(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 4 400 776 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
17.07.2024 Bulletin 2024/29

(21) Application number: **23206923.7**

(22) Date of filing: **31.10.2023**

(51) International Patent Classification (IPC):
F24D 19/08 (2006.01) ***F24H 4/02*** (2022.01)
F24H 15/12 (2022.01) ***F25B 1/00*** (2006.01)
F24D 17/00 (2022.01)

(52) Cooperative Patent Classification (CPC):
F24H 15/12; F24D 17/0089; F24D 19/083; F24H 4/02; F25B 1/00

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(30) Priority: **16.01.2023 IT 202300000459**

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(54) HEAT PUMP SYSTEM INCLUDING A DEGASSING DEVICE AND A BACKUP HEATER

(57) The object of the present invention is a heat pump system (1) comprising at least one refrigeration circuit (2) in which a refrigerant fluid circulates and operates at the primary side (24) of a main heat exchanger (21) and a conditioning circuit (3) in which a technical fluid, used for room heating/cooling functions and/or for the production of domestic water, circulates and operates at the secondary side (25) of said main heat exchanger (21). The conditioning circuit (3) further comprises a circulation pump (30) and at least one backup heater (5). Said backup heater (5) integrates at least one ventilation valve (6) capable of expelling at least any leaks of refrigerant fluid before they spread into said conditioning circuit (3).

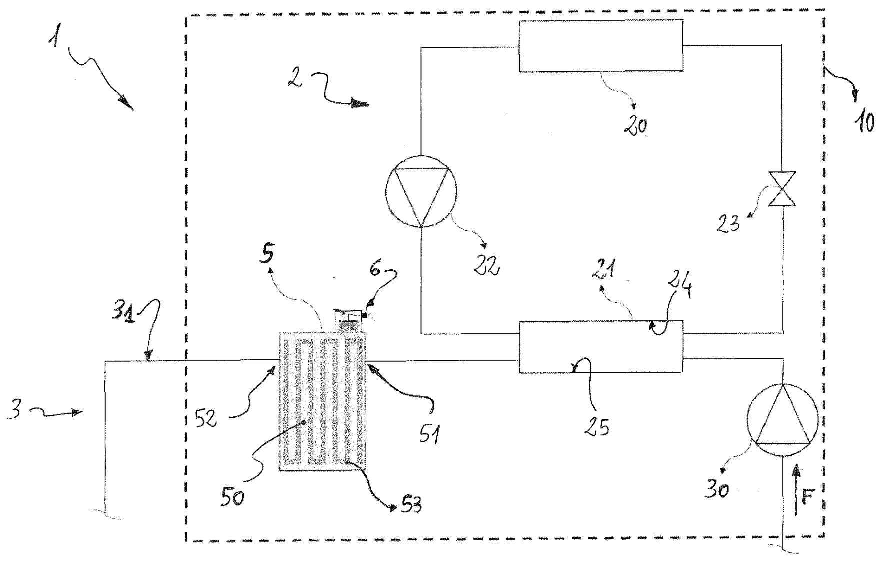

Fig. 3

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Description

[0001] The object of the present invention is a heat pump system for room heating/cooling functions and/or for the production of domestic water preferably operating with a low environmental impact refrigerant and arranged to prevent any refrigerant leaks from reaching and spreading internally into the environment in which said heat pump system is installed and/or operates.

[0002] More precisely, the object of the present invention is a heat pump system for room heating/cooling functions and/or for the production of domestic water capable of integrating a device adapted to intercept and expel said possible refrigerant leaks without this resulting in an increase in the overall number of the functional components of said heat pump.

[0003] Without any limiting intent, the invention falls within the sector of heat pump conditioning equipment for residential and/or industrial/commercial buildings (or the like), where "conditioning" is indifferently referred to as "heating" or "cooling", preferably made by electrical power supply.

[0004] Naturally, nothing prevents the heat pump system of the invention from being extended, with minimal adaptations within the reach of the man skilled in the art, to sectors similar to those of the room heating and/or cooling equipment, for example within the scope of the heat pumps for the production of domestic water.

[0005] It is known that a heat pump system 1' comprises at least (see Fig. 1):

- one refrigeration circuit 2' in which a refrigerant is evaporated at low temperature, brought to high pressure, condensed and finally brought back to an evaporation pressure, and
- one circuit for the technical fluid 3', generally water or the like, arranged for room heating/cooling via radiators, floor radiant panels, fan coils or the like and/or for the production of domestic hot water via special heat accumulators, e.g. via hot water storages.

[0006] Hereinafter, for descriptive simplicity, the circuit 3' of the technical fluid shall be referred to as "conditioning circuit 3'", where, as already mentioned, "conditioning" is indifferently referred to as both room cooling/heating and domestic water heating function.

[0007] Generally, the refrigeration circuit and the conditioning circuit share at least one heat exchanger 21', for example a plate exchanger 21', in which the heat exchange between the relative refrigeration and technical fluid is carried out. More precisely, when a heat pump system 1' is used for heating the environment and/or domestic water, said heat exchanger 21' operates as a condenser. On the contrary, if the same heat pump system 1' operates in cooling mode, said heat exchanger 21' operates as an evaporator.

[0008] The conditioning circuit 3' of a heat pump system 1' may also comprise at least one backup heater 5', generally arranged to provide an additional heating capacity for the technical fluid and/or to protect the heat pump system from freezing during the cold periods of operation.

[0009] It is known that the development of the heat pumps must face a plurality of both technical and environmental challenges.

[0010] On one hand, in fact, it is desired that the heat pump continues to operate in the most efficient possible way, while, on the other, it is increasingly desired to avoid the use of polluting refrigerants so as to reduce the environmental risk (e.g. for contrasting phenomena such as the global warming).

[0011] To meet such intents, the most polluting refrigerants, such as the common R410A, are being progressively replaced with others having a low environmental impact (i.e. having a low *"Global Warming Potential"* or *"GWP"*). For example, the heat pumps operate more and more frequently with refrigerants belonging to the group of the hydrofluorocarbons and/or of the aliphatic hydrocarbons such as, without any limiting intent, propane R290 (chemical formula: C_3H_8) or R32 (a difluoromethane having chemical formula CH_2F_2).

[0012] Such refrigerants (or others belonging to the same families or similar groups), although having a low environmental impact, are not free from drawbacks.

[0013] In fact, it is known that the low environmental impact refrigerants are generally highly flammable.

[0014] Therefore, during the transition from traditional refrigerants to low GWP ones it has been necessary to pay greater attention to their flammability and related problems.

[0015] For example, European and/or national regulations have been issued which provide that any refrigerant leaks, and consequent passage thereof from the refrigeration circuit to the conditioning circuit, must be intercepted and blocked before they reach the room heating and/or cooling system or that for the production of domestic water.

[0016] For example, as shown in document US 2019/0390873 A1, said heat pumps may provide for air tight chambers in which any refrigerant leaks may remain confined without any risk of flammability or dispersion in the environment surrounding the same heat pump and/or be connected to pipes appropriately designed to convey said refrigerant leaks directly into the atmosphere.

[0017] For such purpose, the so-called degassers, appropriately placed in the heat pump system, have been developed to separate, and possibly expel, any refrigerant leaks due to breakages and/or malfunctions of components and/or pipes of the refrigeration circuit. Such breakages and/or malfunctions, in fact, may allow the refrigerant fluid to infiltrate and reach the conditioning circuit, mixing with the technical fluid.

[0018] As shown in Fig. 1, considering as a reference the operating direction of the technical fluid in the conditioning circuit 3', a degasser 4' is positioned immediately downstream of the heat exchanger 21’ in charge, as anticipated, for the heat exchange between the refrigerant of the refrigeration circuit 2’ and the technical fluid (technical water or the like) of the same conditioning circuit 3’. Since it shall be referred to several times during the present description, it is specified that "operating direction" or "operating flow" is to be understood as the direction normally imparted to the technical fluid in the conditioning circuit 3’ by the relevant circulation pump 30’, when the heat pump system operates in heating and/or cooling conditions (see reference F in Fig. 1 or 3).

[0019] For example, said degasser 4’ may be positioned between said heat exchanger 21’ and said backup heater 5’, when provided.

[0020] A known type of degasser 4’ is shown in Fig. 1 and/or 2a, 2b.

[0021] Said degasser 4’ is suitably shaped and sized to define a chamber 40’ therein, referred to as "deaerator chamber 40’", in which the technical fluid of the conditioning circuit 3’, which passes therethrough, may pour and propagate by decreasing the speed thereof.

[0022] As a result of such slowdown, the dragging force of the technical fluid towards any refrigerant leaks also decreases, favouring the interception and separation thereof.

[0023] Any separator devices 43’ inside the deaerator chamber 40’, such as mesh filters (as it is well illustrated in Fig. 2a or 2b), perforated meshes, baffles, turbulators or similar means interfering with the flow of the technical fluid, may facilitate the slowing down thereof and the above-mentioned separation of the refrigerant. Once separated, the refrigerant, which is generally in a gaseous state (e.g. in the form of bubbles B) and with a lower density than that of the technical fluid, tends to rise towards the top parts of the deaerator chamber 40’ wherefrom at least one ventilation valve 6’ allows it to be discharged into the atmosphere before it reaches and spreads into the environment in which the heat pump system 1’ is installed and/or operational (with consequent inconveniences and dangers for the user).

[0024] It is not necessary to dwell too much in the description of details and technical and functional features of said degasser 4’ being it, as mentioned, a component per se already known to a man skilled in the art, widely used and available in a wide variety of models and construction variants (see, in such regard, also the variant described and shown in the prior art document EP 4 075 078 A1 and/or the degasser of document US 6 526 921 B1).

[0025] In such context, however, it is necessary to specify how a degasser 4’ constitutes an additional component for a heat pump system 1’ which may negatively influence the production and installation costs and the size and overall dimensions thereof, especially of the external unit, where it is usually housed. Furthermore, if on one hand the use of a degasser 4’ increases the safety of a heat pump system against possible refrigerant leaks, on the other hand it introduces and generates strong localised load losses and therefore a significant resistance to the circulation of the technical fluid in the conditioning circuit 3’, consequently worsening the efficiency of the entire system 1’.

[0026] There is also an increased risk of leaks of technical fluid from the conditioning circuit 3’ if the hydraulic connections between the relevant pipes and the degasser 4’ are not perfectly sealed. This may lead to an increase in the management and maintenance costs of the heat pump system 1’.

[0027] To try to overcome such problems, an attempt was therefore made to study, without success, a more performing degasser device, for example, of the type illustrated in the documents CN 101 970 940 A and/or EP 2 312 224 B1, according to the preamble of the independent claim attached to the present description.

[0028] The object of the present invention is to obviate such type of inconveniences by providing a low environmental impact heat pump system for room heating/cooling functions and/or for the production of domestic water comprising at least one highly efficient device capable of preventing any refrigerant leaks from spreading internally to the installation and/or usage environment.

[0029] A further purpose of the present invention, at least for one of the executive variants thereof, is to provide a low environmental impact heat pump system for room heating/cooling functions and/or for the production of domestic water in which said at least one device adapted to intercept any such refrigerant leaks does not lead to an increase in the load losses and in the resistance to the flow of technical fluid of the same heat pump system.

[0030] A further object of the present invention, at least for one of the executive variants thereof, is to provide a low environmental impact heat pump system for room heating/cooling functions and/or for the production of domestic water capable of integrating at least one device adapted to intercept any such refrigerant leaks without it leading to an increase in the overall number of the functional components of said heat pump system.

[0031] These and other objects, which shall appear clear hereinafter, are achieved with a heat pump system according to the independent claims.

[0032] Other objects may also be achieved by means of the additional features of the dependent claims.

[0033] Further features of the present invention shall be better highlighted by the following description of a preferred embodiment, in accordance with the patent claims and illustrated, purely by way of a non-limiting example, in the annexed drawing tables, in which:

- Fig. 1 schematically shows a heat pump system for room heating/cooling functions and/or for the production of domestic water according to the state of the art;
- Figures 2a and 2b schematically show a detail of the heat pump system of Fig. 1, in particular a known degasser device, according to a first and second operating configuration;

- Figure 3 schematically shows a heat pump system for room heating/cooling functions and/or for the production of domestic water according to the invention;
- Figure 4 schematically shows a detail of the heat pump system of Fig. 3, in particular of the degasser device of the invention.

[0034] The features of at least one preferred variant of the heat pump system for room heating/cooling functions and/or for the production of domestic water of the invention are now described, making use of the references contained in the figures.

[0035] Reference numeral 1 therefore indicates, as a whole, the heat pump system of the invention that may be used for a domestic or non-domestic environment (e.g. commercial or industrial) heating and/or cooling functions and/or for the production of domestic water, for example domestic hot water.

[0036] As already partially mentioned, a first circuit 2 is shown of the heat pump system 1, in which a refrigerant fluid circulates and which is evaporated at low pressure, brought to high pressure, condensed and finally brought back to an evaporation pressure, and a second circuit 3 crossed by a technical fluid, preferably technical water, that may be used for room heating/cooling and/or for the production of domestic water.

[0037] Hereinafter, for descriptive simplicity, said first 2 and second 3 circuit of the heat pump system 1 of the invention shall be respectively referred to as "refrigeration circuit 2" and "conditioning circuit 3", where, as already mentioned, "conditioning" is indifferently to be referred to as both the cooling/heating function of an environment, and that of domestic water heating.

[0038] Preferably, without any limiting intent, said refrigeration 2 and conditioning 3 circuit, the latter at least partially, may be housed in the external unit 10 of the heat pump system 1.

[0039] During the present description, refrigerant fluid shall be referred to as, without any limiting intent, a low environmental impact refrigerant (e.g. low GWP - *Global Warming Potential*) which, as mentioned, presents a greater flammability risk, such as, for example, the well-known R290 (*Propane*), R32 (*Difluoromethane*), or similar/the like.

[0040] As shown in Fig. 3, the refrigeration circuit 2 comprises, connected to each other via special pipes:

- at least one first heat exchanger 20,
- at least one second heat exchanger 21,
- at least one compressor 22 positioned between said first 20 and second 21 heat exchanger and arranged to compress said refrigerant fluid between a minimum pressure and maximum pressure thereof,
- at least one lamination valve 23 that achieves an expansion, at a substantially constant enthalpy, and cooling of the refrigerant fluid.

[0041] Said refrigerant circuit 2 may be switched, by means of a switching valve (not shown), e.g. "4 ways" between "cooling" and "heating" operating mode (and vice versa) with said first 20 and second 21 heat exchanger that may therefore operate, if necessary, either as a condenser or as an evaporator.

[0042] When in "heating" mode, the refrigerant fluid dissipates heat, by condensing, in the second exchanger 21 which therefore acts as a condenser, while absorbing heat, evaporating, in the first exchanger 20 which acts as an evaporator.

[0043] On the contrary, in "cooling" mode, the above-mentioned first heat exchanger 20 operates as a condenser of the refrigeration circuit 2, while the second exchanger 21 as a relative evaporator.

[0044] More generally, the second heat exchanger 21 is preferably that in which the heat exchange takes place between the refrigerant fluid of the refrigeration circuit 2 and the technical fluid of the conditioning circuit 3.

[0045] For clarity of explanation, said second heat exchanger 21 shall be referred to as "main heat exchanger" or, more simply, "main exchanger".

[0046] When necessary, the main heat exchanger 21 may therefore operate:

- as an evaporator and in such case the refrigerant fluid absorbs, at substantially constant pressure, thermal energy from the technical fluid, by cooling it, or
- as a condenser and in such case the refrigerant fluid yields, at substantially constant pressure, part of the thermal energy thereof to the technical fluid, by heating it.

[0047] Therefore, it may be possible to identify, of said main heat exchanger 21, a primary side 24 at which the refrigerant fluid circulates and operates, and a secondary side 25, at which the technical fluid of the conditioning circuit 3 circulates and operates.

[0048] As anticipated, the conditioning circuit 3 may further comprise at least one circulation pump 30 of the technical fluid and is connected and/or cooperating with one or more terminals (not shown) for ambient heating/cooling and/or for the domestic water.

[0049] Said terminals may therefore operate:

- as heat dissipation devices and/or as conditioning units in heating/cooling modes, in such case comprising, for example, one or more radiators, floor or wall radiant panels, fan coils, convectors or similar devices, and/or
- as heat accumulators containing the fluid circulating in the conditioning circuit 3, for example as a buffers, and/or
- as heat accumulators, for example as hot water storages (or the like) in case of domestic water heating.

[0050] Without any limiting intent and considering the operating direction F of the technical fluid as a reference, the circulation pump 30 may be placed upstream of the secondary side 25 of the main heat exchanger 21 (see Fig. 3).

[0051] The conditioning circuit 3 may further comprise at least:

- one relief valve (not shown) capable of opening for pressures of the technical fluid greater than a safety threshold, generally, of 3 bars, allowing the discharge thereof; such condition may occur in the event of anomalies and/or major failures of one or more components of the heat pump system 1, e.g., in presence of considerable and sudden leaks of refrigerant from the refrigeration circuit 2 due to breakages of the main exchanger 21 thereof (in general, the plate exchanger) and/or the connecting pipes, and/or
- at least one ventilation valve 6, of manual or automatic type, which allows for the evacuation of a gas possibly transported by the technical fluid and suitably intercepted and separated therefrom.

[0052] In the example case, said ventilation valve 6 may therefore allow the expulsion of:

- the refrigerant leaks coming from the refrigeration circuit 2 and which have reached and affected the technical fluid, and/or possibly
- the excess air present in the pipes and/or in the terminals of said conditioning circuit 3.

[0053] As shown in Fig. 3, said conditioning circuit 3 further comprises one backup heater 5, arranged to provide additional heating capacity for the technical fluid and/or to protect the heat pump system 1 from freezing during the coldest periods of operation.

[0054] Generally, said backup heater 5 is a substantially box-shaped body in fluid communication with the pipes of the conditioning circuit 3 and it is therefore also crossed by the technical fluid.

[0055] Without any limiting intent, the backup heater 5, which is preferably installed downstream of the main heat exchanger 21 (referring to the operating direction F of the technical fluid) comprises at least:

- one inlet 51 connected, via pipe sections, to said secondary side 25 of said main heat exchanger 21,
- one outlet 52 connected to the delivery pipe 31 for the terminals of the conditioning circuit 3,
- one chamber 50 in which the additional heating of the technical fluid takes place (hereinafter also referred to as "heating chamber 50"),
- at least one heating element 53, inside said chamber 50, and, preferably, of electric type (i.e. such as to heat such technical fluid by the Joule effect).

[0056] According to a possible executive embodiment, said at least one heating element 53 may for example comprise one or more electric heaters (also referred to as "resistances"), each for example comprising a tubular element, generally metallic, repeatedly wrapped and folded on itself so as to form a plurality of coils or branches 54, adjacent, preferably close to each other (see, for example, Figures 3 and/or 4).

[0057] Naturally, nothing prevents the possibility of adopting alternative or equivalent electric heating elements among those currently available on the market.

[0058] Due to structural, geometric and dimensional affinities, according to the invention, it has been found advantageous to use said at least one backup heater 5 also as a "degasser device".

[0059] According to the invention, the backup heater 5, therefore, also performs a degassing function and may therefore intercept and/or expel at least any refrigerant leaks before they spread into the conditioning circuit 3, preventing them from reaching the pipes, the manifolds, the valves, the radiators or fan coils or any other device of the technical fluid distribution circuit inside a building. For such purpose, according to a possible embodiment of the invention, which is among the preferred ones, the backup heater 5 integrates at least the above-mentioned ventilation valve 6 of the conditioning circuit 3, while:

- the volume of the heating chamber 50 thereof acts also, and if necessary, as a "deaerating chamber" in which, like the traditional and known degasser devices (see ref. 40' in Fig. 1 of the state of the art), the technical fluid may propagate, decreasing its speed and the dragging force of any refrigerant leaks, thus favouring the separation thereof,
- the heating elements 53, inside said heating chamber 50, for example their coils or branches 54 (or similar configurations), operate as "separator devices" capable of interfering with and further slowing down the technical fluid, improving the above-mentioned separation of the refrigerant leaks, equivalent to what achieved by the mesh filters, perforated screens, fins, retarders, baffles, turbulators (or the like) of the degassers of the state-of-the-art (see ref. 43' in Fig. 2a-2b).

[0060] Furthermore, given the known tendency of the refrigerant separated from the technical fluid to rise upwards (e.g. in the form of bubbles B) by the effect of the lower density thereof, the ventilation valve 6, which as seen may be either automatic or manual, is preferably installed at or in the proximity of the top wall 56 of the backup heater 5 and in fluid communication with the heating chamber 50 thereof.

[0061] Said ventilation valve 6 is capable of remaining closed (or closing) in the absence of refrigerant leaks or for modest or tolerable quantities thereof, or of opening when said quantity of refrigerant separated from the technical fluid exceeds significant and no longer negligible values.

[0062] By way of an example, said ventilation valve 6 may consist of a known jolly valve of the type already usable for the expulsion of the excess air that may be present in a heating/cooling system.

[0063] Therefore, although hereinafter the use and operation of said ventilation valve 6 shall be described mainly in relation to said refrigerant leaks, nothing prevents that everything that shall be said with reference thereto may be totally and easily extended also to the exhaust of the excess air in the conditioning circuit 3. In other words, unless otherwise specified, hereinafter, the term "refrigerant leaks" is to be understood, at least by analogy or similar behaviour, also as the excess air to be intercepted and eliminated from the conditioning circuit 3.

[0064] In general, therefore, the backup heater 5, comprising said ventilation valve 6, may, due to the structure thereof, facilitate the evacuation of any gas intercepted and separated from a fluid and therefore may also allow the elimination of said excess air in the technical fluid.

[0065] Without any limiting intent, without prejudice to the possibility of using equivalent solutions, said ventilation valve 6 may be of the automatic type, where the opening of a relative vent 64, aimed at discharging, for example into the atmosphere, the refrigerant intercepted and separated from the technical fluid is assigned to a shutter 60, that may be operated depending on the presence and quantity of said refrigerant.

[0066] By way of an example, as shown in Fig. 4, the shutter 60 may be housed inside a compartment or valve body 61 in fluid communication with the underlying heating chamber 50 of the backup heater 5 and is generally in contact and/or cooperating with the technical fluid that fills and/or passes through the same chamber 50.

[0067] According to a possible executive variant, said shutter 60 may be connected, via a special return means 62 (e.g. a control rod 62) to a float 63 capable of floating in the technical fluid of the heating chamber 50.

[0068] Generally, said ventilation valve 6 is "normally closed", i.e. the shutter 60 is positioned in such a way as to keep the vent 64 closed, but capable of opening immediately in case of refrigerant leaks, thus passing from a "closing configuration" to an "opening configuration".

[0069] More precisely, according to a possible functional mode:

- in the absence of refrigerant leaks, or for modest quantities thereof, the float 63 is normally located in the proximity of the top wall 65 of the ventilation valve 6 and the relative shutter 60 keeps closed or closes the vent 64, while,
- in case of leaks, the refrigerant that was separated rises upwards inside the heating chamber 50 of the backup heater 5 and accumulates thereto, causing the level of the technical fluid present therein to lower and a consequent translation and downward descent of the float 63; this allows the shutter 60, to which the float 63 is connected via the control rod 62, to be switched, from said "closing configuration" to said "opening configuration" of the vent 64.

[0070] Although not shown in the attached figures, nothing prevents said backup heater 5 from comprising, integrated and/or in fluid communication with the heating chamber 50 thereof, also the above-mentioned relief valve (not shown), otherwise alternatively positioned and installed in the conditioning circuit 3 preferably downstream of the main exchanger 21.

[0071] It should also be noted that in order to use in "degasser" mode the backup heater 5 of the invention in total safety, it is preferable that the heating element 53, inside the heating chamber 50, does not reach too high temperatures which may lead to the ignition and combustion of the refrigerant possibly present in the technical fluid and with which, in case of leaks, it may come into direct contact. In particular, it is desired that the surface temperatures T_{risc} of said at least one heating element 53 are sufficiently lower than the self-ignition temperature T_{acc} of the refrigerant used in the heat pump system 1.

[0072] For example, the maximum temperature T_{risc} that may be reached by said heating element 53 may be set and/or adjusted to remain below said self-ignition temperature T_{acc} of the refrigerant fluid by an appropriate safety threshold Δ_{safety} ($T_{risc} < T_{acc} - \Delta_{safety}$).

[0073] For such purpose, without any limiting intent, said at least one heating element 53 may therefore:

- cooperate with a thermostat adapted to disconnect it electrically in case that overtemperature conditions are detected, i.e. if $T_{risc} > T_{acc} - \Delta_{safety}$, or
- comprise a positive temperature coefficient heater (e.g. of the PTC type), or, more generally, a self-regulating heater 53 able to maintain the temperature thereof as constant as possible and preferably below the maximum temperature T_{risc} allowed.

[0074] It appears clear that the solution with a self-regulating heater 53 is preferable as it allows for an intrinsic safety system and avoids the implementation of a thermostat appropriately dedicated to the control and/or regulation of the surface temperatures thereof.

[0075] In conclusion, with the backup heater 5 of the invention, also adapted to act as a degasser device, the intended objectives are achieved.

[0076] For example, as already mentioned, a component specifically and exclusively used for the interception and subsequent expulsion of any refrigerant leaks is eliminated from the heat pump system 1, i.e. the traditional degasser or similar devices (that is, the component 4' of Fig. 1 is eliminated).

[0077] The combination of both a heating function of the technical fluid and the function of intercepting any refrigerant leaks present therein in a single device 5 allows a reduction in the overall number of components of the heat pump system 1 and a consequent reduction in the production and maintenance costs thereof and an optimisation and compaction of the design thereof, e.g. of the external unit 10.

[0078] Furthermore, by avoiding installing a traditional degasser device in the heat pump system 1 of the invention, whose function, as mentioned, is implemented by the backup heater 5, no further localised pressure losses than those already normally and inevitably provided are introduced, which would excessively penalise the circulation of the technical fluid in the conditioning circuit 3. Therefore, there is an improvement in the overall efficiency and safety of the heat pump system 1.

[0079] The integration of a degasser device and backup heater into a single component also reduces the total number of hydraulic connections, fittings, joints, or the like, of the conditioning circuit 3, effectively reducing the risk of technical fluid leakages in case of sealing defects thereof. This may lead to a reduction in the management and maintenance costs of the heat pump system of the invention.

[0080] Finally, it should be noted that with the backup heater 5 of the invention comprising at least one ventilation valve 6 there is the possibility to intercept and discharge, according to methods and with results substantially similar to those provided for the refrigerant leaks, any excess air in the pipes and/or terminals of the conditioning circuit 3, guaranteeing regularity of the flow of technical fluid and the thermal capacity thereof.

[0081] Finally, it should be noted that several variants of the heat pump system of the invention are possible for the man skilled in the art, without departing from the novelty scopes of the inventive idea, as well as it is clear that in the practical embodiment of the invention the various components described above may be replaced with technically equivalent elements. For example, nothing prevents integrating a shutter body (not shown) into the chamber 50 of the backup heater 5, which, in case of significant refrigerant leaks and under the effect of the pressure thereof greater than that of the technical fluid, is capable of closing the outlet 52, preventing them from reaching the various terminals of the conditioning circuit 3 and favouring the separation thereof from the same technical fluid.

Claims

1. Heat pump system (1) comprising at least:

   - a refrigeration circuit (2) wherein a refrigerant fluid circulates and operates at the primary side (24) of a main heat exchanger (21),
   - a conditioning circuit (3) wherein a technical fluid, used for room heating/cooling functions and/or for the production of domestic water, circulates and operates at the secondary side (25) of said main heat exchanger (21),

   the heat exchange between said refrigerant fluid and technical fluid being therefore carried out in said main exchanger (21),
   said conditioning circuit (3):

   - further comprising a circulation pump (30),
   - comprising at least one backup heater (5) of said technical fluid provided with at least one heating chamber (50) and with at least one heating element (53),

   said backup heater (5) further integrating at least one ventilation valve (6) capable of expelling at least the possible leaks of refrigerant fluid before they diffuse into said conditioning circuit (3), the volume of the heating chamber (50) of said backup heater (5) therefore acting as a deaerating chamber (50) wherein said technical fluid may propagate by decreasing the speed thereof and the dragging force of said possible refrigerant leaks, favouring the separation thereof
   - being connected and cooperating with ore or more terminals for said room heating/cooling and/or for the domestic water,

   characterised in that said at least one heating element (53) of said backup heater (5) operates as a separator device capable of interfering and further slowing down the flow of the technical fluid, improving the separation of said possible refrigerant leaks.

2. Heat pump system (1) according to claim 1, **characterised in that** said at least one heating element (53) comprises one or more electric heaters (53).

3. Heat pump system (1) according to claim 2, **characterised in that** said at least one heating element (53) is a positive temperature coefficient heater or a self-regulating heater (53), said at least one heating element (53) maintaining the surface temperature (T_{ris}) thereof lower than the self-ignition temperature (T_{acc}) of the refrigerant fluid.

4. Heat pump system (1) according to claim 2, **characterised in that** said at least one heating element (53) cooperates with a thermostat adapted to unpower it electrically in the event of overtemperatures, said at least one heating element (53) maintaining the surface temperature (T_{ris}) lower than the self-ignition temperature (T_{acc}) of the refrigerant fluid.

5. Heat pump system (1) according to one or more of the previous claims, **characterised in that** said ventilation valve (6) is installed at or in the proximity of the top wall (56) of said backup heater (5) and in fluid communication with said heating chamber (50) thereof.

6. Heat pump system (1) according to the previous claim, **characterised in that** said ventilation valve (6) is a valve comprising at least:

- one vent (64) for the draining of said possible leaks of refrigerant fluid,
- one shutter (60) capable of cooperating with the technical fluid that fills and/or passes through said heating chamber (50) of said backup heater (5) and of opening said vent (64) according to said possible leaks of refrigerant fluid in said technical fluid.

7. Heat pump system (1) according to the previous claim, **characterised in that** said shutter (60) is connected to a float (63) capable of floating in said technical fluid of the heating chamber (50), said float (63):

- being in the proximity of said top wall (65) of said ventilation valve (6) in the absence of refrigerant fluid leaks, in such case the relative shutter (60) keeping closed or closing said vent (64),
- translating and descending downwards when the refrigerant fluid leaks have been separated from said technical fluid, in such case the relative shutter (60) being switched from a "closing configuration" to an "opening configuration" of said vent (64).

8. Heat pump system (1) according to one or more of the previous claims, **characterised in that** said ventilation valve (6) is of the type capable of intercepting and also discharging also the excess air possibly present in said conditioning circuit (3).

9. Heat pump system (1) according to one or more of the previous claims, **characterised in that** said at least one backup heater (5) comprises a relief valve, said relief valve, said relief valve being capable of opening for pressures of the technical fluid greater than one safety threshold.

10. Heat pump system (1) according to one or more of the previous claims, **characterised in that** said at least one backup heater (5) is installed, with reference to the operating direction (F) of the technical fluid, downstream of the main heat exchanger (21).

11. Heat pump system (1) according to one or more of the previous claims, **characterised in that** said refrigeration circuit (2) and, at least in part, said conditioning circuit (3) are housed in an external unit (10) of said heat pump system (1).

12. Heat pump system (1) according to any **previous claim, characterised in that** said refrigerant fluid of the refrigeration circuit (2) is a low environmental impact refrigerant.

13. Backup heater (5) for a heat pump system (1) according to one or more of the claims 1 to 12, comprising at least one heating chamber (50) and at least one heating element (53) for a technical fluid adapted to the room heating/cooling and/or for the production of domestic water, **characterised in that** it further comprises a ventilation valve (6) capable of expelling at least any leaks of refrigerant fluid coming from the refrigeration circuit (2) of said heat pump system (1) before they diffuse in the relative conditioning circuit (3), the volume of said heating chamber (50) thus acting as a deaerating chamber (50) in which said technical fluid may propagate by decreasing the speed and the dragging force thereof of said possible refrigerant leaks, favouring the separation thereof.

14. Usage in a heat pump system (1), according to one or more of the claims 1 to 12, of a backup heater (5), according to at least claim 13, as a "degasser device" for the interception and separation of possible leaks of refrigerant fluid from a technical fluid.

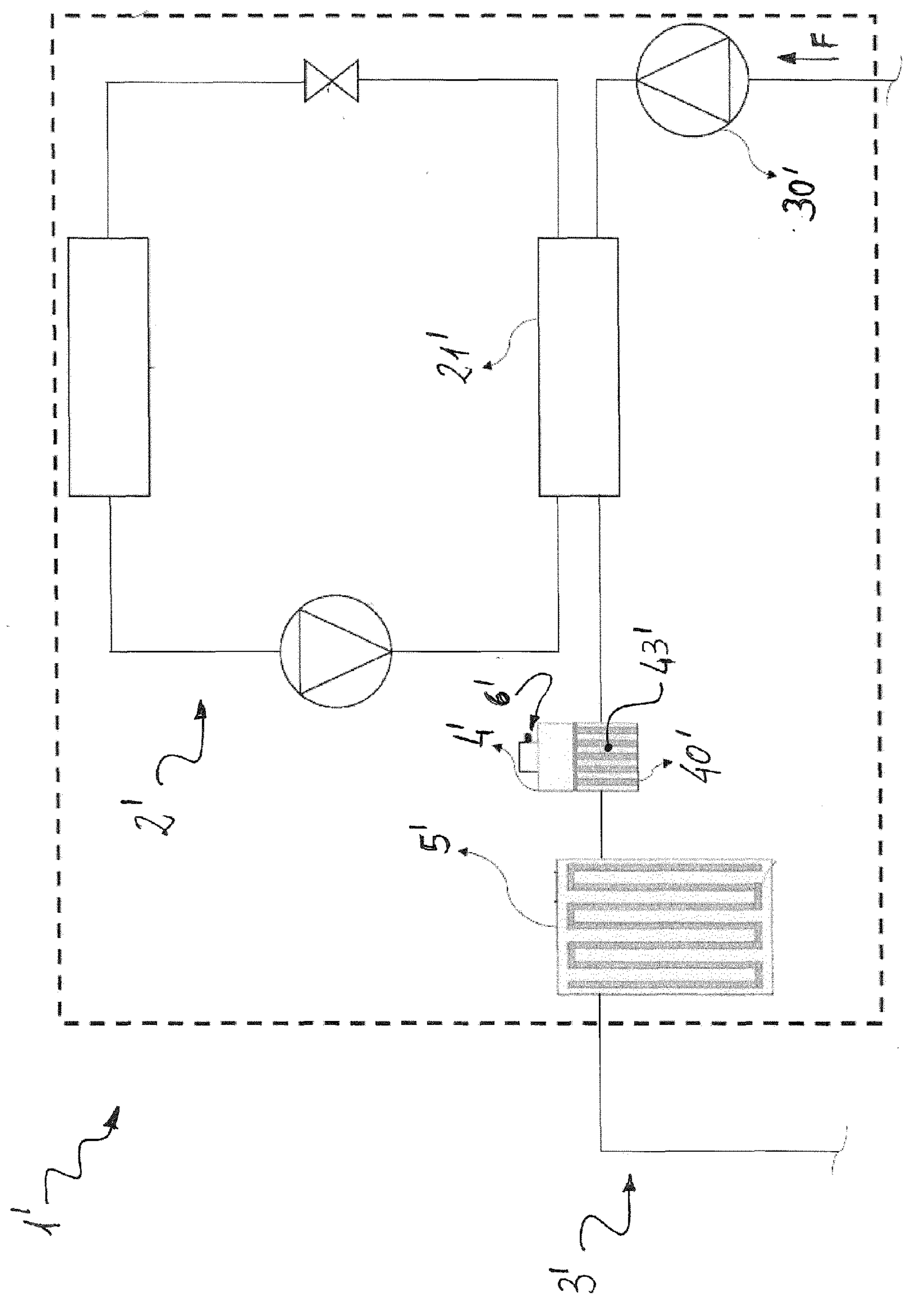

Fig. 1

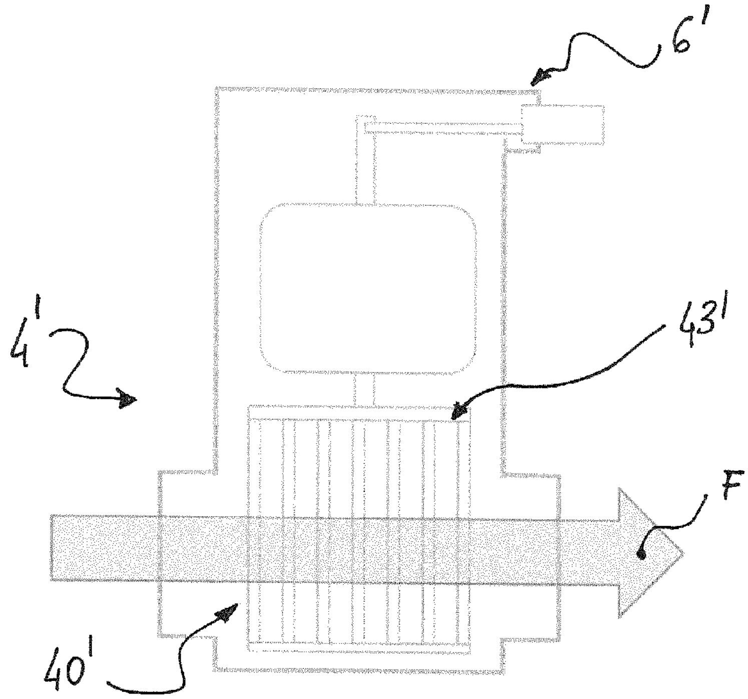

Fig. 2a

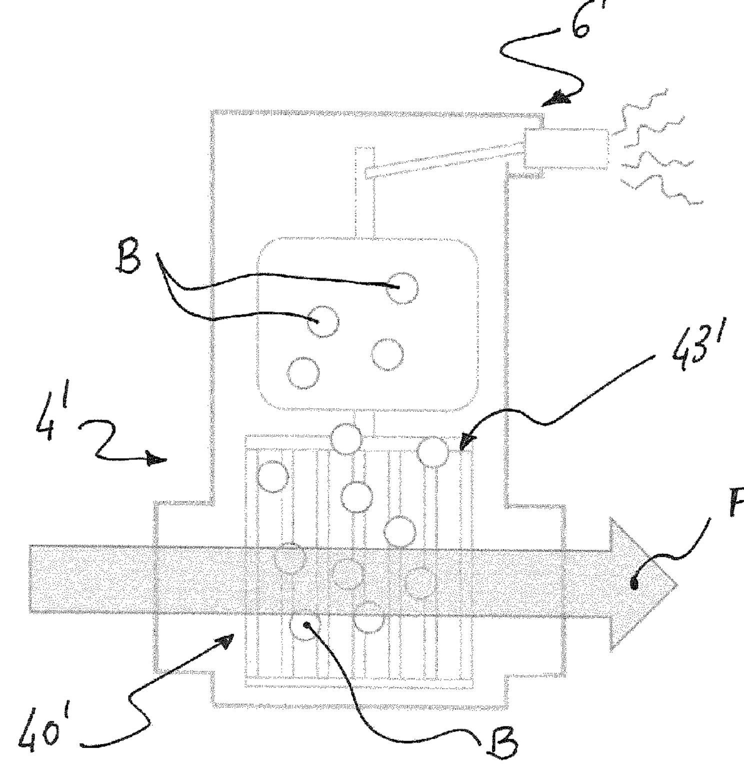

Fig. 2b

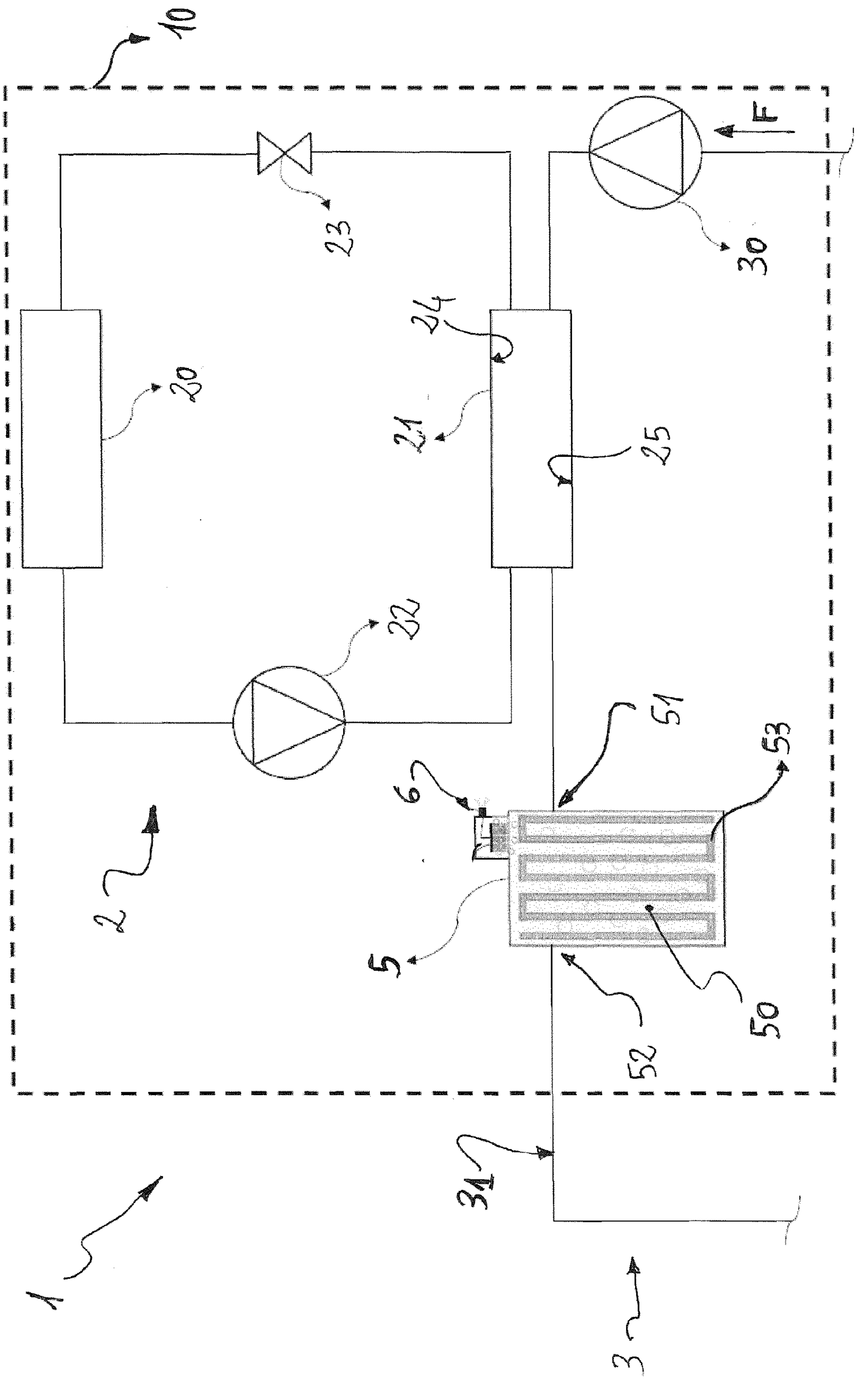

Fig. 3

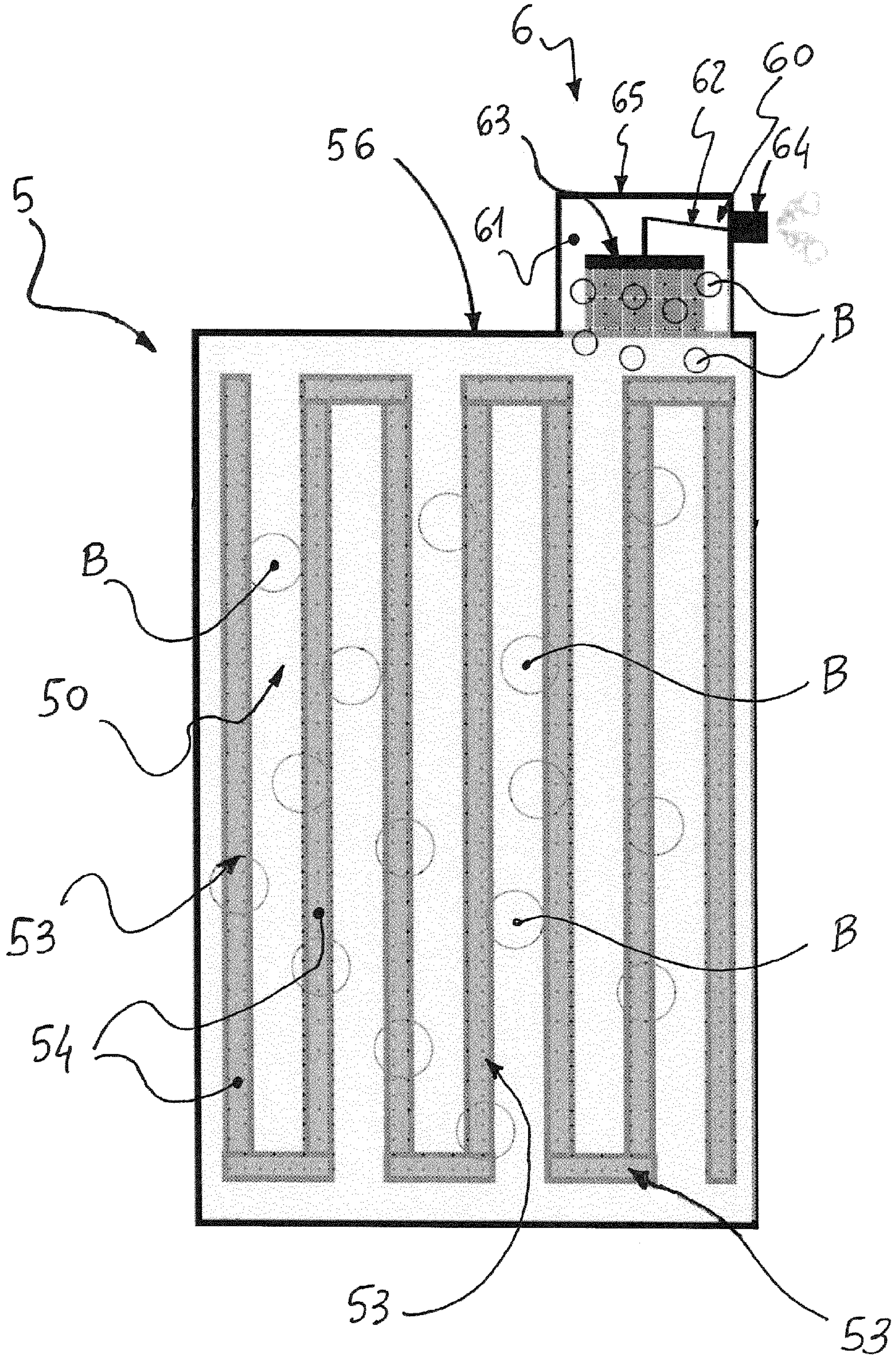

Fig. 4

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EUROPEAN SEARCH REPORT

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The present search report has been drawn up for all claims

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Munich	20 November 2023	Ast, Gabor

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