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(54) HEATING INSTALLATION

(57) A heating installation comprising a heat pump (10) with:
- a working medium circuit (11) with an evaporator (12), a condenser (13), a compressor (14) and an expansion valve (15);
- a first heat exchanger (21) having a first side (21a) connected to the working medium circuit between the compressor (14) and the condenser (13) in order to transfer heat from the working medium of the heat pump to the medium in a circuit (C3); and
- a second heat exchanger (22) having a second side (22b) connected to the working medium circuit between the evaporator (12) and the compressor (14) in order to transfer heat from a medium on its first side (22a) to the working medium of the heat pump to thereby increase the temperature of the working medium to a temperature considerably higher than the prevailing evaporation temperature of the working medium in the evaporator (12).

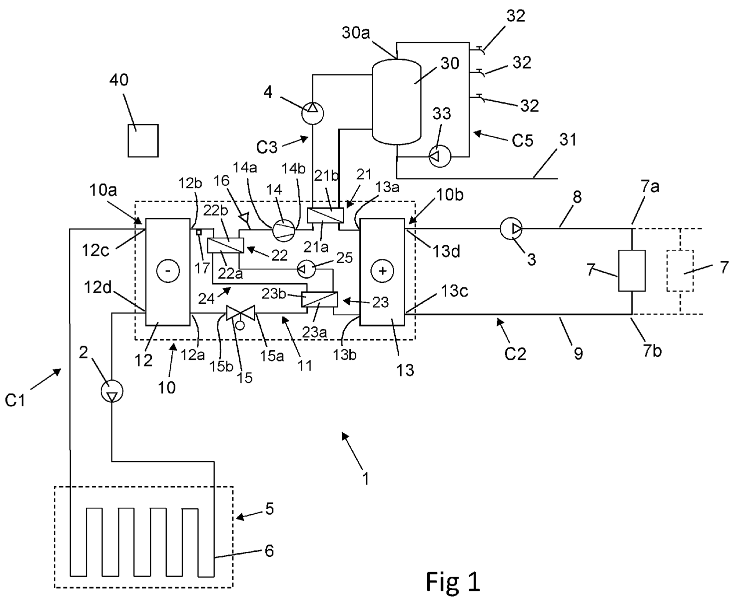

Fig 1

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Description

FIELD OF THE INVENTION AND PRIOR ART

[0001] The present invention relates to a heating installation according to the preamble of claim 1.

[0002] Heating installations with a liquid to liquid heat pump that utilizes heat energy from a liquid medium circulating in a first circuit connected to the input side of the heat pump in order to satisfy different types of heating demands are previously known in various configurations. Such a heating installation may for instance be used in order to heat air and tap hot-water in a building. A heating installation of this type is previously known from WO 2014/184184 A1.

[0003] The heating installation disclosed in WO 2014/184184 A1 comprises a first heat pump for supplying heat to a liquid medium in a second circuit via the condenser of the first heat pump, wherein this second circuit is provided with radiators for heating the air within a building. A heat exchanger connected between the condenser and the expansion valve of the first heat pump is used for transferring heat from the working medium of the first heat pump to a medium in a third circuit, wherein a second heat pump is arranged in the third circuit and configured to provide heat for final heating of tap hot-water by absorbing heat energy from the medium in the third circuit.

OBJECT OF THE INVENTION

[0004] The object of the present invention is to provide a heating installation of the above-mentioned type that has a new and favourable design.

SUMMARY OF THE INVENTION

[0005] According to the invention, said object is achieved my means of a heating installation having the features defined in claim 1.

[0006] The heating installation according to the invention comprises:

- a first circuit containing a medium;
- a second circuit containing a medium;
- a third circuit containing a medium;
- a heat pump, which has an input side connected to the first circuit and an output side connected to the second circuit and which is configured to heat the medium in the second circuit by absorbing heat energy from the medium in the first circuit, the heat pump comprising a working medium circuit that comprises an evaporator, a compressor, a condenser and an expansion valve, wherein:
    - the evaporator is connected to the first circuit in order to allow heat exchange between the medium in the first circuit and a working medium in the working medium circuit via the evaporator,
    - the condenser is connected to the second circuit in order to allow heat exchange between the working medium in the working medium circuit and the medium in the second circuit via the condenser,
    - the expansion valve is arranged in the working medium circuit between a working medium outlet of the condenser and a working medium inlet of the evaporator, and
    - the compressor is arranged in the working medium circuit between a working medium outlet of the evaporator and a working medium inlet of the condenser; and
- an electronic control device for controlling the heat pump.

[0007] Said heat pump comprises a first heat exchanger with a first side and a second side, wherein the first side is connected to the working medium circuit of the heat pump between a working medium outlet of the compressor and the working medium inlet of the condenser and the second side is connected to the third circuit. This first heat exchanger is configured to transfer heat from the working medium in the working medium circuit of the heat pump to the medium in the third circuit. The heat transferred to the medium in the third circuit may for instance be used for final heating of tap hot-water but may also be used for any other suitable purpose.

[0008] Said heat pump also comprises a second heat exchanger with a first side and a second side, wherein the second side of the second heat exchanger is connected to the working medium circuit of the heat pump between the working medium outlet of the evaporator and a working medium inlet of the compressor. This second heat exchanger is configured to transfer heat from a medium on its first side to the working medium in the working medium circuit of the heat pump to thereby increase the temperature of the working medium to a temperature above the prevailing evaporation temperature of the working medium in the evaporator. The heating installation comprises a circulation pump for controlling the flow of medium through the first side of the second heat exchanger.

[0009] The heating installation further comprises at least one temperature sensor configured to measure a temperature that reflects said temperature increase of the working medium in the second heat exchanger and at least one pressure sensor configured to measure a pressure in the working medium circuit of the heat pump that corresponds to the prevailing evaporation pressure of the working medium in the evaporator. The electronic control device is configured to receive measuring values from said at least one temperature sensor and said at least one pressure sensor, wherein, in an operating situation when there is a need to heat the medium in the third circuit, the electronic control device, in dependence on measuring values from said sensors, is configured to control the flow of medium through the first side of the second heat exchanger by controlling said circulation pump such that the working medium is heated in the second heat exchanger to a temperature that is 10-60 °C higher than the prevailing evaporation temperature of the working medium in the evaporator.

[0010] Thus, when flowing through the second side of the second heat exchanger, the working medium is in said operating situation heated, under the effect of heat from the medium flowing through the first side of the second heat exchanger, to a temperature level that is considerably higher than the normal evaporation temperature of the working medium. The electronic control device is preferably configured to control the flow of medium through the first side of the second heat exchanger such that the working medium is heated to a temperature in the range of 15-40 °C in the second heat exchanger.

[0011] Thus, in said operating situation, the second heat exchanger is used in order to raise the temperature of the vaporized working medium that flows between the evaporator and the compressor of the heat pump to a temperature that is considerably higher than the prevailing evaporation temperature of the working medium. The temperature of the working medium is thereafter increased to a much higher temperature level when the pressure of the vaporized working medium is increased by the compressor. The heat energy boost in the working medium downstream of the compressor that is derived from the increase in the temperature of the working medium in the heat exchanger upstream of the compressor, i.e. said second heat exchanger, is extracted by means of the heat exchanger downstream of the compressor, i. e. said first heat exchanger, and utilized for a suitable heating purpose, for instance in order to achieve final heating of tap hot-water. Said heat energy boost will make it possible to achieve a required final heating of tap hot-water under the effect of heat energy derived from the heat pump via the first heat exchanger without requiring any additional heat pump for improving the thermal quality of this heat energy, and it will hereby be possible to achieve final heating of tap hot-water in an energy efficient manner.

[0012] It is a well-known fact that the evaporation temperature of the working medium in an evaporator of a heat pump is proportional to the evaporation pressure of the working medium in the evaporator. It also a well-known fact the pressure is the same throughout the low-pressure side of the working medium circuit of a heat pump, i.e. in the part of the working medium circuit located between the working medium outlet of the expansion valve and the working medium inlet of the compressor. Thus, as well-known to a person skilled in the art, the prevailing evaporation temperature of the working medium in the evaporator of a heat pump may be established based on a measuring value that represents the prevailing pressure in the working medium circuit at any position between the working medium outlet of the expansion valve and the working medium inlet of the compressor.

[0013] The prevailing evaporation temperature established in the above-mentioned manner may be compared by the electronic control device with a temperature value representing the temperature of the working medium flowing out of the second side of the second heat exchanger to thereby ensure that the working medium is heated in the second heat exchanger to the desired extent. Said temperature value may for instance be established by means of a temperature sensor that is configured to measure the temperature of the working medium in the working medium circuit at a position between the second side of the second heat exchanger and the working medium inlet of the compressor. As an alternative, the temperature increase of the working medium when flowing through the second side of the second heat exchanger may be established based on the drop in temperature of the medium flowing through the first side of the second heat exchanger, wherein this temperature drop may be established based on measuring values from a first temperature sensor that is configured to establish a temperature value representing the temperature of the medium flowing into the first side of the second heat exchanger and measuring values from a second temperature sensor that is configured to establish a temperature value representing the temperature of the medium flowing out of the first side of the second heat exchanger. The temperature increase of the working medium when flowing through the second side of the second heat exchanger may also be established in any other suitable manner, for instance by comparing the temperature of the working medium between the working medium outlet of the compressor and the first side of the first heat exchanger with the pressure in the low-pressure side of the working medium circuit, i.e. between the working medium outlet of the expansion valve and the working medium inlet of the compressor, and the pressure in the high-pressure side of the working medium circuit, i.e. between the working medium outlet of the compressor and the working medium inlet of the expansion valve.

[0014] An embodiment of the invention is characterized in:

- that the heat pump comprises a heat transfer circuit containing a medium;
- that the heat pump comprises a third heat exchanger, which has a first side connected to the working medium circuit between the working medium outlet of the condenser and a working medium inlet of the expansion valve and a second side connected to the heat transfer circuit and which is configured to transfer heat from the working medium in the working medium circuit to the medium in the heat transfer circuit;
- that the first side of the second heat exchanger is connected to the heat transfer circuit, wherein the second heat exchanger is configured to transfer heat from the medium in the heat transfer circuit to the working medium in the working medium circuit; and

- that said circulation pump is arranged in the heat transfer circuit for controlling the flow of medium in the heat transfer circuit between the second side of the third heat exchanger and the first side of the second heat exchanger.

[0015] In this case, the third heat exchanger constitutes a so-called subcooler of the heat pump and is used in order to transfer heat from the working medium of the heat pump to the medium in the heat transfer circuit, wherein the second heat exchanger is configured to utilize heat energy from the medium in the heat transfer circuit in order to heat the working medium of the heat pump upstream of the compressor and thereby achieve the above-mentioned heat energy boost in the working medium downstream of the compressor. Hereby, surplus heat of the working medium of the heat pump may be utilized for achieving the desired heat energy boost instead of being wasted, and an increase of the efficiency of the heat pump is obtained.

[0016] According to another embodiment of the invention, the first side of the second heat exchanger is connected to the second circuit, wherein the second heat exchanger is configured to transfer heat from the medium in the second circuit to the working medium in the working medium circuit, and wherein said circulation pump is configured to control the flow of medium between the second circuit and the first side of the second heat exchanger. Hereby, surplus heat of the medium in the second circuit may be utilized for heating the working medium of the heat pump in the second heat exchanger.

[0017] The above-mentioned heat pump is below referred to as the first heat pump.

[0018] Another embodiment of the invention is characterized in:

- that the heating installation comprises a fourth circuit containing a medium;
- that the first heat pump comprises a third heat exchanger, which has a first side connected to the working medium circuit between the working medium outlet of the condenser and a working medium inlet of the expansion valve and a second side connected to the fourth circuit and which is configured to transfer heat from the working medium in the working medium circuit to the medium in the fourth circuit;
- that the heating installation comprises a further heat pump, here denominated second heat pump, which has an input side connected to the fourth circuit and which is configured to heat a medium by absorbing heat energy from the medium in the fourth circuit; and
- that the heating installation comprises a circulation pump arranged in the fourth circuit for controlling the flow of medium in the fourth circuit between the third heat exchanger and the second heat pump.

[0019] The above-mentioned third heat exchanger constitutes a subcooler of the first heat pump and is used in order to transfer heat from the working medium of the first heat pump to the medium in the fourth circuit, wherein the second heat pump is configured to utilize heat energy from the medium in the fourth circuit in order to satisfy desired heating demands. Hereby, surplus heat of the working medium of the first heat pump may be utilized for suitable heating purposes instead of being wasted, and an increase of the efficiency of the first heat pump is obtained. An output side of the second heat pump is with advantage connected to the second circuit, to thereby allow the first and second heat pumps to co-operate in supplying heat energy to the medium in the second circuit.

[0020] Other favourable features of the heating installation according to the invention will appear from the dependent claims and the description following below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The invention will in the following be more closely described by means of embodiment examples, with reference to the appended drawings. It is shown in:

Fig 1	a schematic illustration of a heating installation according to a first embodiment of the present invention,
Fig 2	a schematic illustration of a heating installation according to a second embodiment of the invention,
Fig 3	a schematic illustration of a heating installation according to a third embodiment of the invention,
Fig 4	a schematic illustration of a heating installation according to a fourth embodiment of the invention,
Fig 5	a schematic illustration of a heating installation according to a fifth embodiment of the invention,
Fig 6	a schematic illustration of a heating installation according to a sixth embodiment of the invention, and
Figs 7a and 7b	a schematic illustration of a heating installation according to a seventh embodiment of the invention.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0022] Different embodiments of a heating installation 1 according to the invention are schematically illustrated in Figs 1-7. The illustrated heating installations are configured for heating a house or other building and tap hot-water associated therewith. However, the heating installation according to the invention may also be configured for satisfying other types of heating demands.

[0023] The heating installation 1 according to the invention comprises a first circuit C1, a second circuit C2 and a third circuit C3, each of which containing a liquid medium, such as for instance water. A first circulation pump 2 is arranged in the first circuit C1 for circulating the medium in the first circuit, a second circulation pump 3 is arranged in the second circuit C2 for circulating the medium in the second circuit, and a third circulation pump 4 is arranged in the third circuit C3 for circulating the medium in the third circuit.

[0024] The first circuit C1 is connected to a heat source 5, which is configured to emit heat to the medium in the first circuit. In the illustrated embodiments, the heat source 5 has the form of a thermal energy store, which is connected to the first circuit C1 in order to allow heat exchange between the thermal energy store and the medium in the first circuit C1. The thermal energy store is with advantage a vertical or horizontal ground heat exchanger. A ground heat exchanger comprises collector pipes 6 installed in the ground. In the illustrated embodiments, the medium in the first circuit C1 is circulated through the collector pipes 6 of the thermal energy store in order to absorb heat from the ground. In a vertical ground heat exchanger, the collector pipes 6 are installed in vertical or inclined boreholes in the ground. In a horizontal ground heat exchanger, the collector pipes 6 are installed horizontally at a suitable depth in the ground. However, any other suitable type of heat source may also be used.

[0025] The heating installation 1 comprises a heat pump 10, which has an input side 10a connected to the first circuit C1 and an output side 10b connected to the second circuit C2. The heat pump 10 is configured to heat the medium in the second circuit C2 by absorbing heat energy from the medium in the first circuit C1. The heat pump 10 comprises a working medium circuit 11 with an evaporator 12, a condenser 13, a compressor 14 and an expansion valve 15, preferably an electromechanical expansion valve. The evaporator 12 is connected to the first circuit C1 via an inlet 12c and an outlet 12d of the evaporator in order to allow heat exchange between the medium in the first circuit C1 and the working medium of the heat pump, i.e. the medium in the working medium circuit 11, via the evaporator 12. The condenser 13 is connected to the second circuit C2 via an inlet 13c and an outlet 13d of the condenser in order to allow heat exchange between the working medium of the heat pump and the medium in the second circuit C2 via the condenser 13. The expansion valve 15 is arranged in the working medium circuit 11 between a working medium outlet 13b of the condenser 13 and a working medium inlet 12a of the evaporator 12. The compressor 14 is arranged in the working medium circuit 11 between a working medium outlet 12b of the evaporator 12 and a working medium inlet 13a of the condenser 13.

[0026] The heat pump 10 is a so-called liquid-to-liquid heat pump, which implies that it is configured to transfer heat energy from a liquid medium in the first circuit C1 on the input side 10a of the heat pump to a liquid medium in the second circuit C2 on the output side 10b of the heat pump.

[0027] By heat exchange with the medium in the first circuit C1, the working medium of the heat pump 10 absorbs heat energy via the evaporator 12. Work is added via the compressor 14, whereby the pressure and the temperature of the working medium is increased. In the condenser 13, heat energy is then, by heat exchange, emitted to the medium in the second circuit C2 and the working medium of the heat pump is then returned to the evaporator 12 via the expansion valve 15, the pressure and the temperature of the working medium being lowered when passing the expansion valve.

[0028] The heating installation 1 may comprise one or more heat emitting devices 7 arranged in the second circuit C2 in order to transfer heat from the medium in the second circuit C2 to air within a building. The heat emitting devices 7 may for instance have the form of conventional radiators. An outlet 13d of the condenser 13 of the heat pump 10 is by means of a feed conduit 8 connected to the inlet 7a of said heat emitting devices 7. An outlet 7b of the heat emitting devices 7 is by means of a return conduit 9 connected to an inlet 13c of the condenser 13 of the heat pump. In the illustrated embodiments, the heat pump 10 is consequently configured to heat a medium by utilizing heat energy extracted from the heat source 5 for the purpose of heating the air within a building. However, the heat pump 10 may as an alternative be configured to heat a medium by utilizing heat energy extracted from the heat source 5 for any other suitable purpose.

[0029] The second circulation pump 3 is arranged in the second circuit C2 for controlling the flow of medium in the second circuit between the heat pump 10 and the heat emitting devices 7. In the illustrated embodiments, this circulation pump 3 is arranged in the feed conduit 8, but it could as an alternative be arranged in the return conduit 9.

[0030] The heat pump 10 further comprises a first heat exchanger 21 and a second heat exchanger 22. The first heat exchanger 21 has a first side 21a connected to the working medium circuit 11 between a working medium outlet 14b of the compressor 14 and the working medium inlet 13a of the condenser 13, and a second side 21b connected to the third circuit C3. The first heat exchanger 21 is configured to transfer heat from the working medium of the heat pump 10 to the medium in the third circuit C3. In the embodiments illustrated in Figs 1-5, the first heat exchanger 21 is configured to transfer heat from the working medium of the heat pump 10 to the medium in the third circuit C3 in order to allow final heating of tap hot-water under the effect of the heat transferred to the medium in the third circuit C3 from the working medium of the heat pump 10 via the first heat exchanger 21. In the embodiment illustrated in Fig 6, the first heat exchanger 21 is configured to transfer heat from the working medium of the heat pump 10 to the medium in the third circuit C3 in order to effect an increase of the temperature of the medium flowing through the above-mentioned feed conduit 8. In the embodiment illustrated in Figs 7a and 7b, the heat transferred from the working medium of the heat pump 10 to the medium in the third circuit C3 is in a first operating situation used in order to effect final heating of tap hot-water and in another operating situation used in order to effect an increase of the temperature of the medium flowing through the feed conduit 8.

[0031] In the embodiment illustrated in Fig 1, the first heat exchanger 21 is configured to achieve final heating of the tap hot-water by transferring heat from the working medium of the heat pump 10 to water that circulates in the third circuit C3 between the first heat exchanger 21 and an accumulator tank 30. The accumulator tank 30 is connected to a water supply line 31 and configured to accumulate the tap hot-water final-heated by the first heat exchanger 21. Thus, in this case, the water to be final-heated in order to provide tap hot-water is made to flow in the third circuit C3 from the accumulator tank 30, through the second side 21b of the first heat exchanger 21, while being subjected to final-heating under the effect of heat transferred to the water from the working medium of the heat pump 10, and then back to the accumulator tank 30. The flow of water in the third circuit C3 between the accumulator tank 30 and the first heat exchanger 21 is controlled by means of the third circulation pump 4. Via a tap hot-water circuit C5, tap hot-water is conveyed from an outlet 30a of the accumulator tank 30 to the tapping points 32. Tap hot-water that has passed the tapping points 32 without being tapped is conveyed back to the accumulator tank 30. In the embodiment illustrated in Fig 1, no preheating of the tap hot-water takes place, wherein the accumulator tank 30 is arranged to receive cold water directly from a cold water supply line 31. A circulation pump 33 is arranged in the tap hot-water circuit C5 for circulating the tap hot-water in this circuit.

[0032] In the embodiments illustrated in Figs 2-5, 7a and 7b, a heat emitting device 34, 34' is arranged in the third circuit C3 for final-heating of tap hot-water by transferring heat from the medium in the third circuit C3 to water that is to be heated in order to provide tap hot-water. The flow of water in the third circuit C3 between the heat emitting device 34, 34' and the first heat exchanger 21 is controlled by means of the third circulation pump 4.

[0033] In the embodiments illustrated in Figs 2-5, 7a and 7b, the tap hot-water final-heated by the heat emitting device 34, 34' is conveyed via a tap hot-water circuit C5 to one or more tapping points 32, which for instance may be provided with hot-water taps. Tap hot-water that has passed the tapping points 32 without being tapped is conveyed back to the heat emitting device 34, 34'. A circulation pump 33 is arranged in the tap hot-water circuit C5 for circulating the tap hot-water in this circuit.

[0034] In the embodiment illustrated in Fig 2, the tap hot-water final-heated by the heat emitting device 34' is stored in an accumulator tank 35. In this case, the heat emitting device 34' comprises a heating coil 36, which is arranged in the accumulator tank 35 and through which the medium in the third circuit C3 is allowed to flow in order to transfer heat from the medium in the third circuit C3 to the water in the accumulator tank 35. Via the tap hot-water circuit C5, tap hot-water is conveyed from an outlet 35a of the accumulator tank 35 to the tapping points 32. Tap hot-water that has passed the tapping points 32 without being tapped is conveyed back to the accumulator tank 35. In the embodiment illustrated in Fig 2, no preheating of the tap hot-water takes place, wherein the accumulator tank 35 is arranged to receive cold water directly from a cold water supply line 31.

[0035] In the embodiments illustrated in Figs 3-5, 7a and 7b, the above-mentioned heat emitting device 34 has the form of a heat exchanger with a first side 34a connected to the third circuit C3 and a second side 34b connected to the tap hot-water circuit C5, wherein this heat exchanger is configured to transfer heat from the medium in the third circuit C3 to the water in the tap hot-water circuit C5. In the embodiments illustrated in Figs 4 and 5, the heating installation 1 comprises a heat exchanger 37, in the following referred to as preheating heat exchanger, which has a first side 37a connected to the second circuit C2 and a second side 37b connected to the water supply line 31 upstream of the heat emitting device 34, wherein this heat exchanger 37 is configured to preheat tap hot-water by transferring heat from the medium in the second circuit C2 to water in the water supply line 31. In the illustrated examples, the flow of medium between the preheating heat exchanger 37 and the second circuit C2 is controlled by means of a circulation pump 38. When the circulation pump 38 is in operation, medium is made to flow from a first point P1 in the return conduit 9 of the second circuit C2, through the first side 37a of the preheating heat exchanger 37 and from this heat exchanger 37 to a second point P2 in the return conduit 9 downstream of the first point P1. One or more preheating heat exchangers may also be arranged in the water supply line 31 in the embodiments illustrated in Figs 1 and 2 in order to preheat the tap hot-water in one or more steps before the final-heating thereof.

[0036] The heating installation 1 comprises an electronic control device 40, which is configured to control the compressor 14 and the expansion valve 15 of the heat pump 10. The electronic control device 40 is also configured to control the circulation of medium in the above-mentioned circuits C1-C3 of the heating installation by controlling the circulation pumps 2, 3, 4 provided in these circuits. The electronic control device 40 is configured to control said circulation in dependence on temperature values representing the temperature of the medium at different places in the circuits C1-C3, wherein these temperature values are established by means of temperature sensors (not shown) connected to the electronic control device 40.

[0037] The above-mentioned second heat exchanger 22 of the heat pump 10 has a second side 22b connected to the working medium circuit 11 of the heat pump between the working medium outlet 12b of the evaporator 12 and a working medium inlet 14a of the compressor 14. The second heat exchanger 22 is configured to transfer heat from a medium on its first side 22a to the working medium of the heat pump 10 to thereby increase the temperature of the working medium to a temperature above the prevailing evaporation temperature of the working medium in the evaporator. A circulation pump 25, 26 is arranged in a conduit that is connected to the first side 22a of the second heat exchanger 22, wherein the flow of medium through the first side 22a of the second heat exchanger 22 is controlled by means of this circulation pump 25, 26.

[0038] In an operating situation when there is a heating demand that implies a need to heat the medium in the third circuit C3, the electronic control device 40 is configured to control the flow of medium through the first side 22a of the second heat exchanger 22, by controlling the circulation pump 25, 26 associated with the second heat exchanger, such that the working medium in the working medium circuit 11 is superheated in the second heat exchanger 22 to a temperature that is in the range from 10 °C to 60 °C higher than the prevailing evaporation temperature of the working medium in the evaporator 12, which implies that the temperature of the vaporized working medium that enters the compressor 14 through the inlet 14a thereof is considerably higher than normally in a heat pump of the type here in question. The increased temperature of the vaporized working medium that enters the compressor 14 results in that the vaporized working medium that leaves the compressor 14 via the outlet 14b thereof has a temperature that is considerably higher than normally in a heat pump of the type here in question. When the working medium flows through the first side 21a of the first heat exchanger 21, the temperature boost in the working medium downstream of the compressor 14 caused by the superheating in the second heat exchanger 22 upstream of the compressor 14 is utilized in order to heat the medium in the third circuit C3 to a temperature sufficient for final heating of tap hot-water, wherein the working medium that flows out of the first side 21a of the first heat exchanger 21 towards the condenser 13 of the heat pump 10 has a temperature suitable for the desired heat exchange in the condenser 13.

[0039] The heating installation 1 comprises at least one temperature sensor 16, 16a, 16b (see Figs 1, 2 and 5) configured to measure a temperature that reflects the temperature increase of the working medium when flowing through the second side 22b of the second heat exchanger 22 and a pressure sensor 17 configured to measure a pressure in the working medium circuit 11 that corresponds to the prevailing evaporation pressure of the working medium in the evaporator 12. The electronic control device 40 receives measuring values from these sensors 16, 16a, 16b, 17 and is configured to control the flow of medium through the first side 22a of the second heat exchanger 22 in dependence on measuring values from these sensors 16, 16a, 16b, 17 in order to achieve the desired superheating of the working medium in the second heat exchanger 22. The sensors 16, 16a, 16b, 17 used in the control of said superheating have been omitted in Figs 3, 4, 6, 7a and 7b.

[0040] Said pressure sensor 17 is configured to measure the pressure in the low-pressure side of the working medium circuit 11, i.e. at any position in the working medium circuit 11 between a working medium outlet 15b of the expansion valve 15 and the working medium inlet 14a of the compressor 14. This pressure corresponds to the prevailing evaporation pressure of the working medium in the evaporator 12, which in its turn is proportional to the evaporation temperature of the working medium in the evaporator 12. Thus, the prevailing evaporation temperature of the working medium in the evaporator 12 can be established by the electronic control device 40 based on a measuring value from said pressure sensor 17 as to the prevailing pressure in the low-pressure side of the working medium circuit 11. In the embodiments illustrated in Figs 1, 2 and 5, the pressure sensor 17 is arranged in the part of the working medium circuit 11 located between the evaporator 12 and the second heat exchanger 22, but it may as an alternative be arranged at any other suitable position in the working medium circuit 11 between the expansion valve 15 and the compressor 14. It is of course also possible to take into account measuring values from two or more pressure sensors arranged at different positions in the working medium circuit 11 between the expansion valve 15 and the compressor 14.

[0041] In the embodiments illustrated in Figs 1 and 5, said at least one temperature sensor is a temperature sensor 16 configured to establish a temperature value representing the temperature of the working medium flowing out of the second side 22b of the second heat exchanger 22, wherein this temperature sensor 16 is arranged in the part of the working medium circuit 11 located between the second heat exchanger 22 and the working medium inlet 14a of the compressor 14.

[0042] In the embodiment illustrated in Fig 2, the heating installation 1 comprises:

- a first temperature sensor 16a configured to establish a first temperature value T1 representing the temperature of the medium flowing into the first side 22a of the second heat exchanger (22); and
- a second temperature sensor 16b configured to establish a second temperature value T2 representing the temperature of the medium flowing out of the first side 22a of the second heat exchanger 22.

In this case, temperature increase of the working medium when flowing through the second side 22b of the second heat exchanger 22 is established by the electronic control device 40 by calculations based on the difference between said second temperature value T2 and said first temperature value T1.

[0043] In the embodiments illustrated in Figs 1-4, the heat pump 10 also comprises a third heat exchanger 23 and a heat transfer circuit 24, which contains a medium, preferably in the form of a liquid medium, and which forms a thermal connection between the third heat exchanger 23 and the second heat exchanger 22. The third heat exchanger 23 has a first side 23a connected to the working medium circuit 11 between the working medium outlet 13b of the condenser 13 and a working medium inlet 15a of the expansion valve 15, and a second side 23b connected to the heat transfer circuit 24. The third heat exchanger 23 is configured to transfer heat from the working medium in the working medium circuit 11 downstream of the condenser 13 to the medium in the heat transfer circuit 24. In this case, the first side 22a of the second heat exchanger 22 is connected to the heat transfer circuit 24, wherein the second heat exchanger 22 is configured to transfer heat from the medium in the heat transfer circuit 24 to the working medium in the working medium circuit 11 upstream of the compressor 14. Thus, in this case, the working medium of the heat pump 10 is superheated in the second heat exchanger 22 under the effect of heat derived from the working medium flowing in the part of the working medium circuit 11 located between the condenser 13 and the expansion valve 15. A circulation pump 25 is arranged in the heat transfer circuit 24 in order to control the flow of medium in the heat transfer circuit 24 between the third heat exchanger 23 and the second heat exchanger 22. In this case, the electronic control device 40 is configured to control the flow of medium through the first side 22a of the second heat exchanger 22, and thereby the level of the superheating achieved by the second heat exchanger 22, by controlling the circulation pump 25 in the heat transfer circuit 24.

[0044] In the embodiments illustrated in Figs 5-7, the first side 22a of the second heat exchanger 22 is connected to the second circuit C2, wherein the second heat exchanger 22 is configured to transfer heat from the medium in the second circuit C2 to the working medium in the working medium circuit 11. In the illustrated examples, the flow of medium between the second heat exchanger 22 and the second circuit C2 is controlled by means of a circulation pump 26. In this case, the electronic control device 40 is configured to control the flow of medium through the first side 22a of the second heat exchanger 22, and thereby the level of the superheating achieved by the second heat exchanger 22, by controlling the circulation pump 26. The first side 22a of the second heat exchanger 22 is with advantage connected to the above-mentioned return conduit 9 in order to allow medium flowing through the return conduit 9 to flow through the first side 22a of the second heat exchanger 22 before flowing into the condenser 13 of the heat pump 10. When the circulation pump 26 is in operation, medium is, in the illustrated examples, made to flow from a third point P3 in the return conduit 9 of the second circuit C2, through the first side 22a of the second heat exchanger 22 and from this heat exchanger 22 to a fourth point P4 in the return conduit 9 downstream of the third point P3.

[0045] In the embodiment illustrated in Fig 5, the above-mentioned heat pump 10 constitutes a first heat pump of the heating installation 1, wherein the heating installation 1 also comprises a second heat pump 50 and a fourth circuit C4 containing a liquid medium. In this case, the first heat pump 10 comprises a third heat exchanger 23', which has a first side 23a' connected to the working medium circuit 11 between the working medium outlet 13b of the condenser 13 and a working medium inlet 15a of the expansion valve 15 and a second side 23b' connected to the fourth circuit C4. The third heat exchanger 23' is configured to transfer heat from the working medium in the working medium circuit 11 to the medium in the fourth circuit C4.

[0046] The second heat pump 50 has an input side 50a connected to the fourth circuit C4, wherein the second heat pump 50 is configured to heat a medium by absorbing heat energy from the medium in the fourth circuit C4. A circulation pump 27 is arranged in the fourth circuit C4 for controlling the flow of medium in the fourth circuit C4 between the third heat exchanger 23' and the second heat pump 50.

[0047] The second heat pump 50 comprises a working medium circuit 51 with an evaporator 52, a condenser 53, a compressor 54 and an expansion valve 55, preferably an electromechanical expansion valve. The evaporator 52 is connected to the fourth circuit C4 in order to allow heat exchange between the medium in the fourth circuit C4 and the working medium of the second heat pump 50, i.e. the medium in the working medium circuit 51, via the evaporator 52. In the illustrated example, the condenser 53 is connected to the second circuit C2 in order to allow heat exchange between the working medium of the second heat pump 50 and the medium in the second circuit C2 via the condenser 53. The expansion valve 55 is arranged in the working medium circuit 51 between a working medium outlet 53b of the condenser 53 and a working medium inlet 52a of the evaporator 52. The compressor 54 is arranged in the working medium circuit 51 between a working medium outlet 52b of the evaporator 52 and a working medium inlet 53a of the condenser 53.

[0048] In the illustrated example, the second heat pump 50 is a liquid-to-liquid heat pump and configured to transfer heat energy from the liquid medium in the fourth circuit C4 on the input side 50a of the second heat pump to the liquid medium in the second circuit C2 on the output side 50b of the second heat pump.

[0049] By heat exchange with the medium in the fourth circuit C4, the working medium of the second heat pump 50 absorbs heat energy via the evaporator 52. Work is added via the compressor 54, whereby the pressure and the temperature of the working medium is increased. In the condenser 53, heat energy is then, by heat exchange, emitted to the medium in the second circuit C2 and the working medium of the second heat pump is then returned to the evaporator 52 via the expansion valve 55, the pressure and the temperature of the working medium being lowered when passing the expansion valve.

[0050] In the illustrated example, the flow of medium on the output side 50b of the second heat pump 50 is controlled by means of a circulation pump 28. The condenser 53 of the second heat pump 50 is with advantage connected to the above-mentioned feed conduit 8. When the circulation pump 28 is in operation, medium is, in the illustrated example, made to flow from a first point P5 in the feed conduit 8 of the second circuit C2, through the condenser 53 of the second heat pump 50 and from the second heat pump 50 to a second point P6 in the feed conduit 8 downstream of said first point P5.

[0051] In the embodiment illustrated in Fig 5, the second heat pump 50 is configured to emit heat energy in order to give an addition of heat to the medium in the second circuit C2. However, the second heat pump 50 could as an alternative be configured to emit heat energy for another heating purpose.

[0052] In the embodiment illustrated in Fig 6, the third circuit C3 forms a connection between the second side 21b of the first heat exchanger 21 and the above-mentioned feed conduit 8 of the second circuit C2 in order to allow medium flowing through the feed conduit 8 to flow through the second side 21b of the first heat exchanger 21 before reaching the inlet 7a of the heat emitting devices 7. Heat energy extracted from the working medium of the heat pump 10 by means of the first heat exchanger 21 may hereby be utilized in order to increase the temperature of the medium flowing through the feed conduit 8 in the second circuit C2 and thereby contribute to the heating of the air in the building in question via the heat emitting devices 7 arranged in the second circuit C2. In this case, an inlet on the second side 21b of the first heat exchanger 21 is connected to the second circuit C2 via a first connecting conduit 61, and an outlet on the second side 21b of the first heat exchanger 21 is connected to the second circuit C2 via a second connecting conduit 62. Medium may flow from the feed conduit 8 to the second side 21b of the first heat exchanger 21 via the first connecting conduit 61, through the second side 21b of the first heat exchanger 21 while absorbing heat from the working medium of the heat pump 10, and then back to the feed conduit 8 via the second connecting conduit 62. In the illustrated example, the first connecting conduit 61 is connected to the second circuit C2 at a point P7 in the feed conduit 8, and the second connecting conduit 62 is connected to the second circuit C2 at another point P8 located in the feed conduit 8 downstream of the first-mentioned point P7.

[0053] In the embodiment illustrated in Figs 7a and 7b, the third circuit C3 is connected to the second circuit C2 via a first connecting conduit 61' and a second connecting conduit 62' in order to allow medium flowing through the feed conduit 8 of the second circuit C2 to flow through the second side 21b of the first heat exchanger 21 before reaching the inlet 7a of the heat emitting devices 7. In the illustrated example, the first connecting conduit 61' is connected to the second circuit C2 at a point P7' in the feed conduit 8, and the second connecting conduit 62' is connected to the second circuit C2 at another point P8' located in the feed conduit 8 downstream of the first-mentioned point P7'. In the embodiment illustrated in Figs 7a and 7b, the flow of medium between the second side 21b of the first heat exchanger 21 and the second circuit C2 is controlled by means of the circulation pump 4 and a control valve 63 in the form of a three-way valve. When the circulation pump 4 is in operation with the control valve 63 in a first setting position, medium is made to circulate between the second side 21b of the first heat exchanger 21 and the heat emitting device 34, as illustrated with thick lines in Fig 7a. When the circulation pump 21 is in operation with the control valve 63 in a second setting position, medium is made to flow from the feed conduit 8 of the second circuit C2 to the second side 21b of the first heat exchanger 21 via the first connecting conduit 61', through the second side 21b of the first heat exchanger 21 and then back to feed conduit 8 of the second circuit C2 via the second connecting conduit 62', as illustrated with thick lines in Fig 7b.

[0054] The invention is of course not in any way restricted to the embodiments described above. On the contrary, many possibilities to modifications thereof will be apparent to a person with ordinary skill in the art without departing from the basic idea of the invention such as defined in the appended claims.

Claims

1. A heating installation comprising:

- a first circuit (C1) containing a medium;
- a second circuit (C2) containing a medium;
- a third circuit (C3) containing a medium;
- a heat pump (10), which has an input side (10a) connected to the first circuit (C1) and an output side (10b) connected to the second circuit (C2) and which is configured to heat the medium in the second circuit (C2) by absorbing heat energy from the medium in the first circuit (C1), the heat pump (10) comprising a working medium circuit (11) that comprises an evaporator (12), a compressor (14), a condenser (13) and an expansion valve (15), wherein:

  • the evaporator (12) is connected to the first circuit (C1) in order to allow heat exchange between the medium in the first circuit (C1) and a working medium in the working medium circuit (11) via the evaporator (12),
  • the condenser (13) is connected to the sec-

ond circuit (C2) in order to allow heat exchange between the working medium in the working medium circuit (11) and the medium in the second circuit (C2) via the condenser (13),

• the expansion valve (15) is arranged in the working medium circuit (11) between a working medium outlet (13b) of the condenser (13) and a working medium inlet (12a) of the evaporator (12), and

• the compressor (14) is arranged in the working medium circuit (11) between a working medium outlet (12b) of the evaporator (12) and a working medium inlet (13a) of the condenser (13); and

- an electronic control device (40) for controlling the heat pump (10),

characterized in:

- **that** the heat pump (10) comprises a first heat exchanger (21) with a first side (21a) and a second side (21b), the first side (21a) being connected to the working medium circuit (11) between a working medium outlet (14b) of the compressor (14) and the working medium inlet (13a) of the condenser (13) and the second side (21b) being connected to the third circuit (C3), wherein the first heat exchanger (21) is configured to transfer heat from the working medium in the working medium circuit (11) to the medium in the third circuit (C3);

- **that** the heat pump (10) comprises a second heat exchanger (22) with a first side (22a) and a second side (22b), the second side (22b) of the second heat exchanger (22) being connected to the working medium circuit (11) between the working medium outlet (12b) of the evaporator (12) and a working medium inlet (14a) of the compressor (14), wherein the second heat exchanger (22) is configured to transfer heat from a medium on its first side (22a) to the working medium in the working medium circuit (11) to thereby increase the temperature of the working medium flowing through the second side (22b) of the second heat exchanger (22);

- **that** the heating installation (1) comprises a circulation pump (25; 26) for controlling the flow of medium through the first side (22a) of the second heat exchanger (22);

- **that** the heating installation (1) comprises at least one temperature sensor (16; 16a, 16b) configured to measure a temperature that reflects said temperature increase of the working medium in the second heat exchanger (22) and at least one pressure sensor (17) configured to measure a pressure in the working medium circuit (11) that corresponds to the prevailing evaporation pressure of the working medium in the evaporator (12), wherein the electronic control device (40) is configured to receive measuring values from said at least one temperature sensor (16; 16a, 16b) and said at least one pressure sensor (17); and

- **that** the electronic control device (40), in dependence on measuring values from said at least one temperature sensor (16; 16a, 16b) and said at least one pressure sensor (17), is configured to control the flow of medium through the first side (22a) of the second heat exchanger (22) by controlling said circulation pump (25; 26) such that the working medium is heated in the second heat exchanger (22) to a temperature that is 10-60 °C higher than the prevailing evaporation temperature of the working medium in the evaporator (12).

2. A heating installation according to claim 1, **characterized in:**

- **that** the heat pump (10) comprises a heat transfer circuit (24) containing a medium;

- **that** the heat pump (10) comprises a third heat exchanger (23), which has a first side (23a) connected to the working medium circuit (11) between the working medium outlet (13b) of the condenser (13) and a working medium inlet (15a) of the expansion valve (15) and a second side (23b) connected to the heat transfer circuit (24) and which is configured to transfer heat from the working medium in the working medium circuit (11) to the medium in the heat transfer circuit (24);

- **that** the first side (22a) of the second heat exchanger (22) is connected to the heat transfer circuit (24), wherein the second heat exchanger (22) is configured to transfer heat from the medium in the heat transfer circuit (24) to the working medium in the working medium circuit (11); and

- **that** said circulation pump (25) is arranged in the heat transfer circuit (24) for controlling the flow of medium in the heat transfer circuit (24) between the second side (23b) of the third heat exchanger (23) and the first side (22a) of the second heat exchanger (22).

3. A heating installation according to claim 1, **characterized in that** the first side (22a) of the second heat exchanger (22) is connected to the second circuit (C2), wherein the second heat exchanger (22) is configured to transfer heat from the medium in the second circuit (C2) to the working medium in the working medium circuit (11), and wherein said circulation pump (26) is configured to control the flow of medium between the second circuit (C2) and the first side (22a) of the second heat exchanger (22).

4. A heating installation according to claim 3, **characterized in:**

- **that** the heating installation (1) comprises one or more heat emitting devices (7) arranged in the second circuit (C2) in order to transfer heat from the medium in the second circuit (C2) to air within a building, wherein an outlet (13d) of the condenser (13) of the heat pump (10) is connected to said one or more heat emitting devices (7) by means of a feed conduit (8) included in the second circuit (C2) and wherein an inlet (13c) of the condenser (13) of the heat pump (10) is connected to said one or more heat emitting devices (7) by means of a return conduit (9) included in the second circuit (C2); and
- **that** the first side (22a) of the second heat exchanger (22) is connected to said return conduit (9) in order to allow medium flowing through the return conduit (9) to flow through the first side (22a) of the second heat exchanger (22) before flowing into the condenser (13) of the heat pump (10).

5. A heating installation according to claim 3 or 4, **characterized in:**

- **that** the heating installation (1) comprises a fourth circuit (C4) containing a medium;
- **that** the heat pump (10) comprises a third heat exchanger (23'), which has a first side (23a') connected to the working medium circuit (11) between the working medium outlet (13b) of the condenser (13) and a working medium inlet (15a) of the expansion valve (15) and a second side (23b') connected to the fourth circuit (C4) and which is configured to transfer heat from the working medium in the working medium circuit (11) to the medium in the fourth circuit (C4);
- **that** the heating installation (1) comprises a further heat pump (50), which has an input side (50a) connected to the fourth circuit (C4) and which is configured to heat a medium by absorbing heat energy from the medium in the fourth circuit (C4); and
- **that** the heating installation (1) comprises a circulation pump (27) arranged in the fourth circuit (C4) for controlling the flow of medium in the fourth circuit (C4) between the third heat exchanger (23') and said further heat pump (50).

6. A heating installation according to claim 5, **characterized in that** an output side (50b) of said further heat pump (50) is connected to the second circuit (C2).

7. A heating installation according to any of claims 1-6, **characterized in that** the first heat exchanger (21) is configured to transfer heat from the working medium in the working medium circuit (11) to the medium in the third circuit (C3) to thereby allow final heating of tap hot-water under the effect of the heat transferred to the medium in the third circuit (C3).

8. A heating installation according to claim 7, **characterized in that** the heating installation (1) comprises:

- a heat emitting device (34; 34') arranged in the third circuit (C3) for final heating of tap hot-water by transferring heat from the medium in the third circuit (C3) to water that is to be heated in order to provide tap hot-water; and
- a circulation pump (4) arranged in the third circuit (C3) for controlling the flow of medium in the third circuit (C3) between the second side (21b) of the first heat exchanger (21) and said heat emitting device (34; 34').

9. A heating installation according to claim 8, **characterized in that** said heat emitting device (34) has the form of a heat exchanger, which has a first side (34a) connected to the third circuit (C3) and a second side (34b) connected to a tap hot-water circuit (C5).

10. A heating installation according to claim 8, **characterized in:**

- **that** the heating installation (1) comprises an accumulator tank (35) for accumulating the tap hot-water heated by said heat emitting device (34'); and
- **that** said heat emitting device (34') comprises a heating coil (36), which is arranged in the accumulator tank (35) and through which the medium in the third circuit (C3) is configured to flow in order to transfer heat from the medium in the third circuit (C3) to the water in the accumulator tank (35).

11. A heating installation according to any of claims 7-10, **characterized in that** the heating installation (1) comprises a further heat exchanger (37), which has a first side (37a) connected to the second circuit (C2) and a second side (37b) connected to a water supply line (31) and which is configured to preheat tap hot-water by transferring heat from the medium in the second circuit (C2) to water in the water supply line (31).

12. A heating installation according to any of claims 1-11, **characterized in:**

- **that** the heating installation (1) comprises one or more heat emitting devices (7) arranged in the second circuit (C2) in order to transfer heat from the medium in the second circuit (C2) to air within a building, wherein an outlet (13d) of the condenser (13) of the heat pump (10) is connected to said one or more heat emitting devices (7) by means of a feed conduit (8) included in the second circuit (C2) and wherein an inlet (13c) of the condenser (13) of the heat pump (10) is connected to said one or more heat emitting devices (7) by means of a return conduit (9) included in the second circuit (C2); and

- **that** the second side (21b) of the first heat exchanger (21) is connected to said feed conduit (8) via the third circuit (C3) in order to allow medium flowing through the feed conduit (8) to flow through the second side (21b) of the first heat exchanger (21) before flowing into said one or more heat emitting devices (7).

13. A heating installation according to any of claims 1-12, **characterized in that** said at least one pressure sensor is a pressure sensor (17) that is configured to measure the pressure in the working medium circuit (11) at a position between a working medium outlet (15b) of the expansion valve (15) and the working medium inlet (14a) of the compressor (14).

14. A heating installation according to any of claims 1-13, **characterized in that** said at least one temperature sensor comprises a temperature sensor (16) configured to establish a temperature value representing the temperature of the working medium flowing out of the second side (22b) of the second heat exchanger (22).

15. A heating installation according to any of claims 1-13, **characterized in** said at least one temperature sensor comprises:

- a first temperature sensor (16a) configured to establish a temperature value representing the temperature of the medium flowing into the first side (22a) of the second heat exchanger(22); and

- a second temperature sensor (16b) configured to establish a temperature value representing the temperature of the medium flowing out of the first side (22a) of the second heat exchanger (22).

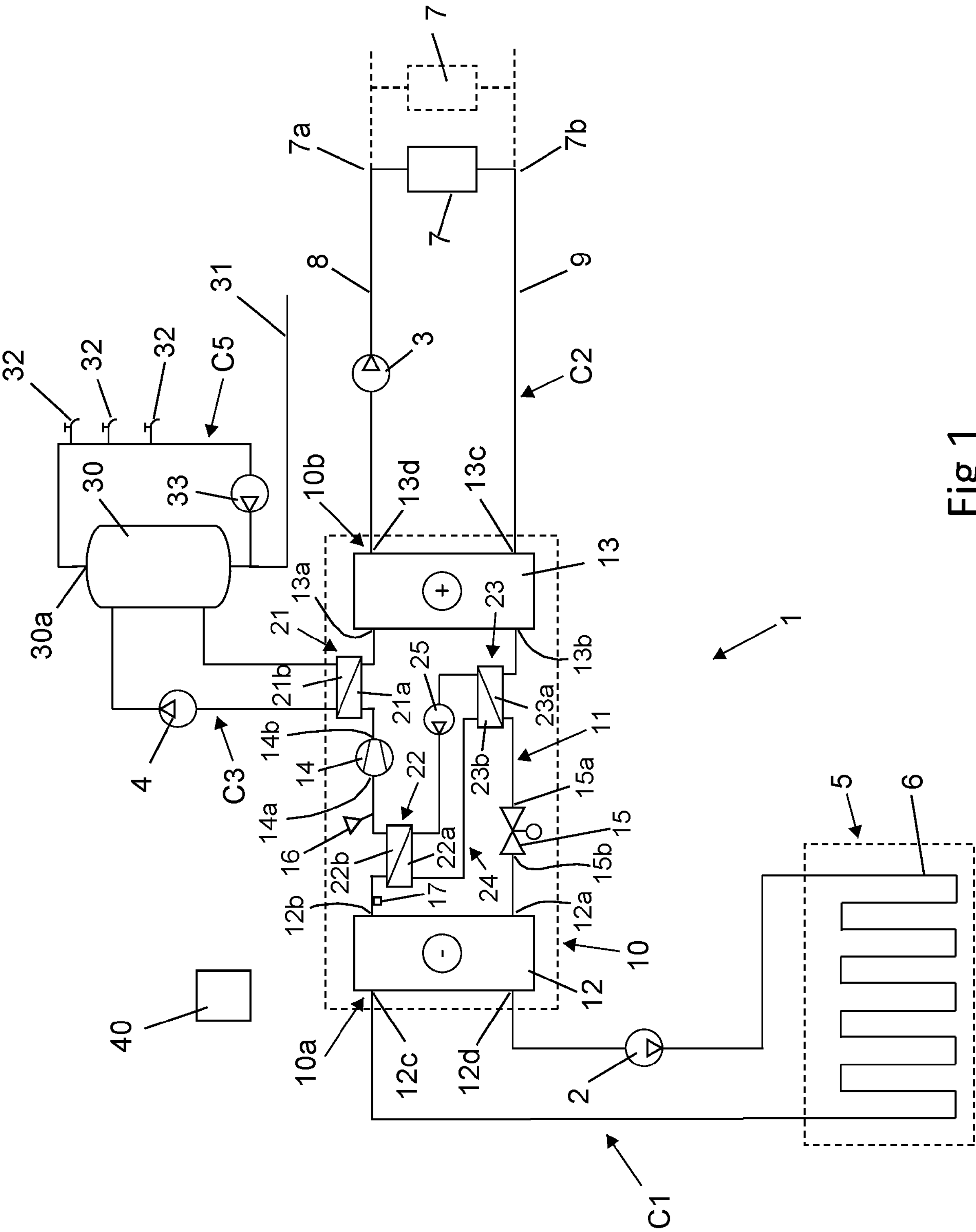
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Fig 1

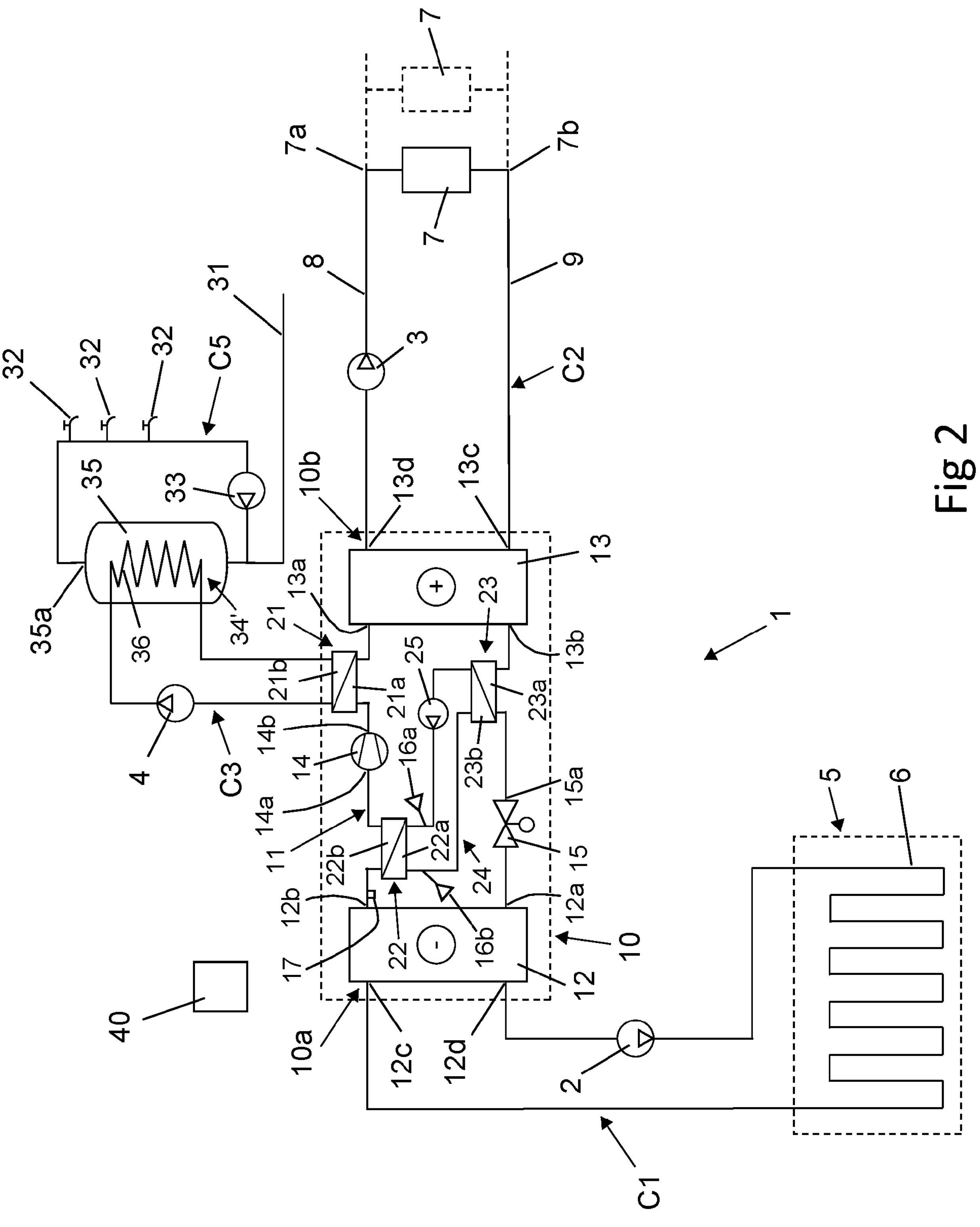
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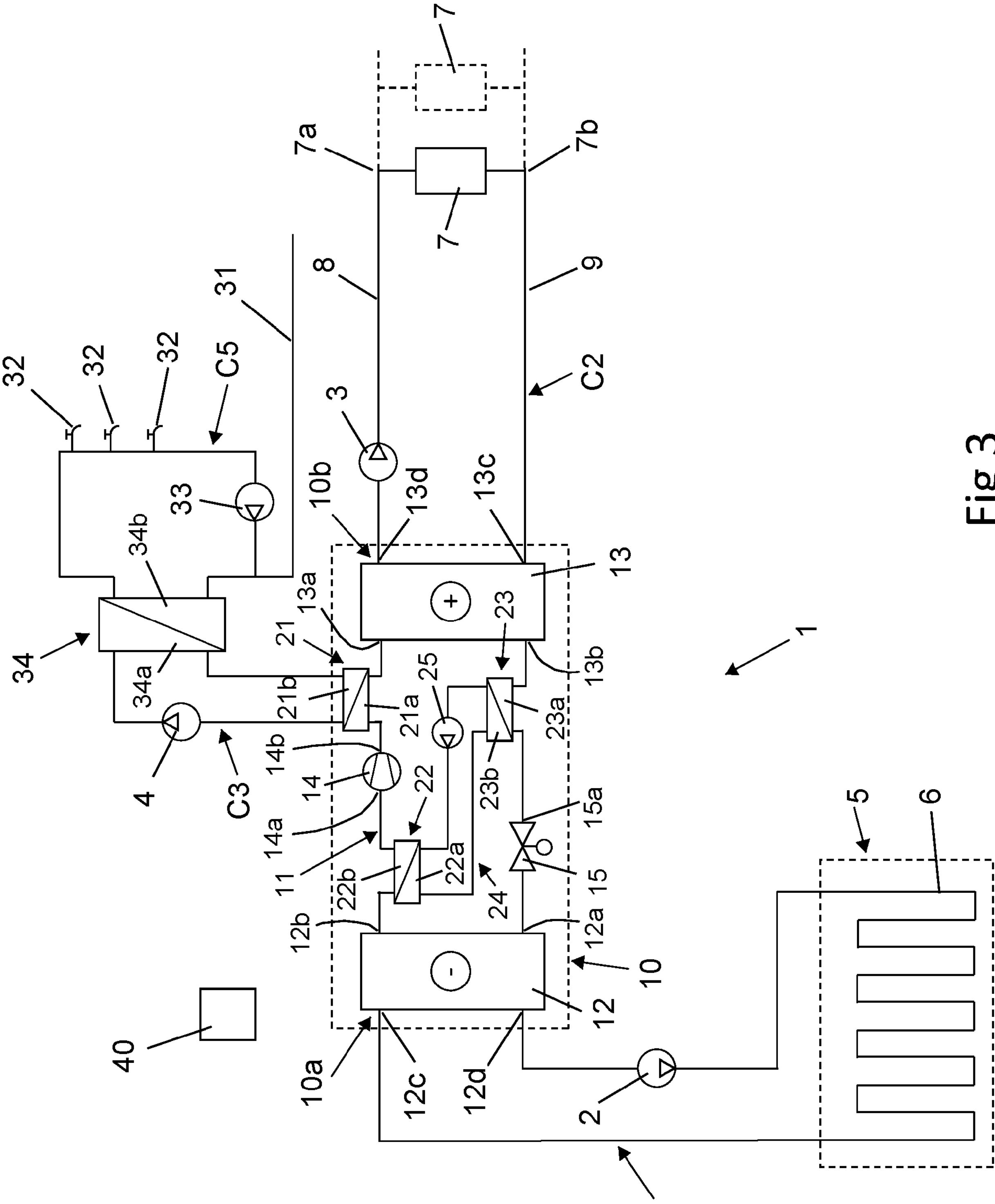
Fig 2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14b
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C3
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Fig 3

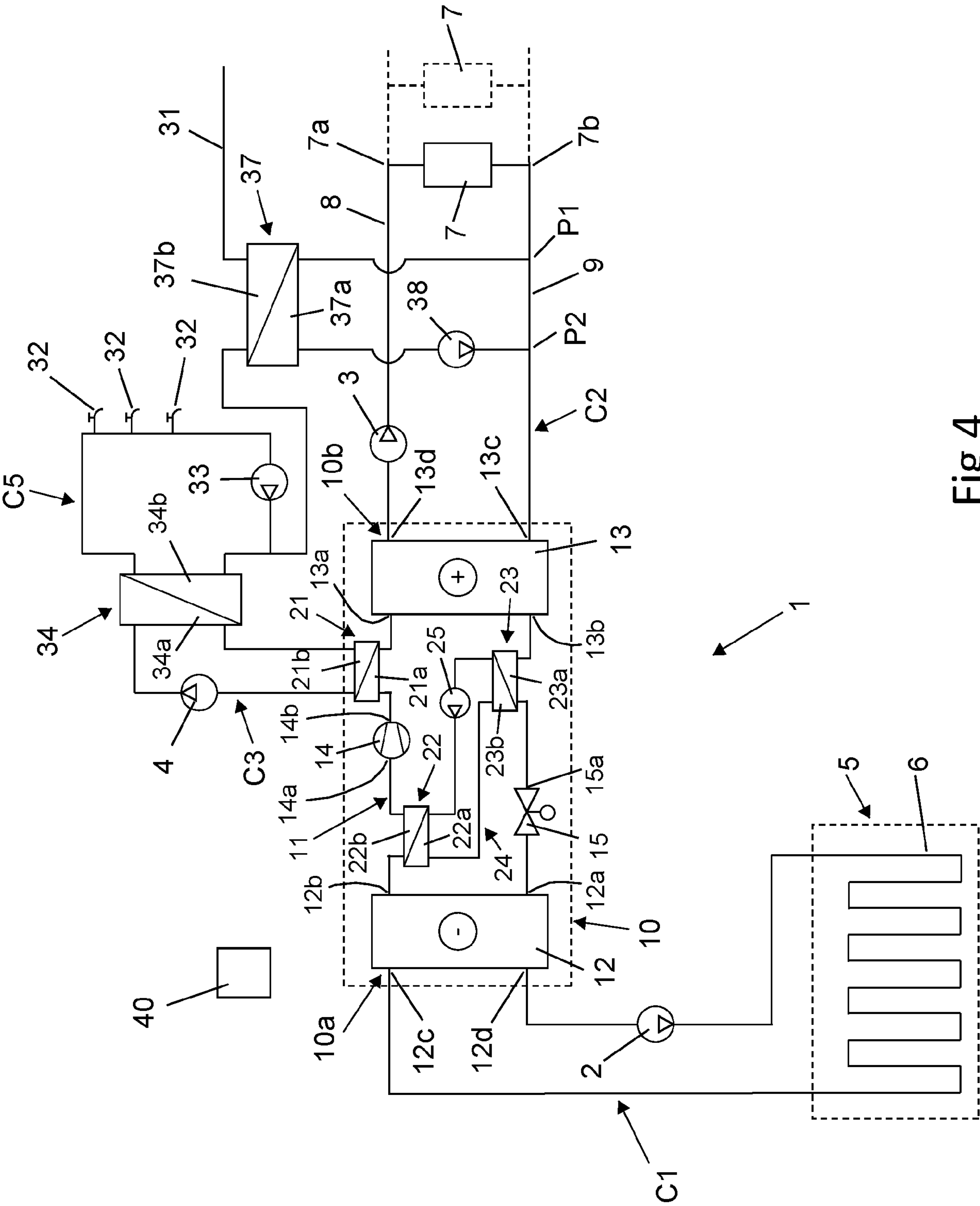
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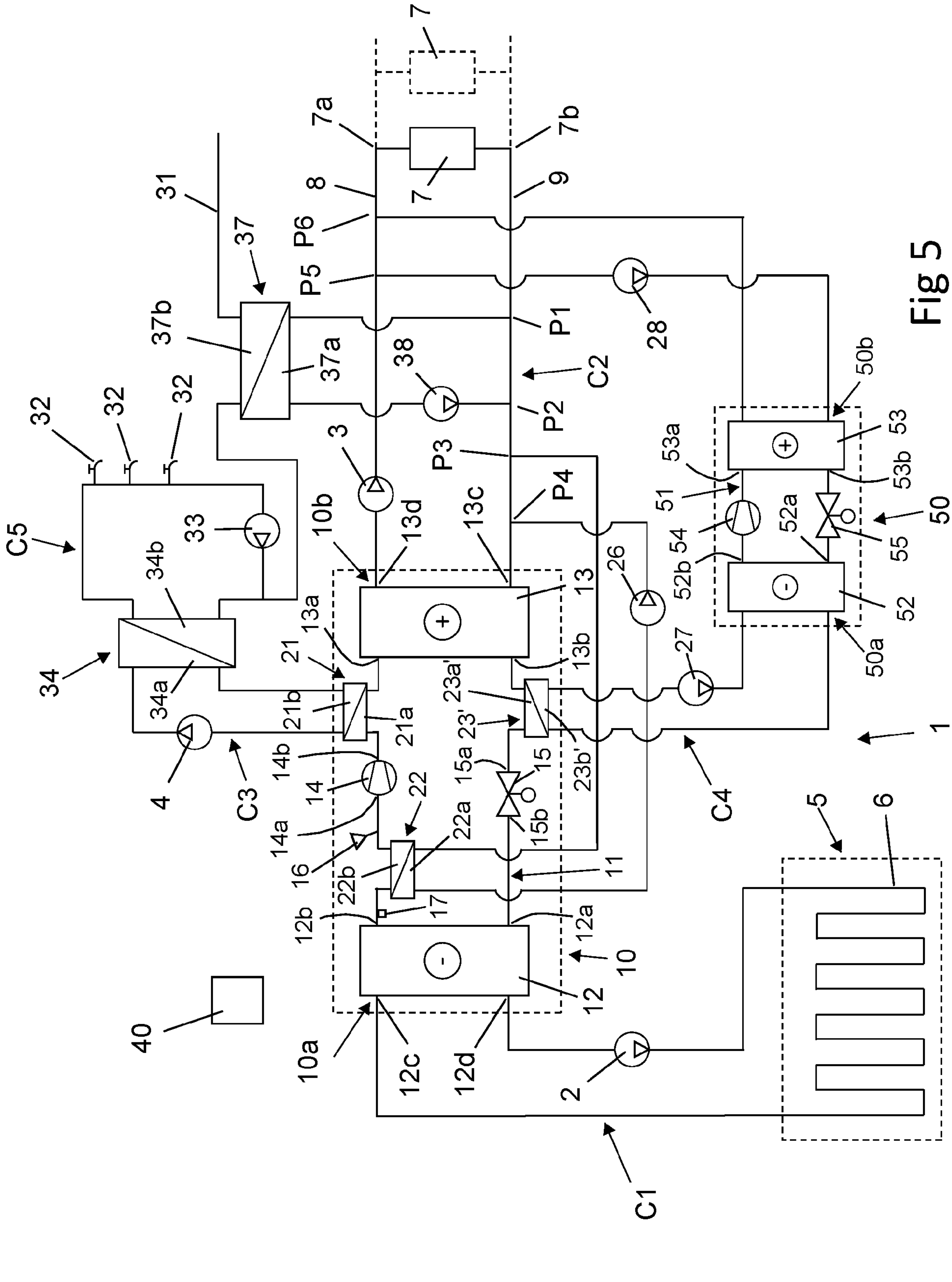
Fig 4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C1
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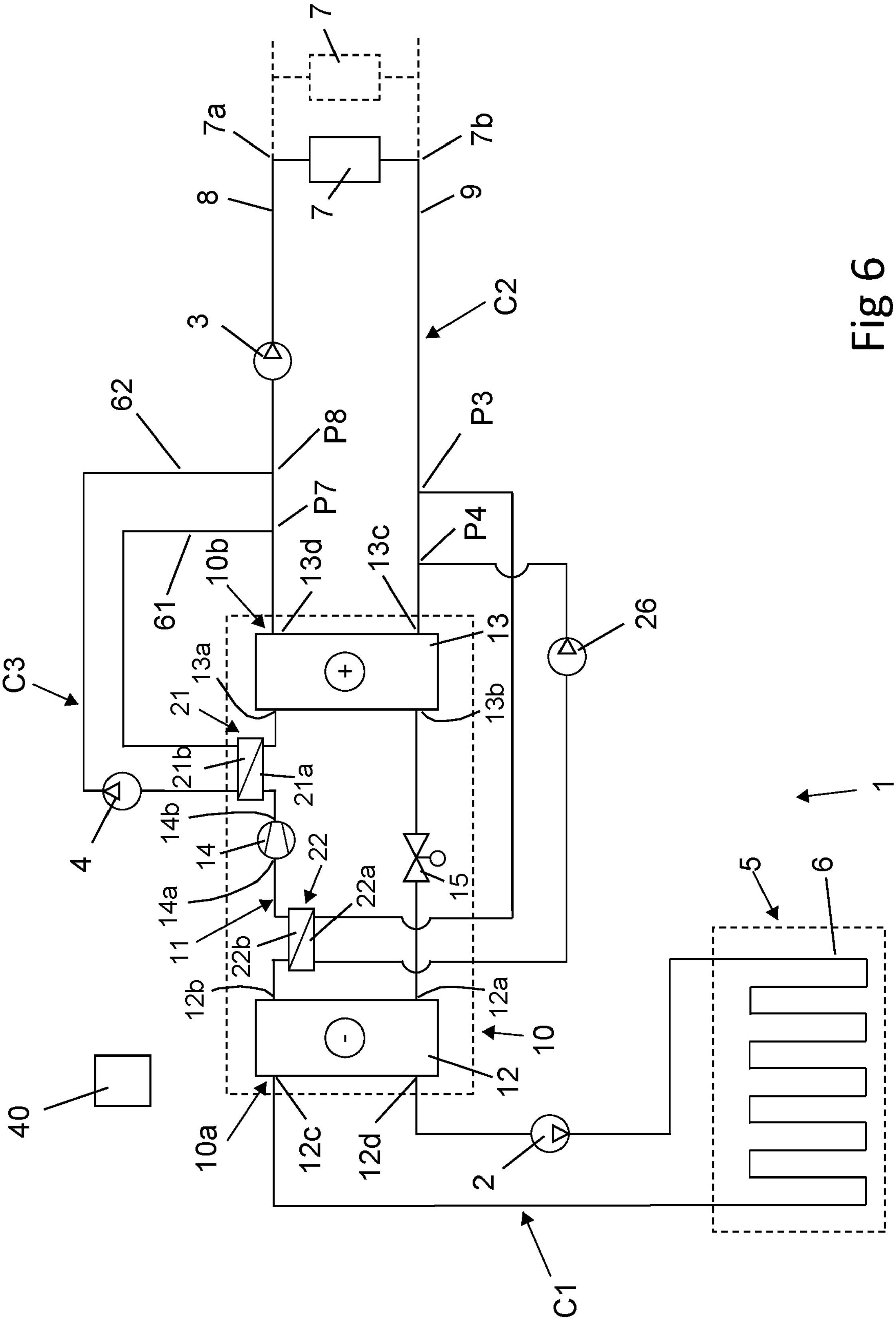
P6

Fig 5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P3
P7
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26
C3
21
13a
13b
21b
21a
4
14b
14
22
15
14a
22a
11
22b
12b
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5
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10a
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12d
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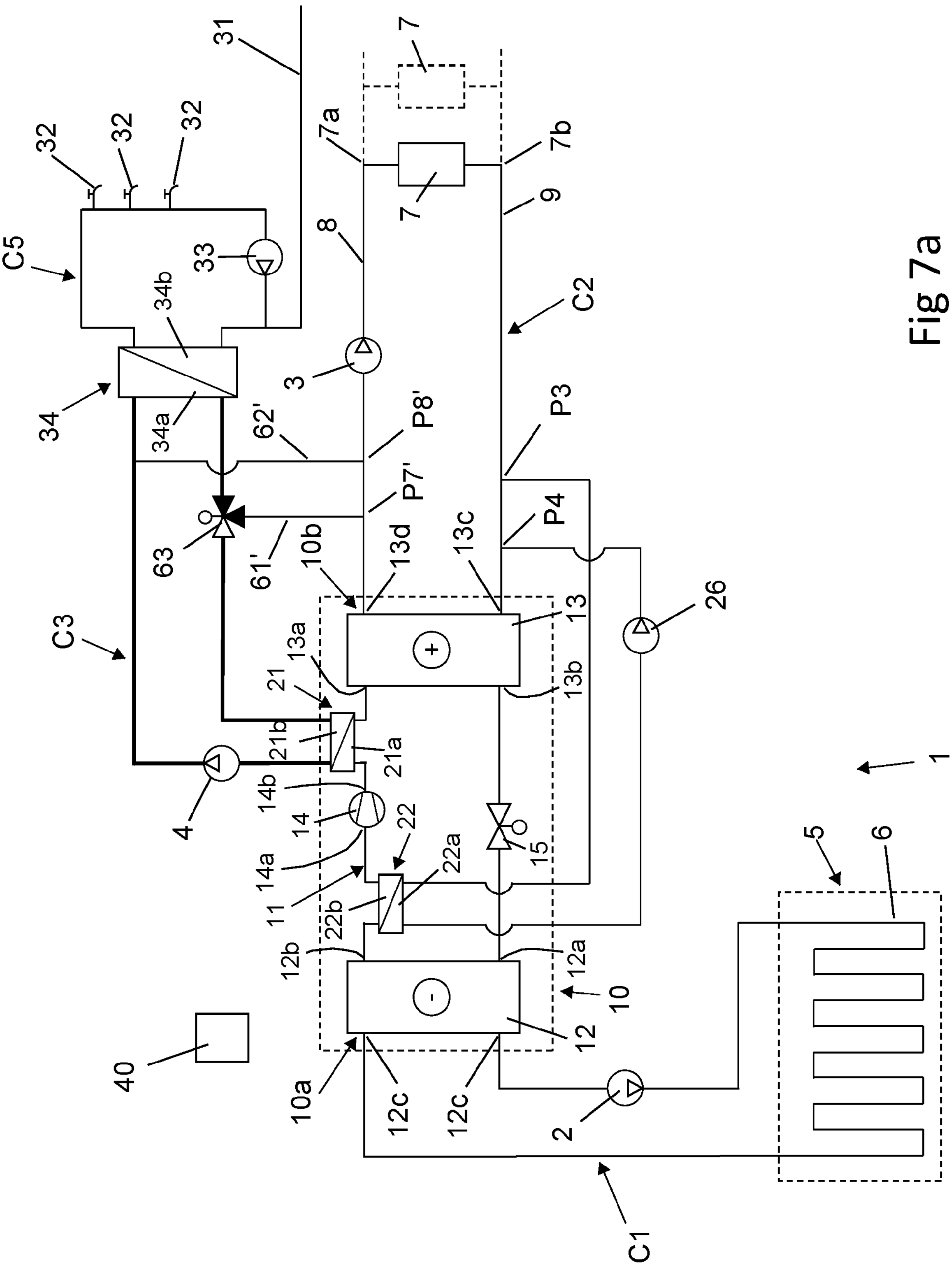
Fig 6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P3
P7'
P4
63
61'
10b
13d
13c
13
26
C3
13a
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21b
21a
13b
4
14b
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22a
15
14a
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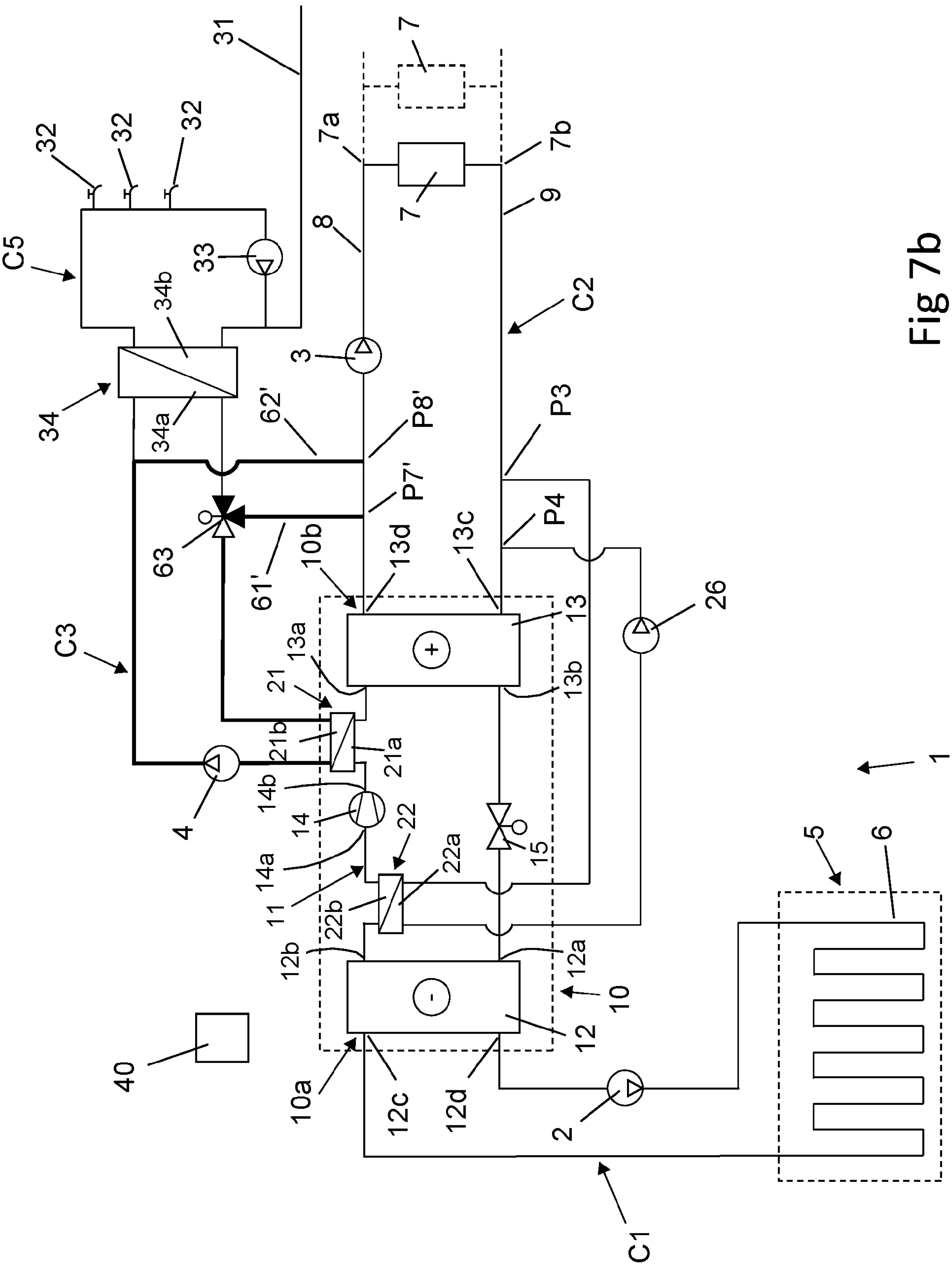
10a
12c
12c
2
C1

Fig 7a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P7'
P4
63
61'
10b
13d
13c
13
26
C3
13a
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21b
21a
13b
4
14b
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14a
22
22a
15
11
22b
12b
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6
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40
10a
12c
12d
2
C1

Fig 7b

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EUROPEAN SEARCH REPORT

Application Number
EP 23 17 4247

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Place of search	Date of completion of the search	Examiner
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