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(54) **HEAT PUMP**

(57) The present invention regards a heat pump apparatus for an air conditioning plant, which comprises an external unit (1), provided with a first heat exchanger (3) susceptible of operating as an evaporator, and an internal unit (1'), provided with a second heat exchanger (19) thermally connected to the first heat exchanger (3) and

susceptible of transferring heat (Q2) to an ambient air flow (26) for heating an environment (I). The heat pump apparatus (100) also comprises an incandescent emitter (8) configured for heating via irradiation the first heat exchanger (3) so as to prevent the formation of ice or frost on the surface of such first heat exchanger (3).

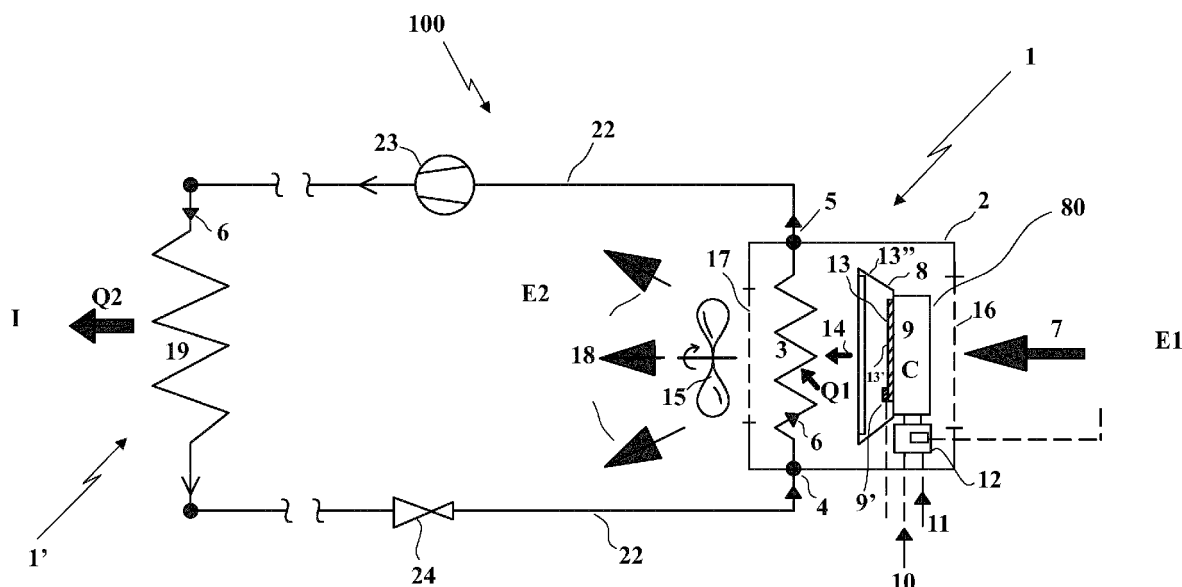


Fig. 1

Description

Field of application

[0001] The present invention regards a heat pump apparatus for an air conditioning plant, according to the preamble of the independent claim No. 1.

[0002] The present apparatus is advantageously intended to be employed, in residential, commercial and industrial fields, in air conditioning plants, in particular of roof top type, so as to control the climate conditions within one or more environments, ensuring an optimized energy yield of the plant, in particular for the automatic defrosting of the heat exchanger of the external unit of the apparatus.

State of the art

[0003] In recent years, in the industrial field of heating environments, there is the particular need to increase the thermal efficiency; in addition, several legal regulations require the at least partial use of renewable energy sources.

[0004] More clearly, the definition reported in the current renewable energy legislation (*Legislative Decree 3 March 2011, No. 28 - Actuation of the Directive 2009/28/CE on the promotion of the use of energy from renewable sources, and amending and subsequent repealing of Directives 2001/77/CE and 2003/30/CE.*), reports that the «energy from renewable sources» is that energy coming from non-fossile renewable sources, i.e. wind energy, solar energy, aerothermal energy, geothermal energy, hydrothermal and oceanic energy, hydraulic energy, biomass, waste gases, residual gases from cleaning processes and biogases.

[0005] In the field of apparatuses for heating environments, apparatuses have been known for some time that are provided with a heat pump heating plant. Such plants exploit aerothermal energy, which is included among the renewable energy sources, contained in the air of the external environment for heating a low-temperature carrier fluid contained in a closed circuit by means of an evaporator, normally positioned outside the environment to be heated within a box-like containment body.

[0006] The carrier fluid thus heated by means of the heat absorbed from the air of the external environment is compressed by a compressor, which creates a pressure difference adapted to force the carrier fluid into the closed circuit, in particular towards a condenser, normally placed within the environment to be heated. In this situation, the high-temperature and high-pressure carrier fluid condenses and transfers, to the environment to be heated, the heat previously absorbed from the external environment. The closed circuit finally connects the condenser and the evaporator by means of a thermal expansion valve, adapted to bring the carrier fluid (by now cooled) back to the operating pressure in order to be able to again absorb heat from the external environment.

[0007] The apparatuses for conditioning environments provided with a heat pump heating plant of the type briefly described above have in practice shown that they do not lack drawbacks. A first drawback lies in the fact that the overall energy efficiency is strongly limited by the temperature difference between the external environment and the environment to be heated. Therefore, in the winter, or generally in the coolest periods of the year, the aforesaid temperature difference is such to negatively affect, in a significant manner, the total output of the heat pump plant. More in detail, when the temperature of the external environment lowers below 7°C, the output of the heat pump plant drastically decreases. In particular, if the temperature of the external environment falls below 2°C, the evaporator risks freezing and/or frosting. If the evaporator freezes, the entire heat pump heating plant stops operating until the complete unfreezing of the evaporator itself takes place.

[0008] In this situation, unfreezing devices are known for allowing the evaporator to continue to work, even at low temperatures, such as electrical heating elements placed at the evaporator itself, which by heating up due to ohmic effect increase the temperature of such evaporator and allow the operation thereof.

[0009] The main drawback of such device for unfreezing the evaporator lies in the fact that the electrical heating elements consume a high amount of energy and lower the overall efficiency of the conditioning apparatus.

[0010] Also known, for the purpose of heating the evaporator in case of freezing, is a method for unfreezing which provides for the use of the heat pump plant by reversing its operating cycle, i.e. operating the evaporator as a condenser for several minutes, so as to transport a part of the heat of the internal environment to be heated to the evaporator itself, which increases its temperature up to complete unfreezing, in order to then again reverse the cycle of the plant for the normal operation thereof.

[0011] The main drawback of the method for unfreezing the evaporator of known type described in brief above lies in the fact that the reversal of the operating cycle drastically lowers the overall output of the conditioning apparatus, since in this situation it removes heat from the internal environment to be heated, for several minutes; such heat will then have to be again transferred with the subsequent reversal of the operating cycle.

[0012] The apparatuses of known type described up to now, so as to never leave the environment to be heated without the necessary heat supply, oblige - during the design phase - an oversizing of the heat flow to be installed with respect to the actual user needs, for example using multiple evaporators, connected to each other in a bank and operating at pre-established intervals.

[0013] The document US 4,995,241 describes a conditioning apparatus which comprises an external unit provided with a main exchanger and with a gas burner, which is arranged below an accumulator, and is intended to be turned on in low-temperature conditions, in a manner such that the flames produced by the burner hit the ac-

cumulator, so as to ensure the evaporation of the carrier fluid coming from the main exchanger and to generate hot vapor towards a compressor of the apparatus. The document US 4,995,241 reports that the heated and pressurized carrier fluid can be conveyed towards the main heat exchanger in order to facilitate the unfreezing thereof.

[0014] The document EP 0599625 describes an apparatus for an air conditioning plant in which the air recirculation fan is provided with a vapor actuation turbine, which is supplied by means of the pressure of the vaporized carrier fluid generated by the heat exchange processes. The hot vapor exiting from the turbine can be employed for the unfreezing cycle of an adjacent apparatus.

[0015] The apparatuses described in these two final documents of the prior art are unable to efficiently resolve the abovementioned problems related to the unfreezing of the evaporator.

Presentation of the invention

[0016] In such context, therefore, the main object of the present invention is to overcome the drawbacks of the above-described prior art, by presenting a heat pump apparatus for an air conditioning plant that is capable of improving the overall output of the apparatus and does not need an increase of the thermal power to be installed, beyond that required for thermally conditioning the internal environment.

[0017] A further object of the present invention is to present a heat pump apparatus for an air conditioning plant which allows reaching high outputs by means of the at least partial use of a renewable energy source.

[0018] A further object of the present invention is to present a heat pump apparatus for an air conditioning plant which allows a continuous operation, which is safe and entirely reliable.

Brief description of the drawings

[0019] The technical characteristics of the invention, according to the proposed task and objects, can be clearly found in the contents of the below-reported claims and the advantages thereof will be more evident in the detailed description of several embodiments illustrated as a non-limiting example in the enclosed drawing tables, in which:

- figure 1 illustrates the present heat pump apparatus, in accordance with a first embodiment of the present invention;
- figure 2 illustrates the present heat pump apparatus, in accordance with a second embodiment of the present invention;
- figure 3 illustrates the present heat pump apparatus, in accordance with a third embodiment of the present invention;
- figure 4 illustrates a detail of the apparatus, object

of the present invention, relative to an external unit of the apparatus itself;

- figure 5 illustrates the external unit of figure 4, in which a temperature control unit and temperature detection means are also represented;
- figure 6 illustrates an air conditioning plant comprising the heat pump apparatus illustrated in figure 1;
- figure 7 illustrates an air conditioning plant comprising the heat pump apparatus illustrated in figure 3;
- figure 8 illustrates the heat pump apparatus of figure 1 in a reversed cycle configuration;
- figures 9A and 9B illustrate, in two different views, a detail of the present heat pump relative to an incandescent emitter that is part of the defrosting means.

Detailed description of a preferred embodiment

[0020] With reference to the enclosed drawings, reference number 100 overall indicates a heat pump apparatus for an air conditioning plant in accordance with a preferred embodiment of the present invention. The present apparatus is advantageously intended to be used, in residential, commercial and industrial fields, in air conditioning plants, in particular of roof top type.

[0021] The heat pump apparatus 100 for an air conditioning plant comprises an external unit 1, which in turn comprises a first containment body 2 preferably intended to be arranged in an external environment E1, E2 and hence provided with structural and insulation characteristics appropriate for the local ambient climate and having characteristics such that it can be positioned both on roofs and on the ground, and in any case directly subjected to rain, snow and ice.

[0022] The external unit 1 is also provided with a first heat exchanger 3 arranged in the first containment body 2 and susceptible of operating as an evaporator in order to absorb a certain amount of heat Q1 from an external air flow 7 drawn from the external environment E1, E2.

[0023] Preferably, the first heat exchanger 3 is of the finned pack type with banks that if necessary can be curved with one, two or three bends. For such banks, external treatments are possible such as powder painting or under cathodolysis and electrolyte tinning on copper exchangers, as well as being able to have a tube made of cupronickel (CuNi9010) for exchangers which work in aggressive environments (salty environments). For the heat pump apparatus 100, the materials constituting the banks of the first heat exchanger 3 must be able to operate at temperatures around 100°C, since they are subjected to heating via irradiation of the defrosting means 80.

[0024] Advantageously, the first heat exchanger 3 can be of the tube bundle type which if necessary can have various shapes, and treatments can be externally made thereon so as to improve the effectiveness of the heat exchange between the air that hits it externally and the fluid that flows internally.

[0025] The external unit 1 is also provided with defrost-

ing means 80 operatively associated with the first heat exchanger 3 so as to be able to heat the external surface of the latter.

[0026] For such purpose, in accordance with the idea underlying the present invention, the defrosting means 80 comprise an incandescent emitter 8 configured for heating, via direct irradiation and in an effective manner, the external surface of the first heat exchanger 3.

[0027] The incandescent emitter 8 comprises supply means 12 connected to a first source of comburent air 10 and to a second source of fuel gas 11.

[0028] Such supply means 12 are preferably provided with an automatic gas flow adjusting valve and with a shutter for the comburent air.

[0029] Advantageously, the supply means 12 of the incandescent emitter 8 comprise mixing systems (of per se known type) for premix burners which generate premixed flames only for the gaseous fuels and where air and fuel must be mixed in a uniform manner before the reaction zone.

[0030] The incandescent emitter 8 also comprises a distribution chamber 9 directly connected to the supply means 12 in order to receive the fuel mixture C to be burned, formed by comburent air preferably drawn from the same external environment E1 and by fuel gas coming from the second source of fuel gas 11 constituted for example by the distribution network in the case of methane gas or by cylinder tank packs in the case of LPG.

[0031] With reference to the examples of figures 1, 9A and 9B, the incandescent emitter 8 is also provided with trigger means 9' actuatable for triggering the combustion of the fuel mixture C with the consequent generation of heat and of combustion products 14.

[0032] Such trigger means 9' are constituted by ignition electrodes which advantageously can also substitute flame detection electrodes 9". The latter ensure the closure of the supply means 12, in particular in order to block the supply of the fuel gas, in the case of lack of ignition or extinguishing of the flame itself.

[0033] The incandescent emitter 8 comprises an emitting body 13 directly connected to the distribution chamber 9, which is configured in order to uniformly receive, over the entire surface thereof, first the fuel mixture C and then the heat generated by the combustion.

[0034] Advantageously, the emitting body 13 is composed by multiple rectangular micro-perforated ceramic plates placed adjacent to each other and such to form a single radiant surface 13'.

[0035] The combustion of the fuel mixture C occurs 1-2 mm below the surface of the micro-perforated ceramic plates and within micro-channels. The heat produced by the combustion immediately heats the ceramic. The process of combustion on the external surface of the micro-perforated ceramic plates allows reaching a temperature of about 1000°C, generating heat that is transferred via irradiation by the radiant surface 13' towards the first heat exchanger 3. The internal part of the ceramic plate directed towards the distribution chamber 9 instead reach-

es a temperature of about 100°C.

[0036] The emitting body 13 carries out the function of heating, via irradiation, due to the radiant surface 13' oriented towards the first heat exchanger 3 which - preferably constituted by multiple micro-perforated ceramic plates brought to a temperature of about 1000°C as a result of the combustion - emits thermal radiations in a manner so as to heat, via direct irradiation, the external surface of the first heat exchanger 3 without there being any physical contact between the parts.

[0037] The incandescent emitter 8 is preferably laterally provided with reflecting screens 13" having the object of further redirecting the thermal radiations emitted by the radiant surface 13' towards the first heat exchanger 3.

[0038] The heat pump apparatus 100 also comprises an internal unit 1' intended to be arranged in a channeling system 301 of an air climate-control plant 300 adapted to introduce, into an environment I, an ambient air flow 26 coming from an ambient source A.

[0039] The internal unit 1' comprises a second heat exchanger 19, thermally connected to the first heat exchanger 3 and intended to be inserted in the channeling system 300 to intercept the ambient air flow 26, and susceptible of transferring heat Q2 to the ambient air flow 26.

[0040] The second heat exchanger 19 is usually of the type with finned banks but if necessary it can also be of the tube bundle type.

[0041] The heat pump apparatus 100 also comprises a control unit 50, which is operatively connected to the abovementioned defrosting means 80 in order to enable the correct operation thereof.

[0042] In particular, the control unit 50 is operatively connected to the supply means 12 in order to drive the latter to supply comburent air and fuel gas to the distribution chamber 9, and is operatively connected to the trigger means 9' in order to drive them to trigger of the combustion of the fuel mixture C formed in the distribution chamber 9.

[0043] Advantageously, the control unit 50 can be operatively also connected to the flame detection electrodes 9", if the latter are present and their role is not substituted by the same electrodes of the trigger means 9'.

[0044] Preferably, both the trigger means 9' and the flame detection electrodes 9" are positioned next to the micro-perforated ceramic plates affected by the combustion and specifically by the part of the emitting radiant surface 13' directed towards the first heat exchanger 3.

[0045] Advantageously, with reference to the examples of figures 1-4, the first containment body 2 of the external unit 1 is provided with a first inlet section 16 and with a first outlet section 17 communicating with the external environment E1, E2.

[0046] The external unit 1 also comprises first ventilation means 15 which are operatively associated with the first heat exchanger 3 and are actuatable by the control unit 50 with the purpose of forcing the external air flow 7 to enter into the first containment body 2 through the first

inlet section 16 and intercept the first heat exchanger 3, as well as forcing a mixture 18 of combustion products 14 and of external air to exit from the first containment body 2 of the external unit 1 through the first outlet section 17.

[0047] Advantageously, with reference to the example of figure 2, the internal unit 1' of the heat pump apparatus 100 comprises a second containment body 27 which houses the second heat exchanger 19, preferably entirely analogous to the first heat exchanger 3.

[0048] The second containment body 27 is provided with a second inlet section 28 and with a second outlet section 29 communicating with the channeling system 301.

[0049] The internal unit 1' comprises second ventilation means 25 which are operatively associated with the second heat exchanger 19 and are actuable by the control unit 50 for the purpose of forcing the ambient air flow 26 to enter into the second containment body 27 through the second inlet section 28 and intercept the second heat exchanger 19 in order to receive the heat Q2 and in order to then always force the heated ambient air flow 26 to exit from the second containment body 27 through the second outlet section 29 in order to be conveyed to the environment I.

[0050] Advantageously, the external unit 1 comprises a first hydraulic circuit 22 which is susceptible of being traversed by a first carrier fluid 6. The first hydraulic circuit 22 intersects the first heat exchanger 3, which is hydraulically connected always to the first hydraulic circuit 22 by means of a first inlet 4 and a first outlet 5 in order to be traversed by the first carrier fluid 6.

[0051] The external unit 1 also comprises a compressor 23 which is inserted in the first hydraulic circuit 22 and has the object of compressing the first carrier fluid 6 coming from the first heat exchanger 3, which operates here as an evaporator.

[0052] The external unit 1 also comprises a thermal expansion valve 24 which is situated inserted in the first hydraulic circuit 22 and has the object of expanding the first carrier fluid 6 which is conveyed towards the first heat exchanger 3, which operates here as an evaporator. Advantageously, with reference to the example of figure 2, the second heat exchanger 19 of the heat pump apparatus 100 is hydraulically connected to the first heat exchanger 3 by means of the aforesaid first hydraulic circuit 22, and is susceptible of operating as a condenser in order to transfer heat Q2 to the ambient air flow 26. In such configuration, the compressor 23 is interposed between the first heat exchanger 3 and the second heat exchanger 19, and works in order to force the first carrier fluid 6 from the first heat exchanger 3, which operates here as an evaporator, to the second heat exchanger 19, which operates here as a condenser.

[0053] A thermal expansion valve 24 is also provided, which is interposed between the second heat exchanger 19 and the first heat exchanger 3, and is adapted to expand and cool the first carrier fluid 6 coming from the

second heat exchanger 19, which operates here as a condenser.

[0054] Advantageously, with reference to the example of figure 3, the external unit 1 of the heat pump apparatus 100 comprises a third containment body 32, which houses a third heat exchanger 43 hydraulically connected to the first heat exchanger 3 by means of the first hydraulic circuit 22 and susceptible of operating as a condenser. In accordance with such embodiment, the compressor 23, interposed between the first heat exchanger 3 and the third heat exchanger 43, works in order to force the first carrier fluid 6 from the first heat exchanger 3, operating here as an evaporator, to the third heat exchanger 43, operating here as a condenser. The thermal expansion valve 24 is interposed between the third heat exchanger 43 and the first heat exchanger 3, and is adapted to expand and cool the first carrier fluid 6 coming from the third heat exchanger 43, operating here as a condenser.

[0055] Advantageously, still with reference to the example of figure 3, the heat pump apparatus 100 also comprises a second hydraulic circuit 38 susceptible of being traversed by a second carrier fluid 41 and hydraulically connected to the second heat exchanger 19.

[0056] In accordance with such embodiment, a fourth heat exchanger 35, which is housed in the third containment body 32 of the external unit 1, is inserted in the second hydraulic circuit 38 and is thermally coupled to the third heat exchanger 43 in order to transfer the heat Q2 from the first carrier fluid 6 to the second carrier fluid 41.

[0057] Pumping systems 42, preferably housed in the third containment body 32 of the external unit 1, are inserted in the second hydraulic circuit 38 and operate in order to circulate the second carrier fluid 41 between the second heat exchanger 19 and the fourth heat exchanger 35.

[0058] Preferably, in the above-described embodiment, the coupling housed in the third containment body 32 of the external unit 1, between the third heat exchanger 43 inserted in the first hydraulic circuit 22, and the fourth heat exchanger 35 inserted in the second hydraulic circuit 38, is attained by means of a plate exchanger typical for transfers of heat between a gas and a liquid.

[0059] Advantageously, with reference to the example of figure 5, the heat pump apparatus 100 comprises first detection means 51, which are operatively connected to the first hydraulic circuit 22 at the first outlet 5 of the first heat exchanger 3, and are configured for measuring first temperature values of the first carrier fluid 6 and subsequently sending to the control unit 50 the corresponding first signals containing the first temperature values.

[0060] If necessary, the control unit 50 is configured in order to enable the operation of the incandescent emitter 8 as a function of said first temperature values.

[0061] Advantageously, still with reference to the example of figure 5, the heat pump apparatus 100 comprises second detection means 52 which are operatively as-

sociated with the first inlet section 16 of the first containment body 2, and are configured for measuring second temperature values of the external air flow 7 and subsequently sending to the control unit 50 the corresponding second signals containing the second temperature values.

[0062] Advantageously, the heat pump apparatus 100 comprises third detection means 53 which are operatively associated with the first outlet section 17 of the first containment body 2, and are configured for measuring third temperature values of the mixture 18 formed by the combustion products 14 and by the external air 7, and subsequently sending to the control unit 50 the corresponding third signals containing the third temperature values.

[0063] If necessary, the control unit 50 is configured in order to enable the operation of the incandescent emitter 8 as a function of the second temperature values and/or of the third temperature values.

[0064] Preferably, the detection means 51, 52, 53 comprise corresponding temperature probes adapted to detect the temperature of the fluid that they intercept.

[0065] Advantageously, the control unit 50 is configured in order to enable the turning on of the incandescent emitter 8 when at least one from among the first, second and third temperature values fall below a corresponding temperature threshold indicative of conditions of the external environment E1, E2 which can determine the formation of frost or ice on the surface of the first heat exchanger 3.

[0066] In the examples of figures 6 and 7, a climate-control plant 300 for an environment is depicted which, in addition to the above-described heat pump apparatus 100, also comprises at least one air channeling system 301 provided with a third inlet section 302, intended to be connected to an ambient source A, and with a third outlet section 303, intended to be connected to an environment I, so as to introduce an ambient air flow 26 coming from the ambient source A into the environment I.

[0067] The climate-control plant 300 is also provided with an air treatment unit 310 comprising a gas burner 311 adapted to generate heat by means of the combustion of a fuel mixture formed by a gas and by comburent air.

[0068] The climate-control plant 300 also comprises heat exchange means 312, which are thermally and operatively connected to the gas burner 311 and for example comprise coil tubes traversed by combustion fumes generated by the gas burner 311 itself. The heat exchange means 312 are inserted in the channeling system 301 for the purposes of intercepting the ambient air flow 26 and transferring thereto the heat generated by the combustion process of the gas burner 311 (and in particular present in the combustion fumes).

[0069] The second heat exchanger 19 of the heat pump apparatus 100 is arranged within the channeling system 301 for the purpose of intercepting the ambient air flow 26.

[0070] The climate-control plant 300 also comprises a first source of comburent air 10 connected to the supply means 12 of the incandescent emitter 8.

[0071] The climate-control plant 300 also comprises a second source of fuel gas 11 connected to the supply means 12 of the incandescent emitter 8 and to the gas burner 311 of the air treatment unit 310.

[0072] The climate-control plant 300 comprises a control unit 313, which is operatively connected to the gas burner 311 of the air treatment unit 310 and to the control unit 50 of the heat pump apparatus 100.

[0073] The control unit 313 is configured in order to enable the operation of the air treatment unit 310 and/or of the heat pump apparatus 100 and is operatively connected to the second source of fuel gas 11 in order to provide the fuel gas respectively to the gas burner 311 and/or to the incandescent emitter 8 when the latter is enabled to operate by the control unit 50.

[0074] Optionally, the control unit 313 can be integrated with the control unit 50 of the heat pump apparatus 100.

[0075] Advantageously, the second source of fuel gas 11 comprises a first branch 11' connected to the gas burner 311 and a second branch 11" connected to the supply means 12 of the incandescent emitter 8.

[0076] Preferably, the second source of fuel gas 11 is also provided with enabling valve means 11''' which are placed to intercept branches 11', 11" and are operatively connected to the control unit 313 so as to selectively enable the passage of the fuel gas into the first branch 11' (in order to supply the burner 311), or into the second branch 11" (in order to supply the incandescent emitter 8), or in both branches 11' and 11" (in order to simultaneously supply both the gas burner 311 and the incandescent emitter 8).

[0077] For example, the aforesaid enabling valve means 11''' comprise a three-way valve placed at the connector between the two branches 11', 11" (as in the examples of figures 6 and 7), or otherwise separate enabling valves, each of which placed in the corresponding branch. In the example of figure 8, the heat pump apparatus 100 is illustrated in a reversed cycle, in which the first heat exchanger 3 operates as a condenser and the second heat exchanger 19 operates as an evaporator. Such operating mode is set for example in the summer months in order to cool (by means of the second heat exchanger 19 operating as an evaporator) the air introduced into the environment I.

[0078] In operation, the control unit 313 of the climate-control plant 300 is set, in particular in the winter months, to enable - in addition to the operation of the heat pump apparatus 100 - the simultaneous operation of the gas burner 311 of the air treatment unit 310 for further heating the air to be introduced into the environment I by means of the heat exchange means 312 of the gas burner 311 itself, only when the temperature of the ambient air flow 26 exiting from the second heat exchanger 19 of the heat pump apparatus 100 (arranged within the channeling

system 301 for the purpose of intercepting the ambient air flow 26) is too low for being directly introduced into the environment I. In such operating condition, the heat pump apparatus 100 is always and in any case turned on.

[0079] In particular, in such operating configuration, the control unit 313 drives the valve means 11" to enable the passage of the fuel gas both into the second branch 11" connected to the incandescent emitter 8, and into the first branch 11' in order to supply the gas burner 311 if it is requested to increase the temperature of the air flow 26 to be introduced into the environment I.

[0080] In the transition seasons, in particular spring and autumn, the control unit 313 of the climate-control plant 300, so as to heat the air to be introduced into the environment I, keeps the operation of the heat pump 100 enabled while if necessary (i.e. when the temperature of the ambient air flow 26 to be introduced into the environment I is already sufficiently heated by the heat pump apparatus 100) it turns off the gas burner 311 of the air treatment unit 310. In particular, in such operating configuration, the control unit 313 drives the control unit 50 of the heat pump apparatus 100 in order to make the latter function with direct cycle, i.e. with the first heat exchanger 3 operating as an evaporator and with the second heat exchanger 19 (or the third heat exchanger 43) operating as a condenser in order to transfer heat Q2 to the ambient air flow 26 intended to enter into the environment I to be heated.

[0081] In particular, both in the latter operating condition, but above all in the operating condition of the previously-described winter months, if the temperature of the external environment falls below a specific threshold value (e.g. about 2°C), the surface of the first heat exchanger 3 (operating as an evaporator) risks freezing and/or frosting. In such situation (identified by the control unit 50, for example by means of one or more of the detection means 51, 52, 53), the control unit 313 drives the control unit 50 to actuate the incandescent emitter 8 in order to heat the surface of the second heat exchanger 3 so as to avoid the formation of ice or frost on such surface. In particular, in such operating configuration the control unit 313 drives the enabling valve means 11" so to enable the passage of the fuel gas into the second branch 11" in order to supply the incandescent emitter 8, possibly maintaining the first branch 11' connected to the gas burner 311 closed if it is not necessary to turn on the latter (in accordance with that discussed above).

[0082] In the summer, the control unit 313 of the climate-control plant 300, in order to cool the air to be introduced into the environment I, enables the operation of the heat pump 100 with reversed cycle (illustrated in the example of figure 8), maintaining gas burner 311 of the air treatment unit 310 turned off.

[0083] The invention thus conceived therefore attains the pre-established objects.

Claims

1. Heat pump apparatus (100) for an air conditioning plant, and such heat pump apparatus (100) comprises:

- an external unit (1) which comprises:

- a first containment body (2) intended to be arranged in an external environment (E1, E2);
- a first heat exchanger (3) arranged in said first containment body (2) and susceptible of operating as an evaporator for absorbing heat (Q1) from an external air flow (7) drawn from said external environment (E1, E2);
- defrosting means (80) operatively associated with said first heat exchanger (3) and actuable for heating the surface of said first heat exchanger (3);

- an internal unit (1') intended to be arranged in a channeling system (301) of a climate-control plant (300) adapted to introduce, into an environment (I), an ambient air flow (26) coming from an ambient source (A);

said internal unit (1') comprising a second heat exchanger (19), thermally connected to said first heat exchanger (3), intended to be arranged in said channeling plant (300) to intercept said ambient air flow (26), and susceptible of transferring heat (Q2) to said ambient air flow (26);

- a control unit (50) operatively connected to said defrosting means (80) in order to enable the operation of said defrosting means (80);

said heat pump apparatus (100) being **characterized in that** said defrosting means (80) comprise an incandescent emitter (8) configured for heating via irradiation said first heat exchanger (3), and such incandescent emitter (8) comprises:

- supply means (12) intended to be connected to a first source of comburent air (10) and to a second source of fuel gas (11);
- a distribution chamber (9) connected to said supply means (12) in order to receive a fuel mixture (C) of said comburent air and of said fuel gas;
- trigger means (9') actuable for generating a combustion of said fuel mixture (C) with consequent generation of heat and combustion products (14);
- at least one emitting body (13), which is configured for receiving the heat generated by said combustion, and is provided with at least one radiant surface oriented towards said first heat exchanger (3) in order to emit thermal radiations

towards said first heat exchanger (3) in a manner so as to heat, via direct irradiation, said first heat exchanger (3);

wherein said control unit (50) is operatively connected to said supply means (12) in order to drive said supply means (12) to supply said fuel mixture (C) to said combustion chamber (9), and is operatively connected to said trigger means (9') in order to drive said trigger means (9') to trigger the combustion of said fuel mixture (C).

2. Heat pump apparatus (100) according to claim 1, **characterized in that** said first containment body (2) is provided with a first inlet section (16) and with a first outlet section (17) communicating with said external environment (E1, E2); wherein said external unit (1) comprises first ventilation means (15) operatively associated with said first heat exchanger (3) and actuatable by said control unit (50):

- in order to force said external air flow (7) to enter into said first containment body (2) through said first inlet section (16) and intercept said first heat exchanger (3),
- and in order to force a mixture (18) of said combustion products (14) and of said external air (7) to exit from said first containment body (2) through said first outlet section (17).

3. Heat pump apparatus (100) according to claim 1 or 2, **characterized in that** said internal unit (1') comprises:

- a second containment body (27) which houses said second heat exchanger (19) and is provided with a second inlet section (28) and with a second outlet section (29) intended to be communicating with said channeling system (301);
- second ventilation means (25) operatively associated with said second heat exchanger (19) and actuatable by said control unit (50):

- in order to force said ambient air flow (26) to enter into said second containment body (27) through said second inlet section (28) and to intercept said second heat exchanger (19) in order to receive said heat (Q2);
- and in order to force said heated ambient air flow (26) to exit from said second containment body (27) through said second outlet section (29) in order to be conveyed to said ambient (I).

4. Heat pump apparatus (100) according to any one of the preceding claims, **characterized in that** said external unit (1) comprises:

- a first hydraulic circuit (22) susceptible of being traversed by a first carrier fluid (6), and in said first hydraulic circuit (22) said first heat exchanger (3) is inserted, which is hydraulically connected to said first hydraulic circuit (22) by means of a first inlet (4) and a first outlet (5) in order to be traversed by said first carrier fluid (6);
- a compressor (23) inserted in said first hydraulic circuit (22) in order to compress said first carrier fluid (6) coming from said first heat exchanger (3) operating as an evaporator;
- a thermal expansion valve (24) inserted in said first hydraulic circuit (22) in order to expand said first carrier fluid (6) conveyed towards said first heat exchanger (3) operating as an evaporator.

5. Heat pump apparatus (100) according to claim 4, **characterized in that** said second heat exchanger (19) is hydraulically connected to said first heat exchanger (3) by means of said first hydraulic circuit (22);

wherein said compressor (23) is interposed between said first heat exchanger (3) and said second heat exchanger (19), in order to force said first carrier fluid (6) from said first heat exchanger (3), operating as an evaporator, to said second heat exchanger (19), operating as a condenser;

wherein said thermal expansion valve (24) is interposed between said second heat exchanger (19) and said first heat exchanger (3), and is adapted to expand and cool said first carrier fluid (6) coming from said second heat exchanger (19) operating as a condenser.

6. Heat pump apparatus (100) according to claim 4, **characterized in that** said external unit (1) comprises a third heat exchanger (43) hydraulically connected to said first heat exchanger (3) by means of said first hydraulic circuit (22) and susceptible of operating as a condenser;

wherein said compressor (23) is interposed between said first heat exchanger (3) and said third heat exchanger (43), in order to force said first carrier fluid (6) from said first heat exchanger (3), operating as an evaporator, to said third heat exchanger (43), operating as a condenser;

wherein said thermal expansion valve (24) is interposed between said third heat exchanger (43) and said first heat exchanger (3), and is adapted to expand and cool said first carrier fluid (6) coming from said third heat exchanger (43) operating as a condenser;

wherein said heat pump apparatus (100) also comprises:

- a second hydraulic circuit (38) susceptible of being traversed by a second carrier fluid (41) and hydraulically connected to said second heat

exchanger (19);

- a fourth heat exchanger (35) inserted in said second hydraulic circuit (38) and thermally coupled to said third heat exchanger (43) in order to transfer heat (Q2) from said first carrier fluid (6) to said second carrier fluid (41);
- pumping systems (42) inserted in said second hydraulic circuit (38) and actuatable in order to make said second carrier fluid (41) circulate between said fourth heat exchanger (35) and said second heat exchanger (19).

7. Heat pump apparatus (100) according to any one of the preceding claims 4 to 6, **characterized in that** it comprises first detection means (51) operatively connected to said first hydraulic circuit (22) at the first outlet (5) of said first heat exchanger (3), and configured for measuring first temperature values of said first carrier fluid (6) and for sending, to said control unit (50), corresponding first signals containing said first temperature values;
wherein said control unit (50) is configured for enabling the operation of said incandescent emitter (8) as a function of said first temperature values.

8. Heat pump apparatus (100) according to claim 2, **characterized in that** it comprises:

- second detection means (52) operatively associated with the first inlet section (16) of said first containment body (2) and configured for measuring second temperature values of said external air flow (7) and for sending, to said control unit (50), corresponding second signals containing said second temperature values, and/or
- third detection means (53) operatively associated with the first outlet section (17) of said first containment body (2) and configured for measuring third temperature values of said mixture (18) of said combustion products (14) and of said external air, and for sending, to said control unit (50), corresponding third signals containing said third temperature values;

wherein said control unit (50) is configured for enabling the operation of said incandescent emitter (8) as a function of said second temperature values and/or of said third temperature values.

9. Climate-control plant (300) for an environment, which comprises:

- at least one air channeling system (301) provided with a third inlet section (302) intended to be connected to an ambient source (A) and with a third outlet section (303) intended to be connected to an environment (I), and adapted to introduce into said environment (I) an ambient

air flow (26) coming from said ambient source (A);

- an air treatment unit (310) comprising:

- a gas burner (311) adapted to generate heat via combustion of a fuel gas;
- heat exchange means (312) operatively connected to said gas burner (311) and placed in said channeling system (301) in order to intercept said ambient air flow (26) in order to transfer heat to said ambient air flow (26);

- a heat pump apparatus (100) according to any one of the preceding claims, wherein said second heat exchanger (19) is arranged in said channeling system (301) in order to intercept said ambient air flow (26);

- a first source of comburent air (10) connected at least to the supply means (12) of said incandescent emitter (8);

- a second source of fuel gas (11) connected to the supply means (12) of said incandescent emitter (8) and to the gas burner (311) of said air treatment unit (310);

- a control unit (313), which is operatively connected to the gas burner (311) of said air treatment unit (310) and to the control unit (50) of said heat pump apparatus (100); it is configured for enabling the operation of said air treatment unit (310) and/or of said heat pump apparatus (100); and it is operatively connected to said second source of fuel gas (11) in order to provide said fuel gas respectively to said gas burner (311), or to said incandescent emitter (8) when the latter is enabled by said control unit (50).

10. Climate-control plant (300) according to claim 9, **characterized in that** said second source of fuel gas (11) comprises:

- a first branch (11') connected to said gas burner (311) and a second branch (11'') connected to the supply means (12) of said incandescent emitter (8);

- enabling valve means (11''') placed to intercept said branches (11', 11'') and operatively connected to said control unit (313) in order to enable the passage of said fuel gas into said first branch (11') and/or into said second branch (11'').

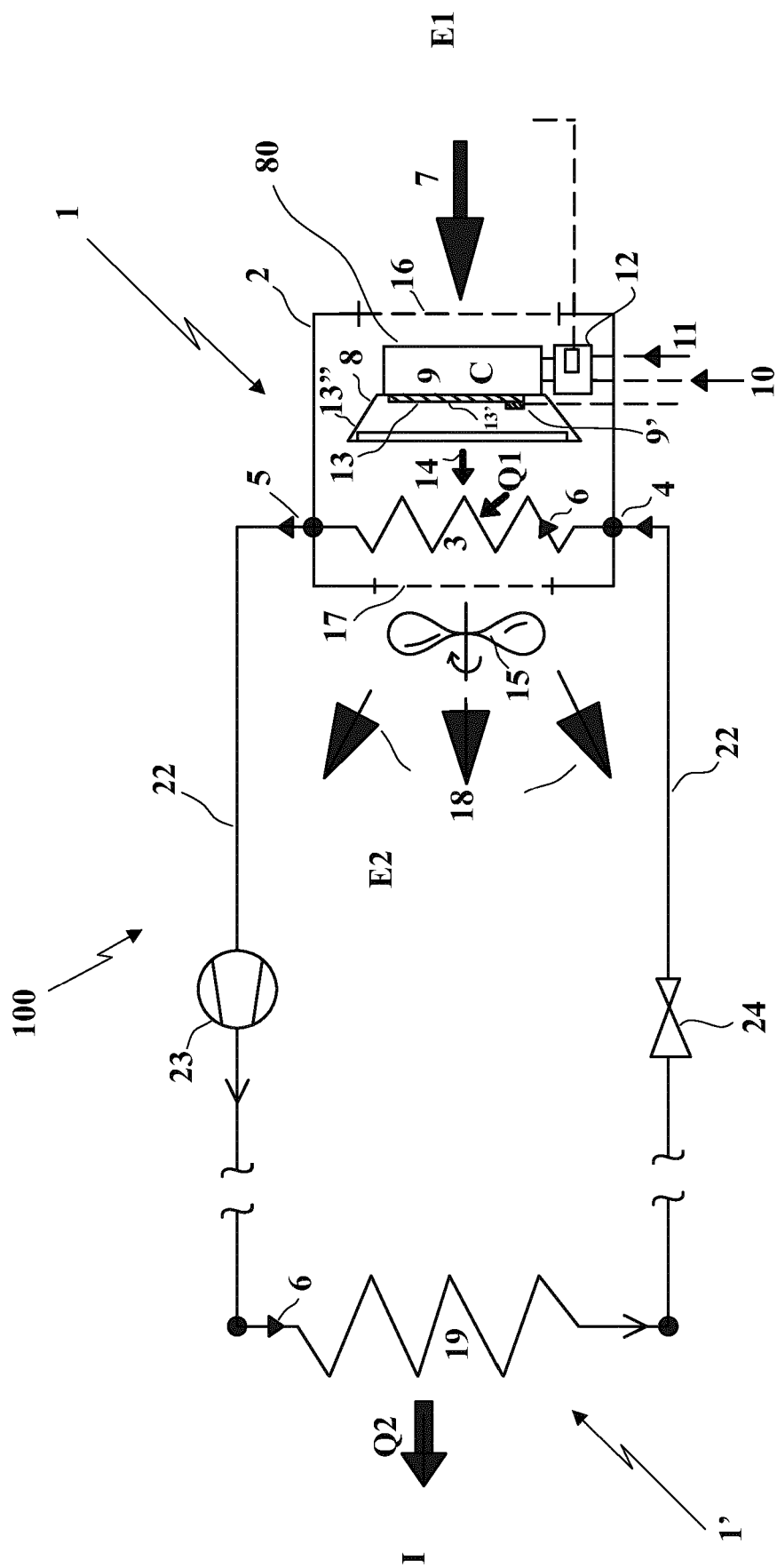


Fig. 1

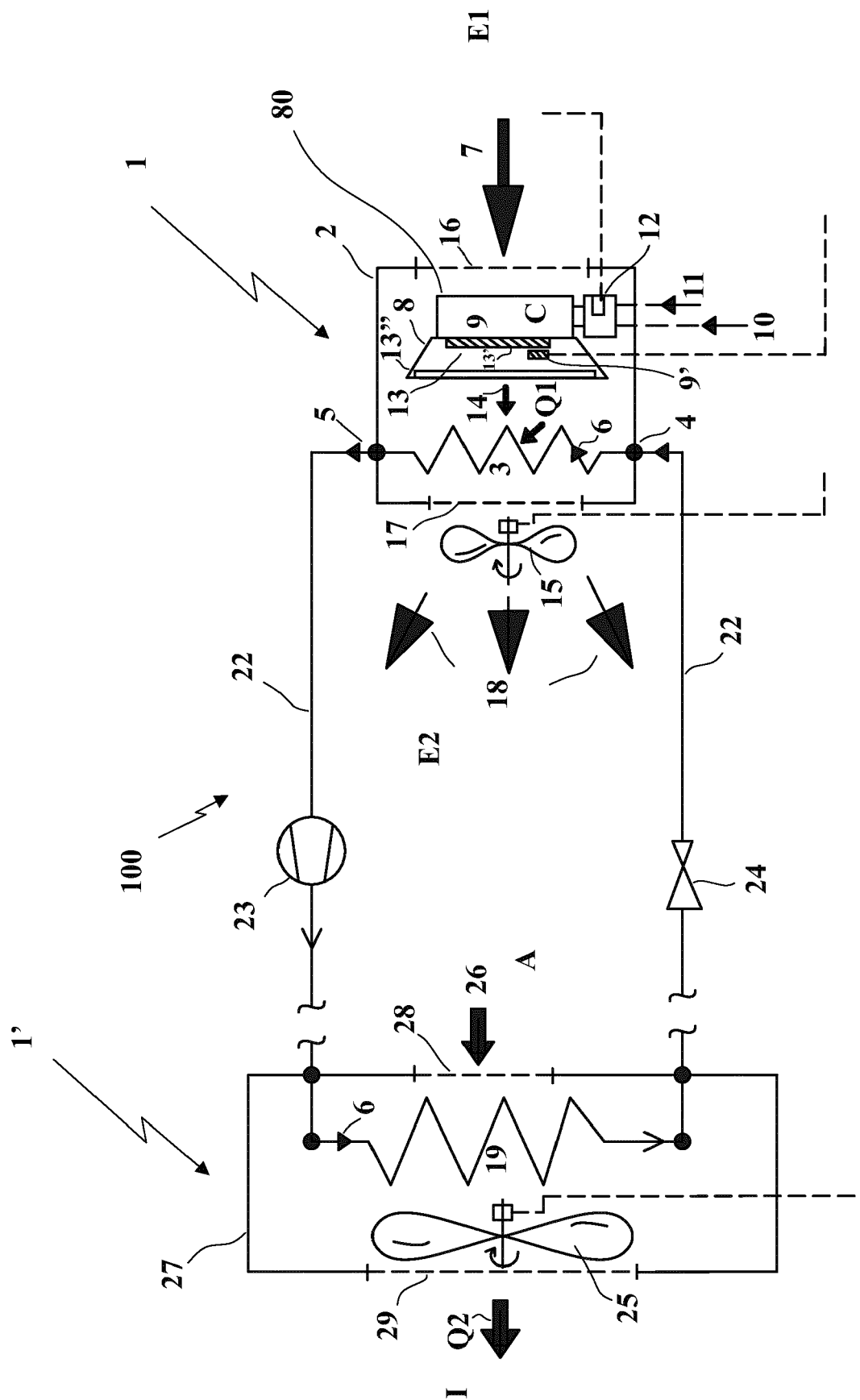


Fig. 2

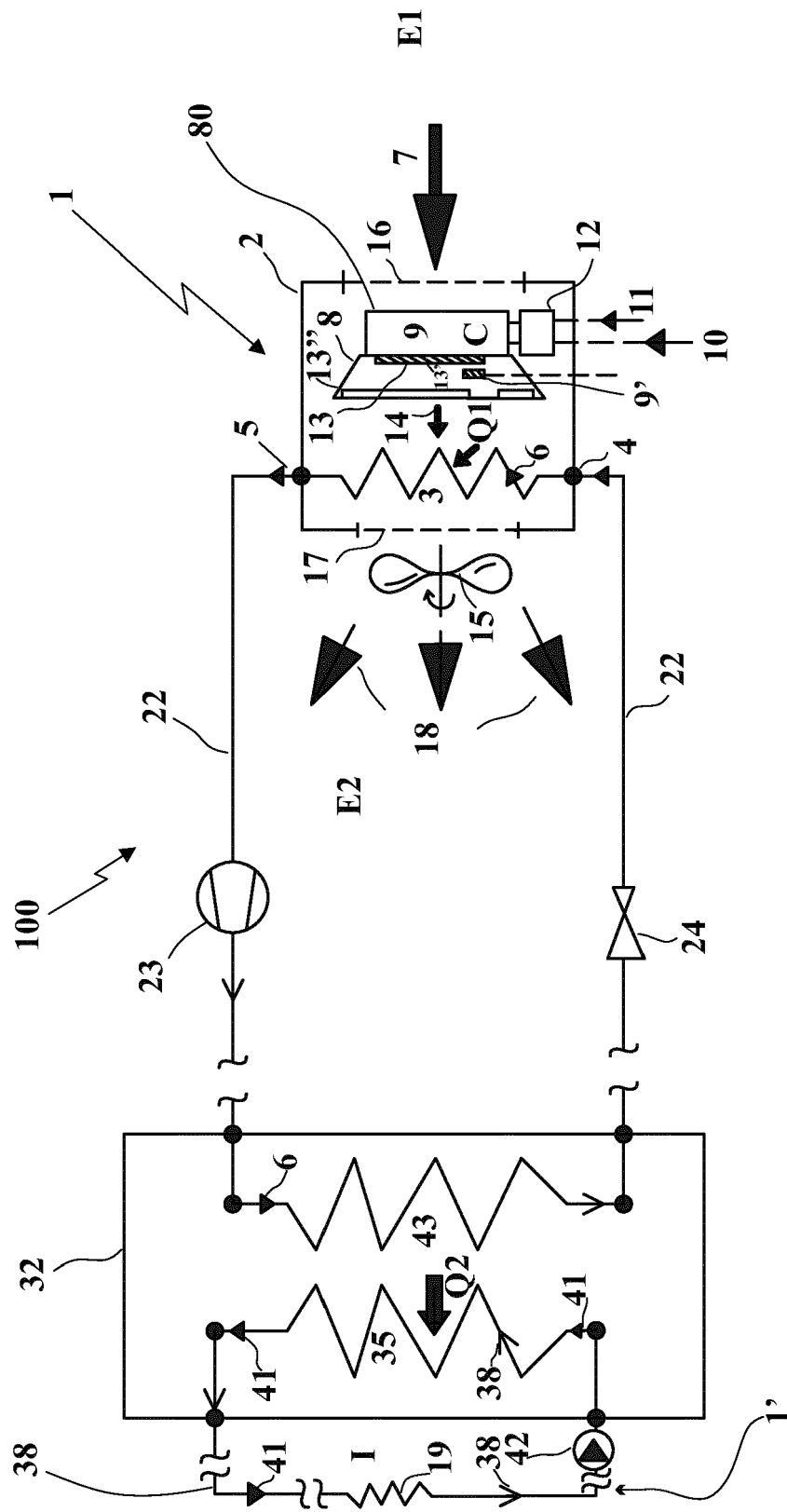


Fig. 3

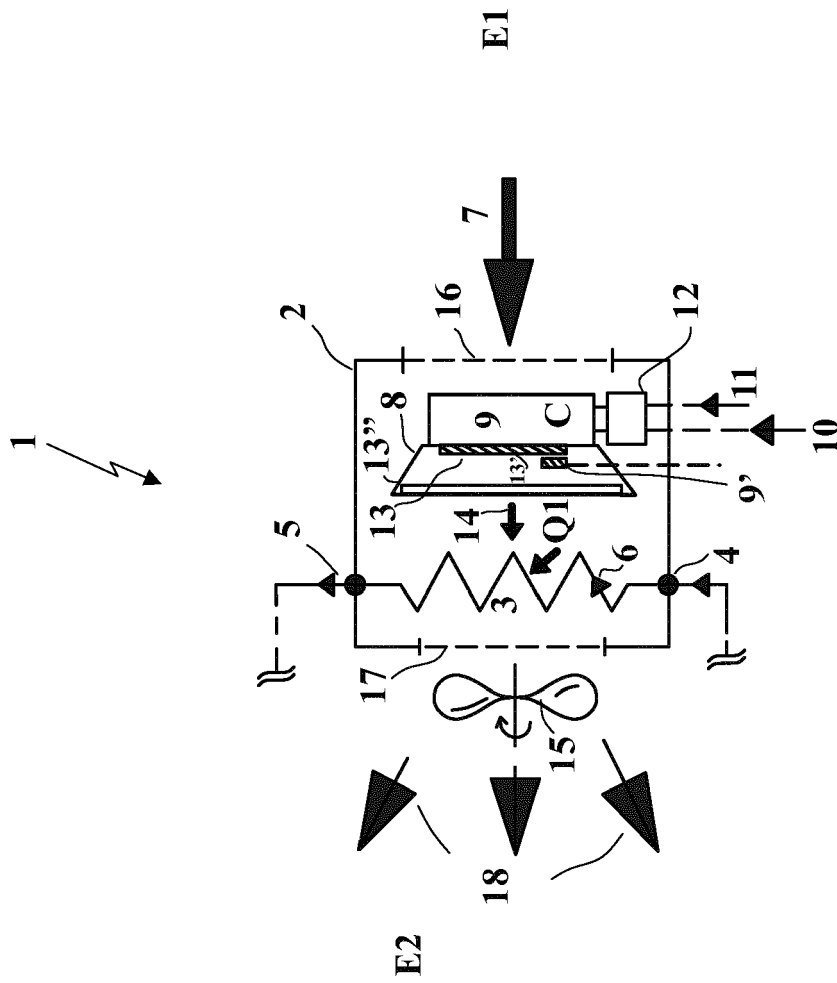


Fig. 4

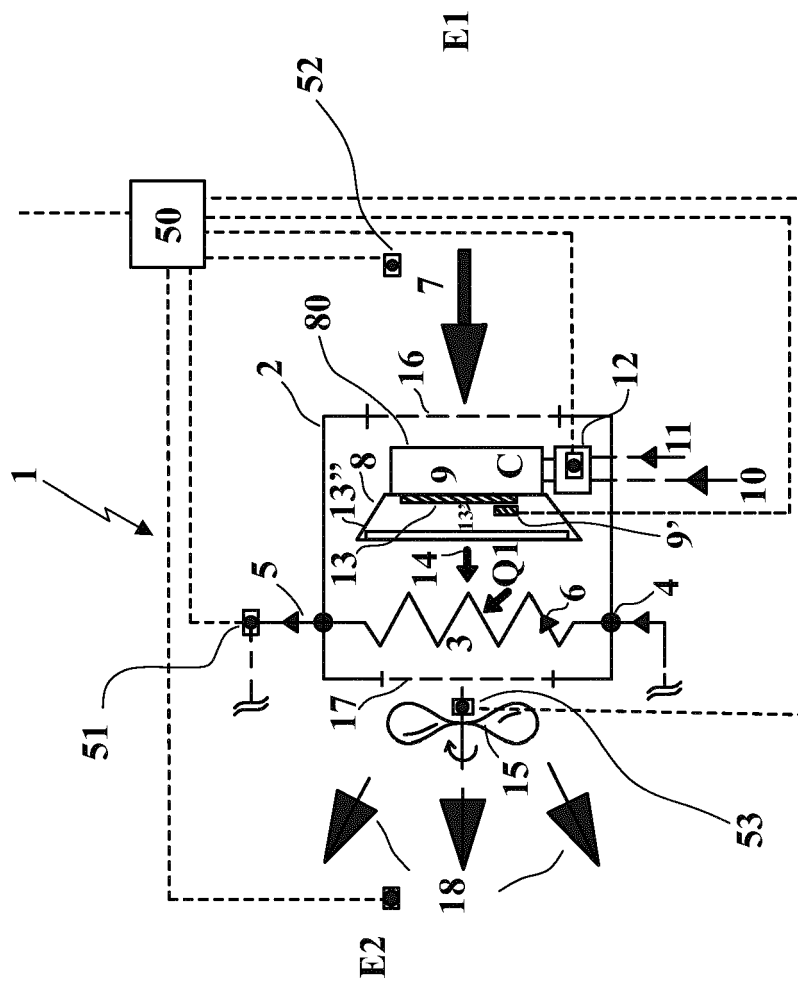


Fig. 5

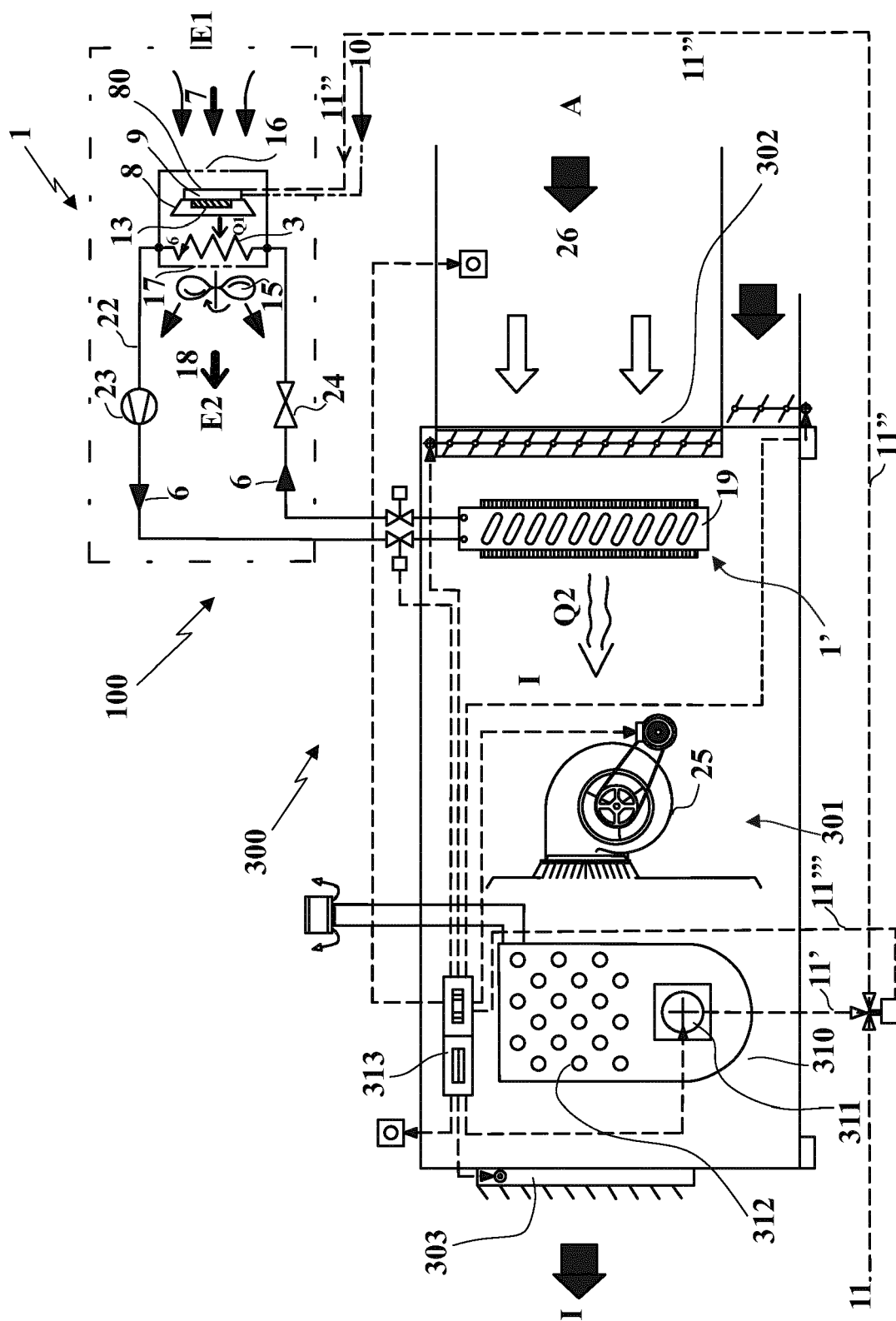


Fig. 6

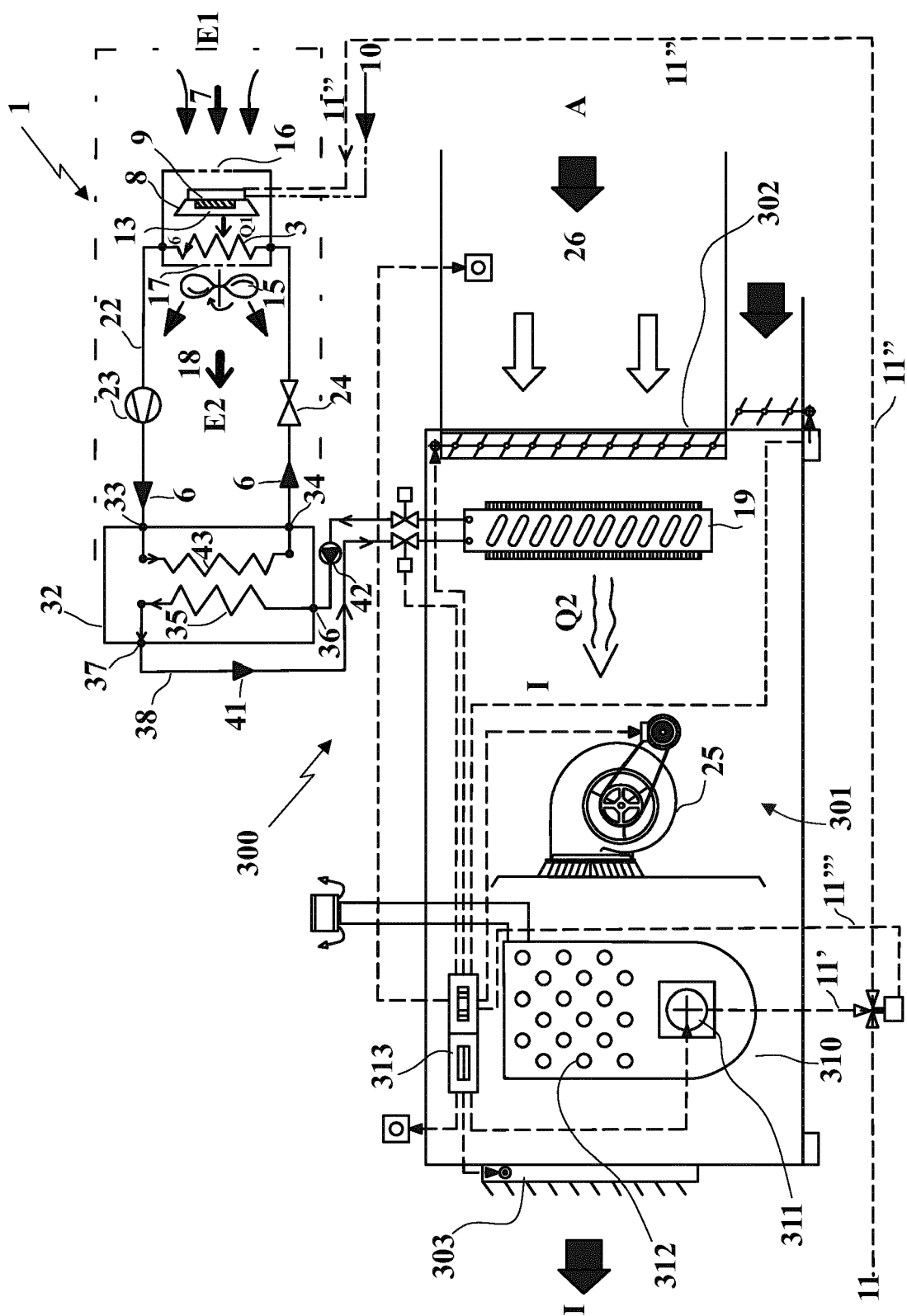
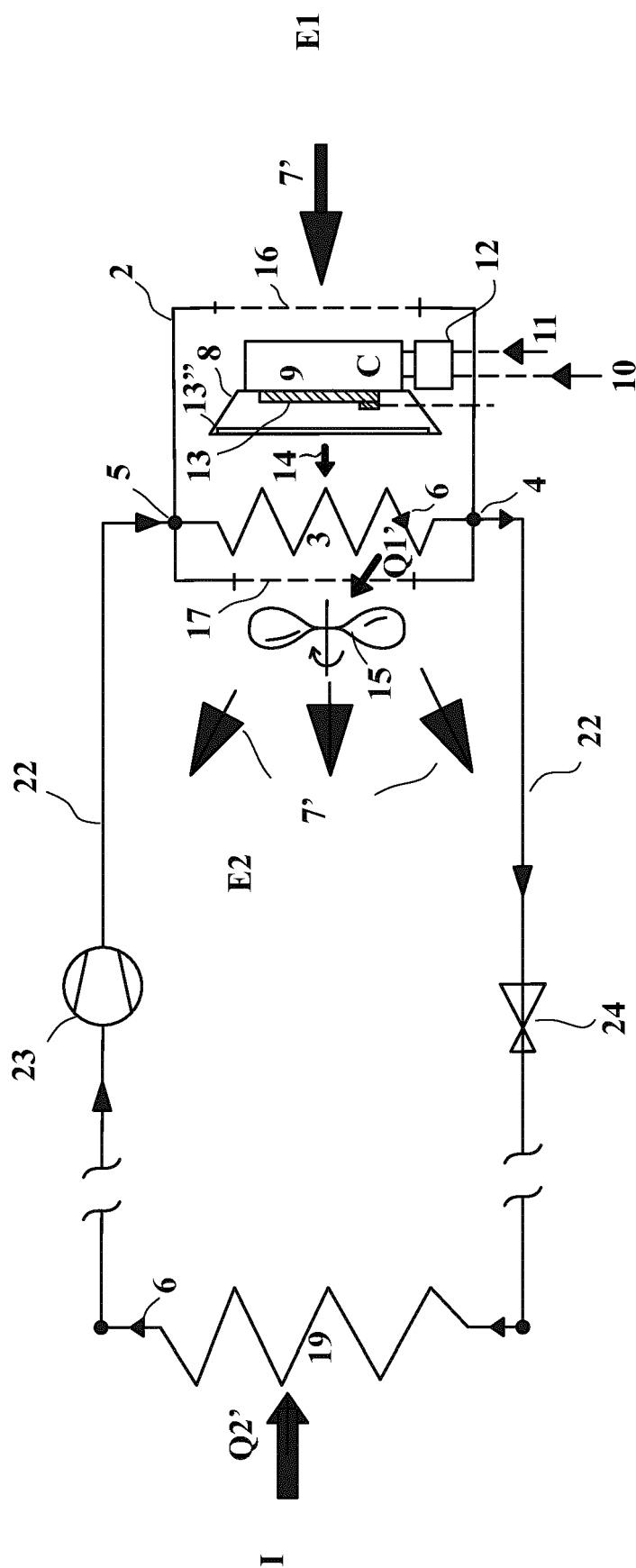


Fig. 7

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Fi. 8

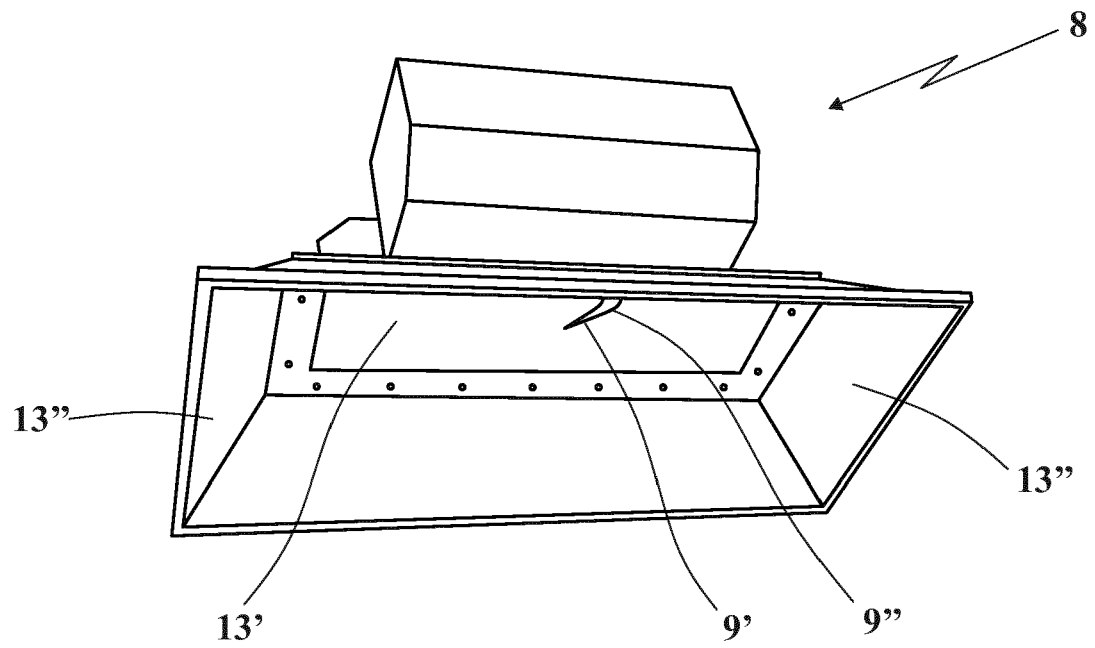


Fig. 9A

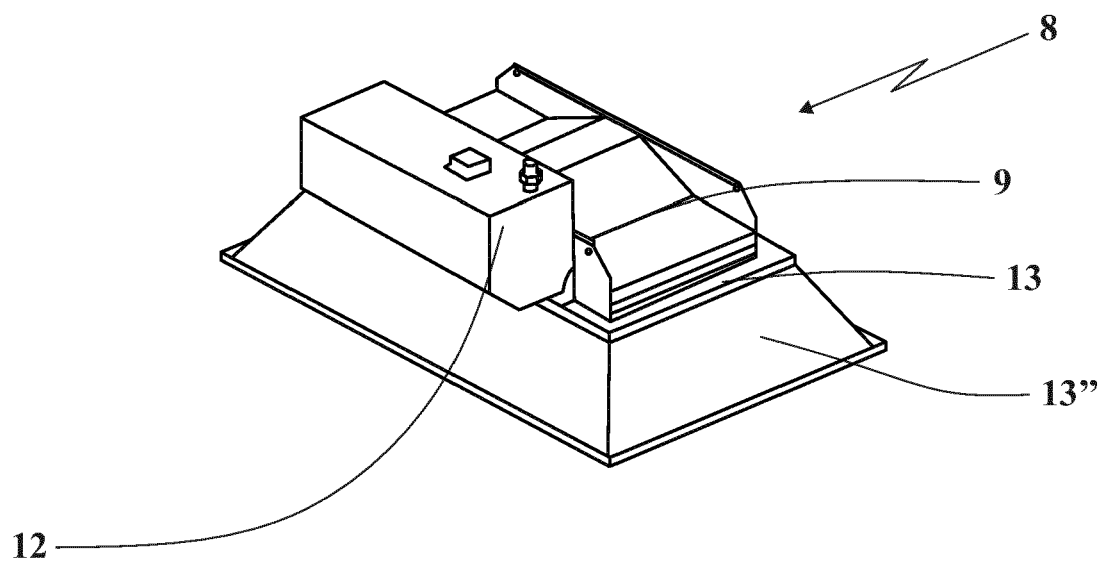


Fig. 9B



EUROPEAN SEARCH REPORT

Application Number
EP 19 17 7502

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 20 September 2019	Examiner Anconetani, Mirco
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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20-09-2019

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