to the invention, a thermal storage device **28** is incorporated in the air conditioning circuit **12** according to the present invention to store the calories carried by the coolant for subsequent use thereof according to the device operating modes.

[0038] According to one preferential arrangement, the thermal storage device **28** is arranged between the external heat exchanger **20** and the second expansion member **22**.

[0039] The air conditioning circuit **12** also comprises a first switching means **32**, particularly consisting of a first "three-way" valve **32**, particularly a first electrovalve **32**, arranged at the outlet of the first heat exchanger **16**. The first "three-way" valve **32** is connected, via a first bypass pipe **70**, to a first inlet of the thermal storage device **28**. A first outlet of the thermal storage device **28** is connected, via a first return pipe **72**, to the air conditioning circuit, downstream from the first "three-way" valve **32**, at a first connection point **50**. Such an arrangement makes it possible to control the storage of calories from the heat exchanger **16** to the storage device **28**.

[0040] The air conditioning circuit **12** comprises a first bypass arm **36**, arranged parallel with the first expansion member **18**. The first bypass arm **36** is arranged between a second connection point **52**, advantageously arranged downstream from the first connection point **50**, and a third connection point **54**, arranged downstream from the first expansion member **18**.

[0041] Preferentially, the first bypass channel **36** comprises a first control valve **30**, suitable for adopting an open position or a closed position to enable or block coolant circulation in the first bypass channel **36**, respectively.

[0042] The air conditioning circuit **12** also comprises a second switching means **34**, particularly a second "three-way" valve **34**, particularly a first electrovalve **34**, arranged at the outlet of the external heat exchanger **20**. The second "three-way" valve **34** is connected to a second bypass arm **38** and to a second inlet of the thermal storage device **28**, respectively.

[0043] The second bypass arm **38** is arranged between the second "three-way" valve **34** and a fourth connection point **56**, arranged downstream from the thermal storage device **28**.

[0044] The circulation of the coolant in the second bypass arm **38**, bypassing the storage device **28**, or in the storage device **28** is controlled by the second "three-way" valve **34** arranged at the outlet of the external heat exchanger **20**.

[0045] Thus, according to the present invention, the thermal storage device **28** is mounted both:

- **[0046]** at the outlet of the first heat exchanger **16**, to store the calories produced by and/or remaining in the first heat exchanger **16** in the first storage device **28**, with a maximum yield, and
- **[0047]** at the outlet of the external heat exchanger **20**, to redistribute the calories via the coolant.

[0048] According to the invention, the storage device **28** may consist of a storage fluid tank storing the calories by working with sensible heat, or using a phase change material storage material storing the calories by working with latent heat.

[0049] Advantageously, the thermal storage device **28** is a dual-fluid heat exchanger enabling heat exchange between the coolant and the storage fluid/material.

[0050] Such a device **28** makes it possible to reduce the mass required and limit storage temperature variations. The phase change material has, according to the requirements of the invention, a phase change temperature between 5° C. and 25° C., particularly between 5° C. and 20° C., preferentially between 10° C. and 20° C. and notably between 10° C. and 15° C.

[0051] Thus, according to the various possible designs of the air conditioning circuit **12** specific to the various operating modes according to the figures in the present invention, the storage device **28** is suitable for storing the calories carried by the coolant from the first heat exchanger **16** and/or from the external heat exchanger **20**. Therefore, the storage device **28** is thus a heat and/or cold storage device.

[0052] In the present description, the term "calorie" covers all types of heat liable to be carried, in particular, by a coolant, a heat transfer fluid, an air flow, etc. The storage device **28** can thus store cold or heat according to the energy stored by the coolant, heat transfer fluid or air flow and according to the storage status of the storage device **28**.

[0053] Finally, the air conditioning circuit **12** comprises a third bypass arm **42**, arranged in parallel with the second expansion member **22** and the second heat exchanger **24**. The third bypass arm **42** is arranged between a fifth connection point **58**, arranged downstream from the second expansion member **22**, and a sixth connection point **60**, arranged downstream from the second heat exchanger **24**. Advantageously, the sixth connection point **60** is arranged upstream from the accumulator **26**.

[0054] Preferentially, the third bypass channel **42** comprises a second control valve **40**, suitable for adopting an open position or a closed position to enable or block coolant circulation in the third bypass channel **42**, respectively.

[0055] In the various designs of the air conditioning circuit **12**, preferentially, the first expansion member **18** and the second expansion member **22** are suitable for adopting closed positions when the first control valve **30** and the second control value **40** are in the open position, respectively.

[0056] Such an air conditioning circuit **12** thus makes it possible to provide various operating methods according to user requirements and thus improve the comfort thereof.

[0057] FIG. **1** represents a schematic view of the device according to the present invention in a first operating mode, referred to as the "heating—storage mode", wherein the vehicle interior is heated and the energy stored in the storage device **28** is maintained.

[0058] With reference to the diagram in FIG. **1** illustrating the first operating mode, the first "three-way" valve **32** is controlled so as to enable the circulation of the coolant in the storage device **28** and the second "three-way" valve **34** is controlled so as to enable the circulation of the coolant in the second bypass arm **38**, bypassing the storage device **28**.

[0059] The first control valve **30** is in the closed position to block the circulation of the coolant in the first bypass arm **36**, the coolant circulating in the first expansion member **18**.

[0060] The second control valve **40** is in the open position to enable the circulation of the coolant in the third bypass arm **42**, bypassing the second expansion member **22** and the second heat exchanger **24**.

[0061] In this way, in the first operating mode, referred to as the "heating—storage mode", the coolant from the compressor **14** passes, in succession, through the first heat exchanger **16**, the first "three-way" valve **32**, the first bypass pipe **70**, the thermal storage device **28**, the first return pipe **72**, the first expansion member **18**, the external heat exchanger **20**, the second "three-way" valve **34**, the second bypass arm **38**, the third bypass arm **42** and the accumulator **26** before returning to the compressor **14**.

[0062] In the first operating mode design according to FIG. **1**, the external heat exchanger **20** operates as an evaporator **20**.

[0063] The coolant condenses in the first heat exchanger **16** by exchanging heat with the air flow passing therethrough. The air flow channeled by the circulation pipe is thus heated on passing through the first heat exchanger **16** before being distributed in the vehicle interior.

[0064] The coolant is then expanded in the first expansion member **18** before being evaporated in the external heat exchanger **20**, operating in this design as an evaporator **20**. For this purpose, the external heat exchanger **20** is traversed by an external air flow exchanging calories with the coolant, which is cooled in the arrangement in FIG. **1**. The external air flow is not intended to be distributed in the vehicle interior.

[0065] In the design in FIG. **1**, the second heat exchanger **24** is not operational. Therefore, the air flow liable to be distributed in the vehicle interior and channeled by the circulation pipe is only heated by the first heat exchanger **16**.

[0066] Before the first operating mode is started, the temperature of the coolant contained in the storage device **28** is close to the external temperature. In this operating mode, the coolant passes through the second bypass arm **38** by controlling the second "three-way" valve **34**. Indeed, in the first operating mode, it is not intended for the storage device **28** to be used to restore stored calories. The first operating mode merely makes it possible to maintain the storage of calories contained therein.

[0067] According to the arrangement of the air conditioning circuit in FIG. **1**, at the outlet of the first heat exchanger **16**, the coolant circulates in the storage device **28** where it is cooled. As specified above, the temperature of the coolant initially contained in the storage device **28** is close to the external temperature, below the temperature of the coolant at the outlet of the first heat exchanger **16**.

[0068] In this way, in the design of the first operating mode according to FIG. **1**, the storage device **28** collects the calories carried by the coolant from the first heat exchanger **16**. Therefore, the storage device **28** is thus a heat storage device.

[0069] Advantageously according to the invention, during the first operating mode, referred to as the "heating—storage mode", the storage device **28** accumulates energy in the form of calories.

[0070] Furthermore, the storage device **28** helps improve the cycle performance coefficient by reducing the temperature at the outlet of the first heat exchanger **16**. Increasing the performance coefficient thus makes it possible to store energy at least cost in respect to the power consumed by the compressor **14**.

[0071] In the design according to the first operating mode, energy is thus stored in the storage device **28** with an improved performance coefficient of the air conditioning circuit **12** cycle.

[0072] Also according to the invention, the calories stored in the storage device **28** are preferably at a mean temperature between 5° C. and 20° C., preferentially between 10° C. and 15° C.

[0073] FIG. **2** represents a schematic view of the device according to the present invention in a second operating mode, referred to as the "first heating—defrosting mode", wherein the vehicle interior is heated and the external heat exchanger **20** is defrosted using the storage device **28** at the low pressure end of the air conditioning circuit **12** and restoration of the energy stored.

[0074] With reference to the diagram in FIG. **2** illustrating the second operating mode, the first "three-way" valve **32** is controlled so to enable the direct connection of the outlet of the first heat exchanger **16** with the inlet of the first expansion member **18**, the circulation of the coolant not being authorized in the storage device **28**, and the second "three-way" valve **34** is controlled so as to enable the direct circulation of the coolant via the storage device **28**.

[0075] The first control valve **30** is in the closed position to block the circulation of the coolant in the first bypass arm **36**, the coolant circulating in the first expansion member **18**.

[0076] The second control valve **40** is in the open position to enable the circulation of the coolant in the third bypass arm **42**, bypassing the second expansion member **22** and the second heat exchanger **24**.

[0077] In this way, in the second operating mode, referred to as the "first heating—defrosting mode", the coolant from the compressor **14** passes, in succession, through the first heat exchanger **16**, the first "three-way" valve **32**, the first expansion member **18**, the external heat exchanger **20**, the second "three-way" valve **34**, the second bypass arm **38**, the third bypass arm **42** and the accumulator **26** before returning to the compressor **14**.

[0078] In the second operating mode design according to FIG. **2**, the external heat exchanger **20** operates as an evaporator **20**.

[0079] According to the second operating mode illustrated in FIG. **2**, defrosting of the external surfaces of the external heat exchanger **20** may be performed at low pressures.

[0080] The coolant condenses in the first heat exchanger **16** by exchanging heat with the air flow passing therethrough. The air flow channeled by the circulation pipe is thus heated on passing through the first heat exchanger **16** before being distributed in the vehicle interior.

[0081] So as to heat the vehicle interior and simultaneously defrost the external heat exchanger **20**, the coolant evaporates partially in the external heat exchanger **20**, at a pressure determined by the storage device **28**, thus making it possible to defrost or limit the frosting of the external heat exchanger **20**. The storage device **28** thus acts, in this design, as a thermal load, performing a "thermal leverage" function at the low pressure end. The heat conveyed by the storage device **28** compensates for the cooling of the coolant such that the defrosting capacity is essentially provided by the storage device **28**.

[0082] The energy stored in the form of calories in the storage device **28** can thus be used at the low pressure end of the air conditioning circuit **12** to complete the evaporation of the coolant leaving the external heat exchanger **20**, which is defrosted.

[0083] The storage device **28** thus helps defrost the external heat exchanger **20** without impairing the efficiency of the air conditioning circuit **12**, which is the aim of the present invention.

[0084] Furthermore, according to the storage status of the storage device **28**, in the second operating mode design according to FIG. **2**, the storage device **28** may also collect calories carried by the coolant from the external heat exchanger **20**. Therefore, alternatively, the storage device **28** is thus a cold storage device.

[0085] FIG. **3** represents a schematic view of the device according to the present invention in a third operating mode, referred to as the "second heating—defrosting mode", wherein the vehicle interior is heated and the external heat exchanger is defrosted using the storage device **28** at the high pressure end of the air conditioning circuit **12** and restoration of the stored energy.

[0086] With reference to the diagram in FIG. **3** illustrating the third operating mode, the first "three-way" valve **32** is controlled so to enable the direct connection of the outlet of the first heat exchanger **16** with the inlet of the first expansion member **18**, the circulation of the coolant not being authorized in the storage device **28**, and the second "three-way" valve **34** is controlled so as to enable the direct circulation of the coolant via the storage device **28**.

[0087] The first control valve **30** is in the open position to enable the circulation of the coolant in the first bypass arm **36**, the coolant bypassing the first expansion member **18**.

[0088] The second control valve **40** is in the closed position to block the circulation of the coolant in the third bypass arm **42**, the coolant circulating in succession in the second expansion member **22** and the second heat exchanger **24**.

[0089] In this way, in the third operating mode, referred to as the "second heating—defrosting mode", the coolant from the compressor **14** passes, in succession, through the first heat exchanger **16**, the first "three-way" valve **32**, the first bypass arm **36**, the external heat exchanger **20**, the second "three-way" valve **34**, the storage device **28**, the second expansion member **22**, the second heat exchanger **24** and the accumulator **26** before returning to the compressor **14**.

[0090] The coolant condenses in the first heat exchanger **16** by exchanging heat with the air flow passing therethrough. The air flow channeled by the circulation pipe is thus heated on passing through the first heat exchanger **16** before being distributed in the vehicle interior.

[0091] In the third operating mode design according to FIG. **3**, the external heat exchanger **20** operates as a condenser **20**.

[0092] According to the third operating mode of the air conditioning circuit **12** illustrated in FIG. **3**, defrosting of the external surfaces of the external heat exchanger **20** may also be performed at high pressures.

[0093] The coolant condenses in the first heat exchanger **16** by exchanging heat with the air flow passing therethrough. The air flow channeled by the circulation pipe is thus heated on passing through the first heat exchanger **16** before being distributed in the vehicle interior.

[0094] The coolant then passes through the external heat exchanger **20** exchanging calories with the air flow passing through the external heat exchanger **20**.

[0095] In the event of the coolant not being completely condensed in the first heat exchanger **16**, the coolant continues to condense in the external heat exchanger **20** thus enabling the defrosting of the external heat exchanger **20**.

[0096] Furthermore, according to the design in FIG. **3**, the coolant at the outlet of the first heat exchanger **16** is at a high temperature and high pressure. By bypassing the first expansion member **18**, the state of the coolant is substantially unchanged. Therefore, the external heat exchanger **20** is traversed by the coolant at a high temperature and at a high pressure thus helping, additionally and alternatively, defrost the external heat exchanger **20**.

[0097] At the outlet of the external heat exchanger **20**, the second "three-way" vale **34** is arranged to enable the direct circulation of the coolant via the storage device **28**. The coolant thus recovers energy on passing through the storage device **28** prior to expansion by the second expansion member **22**.

[0098] According to the previous storage statuses in question, the storage device **28** may alternatively store heat or cold. Therefore, the coolant is cooled or heated on passing through the storage device **28** prior to expansion by the second expansion member **22**.

[0099] Preferentially, on passing through the second expansion member **22**, the pressure and temperature of the coolant fall before passing through the second heat exchanger **24** wherein the coolant vaporizes by absorbing heat from the air flow passing therethrough to thus produce the cooled air flow.

[0100] The energy stored in the form of calories in the storage device **28** can thus be used at the high pressure end of the air conditioning circuit **12**. The storage device **28** thus enables heat exchange between the coolant and the storage fluid/material. The coolant is then situated at the outlet of the storage device **28** in a specific pressure and temperature state before passing through the second expansion member **22** wherein the expansion of the coolant is controlled such that, at the outlet of the second expansion member **22**, the low pressure of the coolant is greater than the saturation pressure of the air flow entering the second heat exchanger **24**. It is thus possible to defrost or prevent frosting of the second heat exchanger **24** without impairing the efficiency of the air conditioning circuit **12**.

[0101] According to this arrangement, the high pressure end of the air conditioning circuit **12** advantageously supplies a minimal amount of heat so as to heat the air flow suitable for being distributed in the vehicle interior. An additional, particularly electric, heating member may be arranged upstream from the first heat exchanger **16**, according to the direction of circulation of the air flow in the circulation pipe, so as to heat the air flow completely or partially to the desired temperature.

[0102] FIG. **4** represents a schematic view of the device according to the present invention in a fourth operating mode, referred to as the "demisting—defrosting mode", wherein the vehicle interior is demisted and/or frost formation on the external heat exchanger **20** is limited using the storage device **28**.

[0103] With reference to the diagram in FIG. **4** illustrating the fourth operating mode, the first "three-way" valve **32** is controlled so as to enable the circulation of the coolant in the storage device **28** and the second "three-way" valve **34** is controlled so as to enable the circulation of the coolant in the second bypass arm **38**, bypassing the storage device **28**.

[0104] The first control valve **30** is in the closed position to block the circulation of the coolant in the first bypass arm **36**, the coolant circulating in the first expansion member **18**.

[0105] The second control valve **40** is in the open position to enable the circulation of the coolant in the third bypass arm **42**, bypassing the second expansion member **22** and the second heat exchanger **24**.

[0106] In this way, in the fourth operating mode, referred to as the "demisting—defrosting mode", the coolant from the compressor **14** passes, in succession, through the first heat exchanger **16**, the first "three-way" valve **32**, the first bypass pipe **70**, the thermal storage device **28**, the first return pipe **72**, the first expansion member **18**, the external heat exchanger **20**, the second "three-way" valve **34**, the second bypass arm **38**, the third bypass arm **42** and the accumulator **26** before returning to the compressor **14**.

[0107] In the fourth operating mode design according to FIG. **4**, the external heat exchanger **20** operates as an evaporator **20**.

[0108] In order to demist the vehicle interior windows and/or limit frost formation in the external heat exchanger **20** according to FIG. **4**, the coolant evaporates in the external heat exchanger **20** by absorbing the heat from the air flow passing through the external heat exchanger **20**.

[0109] The fluid then passes through the bypass channel **38** by controlling the second "three-way" valve **34**, since, in this operating mode, it is not intended for the storage device **28** to be used, but merely for the stored heat contained therein to be maintained.

[0110] The fluid then circulates in the expansion member **22** and the main evaporator **24** in succession. For this, the second control valve **40** is closed, the second expansion member **22** being open such that the coolant passes through the second heat exchanger **24**. On passing through the second expansion member **22**, the pressure and temperature of the coolant fall before passing through the second heat exchanger **24** wherein the coolant vaporizes by absorbing heat from the air flow passing therethrough to thus produce the cooled air flow.

[0111] According to the previous storage statuses in question, the coolant may pass through or bypass the storage device **28**. The storage device **28** is thus, according to requirements and the type of storage carried out, an energy accumulator or a thermal load, carrying out a "thermal leverage" function at the low pressure end, as defined above with reference to FIG. **1**.

[0112] When the storage device **28** is used as a thermal load, carrying out a "thermal leverage" function at the low pressure end, a positive evaporation temperature can be defined in the external heat exchanger **20** to limit the risks of frosting of the external heat exchanger **20**.

[0113] In this operating mode, the storage device **28** is advantageously situated in a temperature range between 10° C. and 15° C.

[0114] Moreover, according to the energy storage temperature, the storage device **28** may be used as an additional cooling element, improving the performance coefficient of the air conditioning circuit **12**.

[0115] Therefore, the temperature of the storage device **28** makes it possible to define the design of the second "three-way" valve **34** in order to define whether, during the cycle, the storage device **28** is used to optimize the performance coefficient of the air conditioning circuit **12** by storing calories. In this way, for example, if the storage temperature, in the storage device **28**, is below a reference temperature, for example 15° C., the coolant from the air conditioning circuit **12** will supply the storage device **28** with calories until the reference temperature is reached. Once the reference temperature has been reached, the air conditioning circuit **12** will use the stored energy from the storage device **28** to optimize the performance coefficient of the air conditioning circuit **12** by deciding to restore the stored energy at the low pressure end as for the energy restoration for the defrosting function.

[0116] FIG. **5** represents a schematic view of the device according to the present invention in a fifth mode, referred to as the "cooling mode", wherein the interior is cooled using the storage device **28**.

[0117] With reference to the diagram in FIG. **5** illustrating the fifth operating mode, the first "three-way" valve **32** is controlled so as to enable the direct connection of the outlet of the first heat exchanger **16** with the inlet of the first expansion member **18**, the circulation of the coolant not being authorized in the storage device **28**, and the second "three-way" valve **34** is controlled so as to enable the direct circulation of the coolant via the storage device **28**.

[0118] The first control valve **30** is in the open position to enable the circulation of the coolant in the first bypass arm **36**, the coolant bypassing the first expansion member **18**.

[0119] The second control valve **40** is in the closed position to block the circulation of the coolant in the third bypass arm **42**, the coolant circulating in succession in the second expansion member **22** and the second heat exchanger **24**.

[0120] In this way, in the fifth operating mode, referred to as the "cooling mode", the coolant from the compressor **14** passes, in succession, through the first heat exchanger **16**, the first "three-way" valve **32**, the first bypass arm **36**, the external heat exchanger **20**, the second "three-way" valve **34**, the storage device **28**, the second expansion member **22**, the second heat exchanger **24** and the accumulator **26** before returning to the compressor **14**.

[0121] In the fifth operating mode design according to FIG. **5**, the external heat exchanger **20** operates as a condenser **20**.

[0122] The energy stored in the form of calories in the storage device **28** can thus be used at the "high pressure" end of the air conditioning circuit **12**. The energy stored in the storage device **28** is thus heated by the "high temperature" of the coolant before passing through the second expansion member **22**. The coolant is thus in a subcooled state at the outlet of the storage device **28**.

[0123] Therefore, the temperature of the storage device **28** makes it possible to define the design of the second "three-way" valve **34** in order to define whether, during the cycle, the storage device **28** is used to optimize the performance coefficient of the air conditioning circuit **12** by storing calories. In this way, for example, if the storage temperature, in the storage device **28**, is below a reference temperature, for example 15° C. as may occur when starting the vehicle, the coolant from the air conditioning circuit **12** is cooled in the storage device **28**, releasing heat. The storage device **28** thus becomes an additional cooler until the reference temperature is reached. The performance coefficient of the air conditioning circuit **12** during this operating mode is thus improved.

[0124] According to the invention, a second embodiment of the invention can be envisaged and is illustrated in FIG. **6** representing a schematic view of the device according to a second embodiment of the invention comprising a circuit on water in a design equivalent to that in FIG. **3**.

[0125] The other operating modes of this second embodiment may be deduced from the various designs represented in FIGS. **1** to **5** with reference to the first embodiment.

[0126] The first and second switching means **32** and **34** are replaced by a first intermediate heat transfer fluid/coolant heat exchanger **44** and a second intermediate heat transfer fluid/coolant heat exchanger **46**, respectively, to store energy in the thermal storage device **28**.

[0127] The first and second intermediate heat transfer fluid/coolant heat exchangers **44** and **46** form, with the thermal storage device **28**, wherein a heat transfer fluid, particularly water, circulates, linking the thermal storage device **28** and the low pressure end and/or the high pressure end of the air conditioning circuit **12** according to the operating modes of the air conditioning circuit **12**.

[0128] The first and second intermediate heat transfer fluid/coolant heat exchangers **44** and **46** are thus dual-fluid heat exchangers enabling heat exchange between the coolant and the heat transfer fluid.

[0129] As represented in FIG. **6**, the thermal storage device **28** is connected to the first intermediate heat transfer fluid/coolant heat exchanger **44** respectively via a first bypass pipe **70** and a first return pipe **72**. Moreover, the thermal storage device **28** is connected to the second intermediate heat transfer fluid/coolant heat exchanger **46** respectively via a second bypass pipe **80** and a second return pipe **82**.

[0130] The arrangement according to FIG. **6** is such that the thermal storage device **28** is not traversed by the coolant. However, according to one alternative embodiment not shown, the thermal storage device **28** may be embodied in the form of a three-fluid heat exchanger between the coolant, heat transfer fluid and storage fluid/material. In such a case, the three-fluid thermal storage device **28** may be traversed by the heat transfer fluid and be arranged as defined in FIGS. **1** to **5**.

[0131] For all the embodiments described above, a particular arrangement, not shown, of the second expansion member **22** may also be envisaged. Indeed, the second expansion member **22** may be formed in an equivalent manner to the first expansion member **18** and comprise a bypass arm comprising a dedicated control valve.

[0132] In addition to this alternative embodiment, it is also possible for the first connection point **58** to be arranged downstream from the second expansion member **22** and the bypass arm connection point of the second expansion member **22**.

[0133] It should be understood, however, that these examples of operation are given as illustrations of the subject matter of the invention. Obviously, the invention is not limited to these embodiments described above and merely given as examples. It covers various modifications, alternative forms and other alternative embodiments liable to be envisaged by those skilled in the art within the scope of the present invention, in particular any combinations of the various embodiments described above.

[0134] Furthermore, the various operating modes described above may be taken separately or combined to embody alternative embodiments and various designs of the same air conditioning circuit according to an air conditioning circuit thermal management method as defined according to the present invention.

1. An air conditioning circuit (**12**) for a heating, ventilation and/or air conditioning installation, the air conditioning circuit (**12**) comprising at least, according to the direction of closed circuit coolant circulation, a compressor (**14**), a first heat exchanger (**16**), a first expansion member (**18**), an external heat exchanger (**20**) and a second heat exchanger (**24**),

characterized in that the air conditioning circuit (**12**) comprises a storage device (**28**) connected to the outlet of the first heat exchanger (**16**) and to the outlet of the heat exchanger (**20**).

2. An air conditioning circuit (**12**) according to claim **1**, characterized in that the air conditioning circuit (**12**) comprises a first bypass arm (**36**) arranged in parallel with the first expansion member (**18**).

3. An air conditioning circuit (**12**) according to claim **1**, characterized in that the air conditioning circuit (**12**) comprises a first switching means (**32**) at the outlet of the first heat exchanger (**16**) to control the circulation of the coolant through the storage device (**28**).

4. An air conditioning circuit (**12**) according to claim **3**, characterized in that the first switching means (**32**) is arranged upstream, according to the direction of closed circuit circulation of a coolant, from the first expansion member (**18**).

5. An air conditioning circuit (**12**) according to claim **3**, characterized in that the first switching means (**32**) is a first "three-way" valve (**32**).

6. An air conditioning circuit (**12**) according to claim **3**, characterized in that the first switching means (**32**) is a first intermediate heat transfer fluid/coolant heat exchanger (**44**).

7. An air conditioning circuit (**12**) according to claim **1**, characterized in that the air conditioning circuit (**12**) comprises a second switching means (**34**) arranged at the outlet of the external heat exchanger (**20**) to control the circulation of the coolant through the storage device (**28**).

8. An air conditioning circuit (**12**) according to claim **7**, characterized in that the second switching means (**34**) is a second "three-way" valve (**34**).

9. An air conditioning circuit (**12**) according to claim **8**, characterized in that the air conditioning circuit (**12**) comprises a second bypass arm (**38**) of the storage device **28**) connected to the second "three-way" valve (**34**).

10. An air conditioning circuit (**12**) according to claim **7**, characterized in that the second switching means (**34**) is a second intermediate heat transfer fluid/coolant heat exchanger (**46**).

11. An air conditioning circuit (**12**) according to claim **1**, characterized in that the air conditioning circuit (**12**) comprises a second expansion member (**22**).

12. An air conditioning circuit (**12**) according to claim **11**, characterized in that the air conditioning circuit (**12**) comprises a third bypass arm (**42**) arranged in parallel with the second expansion member (**22**) and/or the second heat exchanger (**24**).

13. An air conditioning circuit (**12**) according to claim **11**, characterized in that the second expansion member (**22**) is controlled such that the pressure of the coolant at the outlet of the second expansion member (**22**) is greater than the saturation pressure of the air flow to be distributed in the vehicle interior entering the second heat exchanger (**24**).

14. An air conditioning circuit (**12**) according to claim **13**, characterized in that the first switching means (**32**) and the second switching means (**34**) are designed such that the coolant from the compressor (**14**) passes successively through the first heat exchanger (**16**), the first bypass pipe (**70**), the thermal storage device (**28**), the first return pipe (**72**), the first expansion member (**18**), the external heat exchanger (**20**), the second bypass arm (**38**) and the third bypass arm (**42**).

15. An air conditioning circuit (**12**) according to claim **13**, characterized in that the first switching means (**32**) and the second switching means (**34**) are designed such that the coolant from the compressor (**14**) passes successively through the first heat exchanger (**16**), the first expansion member (**18**), the external heat exchanger (**20**), the storage device (**28**) and the third bypass arm (**42**).

16. An air conditioning circuit (**12**) according to claim **13**, characterized in that the first switching means (**32**) and the second switching means (**34**) are designed such that the coolant from the compressor (**14**) passes successively through the first heat exchanger (**16**), the first bypass arm (**36**), the external heat exchanger (**20**), the storage device (**28**), the second expansion member (**22**) and the second heat exchanger (**24**).

17. An air conditioning circuit (**12**) according to claim **13**, characterized in that the first switching means (**32**) and the second switching means (**34**) are designed such that the coolant from the compressor (**14**) passes successively through the first heat exchanger (**16**), the first bypass pipe (**70**), the thermal storage device (**28**), the first return pipe (**72**), the first expansion member (**18**), the external heat exchanger (**20**), the second bypass arm (**38**), the second expansion member (**22**) and the second heat exchanger (**24**).

18. An air conditioning circuit (**12**) according to claim **1**, characterized in that the storage device (**28**) contains a phase change material having a phase change temperature between 5° C. and 20° C.

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