(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
30 October 2008 (30.10.2008)

PCT

(10) International Publication Number
WO 2008/130306 A1

(51) International Patent Classification:
F24D 11/02 (2006.01) *F24J 2/04* (2006.01)
F24D 17/02 (2006.01)

(21) International Application Number: PCT/SE2008/000280

(22) International Filing Date: 21 April 2008 (21.04.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PA200700605 24 April 2007 (24.04.2007) DK

(71) Applicant *(for all designated States except US)*: **THERMIA VÄRME AB** [SE/SE]; Box 950, SE-671 29 Arvika (SE).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: **SALTIN, Per-Johan** [SE/SE]; Jontes Backe 7, SE-656 38 Karlstad (SE).

(74) Agent: **EHRNER & DELMAR PATENTBYRA AB**; Box 10316, SE-100 55 Stockholm (SE).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

(54) **Title:** A SOLAR ASSISTED HEAT PUMP SYSTEM

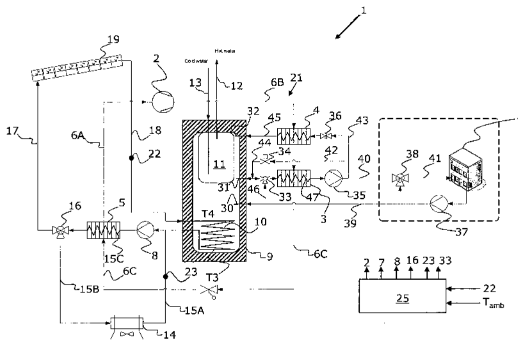

Fig.2

(57) **Abstract:** The present invention relates to a solar assisted heat pump system comprising a heat pump with an evaporator, a condenser, an expansion valve and a compressor, the heat pump having a first heat transfer circuit, and the heat pump system further comprising a secondary heat transfer circuit comprising a solar collector, and a third heat transfer circuit with an additional outdoor heat source, the second and third heat transfer circuits sharing a common pipe section connected to a water tank. The evaporator (5) of the heat pump (21) is arranged outside the tank (11) in heat exchanging connection with the common pipe section (15C) of the second and third heat transfer circuit, and the third heat transfer circuit is configurable for operation in a closed loop.

WO 2008/130306 A1

A solar assisted heat pump system

The invention relates to a solar assisted heat pump system of the type, that uses several heat sources. Heat sources for heat pumps are in well known manner solar collectors, outdoor units or aggregates collecting energy from the soil or from water.

A solar assisted heat pump system using several sources of energy is known from the book "Wärmepumpen" by Herbert Kirn, pp.129-130, published by C.F.Müller, Karlsruhe 1976. Figure 1 shows this system, which has an outdoor unit and a solar collector delivering thermal energy to a water tank. An evaporator of a heat pump is placed inside the tank, hereby absorbing the heat from the water. The heat pump has a first heat transfer circuit, the outdoor unit a second heat transfer circuit and the solar collector a third. The second and third circuits are not independent from each other, but share a pump and part of the piping system to and from the tank. A 3-way valve is placed after the pump and is intended to switch the operational mode of the heat pump system between either solar collector operation, or outdoor unit operation. The system is in solar collection mode as long as the temperature v_s of the collector is above the ambient temperature v_l. If the temperature v_{sp} of the reservoir has reached the same temperature as the collector, the pump is switched off. Once the temperature v_{sp} of the tank is lower than the outdoor temperature and the temperature v_s of the collector equals the outdoor temperature, the outdoor unit is activated by means of the 3-way valve. Thus, the system runs either in collector mode or in outdoor unit mode. The system has the drawback, that the outdoor unit cannot be operated at low ambient temperatures without reducing the efficiency of the system. After a full day, the water in the tank has reached a higher temperature than in the morning. If during the night the ambient temperature is a few degrees above the tank temperature, the outdoor unit might in principle add energy to the water in the tank. However, experience has shown that the brine temperature when entering the tank is about 2-3 °C below the ambient temperature , and would thus cool the water instead of heating. Therefore, if the outdoor temperature gets close to the tank temperature, the outdoor unit will not be activated.

The present invention has as a general goal to improve the efficiency of a heat pump system using several energy sources. More specifically, the object of the invention is to make the combined use of a solar collector and an additional heat source at low outdoor temperatures thermally feasible.

This is achieved with a solar assisted heat pump system according to claim 1. The inventive system comprises three heat transfer circuits and is characterised in that the evaporator of the heat pump is arranged outside the tank in heat exchanging connection with a common pipe section of the second and third heat transfer circuit, and that the third heat transfer circuit is configurable for operation in a closed loop. By placing the evaporator outside the tank and heat exchanging with a pipe section which is common to the heat transfer loop of the solar collector and the heat transfer loop of the additional outdoor heat source, the outdoor heat source can be operated at lower ambient temperatures, because the outdoor heat source is not feeding cold brine directly into the tank, hereby lowering the thermal efficiency of the system. The third heat transfer circuit is configurable for operation in a closed loop, which means that the additional outdoor heat source can be disconnected from the brine circuit to the solar collector. Thus, it is possible to run the additional outdoor heat source independently from operation of the solar collector, i.e. independently of the second heat transfer circuit.

The common pipe section is preferably the pipe section placed between an outlet of a coil placed inside the tank, and a valve. In this common pipe section a pump can be inserted which circulates the brine in the common pipe section and, if needed, in the closed loop.

Preferably, the valve is connected to the input of the solar collector and to the input of the additional outdoor heat source. The valve is fed from the common pipe section and distributes the brine between the second and the third heat transfer circuit. This enables the manufacture of a physically compact system.

Advantageously, the valve is of the type that can be modulated, often called a mixing valve. This is in difference to standard 3-way valves, which are on –off valves. If the valve is modulated by a controller, the brine can be split in any ratio between the second and the third heat transfer circuit. Thus, any ratio between 0 and 100% is possible, allowing precise regulation of the system.

Splitting a heated brine between the two circuits is preferably used for defrosting the additional outdoor heat source, if such source is a unit extracting heat from the ambient air. The brine will be split by the valve, and a portion will pass through the solar collector and another portion passing the outdoor unit, hereby defrosting it. The flow rate through the outdoor unit during defrosting is controlled by the modulation of the valve.

In another embodiment of the invention, a bypass between the inlet pipe to the solar collector and the outlet pipe of the collector is made by means of a valve inserted in the inlet pipe, and by a pipe connected to said outlet. This has the advantage during defrosting at night time, that the brine will not be cooled by the surface of the collector and reduce the temperature in the tank .

The invention will now be described on the basis of the figures, where:

Fig.1 is a drawing of a prior art solar assisted heat pump system
Fig.2 is a drawing of a first embodiment of the inventive system
Fig.3 is drawing of a second embodiment of the inventive system
Fig.4 is drawing of a third embodiment of the inventive system
Fig.5 is drawing of a fourth embodiment of the inventive system
Fig.6 is drawing of a fifth embodiment of the inventive system
Fig.7 is a graph of the energy content of a tank using the reloading function
Fig.8 is a diagram of another solar assisted heat pump system

Detailed description of the invention

Figure 2 shows the inventive solar assisted heat pump system 1. The system is described for heating a house 50, but is adaptable for cooling purposes also. The heat pump 21 comprises a compressor 2 connected to condenser 3 via pipe 6B, an expansion valve 7 connected to the condenser via pipe 6C and to an evaporator 5 via pipe 6D. An auxiliary condenser 4 is inserted in pipe 6B before condenser 3 in order to raise the temperature in the top of the tank, but can in principle be omitted. Experience has shown that using two separate condensers improves the coefficient of performance (COP) as described in WO2007/004962 by the applicant, which document is incorporated herein by reference.

The evaporator is connected via pipe 6a to the compressor. In a known manner, a heat transfer medium is circulated through the pipes and components of heat pump 21 by compressor 2. Preferably, refrigerant R407C is used as heat transfer medium, because it can absorb more heat than e.g. R134a. The heat pump system further comprises a water tank 9, which receives cold water from pipe 13. Hot tap water is stored in a reservoir 11 placed inside the tank and fed to a consumer via pipe 12.

The heat pump system has two energy sources. First, an outdoor heat source which in this embodiment is an outdoor air unit 14, is placed in outdoor surroundings and functions in a known manner as heat source for the heat pump 21. More specifically, outdoor unit 14 comprises a heat exchanger (not shown in the figure) which extracts thermal energy from the ambient air and transmits this energy to the heat pump 21 via a liquid brine in pipe 15a and heat exchanger section 15C. The second energy source for the heat pump system is a solar collector 19, typically placed on the roof of a house in a residential area. The solar collector 19 is connected via pipe 18 to a condenser 10 placed at the bottom of tank 9. A pump 8 is via evaporator 5 connected to a mixing valve 16, which via pipe 17 is connected to solar collector 19, and via pipe 15B connected to the input of outdoor unit 14. Condenser 3 is connected to tank 9 via inlet/outlets 30 and 31, and the auxiliary condenser is connected via inlet/outlet 32. Pump 35 is supplying heat to the house 50 from inlet/outlet 31 via pipes 40 and 41. A control unit 25 incorporates microprocessor and control software and controls valve 16, pump 8 and expansion valve 7. The solar assisted heat pump system can be described as comprising three heat transfer circuits. The first circuit is the heat pump circuit itself, illustrated by reference number 21. The second circuit is the circuit described by the loop collector 19, pipe 18, coil 10, pump 8, pipe section 15C in heat exchanging connection with the evaporator 5, valve 16 and pipe 17. The third heat transfer circuit is described by the loop outdoor unit 14, pipe 15a, pump 8, section 15C, valve 16 and pipe 15B. The pipe section from the outlet of coil 10 to the inlet of valve 16 is in this application named the common pipe section 15C. In this section, the second and third heat transfer circuits share the piping and the evaporator 5.

The heat pump system of Figure 2 functions in the following way. During day time operation, the heat transfer medium in solar collector 19 absorbs heat from the sun and transfers this energy to the coil 10 via pipe 18. Pump 8 ensures a rate of flow, which is sufficient to extract the optimum energy during daytime. Coil 10 exchanges the heat from the brine to the water in tank 9, and pump 8 feeds the evaporator 5 of the heat pump 21. More precisely, pipe 15C is in heat exchanging relationship with evaporator 5, which absorbs heat from the pipe. Thus, the temperature of the brine when leaving coil 10 is higher than the temperature after having passed evaporator 5 and entering valve 16. Pump 8 is preferably speed controlled by controller 25.
At the same time as the collector supplies energy to the tank, outdoor unit 14 adds energy to the heat pump 21, because pump 8 not only draws liquid from coil 10, but also from the outdoor unit. Thus, evaporator 5 gets energy for evaporation from two sources at the same time. During daytime operation, valve 16 splits the flow of brine between the solar collector and the outdoor unit. More specifically, mixing valve 16 is regulated by controller 25, which

modulates the opening times of the valve 16 towards pipe 17 and towards pipe 15B. Modulation is done in dependence of a temperature of the brine from the collector 19, which temperature is measured on measuring spot 22 and compared to the measured outside temperature or to a temperature on the tank. The result of this temperature difference determines to which degree the collector 19 and the mixing valve 16 contributes energy to the tank.

During night time, or during cloudy times, controller 25 closes valve 16, whereby no brine is reaching the solar collector. Only the outdoor unit is supplied with brine, which unit is then the sole supplier of thermal energy to the evaporator 5 of heat pump 21. During night time the large area of the collector would cause an unduly high reduction of the thermal energy in the tank, because of a low brine temperature. By closing pipe 17 with valve 16 it is achieved, that the brine does not transfer cold into the tank 11 from collector 19. Correspondingly, outdoor unit 14 does not deliver the heated brine to the coil 10 in the tank 11, but instead directly feeds the evaporator 5 via the heat exchanger section 15C. If valve 16 has closed the connection to pipe 17, the brine of the outdoor unit circulates in a semi closed circuit through pipes 15a, pump 8, heat exchanger section 15c, valve 16 and pipe 15b. Thus, even though the brine temperature is low, it will not cool the water in the tank 11 down, because the brine from the onset is not allowed to enter the tank. Compared to a solution with the outdoor unit feeding a coil in the tank, the outdoor unit in the inventive system will be able to work in the range of low ambient temperatures without reducing the efficiency of the heat pump system.

The outdoor unit 14 tends to get frosted, and can in this system be defrosted by applying heated brine from coil 10 via pipe 15B to the outdoor unit. Pump 8 will circulate the brine, and valve 16 is splitting the flow of brine into two, namely via pipe 17 and pipe 15B. The split can be any value between 0-100%, but is typically selected to 50%-50%. Defrosting is commenced if the difference between the ambient temperature T_{amb} and the return temperature from the outdoor unit, measured by controller 25 at measuring spot 23, becomes too large. The typical duration of a defrost cycle depends on the time of the year, but can take a couple of minutes. If the ambient temperature is around 0 °C, defrosting will be made once every hour.

During defrosting by splitting the flow, collector 19 will be loaded with a brine, which is hotter than the outside temperature. If defrosting is done during the night, the brine will loose thermal energy to the ambient surroundings through the large solar collector surface. To avoid this, Figure 3 shows a second embodiment of the invention with 3-way valve 26 making a bypass with pipe 27 to pipe 18. In this way collector 19 can be bypassed, and a loss of energy in the tank due to the entry of cold brine is avoided.

The inventive heat pump system makes use of a function which in the following is called a reloading function. Basically speaking, it creates room for the transfer of extra thermal energy from the solar collector by moving hot water from the bottom of the tank to a higher level in the tank. The thermal energy level of the bottom water is raised to a higher energy level by means of the condenser of the heat pump. More specifically, on a sunny day, the temperature of the brine in collector 19 will be high, and the amount of thermal energy supplied to coil 10 via pipe 18 will be high. After a period of some hours, the heat absorption capacity of the water in the tank 11 will be reduced, because the temperature difference between the brine temperature T3 and the water temperature T4 is small. Typically in the described situation, the brine temperature will be 20 °C and the water temperature in the bottom of the tank will be 25°C. In order to increase the temperature difference, the hot bottom water is moved away from the bottom by means of pipe inlet/outlet 30, pipe section 46, valve 33, condenser 3, pump 35, pipe section 42, valve 34 and inlet/outlet 31. This will be explained in more detail in the following. Controller 25 starts the compressor 2 and opens valve 33 in the direction from pipe section 46 to heat exchanger section 47 and starts pump 35 while closing valve 38. During the passage of heat exchanger section 47, the water from the tank absorbs thermal energy from heat pump condenser 3 and is via solenoid valve 34 and inlet/outlet pipe 31 fed to the middle of the tank 11. Thus, not only is the hot water removed away from the bottom of the tank, it is also raised in temperature and returned to the tank, hereby raising the overall mean temperature of the water in the tank. Additionally valve 36 can be opened to allow the water to enter the tank via pipe 43, auxiliary condenser 4, pipe 45 and inlet/outlet 32. In this way, the bottom water is distributed also to the top level of the tank.

The heat transfer medium of the heat pump 21 is in pipe section 6C lowered in temperature due to the condenser interaction and the medium is expanded by controllable expansion valve 7, whereby the medium reaches a low temperature. Evaporator 5 extracts heat from the brine in the heat exchanger section 15C, which brine is then fed via valve 16 to the collector. Thus, because the temperature of the heat transfer medium in the circuit of the heat pump 21 is lowered by the reloading procedure just described, the solar collector 19 benefits from a brine which has a low temperature and thus an enlarged heat absorption capability. The reloading function just described thus gives two specific advantages, namely raising the mean temperature of the water in the tank and additionally enabling the collector to absorb more energy from the sun. In total, the COP is raised by 30% compared to a heat pump system without a reloading function.

Figure 6 shows a comparative graph of a system with the reloading function and a system without. Curve B is achieved with a system corresponding to the prior art of Figure 1. The water in the tank becomes “saturated”, i.e. it is not possible to put more energy from a solar collector into the tank. The value “1” on the Y-axis is a normative value and equals what a conventional system would be able to absorb. Curve A shows the rise in energy content of the water in a system using the reloading function, whereas curve C depicts the course over time of the energy content in the bottom part of the tank.

During passage of the brine through collector 19 it must be assured, that the flow rate does not fall below a minimum rate. During energy rich solar radiation on sunny days, the brine temperature may reach a level, which is detrimental to the solar panel. By removing brine at a minimum flow rate, the temperature will not reach a level, e.g. boiling level, that will destroy the collector. Control 25 measures this temperature at measuring spot 22, and modulates the valve 16 accordingly.

During a sunny day, the outdoor unit 14 will deliver less thermal energy than the solar collector 19. Therefore, on such a day the outdoor unit will as a rule not be part of the brine circuit (valve 16 being closed to pipe 15B), because the solar collector alone can supply more energy than the outdoor unit and the collector in combination.

Figure 4 shows a third embodiment of the inventive heat pump system. Pipes 18 and 15a are connected to 3-way valve 20 via pipe 24. The idea behind this embodiment is, that a low temperature brine flowing from the collector 19 can be directed to the evaporator 5 instead of entering tank 11 and lowering the temperature. Thus, even at small temperatures of brine from the collector, this can add energy to the system instead of fully closing valve 16 to pipe 17. In this embodiment, when defrosting the outdoor unit 14, it is not necessary to split the flow of brine as in the embodiment of Figure 2 or Figure 3.

Figure 5 shows a fourth embodiment of the invention. In difference to the contents of the tank 11 of Figure 2, tank 65 of Figure 5 comprises five coils 60, 61, 62, 63 and 64 distributed across the height of the tank. The tank is split into three compartments by circular separating plates 71 and 72. The separating plate 71 contains two hollow pipes 73 and 77 used for circulation of water between the compartments. The basic idea by dividing the tank into compartments by using separating plates is to prevent the flow or circulation of hot water from the top of the tank to the bottom or the compartment below, and to allow the circulation to a higher place in the tank if the water in the bottom or the compartment beneath is warm. If the water above a plate is warm, there will be little tendency to flow. If the water below the compartment is warm, there will be good circulation of water. The pipes 73 and 77 in the plate 71 are shifted in relation to each other. Pipe 73 is stretching more into the top compartment than into the middle compartment below. Likewise, pipe 77 extends longer into the middle compartment than into the top compartment. By using a separating plate and shifted pipes, the free circulation of the water in the tank is limited, but promoting the movement of water to the top of said tank.

Staying with Figure 5, the reloading function is also implemented here in that water is taken out from the middle compartment and brought into heat exchanging connection with condenser 78 when pump 66 is activated. Valve 67 feeds the heated water via pipe 70 back to the top of the tank. Further in Figure 5, valve 26 and pipe 78 can bypass solar collector 19. The advantage of this bypassing is achieved during night hours when defrost of the outdoor unit is commenced. Valve 26 bypasses the brine instead of allowing it to pass through the solar collector, whereby the brine will give off its heat to the dark night and return cold to the coil 60. Thus, the bypass prevents energy loss.

Figure 6 shows a fifth embodiment of the invention. The system of Figure 5 is slightly amended by moving the valve 26 from Figure 5 to the position taken by valve 80 of Figure 6. By placing the 3-way valve in connection with the input to the pump 8 and in connection with the input to coil 60, there is no need for splitting the brine flow to solar collector 19 during defrost.

The inventive heat pump system of Figures 2-4 can be operated in several different modes:

Solar collector mode, where the energy supplied to the tank 11 stems from the collector 19 only. Typically, during summer time and ambient temperature around 25°C, the temperature in the pipe 17 to the collector will be 75 °C, and the temperature of the brine leaving the collector will be 80 °C. The water in the top of the tank will have a temperature of 65°C. In the autumn the corresponding temperatures will be 40°C, 45°C and 55°C.

Solar collector and Heat pump mode, where the temperature of the tank 11 is controlled with the heat pump 21 and the energy contribution from the collector 19. This mode is typically used if there is not enough sun. Then the compressor 2 of the heat pump will be started together with the reloading function described above, and the energy created by the compressor is fed into the top of the tank via inlet/outlet 32 and 31.

Producing hot tap water mode, where only the heat pump 21 is operating, and where tank water is raised in temperature by letting pump 35 draw water from inlet/outlet 31 through heat exchanger section 47 and pipe 43, and further through valve 36 to reservoir 11 via inlet/outlet 32 (with or without additional condenser 4 in the pipe).

Stored energy mode, where the house 50 is heated with the energy present in the tank 11. Heating is done via inlet/outlet 31, pump 35, pump 37 and inlet/outlet 30. The heat pump 21 is idle, as may outdoor unit 14 and collector 19 be. The content of the tank is circulated between house and tank.

House heating mode, where the house 50 is heated by means of the heat pump 21. If the temperature of the tank 11 gets too low compared to the demand from the house, the compressor 2 of the heat pump is started. Typical temperature figures in the autumn at ambient temperature of 0°C are the following (heat pump active and reloading function active): temperature of water fed to house 50 is approx. 50°C, return temperature 40°C. The temperature of water being reloaded to tank (e.g. via valve 36 and inlet/outlet 32 in Figure 2) is approx. 95°C, and the water temperature in top of tank is 55°C.

Figure 8 shows a solar assisted heat pump system 140 with solar collector 106 feeding brine through shut-off valve 133, pipe 116, filter drier 127, valve 108 and feeding evaporator 109. Evaporator 109, expansion valve 111, compressor 110 and condenser 112 is the heat pump of the system 140. The input of outdoor unit 113 is connected via 3-way valve 118 to the inlet pipe of the solar collector, and the output of the unit likewise. A water storage tank 100 receives heated water from the heat pump station 141. The system further comprises:

101 a heat exchanger
102 a circulation pump
104 a circulation pump for a fresh water module
105 a pump for hot water cirkulation
120 a mixing valve for a hot water module
121 a circulation pump for a heating module
124 an additional electrical heater

The invention has above been described with different embodiments, which can be combined in various ways.

Claims

1. A solar assisted heat pump system comprising a heat pump with an evaporator, a condenser, an expansion valve and a compressor, the heat pump having a first heat transfer circuit, and the heat pump system further comprising a secondary heat transfer circuit comprising a solar collector, and a third heat transfer circuit with an additional outdoor heat source, the second and third heat transfer circuits sharing a common pipe section connected to a water tank characterized in that the evaporator (5) of the heat pump (21) is arranged outside the tank (11) in heat exchanging connection with the common pipe section (15C) of the second and third heat transfer circuit, and that the third heat transfer circuit is configurable for operation in a closed loop.

2. A system as in claim 1 wherein the common pipe section (15C) is connected to the outlet of a coil (10) in the tank (11) and to the input of a valve (16).

3. A system as in claim 2 wherein the valve (16) is connected to the input of the solar collector (19) and to the input of the additional outdoor heat source (14).

4. A system as in claim 3, wherein the valve (16) is modulated by a control unit (25) and splitting the amount of flow of brine from the common pipe section (15C) to the solar collector (19) and the additional outdoor heat source (14) between 0 and 100%.

5. A system as in claim 4, wherein the additional outdoor heat source is an outdoor unit extracting heat from the ambient air, and where the outdoor unit (14) is defrosted by feeding brine heated by the water in the tank (9) through the unit (14).

6. A system according to one of the claims 1-5, wherein a bypass valve (26) is inserted in the input pipe (17) to the solar collector (19) and where the bypass valve is connected to the output pipe 18 of the solar collector.

7. A system according to claims 1-5, wherein the output pipe (15A) of outdoor unit 14 and the output pipe of solar collector (11) are connected to a valve (20), which valve is connected to the inlet to a coil (10) in the tank (11), and to the common pipe section (15C).

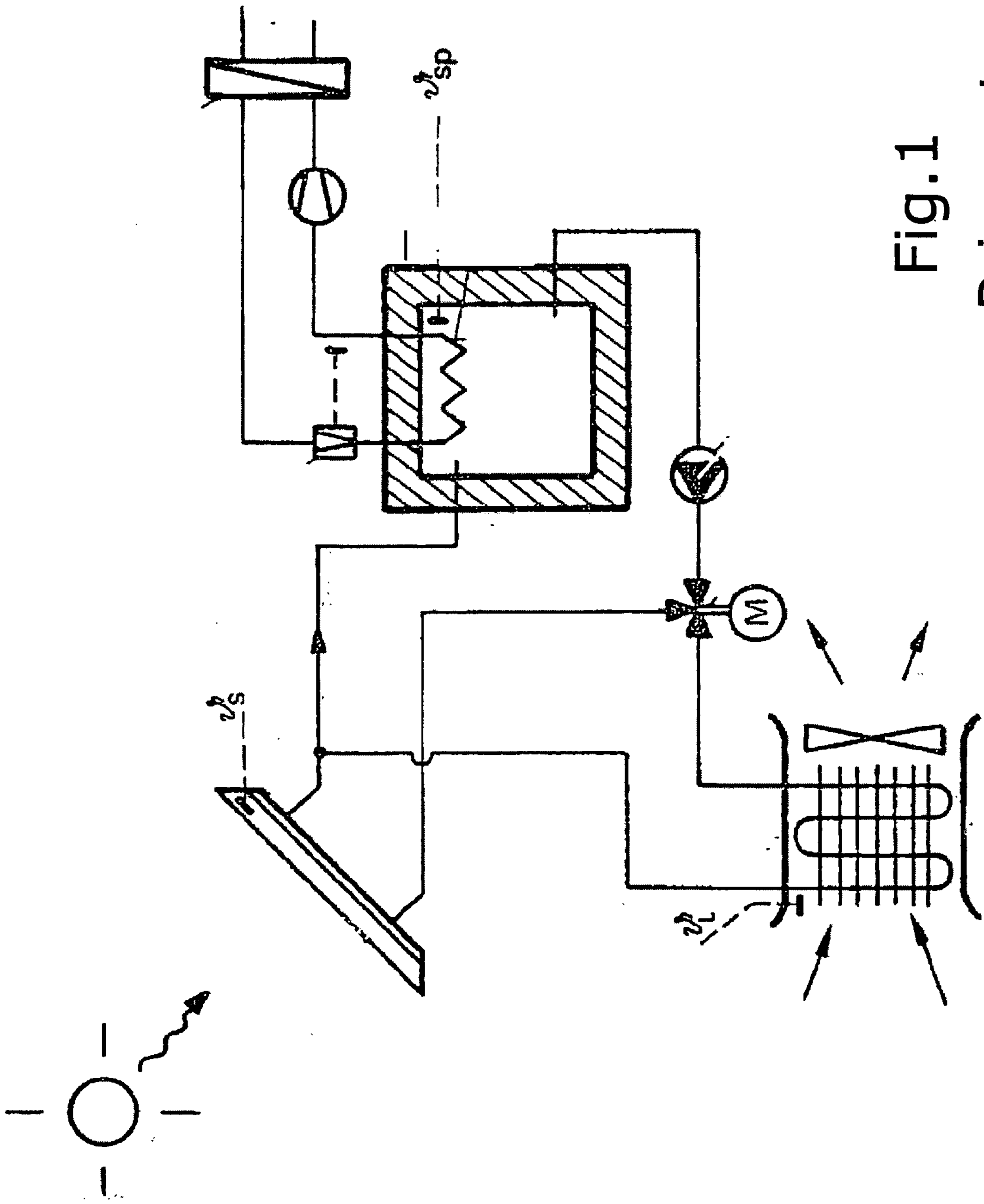

Fig.1
Prior art

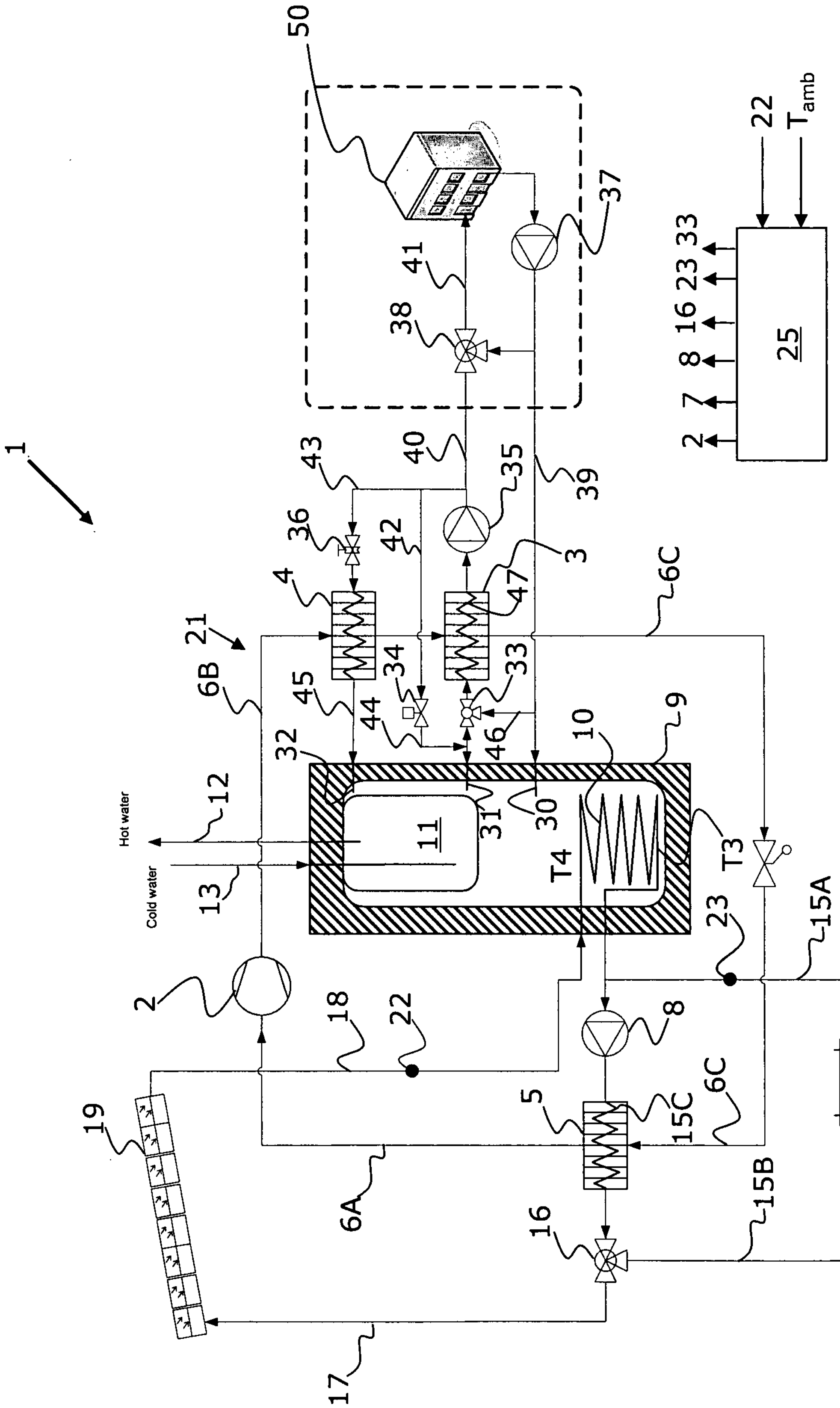
1
2
3
4
5
6A
6B
6C
8
9
10
11
12
13
14
15A
15B
15C
16
17
18
19
21
22
23
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
50
Hot water
Cold water
T3
T4
25
2 7 8 16 23 33
22 T_amb

Fig.2

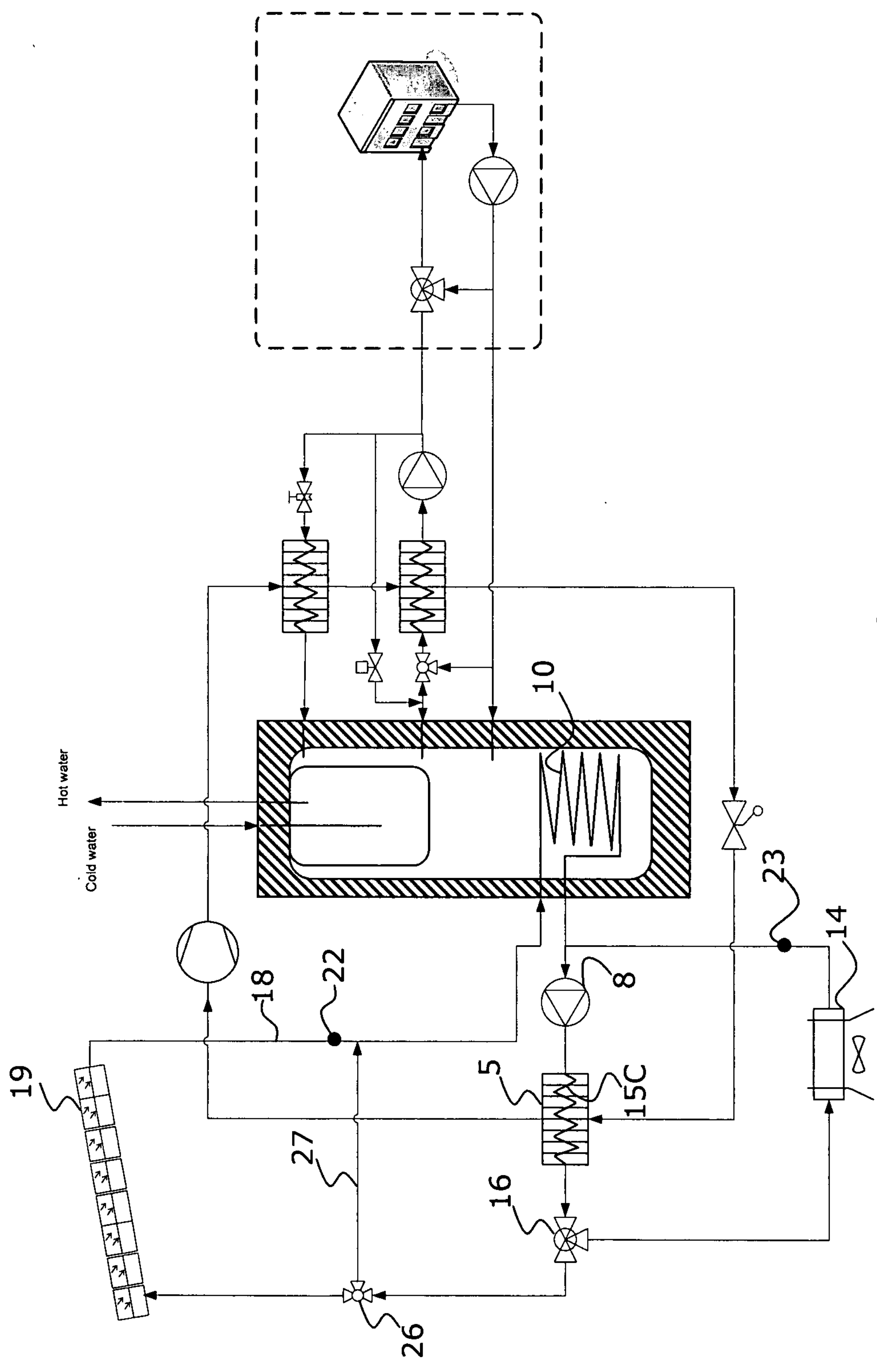

Fig.3

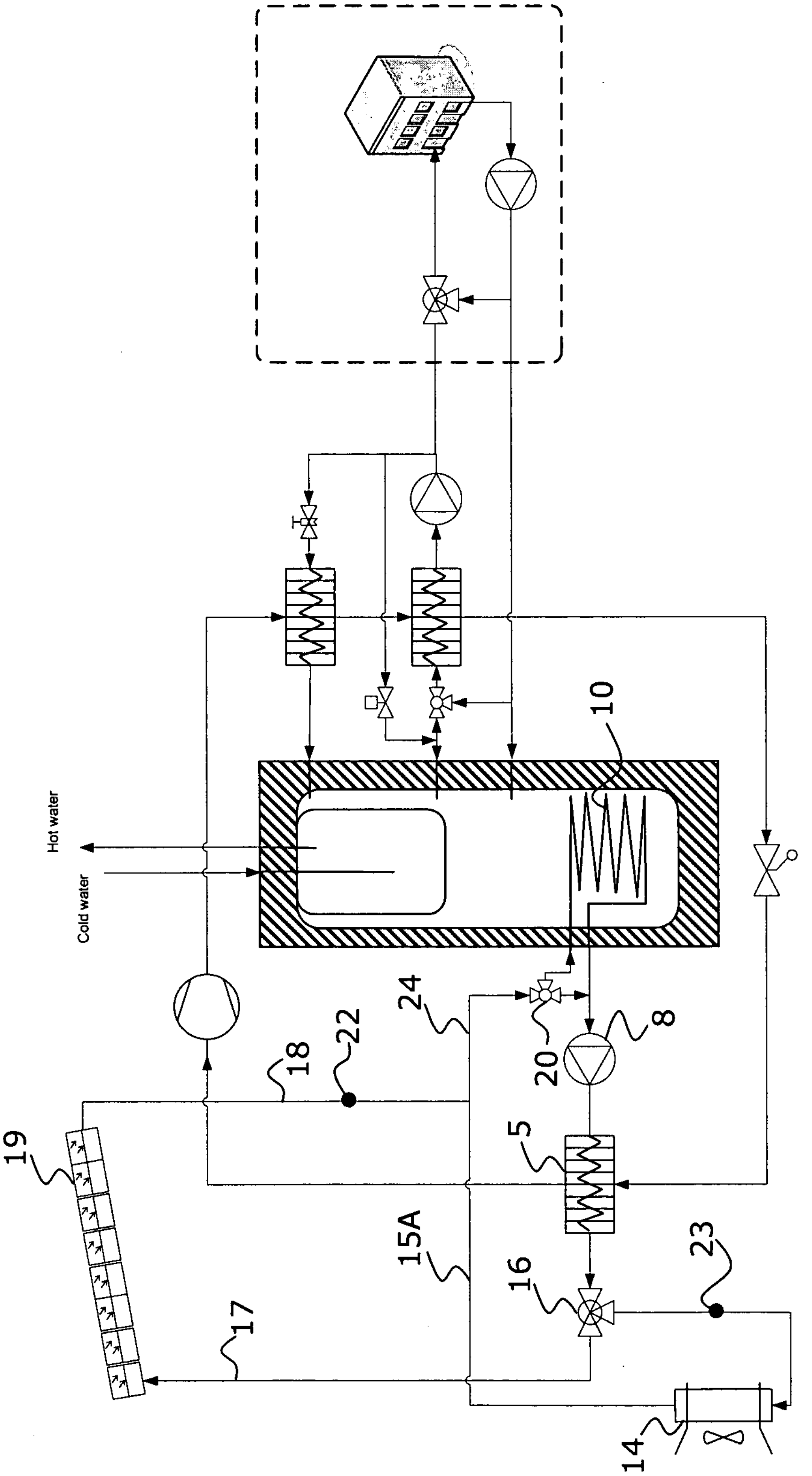

Fig.4

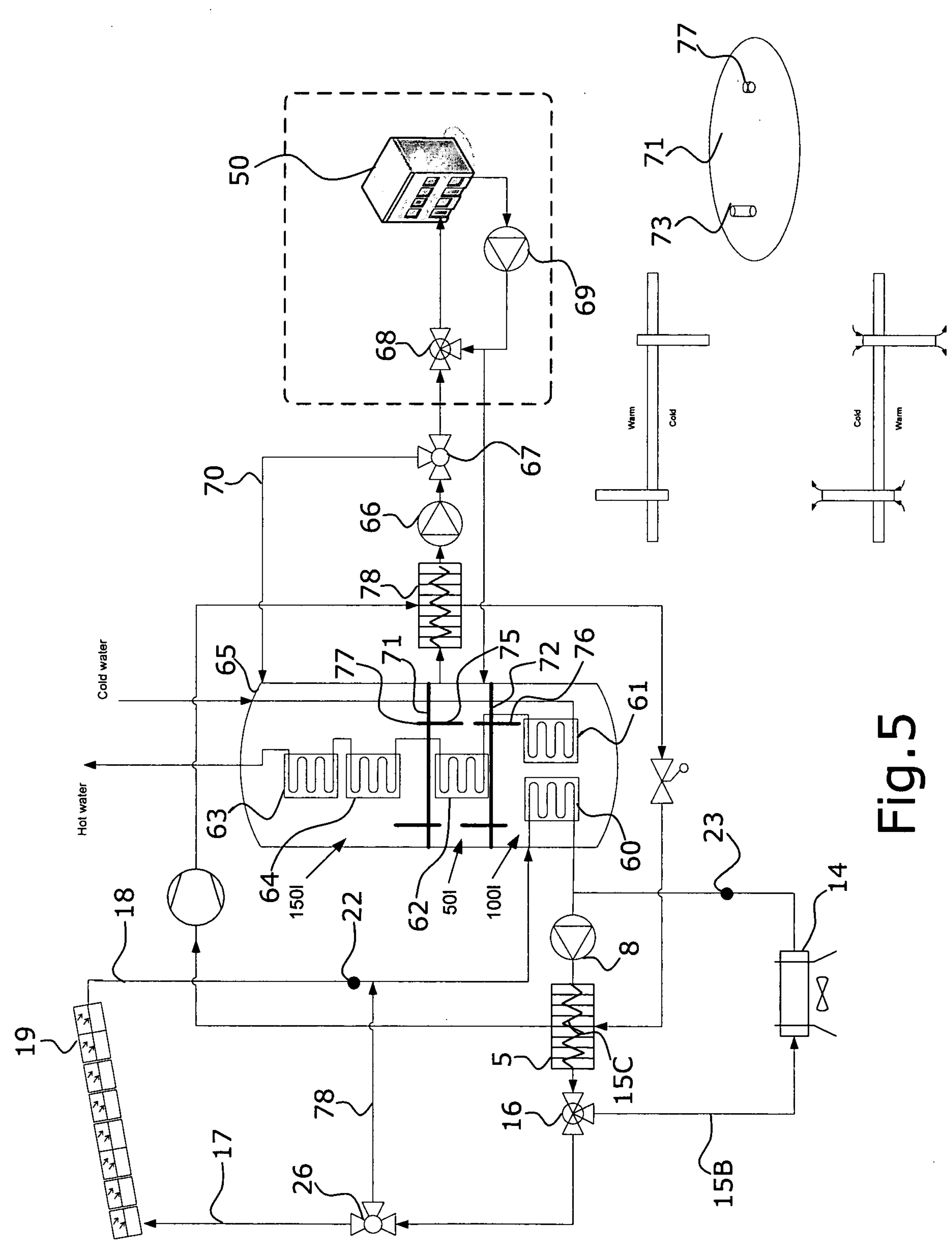
50
69
68
67
66
70
78
65
77
71
75
72
76
61
Cold water
Hot water
63
64
62
60
150l
50l
100l
18
22
23
14
8
19
5
15C
16
15B
78
17
26
77
71
73
Warm
Cold
Cold
Warm

Fig.5

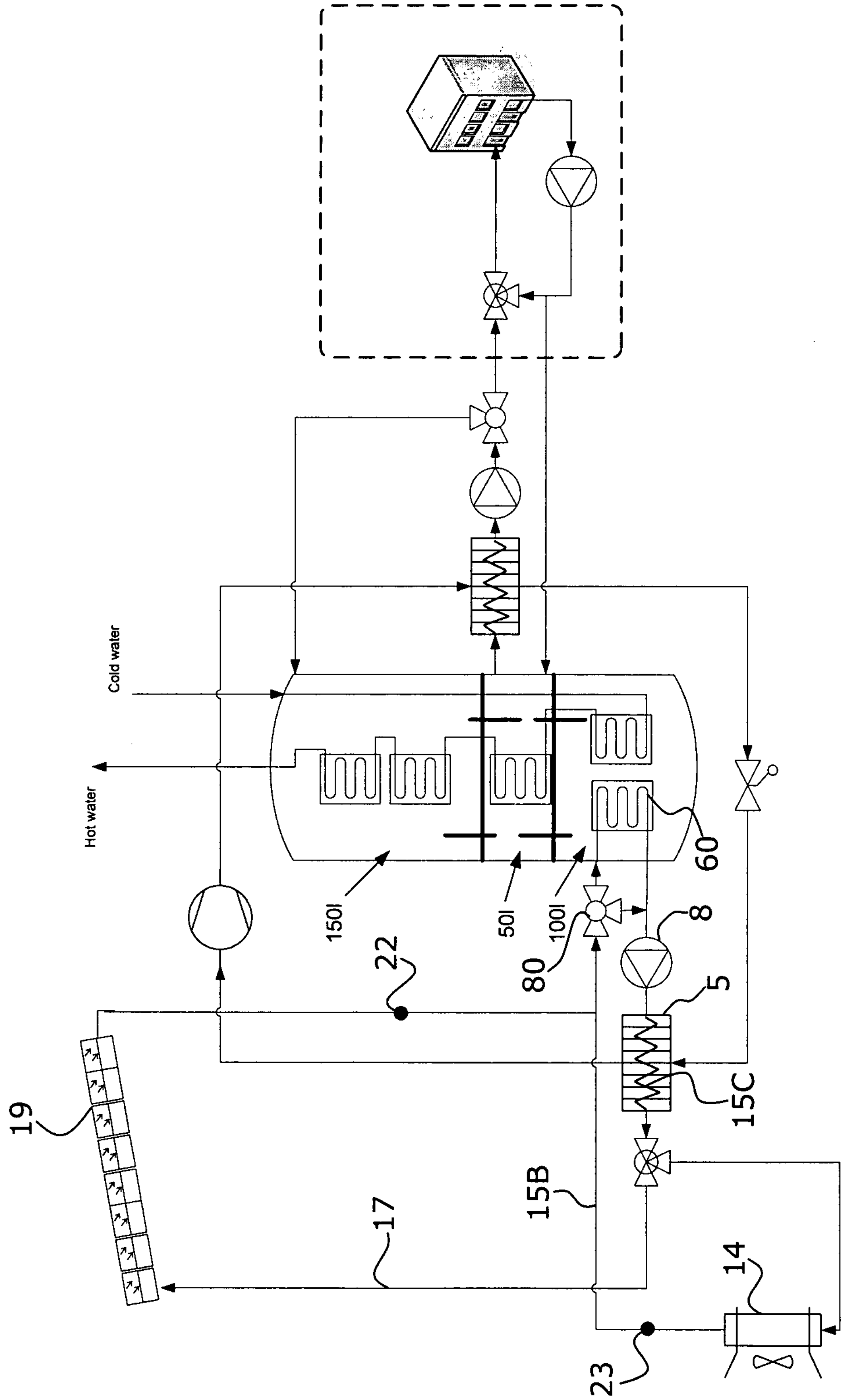
Cold water
Hot water
150l
50l
100l
60
8
80
22
5
15C
19
17
15B
14
23

Fig.6

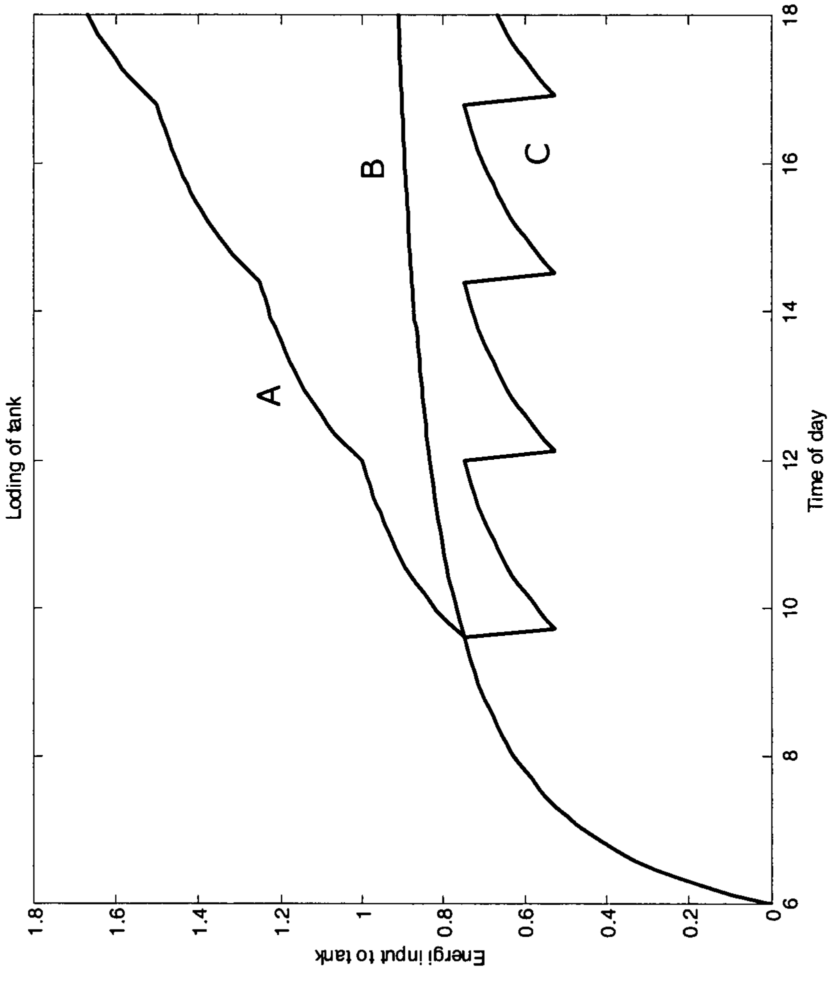
Loding of tank
Energi input to tank
Time of day
A
B
C
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
6
8
10
12
14
16
18

Fig.7

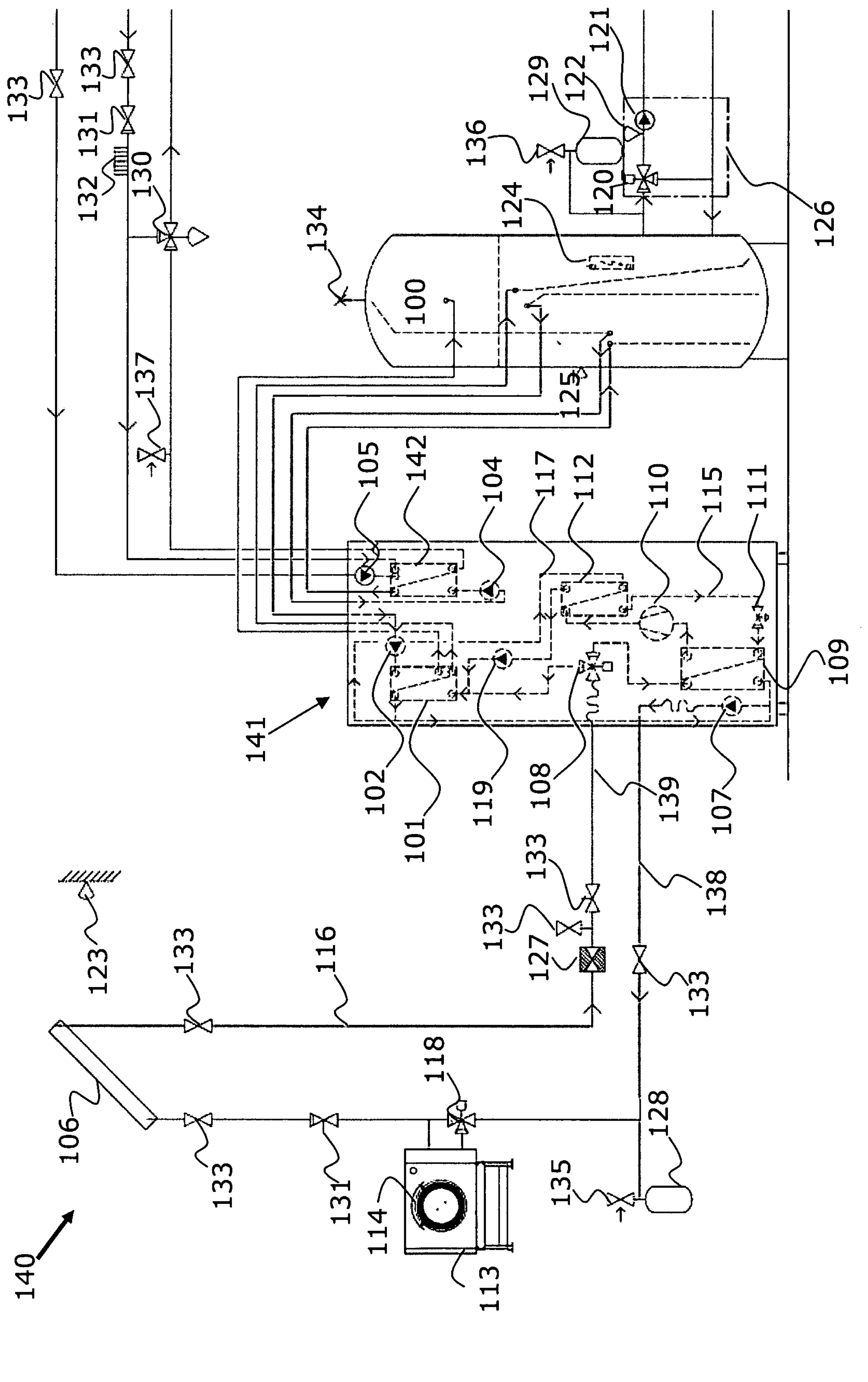
140
141
100
101
102
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
142

Fig.8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2008/000280

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: F24D, F24J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2505990 A1 (CALORIES GEOTHERMIQUES ET SOLARIES (CALGEOSOL)), 19 November 1982 (19.11.1982), page 1, line 1 - line 35; page 3, line 4 - line 20; page 3, line 36 - line 40, figure 1 --	1-4,6,7
X	SE 518788 C2 (STT SVENSK TORK OCH KYLTEKNIK AB), 19 November 2002 (19.11.2002), figure 1, abstract --	1-4,6,7
A	SE 0500674 L (NIBE INDUSTRIER AB), 31 October 2006 (31.10.2006) --	1-7

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 June 2008	03 -07- 2008

Name and mailing address of the ISA/	Authorized officer
Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Anna Salomonsson / JA A

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 61099059 A, MATSUSHITA ELECTRIC IND CO LTD., 1986-05-17: (abstract) Retrieved from PAJ database; Original document: Fig. 1	1-7
A	DE 3330479 A1 (LINDINGER, KURT), 7 March 1985 (07.03.1985), figure 1, abstract	1-7
A	WO 03042600 A1 (FÖRSTA NÄRVÄRMEVERKET AB), 22 May 2003 (22.05.2003), figure 1, abstract	1-7
A	US 4187687 A (SAVAGE), 12 February 1980 (12.02.1980), figures 1,2, abstract	1-7
A	EP 1248055 A2 (VAILLANT GMBH), 9 October 2002 (09.10.2002), figure 1, abstract	1-7
A	US 4363218 A (NUSSBAUM), 14 December 1982 (14.12.1982), figure 1, abstract	1-7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2008/000280

International patent classification (IPC)

F24D 11/02 (2006.01)
F24D 17/02 (2006.01)
F24J 2/04 (2006.01)

Download your patent documents at www.prv.se
The cited patent documents can be downloaded at www.prv.se by following the links:

- In English/Searches and advisory services/Cited documents (service in English) or
- e-tjänster/anförda dokument(service in Swedish).

Use the application number as username.
The password is **FCIFOGNHHK**.

Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

FR	2505990	A1	19/11/1982	NONE			
SE	518788	C2	19/11/2002	SE	9703457	A,L	26/03/1999
SE	0500674	L	31/10/2006	NONE			
DE	3330479	A1	07/03/1985	NONE			
WO	03042600	A1	22/05/2003	AT	335172	T	15/08/2006
				CA	2461458	A	22/05/2003
				CN	1561442	A	05/01/2005
				DE	60213637	D	00/00/0000
				EP	1438536	A,B	21/07/2004
				JP	2005509828	T	14/04/2005
				RU	2004113449	A	27/10/2005
				SE	0103257	A,L	02/04/2003
				US	20050155753	A	21/07/2005
US	4187687	A	12/02/1980	NONE			
EP	1248055	A2	09/10/2002	AT	413302	B	15/01/2006
				AT	7572001	A	15/06/2005
				DE	10214216	A	31/10/2002
US	4363218	A	14/12/1982	NONE			