(19) Europäisches Patentamt
European Patent Office
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(11) EP 3 070 418 A2

(12) # EUROPEAN PATENT APPLICATION

(43) Date of publication:
21.09.2016 Bulletin 2016/38

(21) Application number: **16160865.8**

(22) Date of filing: **17.03.2016**

(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 MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(30) Priority: **18.03.2015 IT BO20150132**

(51) Int Cl.:
F25B 13/00 *(2006.01)* ***F25B 39/00*** *(2006.01)*
F25B 41/00 *(2006.01)* ***F25B 41/04*** *(2006.01)*

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(54) **REFRIGERATION SYSTEM**

(57) An operating method and refrigeration circuit (1), in particular for a heat pump (2) with cycle inversion; wherein the refrigeration circuit (1) has a finned heat exchanger (5), which is adapted to be installed on the outside of a room (H) to be conditioned, and a utility (7), adapted to be installed on the inside of the room (H) to be conditioned; wherein the exchanger (5) is adapted to be flowed through, on the outside, by an air flow in a given direction (W) and, on the inside, by a refrigerant fluid (F), which can selectively flow either in a first direction (R1) or in a second direction (R2); wherein the exchanger (5) is flowed through by the fluid (F) always in a countercurrent flow relative to the direction (W) of the outside air whatever the feeding direction (R1; R2) of the refrigerant fluid (F) on the inside of the refrigeration circuit (1) is.

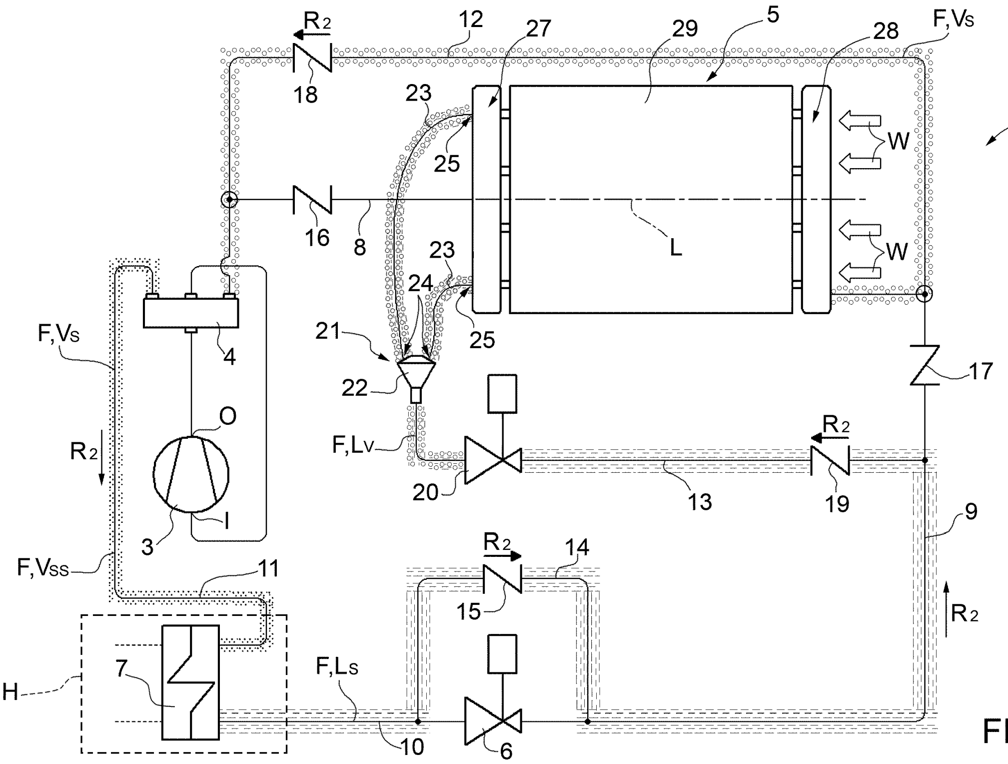

FIG.2

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Description

[0001] The present patent application concerns an operating method and a reversible refrigeration circuit, in particular for a heat pump with cycle inversion with air condensation.

[0002] It is known that a heat pump comprises a reversible refrigeration circuit, which in turn comprises: a fin heat exchanger adapted to be installed in an outdoor environment; and a utility adapted to be installed inside a room to be conditioned.

[0003] The heat exchanger in turn comprises: manifolds; one or more heat exchange pipes which fluidly connect the manifolds to one another; and a plurality of fins which project radially, in a known way, from said heat exchange pipes.

[0004] During use of the exchanger, it is known that the manifolds and the heat exchange pipes are flowed through by a refrigerant fluid in a first or in a second direction according to the type of use; whereas the finned pack is always flowed through by an air flow in a given direction. Therefore, in an operating condition the refrigerant fluid and the external air are in equicurrent, thus reducing the efficiency of the cooling circuit. This is particularly disadvantageous when the refrigerant circuit is operated to heat the utility, as will be described in further detail below.

[0005] It is also known that the heat exchanger acts as a condenser or evaporator of the refrigeration cycle, according to the direction in which the refrigerant fluid flows through the inside of the refrigeration circuit. In the case of operation of the exchanger of known type as an evaporator (therefore supplying heat to the utility), the refrigeration circuit has a low efficiency, especially when the heat exchanger is installed in an outdoor environment at low temperatures.

[0006] In fact, during the winter period the outdoor temperatures can be extremely low and, due to the degree of relative humidity of the air, evaporation temperatures inside the heat exchanger can drop well below 0°C, frosting the humidity contained in the air on the surface of the heat exchanger fins.

[0007] It can be observed that the frost or, even worse, a layer of ice on the heat exchanger fins prevents optimal passage of the air and jeopardizes correct operation of the heat exchanger.

[0008] The object of the present invention is to reduce, or even avoid, the formation of frost or ice on the fins of a heat exchanger installed outdoors, when the refrigeration circuit is used to heat the utility.

[0009] The object of the present invention is to provide an operating method and a refrigeration circuit which overcome the above-mentioned drawbacks.

[0010] According to the present invention, an operating method and refrigeration circuit are provided as cited in the attached claims.

[0011] The invention will now be described with reference to the accompanying drawings, which illustrate a non-limiting embodiment example, in which:

- figure 1 illustrates a diagram of operation of the refrigeration circuit according to the present invention in a first operating configuration;
- figure 2 is similar to figure 1 and illustrates the diagram of the refrigeration circuit according to the present invention in a second operating configuration;
- figure 3 is a schematic view, partially in section in a plane, of a detail of the refrigeration circuit according to the present invention;
- figure 4 is a lateral schematic view, partially in section, of the detail of figure 3;
- figure 5 represents schematically and by way of example a top plan view of the detail of figure 3 appearing in figure 4e; and
- figure 6 illustrates an enlargement partially in section of a detail of figure 5.

[0012] In figure 1, the number 1 indicates as a whole a refrigeration circuit of a heat pump 2 which comprises:

- a compressor 3;
- a switch 4 adapted to regulate the feed direction R1 or R2 of a refrigerant fluid F inside the refrigeration circuit 1;
- a heat exchanger 5, which is adapted to be installed on the outside of a room H to be conditioned;
- a thermal expansion valve 6; and
- a utility 7, which is adapted to be installed inside a room H to be conditioned.

[0013] In particular, the thermal expansion valve 6 is a thermostatic valve of known type and illustrated schematically.

[0014] The switch 4 is of known type and illustrated schematically. The switch 4 is connected, in a known way, both to the inlet I and to the delivery O of the compressor 3.

[0015] The refrigeration circuit 1 further comprises:

- a branch 8 which fluidly connects the switch 4 to the exchanger 5;
- a branch 9 which fluidly connects the exchanger 5 to the thermal expansion valve 6;
- a branch 10 which fluidly connects the thermal expansion valve 6 to the utility 7; and
- a branch 11 which connects the utility 7 to the switch 4.

[0016] In addition, the heat pump 2 comprises:

- a deviation branch 12, which connects the branch 9 to the switch 4 in parallel to the exchanger 5;
- a deviation branch 13 which connects the branch 9 directly to the inside of the exchanger 5, as will be

illustrated in further detail below; and

- a by-pass branch 14, which fluidly connects the branch 10 to the branch 9 in parallel to the thermal expansion valve 6.

[0017] According to the illustrations of figures 1 and 2, the branch 8 comprises a non-return valve 16, which allows flow of the fluid F in the direction R1 from the switch 4 towards the exchanger 5.

[0018] The branch 9 comprises a non-return valve 17, which allows flow of the fluid F in the direction R1 from the exchanger 5 towards the thermal expansion valve 6. The deviation branch 13 connects to the branch 9 downstream of the valve 17.

[0019] The deviation branch 12 comprises a non-return valve 18, which allows flow of the fluid F in the direction R2 from the exchanger 5 towards the compressor 3.

[0020] The branch 14 comprises a non-return valve 15, which allows flow of the fluid F in the direction R2 from the utility 7 towards the exchanger 5.

[0021] The deviation branch 13 comprises a non-return valve 19, which allows flow of the fluid F in the direction R2 from the utility 7 to the exchanger 5, a thermal expansion valve 20 and a distribution system 21, as will be illustrated in further detail below. The thermal expansion valve 20 is arranged along the deviation branch 13 between the valve 19 and the distribution system 21. Preferably, the thermal expansion valve 20 is a thermostatic valve of known type and illustrated schematically.

[0022] The distribution system 21 comprises a distributor 22 (of known type and generally called Venturi gas distributor) and a plurality of capillary tubes 23, each of which has an end portion 24 and an end portion 25.

[0023] As illustrated in the figures, the distributor 22 comprises a body axially symmetrical and hollow inside, which has a substantially frustoconical shape, in particular having a narrowing, so as to create a Venturi effect inside it.

[0024] The distributor 22 has a plurality of radial openings (of known type and not illustrated); in each radial opening, an end portion 24 of a respective capillary tube 23 is engaged in a known way and is schematically illustrated.

[0025] According to figure 3, the heat exchanger 5 is of the fin type, with a longitudinal axis L and is adapted to be lapped by an air flow according to the direction W substantially perpendicular to the axis L and illustrated in figure 3.

[0026] In particular, the exchanger 5 comprises: a manifold assembly 27, a manifold assembly 28, a plurality of heat exchange pipes 40 substantially parallel to the axis L, each pipe 40 being bent so as to form coils with a plurality of sections parallel to one another, and a plurality of fins of known type and not illustrated. Substantially the fins are perpendicular to each heat exchange pipe 40. In the figures, the schematic block 29 represents a heat exchange unit of known type comprising heat exchange pipes 40 and fins.

[0027] According to figure 3, the manifold assembly 27 comprises a manifold 30 having an internal cavity 31 and a longitudinal axis A substantially perpendicular to the axis L, an inlet 33, a plurality of pipes 34, which communicate with respective pipes 40 of the heat exchange unit 29, and a plurality of openings 32. In particular, the pipes 34 are adapted to establish communication between the cavity 31 of the manifold 30 and the heat exchange pipes 40 (illustrated in figure 4) of the heat exchange unit 29.

[0028] The pipes 34 project from a longitudinal wall 36, which is opposite the wall 35. Each pipe 34 is adapted to establish communication between the cavity 31 and the outside. The pipes 34 are substantially perpendicular to the axis A and are uniformly distributed along the axis A. Each pipe 34 has an internal diameter adapted to house a respective capillary tube 23.

[0029] Each opening 32 is provided on the wall 35 and is arranged substantially at a respective pipe 34. Each opening 32 has a diameter adapted to house a respective capillary tube 23.

[0030] According to figure 3, an end portion 25 of a capillary tube 23 is arranged across the respective opening 32 and the cavity 31 of the manifold 30 and is inserted inside a respective pipe 34.

[0031] The capillary tubes 23 are tightly fixed on the wall 35 of the manifold 30. In particular, each capillary tube 23 is braze-welded with the wall 35.

[0032] Advantageously, each pipe 34 and each capillary tube 23 define two inlets I1 and I2 feeding a respective pipe 40 of the heat exchanger 5. The inputs I1 and I2 are distinct from each other and are configured to feed fluid F supplied by two different branches of the refrigeration circuit 1.

[0033] The inlet I1 is composed of the circular crown 51 delimited between a pipe 34 and the respective capillary tube 23. Advantageously, the inlet I1 faces the inside of the cavity 31 of the manifold 30 and is configured to feed into the respective pipe 40 the fluid F in the form of superheated vapour Vss coming from the branch 8 when the fluid flows inside the refrigeration circuit 1 in the direction R1.

[0034] Advantageously, the inlet 12 is composed of the area 50 through which the capillary tube 23 passes. The inlet 12 is configured to feed the fluid F in the liquid-vapour two-phase state Lv coming from the branch 13, through the feed system 21, when the fluid flows inside the refrigeration circuit 1 in the direction R2.

[0035] In other words, advantageously, the heat exchanger 5 of the type described above has for each pipe 40 two inlets I1, I2 configured to feed fluid F coming from two different sources (from the branch 8 through the manifold 30 or from the branch 13 through the feed system 21) and in two different physical states.

[0036] Thanks to the possibility of feeding each pipe 40 with two different types of sources (manifold 30 or feed system 21) through two respective inlets I1, I2, according to the feed direction R1, R2 of the fluid F in the refrigeration circuit 1 (or according to the state of the fluid F which is fed to the heat exchanger 5), optimal operation and maximum efficiency of the heat exchanger 5 are always guaranteed.

[0037] The inlet 33 projects from a longitudinal wall 35 of the manifold 30 and is arranged in a substantially central position of the manifold 27. The inlet 33 connects the cavity 31 with the outside.

[0038] The manifold assembly 28 is of known type and comprises a manifold 37 substantially parallel to the manifold 30 and an outlet 38, which is arranged at one end of the manifold 37.

[0039] It is observed that the present solution can be applied regardless of the refrigerant fluids used.

[0040] Furthermore, the present solution is applicable both to systems with electromechanical type control and to systems with microprocessor control combined with appropriate control software.

[0041] In use, the switch 4 is operated in a known way (manually or by traditional control means) so as to set the operating configuration of the refrigeration circuit 1 to cool or heat the utility 7.

[0042] As illustrated in figure 1, to cool the utility 7, the switch 4 directs the refrigerant flow F in the direction R1 inside the circuit 1.

[0043] During operation of the refrigeration circuit 1 to cool the utility 7, the heat pump 2 operates substantially like a traditional heat pump 2.

[0044] In particular, the flow F coming out of the compressor 3 in the state of superheated vapour Vss is conveyed to the exchanger 5 through the branch 8. The superheated vapour Vss enters the manifold assembly 27 through the inlet 33 and flows, in a known way, through the pipes 40 of the exchanger 5 in a countercurrent flow relative to the direction W of the air flow, as illustrated in figure 4.

[0045] During crossing of the exchanger 5, the superheated vapour Vss condenses to obtain, at the outlet of said exchanger 5, substantially saturated liquid Ls, which is directed to the thermal expansion valve 6. As it crosses the thermal expansion valve 6, the fluid F in the saturated liquid state Ls passes to a liquid-vapour state Lv and is directed to the utility 7, which acts as an evaporator.

[0046] Through the utility 7, the fluid F in the liquid-vapour state Lv passes to the saturated vapour state Vs and is sent to the inlet I of the compressor 3 through the switch 4.

[0047] During operation of the refrigeration circuit 1 to cool the utility 7, the thermal expansion valve 20, the deviation branch 12, the deviation branch 13 and the by-pass branch 14 are closed.

[0048] As illustrated in figure 2, to heat the utility 7, the switch 4 directs the refrigerant flow F in the direction R2 inside the refrigeration circuit 1.

[0049] The flow F coming out of the compressor 3 is in the state of superheated vapour Vss and is sent to the utility 7, which operates as a condenser. Through the utility 7 the refrigerant fluid F passes to the saturated liquid state Ls. It is observed that in this operating configuration the thermal expansion valve 6 is closed and the saturated liquid Ls crosses the by-pass branch 14. Furthermore, the saturated liquid Ls is conveyed through the deviation branch 13 and across the thermal expansion valve 20.

[0050] Through the thermal expansion valve 20 the saturated liquid Ls passes to the liquid-vapour two-phase state Lv. Through the distributor 21 the liquid-vapour Lv is uniformly distributed among all the capillary tubes 23, each of which conveys directly the liquid-vapour Lv inside a respective pipe 40. In particular, each capillary tube 23 feeds the fluid F in the liquid-vapour two-phase state Lv into a respective pipe 40 through a respective inlet 12.

[0051] In this way, the fluid F in the liquid-vapour state Lv is uniformly distributed inside the exchanger 5 (in other words the fluid F in the liquid-vapour state is uniformly distributed among the pipes 40 of the heat exchanger 5), without the risk of the liquid separating from the vapour inside the manifold assembly 27 (which would inevitably lead to poor operation of the exchanger 5).

[0052] Furthermore, it can be observed that the fluid F in the liquid-vapour state Lv is fed into the exchanger 5 in a countercurrent flow relative to the direction W of the air thanks to the unit formed of: the deviation branch 13, the thermal expansion valve 20, the distributor 22 and the pipes 34.

[0053] Through the exchanger 5, the fluid F is transformed into saturated vapour Vs and is fed through the deviation branch 12 to the switch 4. Then, through the switch 4, the saturated vapour Vs is sent to the compressor 3.

[0054] It is observed that the fluid F can be any type of refrigerant fluid commonly used in heat pumps. For example the fluid F can be a fluid chosen from those indicated in the ASHRAE classification.

[0055] As illustrated above, in the heat pump 2 the refrigerant fluid F crosses the exchanger 5, again in a countercurrent flow relative to the direction W of the air.

[0056] In this way, also when the utility 7 is heated and the flow F flows in the direction R2, a higher evaporation temperature is guaranteed with respect to the heat pumps of traditional type in which the fluid F in the liquid-vapour state Lv is in equicurrent with the direction W of the air.

[0057] In this way a higher evaporation temperature is obtained and it is possible to avoid the formation of ice on the fins of the exchanger 5. Therefore, the method and the refrigerant circuit 1 described above improve the refrigeration efficiency of the heat pump 2.

[0058] Furthermore, by feeding the pipes 40 with two different inlets I2 and I1 and respective different distribution systems (the manifold 30 or the capillary tubes 23), according to the state of the fluid F (superheated vapour Vss in the case of feeding through the branch 8 or liquid-vapour Lv in the case of feeding through the branch 13) which is fed to the heat exchanger 5, the fluid F, especially when in the liquid-vapour state Lv, is prevented from following, inside the exchanger 5, preferential paths generated by its physical state, thus reducing the performance of the heat exchanger 5.

[0059] Therefore, the solution of the type described above always guarantees optimal operation and maximum performance of the heat exchanger 5 in any operating condition, minimizing in particular the negative effects of the flow of fluid F in the liquid-vapour state Lv thanks to the use of the double feed system of the pipes 40, and in particular to the use of the capillary tubes 23.

[0060] It has been ascertained that a method and a refrigeration circuit 1 of the type described above allow an improvement in the coefficient of performance (COP) by +6% with respect to a traditional heat pump in which the cooling takes place in equicurrent.

Claims

1. An operating method of a reversible refrigeration circuit, in particular for a heat pump (2) with cycle inversion; the circuit (1) comprising: a heat exchanger (5), in particular a fin heat exchanger (5), which is installed on the outside of a room (H) to be conditioned, and a utility (7), which is installed on the inside of the room (H) to be conditioned; wherein the heat exchanger (5) is suited to be flowed through, on the outside, by an air flow in a given direction (W) and, on the inside, by a refrigerant fluid (F); wherein the fluid (F) can selectively flow either in a first direction (R1) or in a second direction (R2); the method being **characterized in that** the refrigerant fluid (F) is always fed through the heat exchanger (5) in a countercurrent flow relative to the direction (W) of the outside air whatever the feeding direction (R1; R2) of the refrigerant fluid (F) on the inside of the refrigeration circuit (1) is.

2. A method according to claim 1 and comprising the steps of:

   - causing the refrigerant fluid (F) to flow on the inside of the circuit (1) in the first direction (R1) so as to cool the utility (7);
   - feeding the refrigerant fluid (F) in the second direction (R2) so as to heat the utility (7);

   the method being **characterized in that** the heat exchanger (5) is flowed through by the refrigerant fluid (F) in a countercurrent flow relative to the direction (W) of the outside air both when the refrigerant fluid (F) flows in the first direction (R1) and when the refrigerant fluid (F) flows in the second direction (R2).

3. A method according to claim 1 or 2, wherein the circuit (1) comprises: a first deviation branch (12), which connects an output (38) of the heat exchanger (5) to a switch (4); and a second deviation branch (13), which feeds the refrigerant fluid (F) to a feeding system (21) of the heat exchanger (5); the refrigerant fluid (F) being directed along both the first and the second deviation branch (12, 13) when it flows in the second direction (R2).

4. A method according to claim 3, wherein the circuit (1) comprises a main thermal expansion valve (6), a bypass branch (14) to bypass the main thermal expansion valve (6), and an auxiliary thermal expansion valve (20), which is arranged along the second deviation branch (13); the refrigerant fluid (F) being deviated into the bypass branch (14) and being expanded by means of said auxiliary thermal expansion valve (20) when it flows in the second direction (R2).

5. A method according to claim 3 or 4, wherein the heat exchanger (5) comprises a plurality of heat exchanger pipes (40), which are parallel to one another; wherein the heat exchanger pipes (40) are fluidly connected, at their ends, to a first and a second manifold (30, 37); wherein the feeding system (21) comprises a plurality of capillary tubes (23), which extend through the first manifold (30) and lead directly into the respective heat exchanging pipes (40); in use, when the refrigerant fluid (F) flows in the second direction (R2), each capillary tube (23) feeds the refrigerant fluid (F) directly into a respective heat exchange pipe (40).

6. A method according to one of the preceding claims, wherein the heat exchanger (5) comprises a plurality of heat exchange pipes (40), which are parallel to one another and arranged so that the fluid (F) flowing inside is in a countercurrent flow relative to the direction (W) of the outside air; wherein the refrigerant circuit (1) comprises, to feed the fluid (F) to each pipe (40), a manifold (30) and a feed system in turn comprising a plurality of capillary tubes (23); wherein each pipe (40) has a first and a second inlet (I1, I2); the first inlet (I1) being configured to receive the fluid (F) fed from said manifold (30); the second inlet (12) being configured to receive fluid (F) fed from said feed system (21) through said capillary tubes (23); the method comprising the steps of:

   - feeding the fluid (F) to each pipe (40) of the heat exchanger (5) through said first inlet (I1) when the fluid (F) flows in a first direction (R1); or
   - feeding the fluid (F) to each pipe (40) of the heat exchanger (5) through said second inlet (I2) when the fluid (F) flows in a second direction (R2).

7. A reversible refrigeration circuit (1) suited to carry out a method according to one of the previous claims; the refrigeration circuit (1) comprising a heat ex-

changer (5), in particular a fin heat exchanger (5), which is suited to be installed on the outside of a room (H) to be conditioned, and a utility (7), which is suited to be installed on the inside of said room (H) to be conditioned; wherein the heat exchanger (5) is suited to be flowed through, on the outside, by an air flow in a given direction (W) and, on the inside, by a refrigerant fluid (F); wherein the fluid (F) can selectively flow either in a first direction (R1) or in a second direction (R2); the refrigeration circuit (1) being **characterized in that** it comprises: a first deviation branch (12), which connects an output of the heat exchanger (5) to switching means (4) of the fluid (F) direction; and a second deviation branch (13), which feeds the refrigerant fluid (F) to a feeding system (21) of the heat exchanger (5).

8. A refrigeration circuit (1) according to claim 7 and comprising a main thermal expansion valve (6), a bypass branch (14) to bypass the main thermal expansion valve (6), and an auxiliary thermal expansion valve (20), which is arranged along the second deviation branch (13); the refrigerant fluid (F) being deviated into the bypass branch (14) and being expanded by means of said auxiliary thermal expansion valve (20) when it flows in the second direction (R2).

9. A refrigeration circuit (1) according to claim 7 or 8, wherein the heat exchanger (5) comprises a plurality of heat exchanging pipes (40), which are parallel to one another and are fluidly connected, at their ends, to a first and a second manifold (30, 37); wherein the feeding system (21) comprises a plurality of capillary tubes (23), which extend through the first manifold (30) and lead directly into the respective heat exchange pipes; when the refrigerant fluid (F) flows in the second direction (R2), each capillary tube (23) is suited to feed the refrigerant fluid (F) directly into a respective heat exchange pipe (40).

10. Refrigeration circuit (1) according to one of the preceding claims, wherein the heat exchanger (5) comprises a plurality of heat exchange pipes (40), which are parallel to one another and arranged so that the fluid (F) flowing inside from an inlet end (Ii) to an outlet end (Iu) is in a countercurrent flow relative to the direction (W) of the outside air; wherein each pipe (40) has at a first inlet end (Ii) of the fluid (F) a first inlet (I1) and a second inlet (I2); the refrigeration circuit (1) further comprises a manifold (30) which is configured to feed the fluid (F) to each pipe (40) through a respective first inlet (I1) when the fluid (F) flows in a first direction (R1); the refrigeration circuit (1) further comprises a feed system (21) which in turn comprises a plurality of capillary tubes (23), each of which is configured to feed the fluid (F) to a respective pipe (40) through a respective second inlet (12) when the refrigerant fluid (F) flows in a second direction (R2).

11. Refrigeration circuit (1) according to one of the claims from 7 to 10 and further comprising: a compressor (3); a switch (4); a main thermal expansion valve (6); a first branch (8) which connects the switch (4) to the heat exchanger (5); a second branch (9) which connects the heat exchanger (5) to the main thermal expansion valve (6); a third branch (10) which connects the main thermal expansion valve (6) to the utility (7); a fourth branch (11) which connects the utility (7) to the switch (4); wherein the switch (4) is connected in a known way both to an inlet (I) and to an outlet (O) of the compressor (3); wherein the switch (4) is adapted to feed the fluid (F) coming out of the compressor (3) either into the first branch (8) in the first direction (R1) or into the fourth branch (11) in the second direction (R2), as required.

12. Circuit (1) according to claim 11, wherein the first deviation branch (12) connects the first branch (8) to the second branch (9) in parallel to the heat exchanger (5); the first deviation branch (12) comprising a one-way valve (18), which allows passage of the refrigerant fluid (F) only when it flows in the second direction (R2); wherein the second deviation branch (13) deviates the refrigerant fluid (F) from the second branch (9) when the refrigerant fluid (F) flows in the second direction (R2); wherein the second deviation branch (13) comprises a one-way valve (19), which allows passage of the refrigerant fluid (F) only when it flows in the second direction (R2).

13. Heat exchanger (5) for a refrigeration circuit (1) according to one of the claims from 7 to 12 and comprising a heat exchange unit (29) with a plurality of heat exchange pipes (40); wherein the heat exchanger (5) comprises first and second means (26; 23) for feeding the refrigerant fluid (F) into said pipes (40).

14. Heat exchanger (5) according to claim 13, wherein the first means comprise a manifold (30) having: a cavity (31), an inlet (30) and a plurality of openings (34), each of which establishes communication between a respective heat exchange pipe (40) and said cavity (31); and wherein the second means comprise a plurality of capillary tubes (23), each of which leads into a respective heat exchange pipe (40).

15. Heat exchanger according to claim 13 or 14, wherein the exchanger (5) comprises a plurality of heat exchange pipes (40) parallel to one another and arranged so that the fluid (F) flowing inside it from an inlet end (Ii) to an outlet end (Iu) is in a countercurrent flow relative to the direction (W) of the outside air; wherein each pipe (40) has at a first inlet end (Ii) a first inlet (I1) and a second inlet (I2); wherein the heat exchanger (5) comprises, as first means for feeding the fluid (F), a manifold (30) which is configured to feed the fluid (F) to each pipe (40) through a respective first inlet (I1) when, in use, the fluid (F) flows in a first direction (R1); wherein the heat exchanger (5) comprises, as second means for feeding the fluid (F), a feed system (21) which in turn comprises a plurality of capillary tubes (23), each of which is configured to feed the fluid (F) to a respective pipe (40) through a respective second inlet (12) when, in use, the refrigerant fluid (F) flows in a second direction (R2).

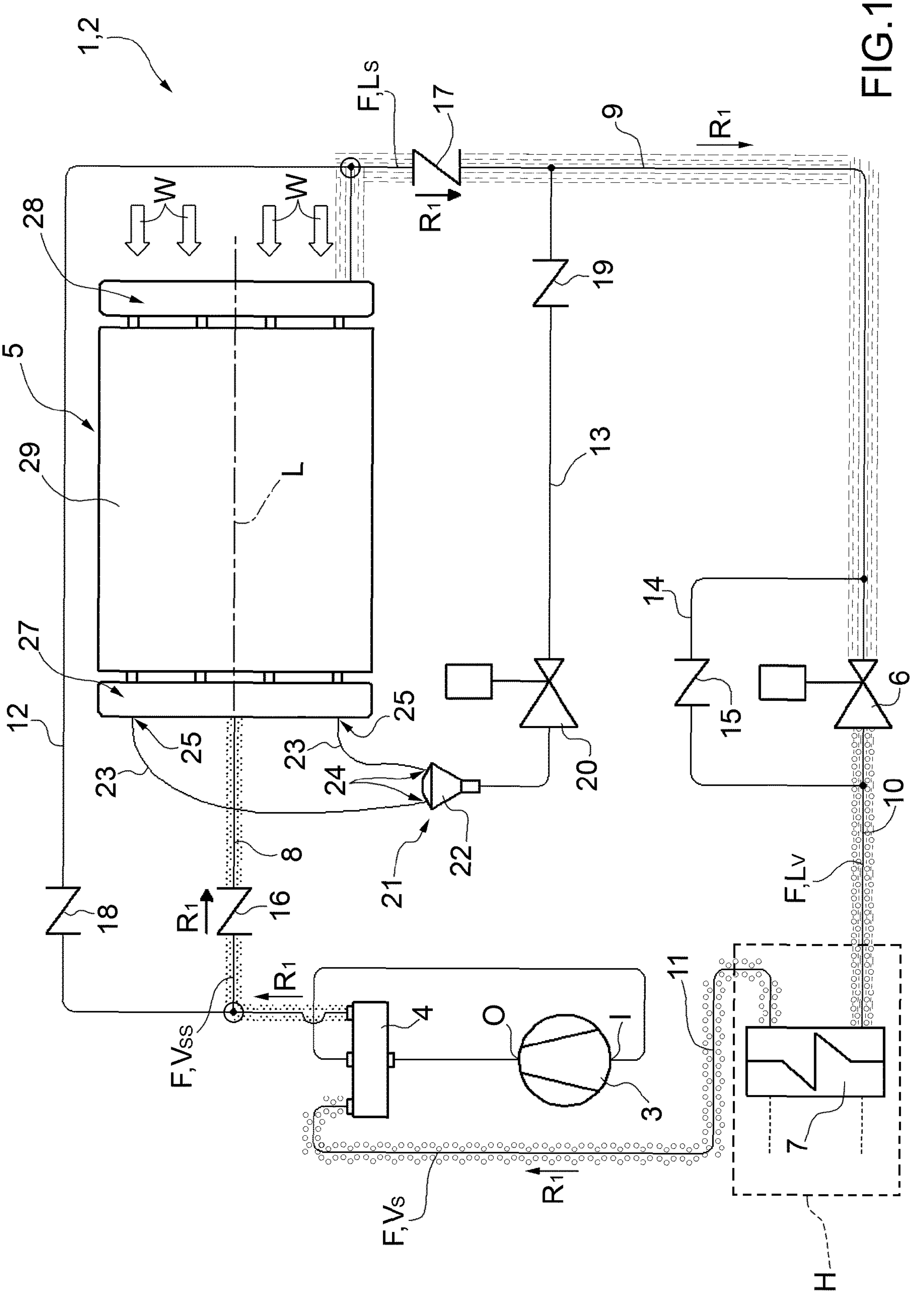
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FIG.1

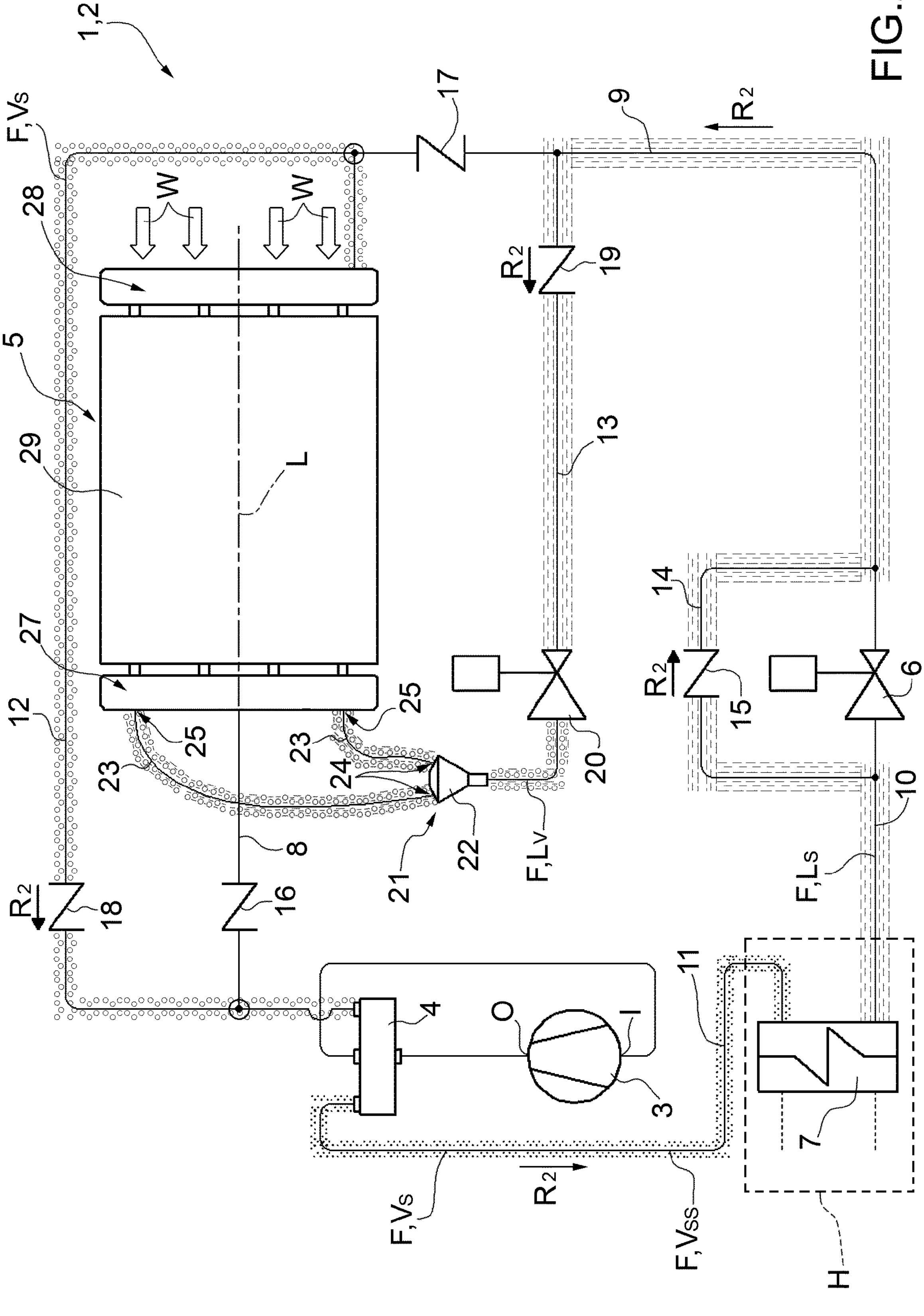
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FIG.2

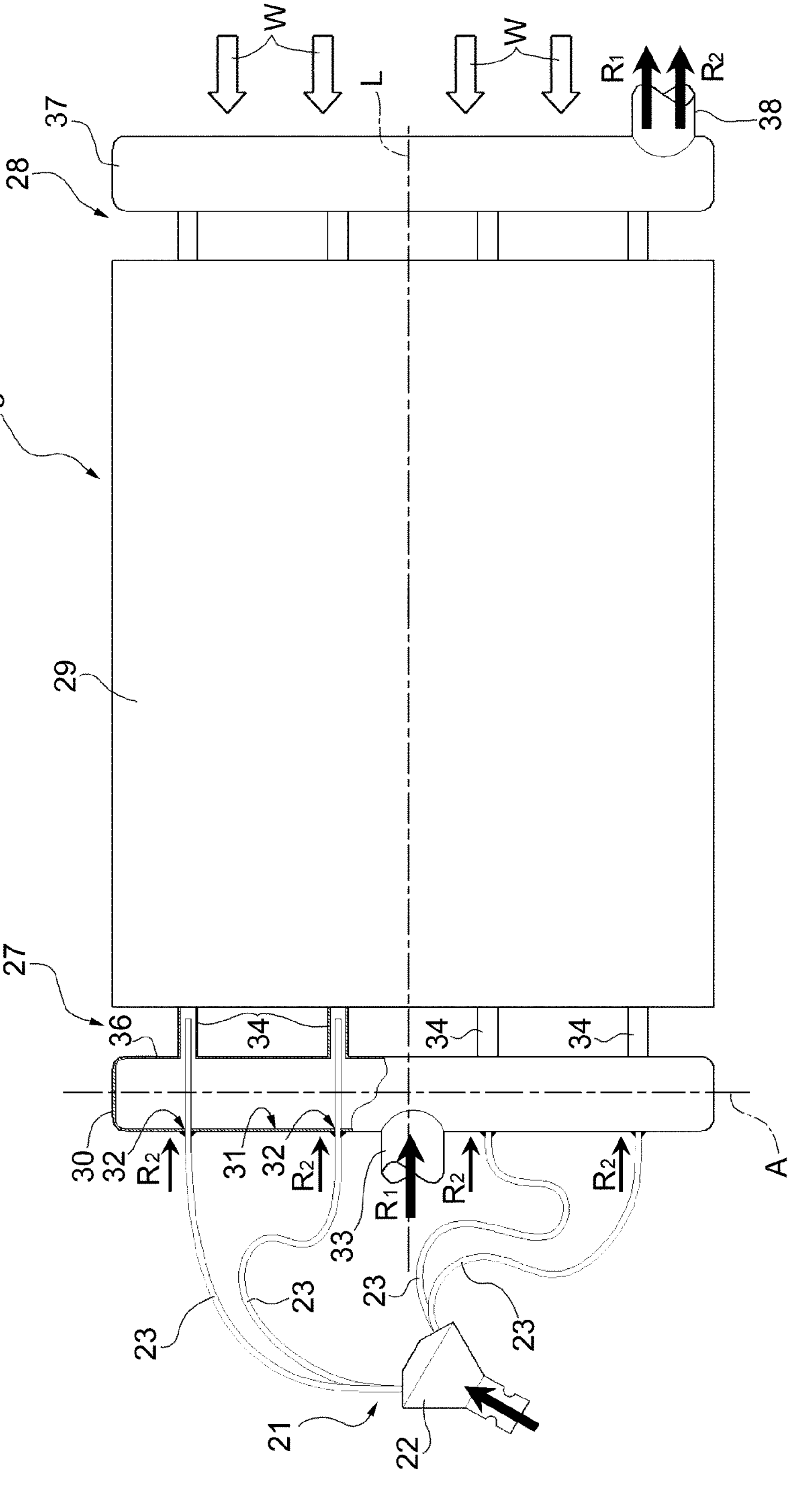
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FIG.3

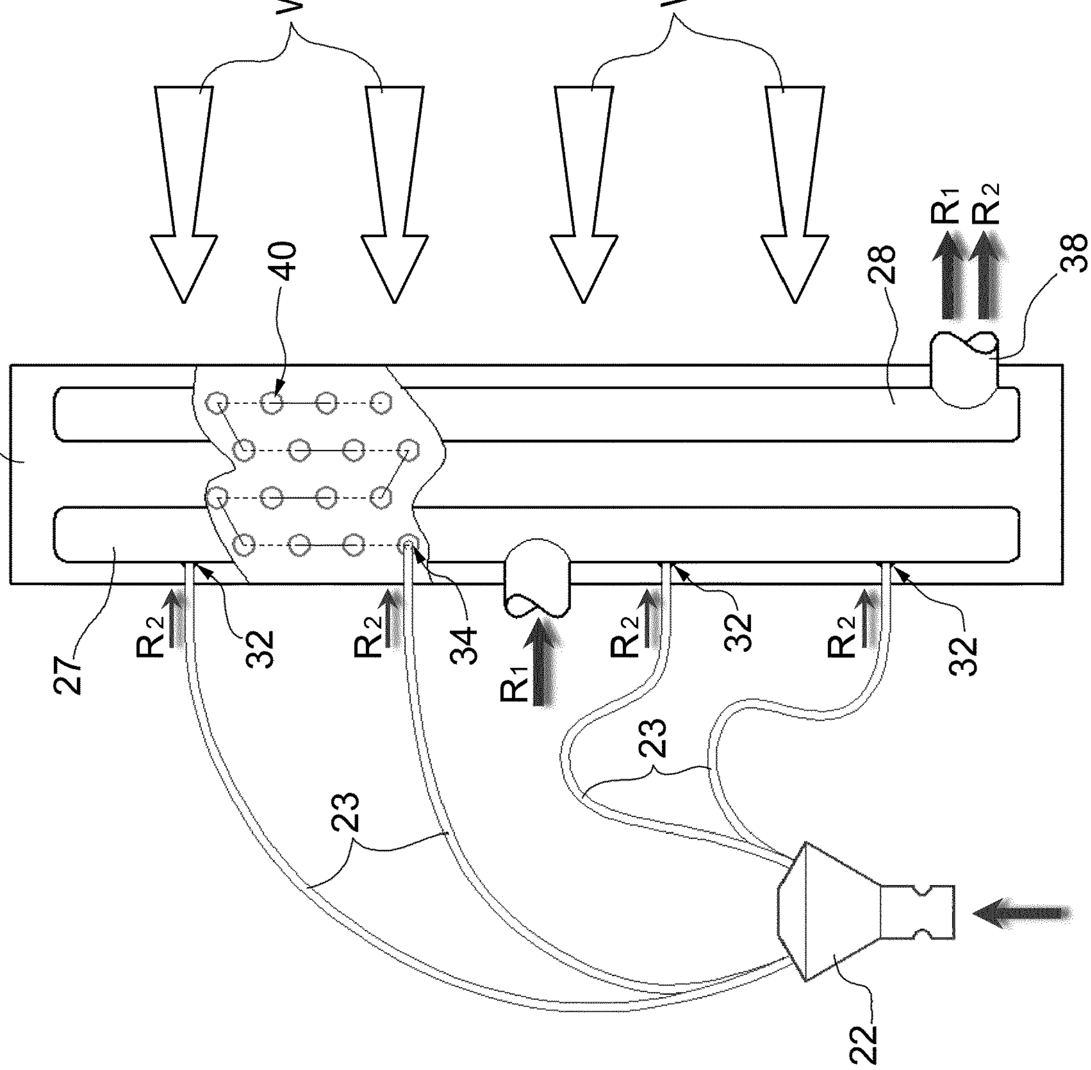

FIG.4

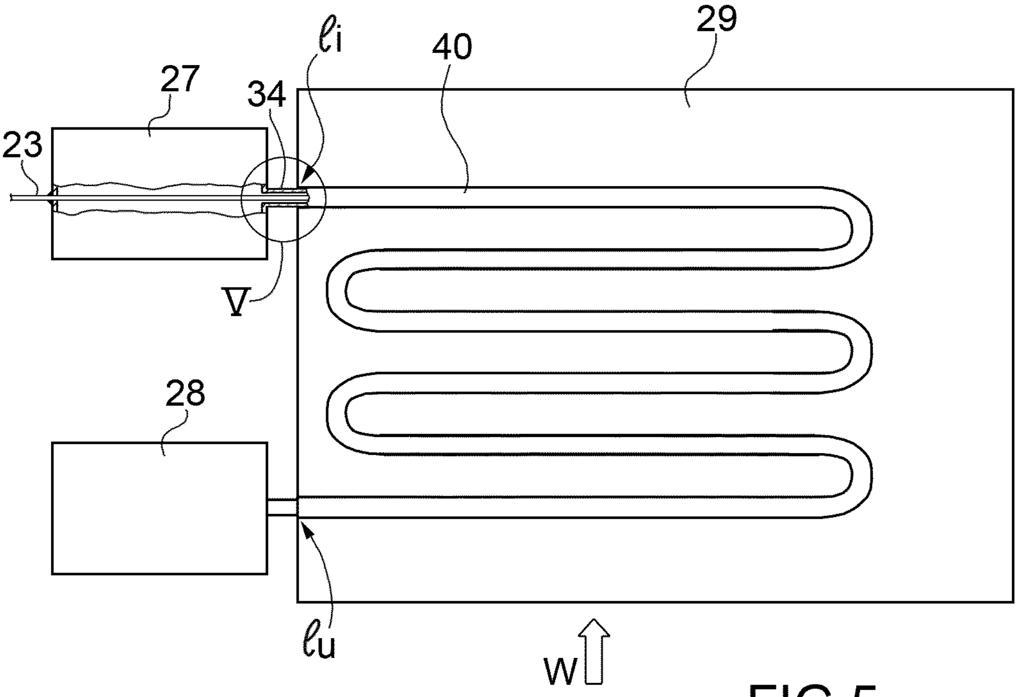

FIG.5

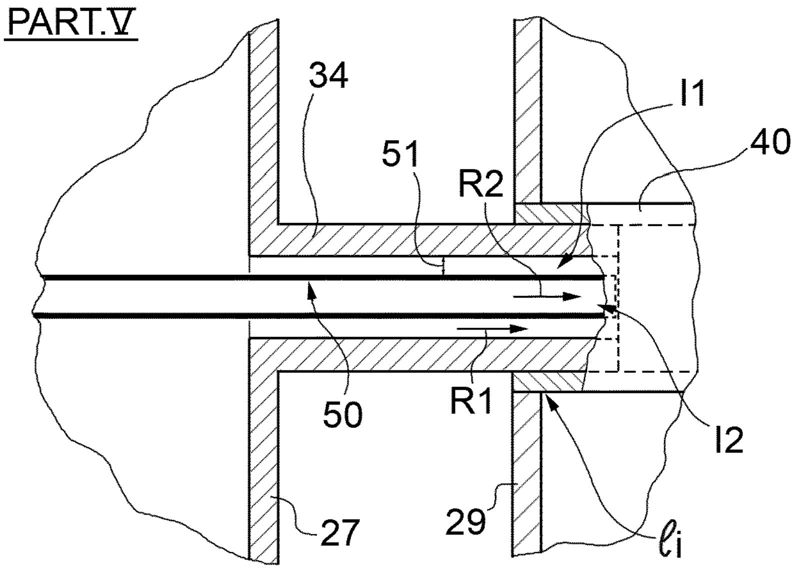

FIG.6