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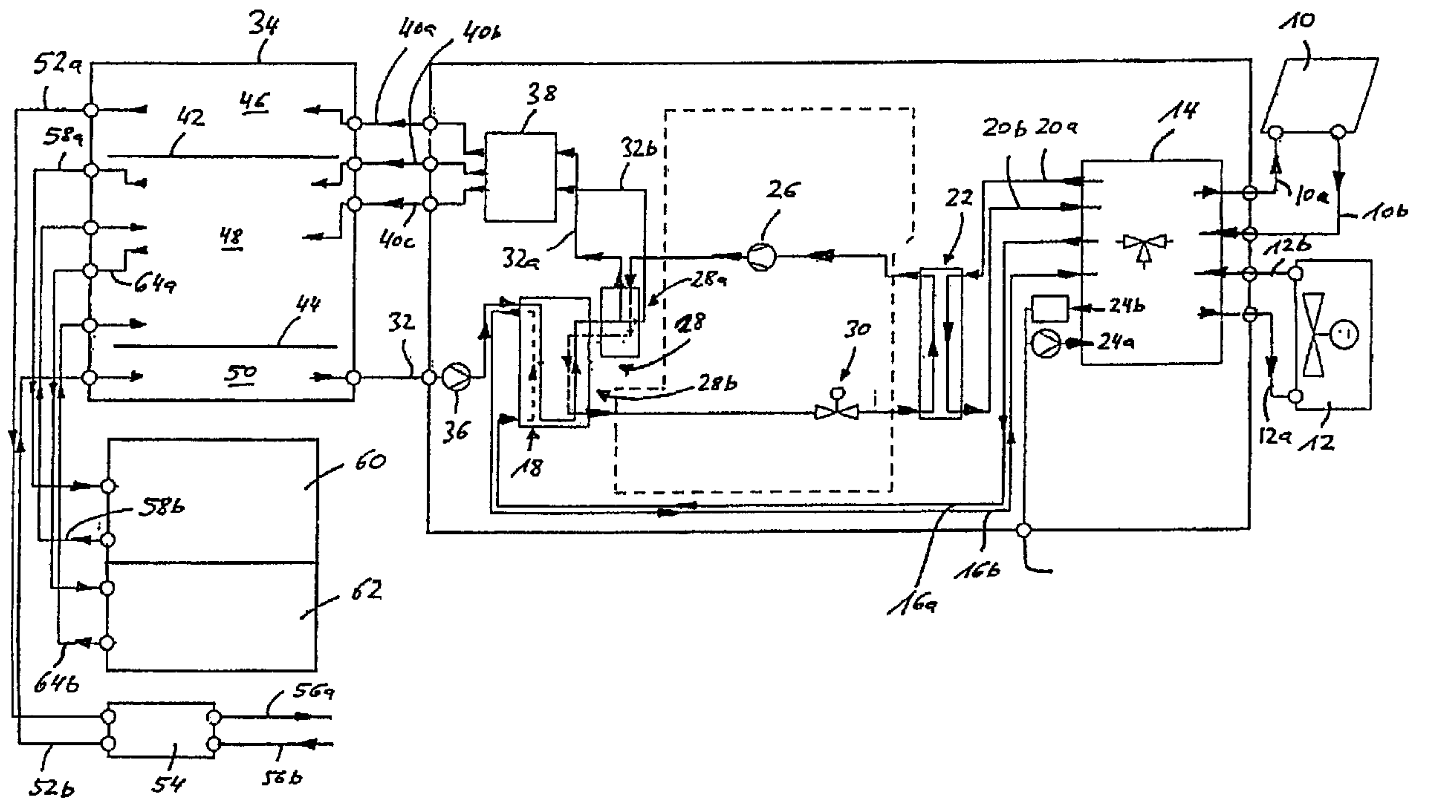
(54) Title: HOT WATER AND HEATING SYSTEM OPERATING ON THE BASIS OF RENEWABLE ENERGY CARRIERS



(57) Abrégé/Abstract:
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Hot water and heating system operating on the basis of renewable energy carriers

Abstract

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Description

The invention relates to a hot water and heating system, which operates on the basis of renewable energy carriers. For economic and political reasons, the importance of renewable energies is becoming ever greater. Obtaining energy from the sun, air or geothermal heat is known in various embodiments. This also applies to combinations of the systems with one another.

In the field of housing construction, but also in the case of offices or commercial buildings, it is particularly important to produce hot water for heating circuits and/or for heating fresh water.

The continuous provision of energy poses a substantial problem in this context. In summer, solar energy is available virtually limitlessly; but in summer the minimum requirement also exists for hot water for heating purposes and/or for heating fresh water.

In transitional periods such as autumn, and in winter, this requirement increases. When the sky is overcast and outside temperatures are relatively low, scarcely any energy contributions of note can be provided via solar collectors, for example.

It is intended with the invention to provide a hot water and heating system that permits an all-year-round supply to residential, office and commercial buildings independently of the weather as far as possible.

To achieve this object, the invention starts out from the following considerations:

The system can be subdivided into various system circuits. A so-called brine circuit takes care, for example, of the heating of a carrier medium such as glycol by a solar collector. If sufficient primary energy (sun) is available, the brine can be heated to temperatures of 60°, 100° or more degrees Celsius and transferred directly to water via a heat exchanger.

Alternatively, the brine circuit can be routed via the evaporator part of a heat pump, where the brine can be cooled down for example by 5°-10°C. A refrigerant, which circulates in the heat pump, is used furthermore to heat water, which can be stored in an insulated vessel.

The brine circuit, refrigerant circuit and water circuit are thus linked according to the invention.

The system comprises so-called primary energy heat exchangers (PHEs). These include said solar collectors, air heat exchangers or geothermal heat probes in any number and combination. Using these PHEs, primary energy such as solar energy is transferred to a heat carrier medium, termed brine below (for example glycol).

Furthermore, the system comprises a heat pump, which consists at least of an evaporator part, a compressor, a condenser part and an expansion device, wherein the heat pump has a refrigerant, such as CO_2 or ammonia, flowing through it.

The evaporator part of the heat pump can be formed by a heat exchanger. This is described as a secondary energy heat exchanger (SHE), because in the SHE the heat is transferred from the brine already heated in the PHE to the refrigerant or vice-versa.

An SHE can also be a heat exchanger that facilitates a heat transfer from the brine to water.

The condenser part of the heat pump forms a tertiary energy heat exchanger (THE) in this terminology, as in a third stage heat is transferred from the refrigerant to water.

The system also includes a so-called buffer tank, which is used for layered storage of water for at least one closed water circuit. Since hot water is lighter than cold water, a temperature gradient from top to bottom results in the buffer tank. Due to intermediate floors, so-called layer or layers plates, different sections (temperature zones) can be delimited from one another, wherein fluidic connections between the sections are permitted.

The system is connectable to at least one high-temperature heating circuit (in particular for radiators). To this end, water with an input temperature of 50°-90°C, for example, can be taken from the buffer tank. A heating circuit for low temperatures can likewise be connected, for example for floor heating systems, which operate at input flow temperatures of 20°-60°C, for example.

The hot water of the buffer tank can likewise be used for heating fresh water, for example via an interconnected heat exchanger. The buffer tank has corresponding supply and removal lines for the circulation water for this purpose.

The water supplied to the buffer tank can be routed into the appropriate temperature zone according to its temperature.

At least one section (one temperature zone) of the buffer tank can have a supplementary heating system, in order if necessary to be able to heat water in the buffer tank independently of the PHEs. The supplementary heating can be realized for example by way of a conventional heating system using fossil fuels. An electric supplementary heating system is likewise possible.

All types of heat exchangers, especially plate heat exchangers, are suitable as SHEs or THEs.

The individual system components, in particular inside the functional system circuits (brine circuit, refrigerant circuit, water circuit), can be connected via suitable multiway valves, which can also be mixing valves, individually or in groups, if applicable also all at the same time.

Accordingly the invention relates in its most general embodiment to a hot water and heating system, which operates on the basis of renewable energy carriers and comprises the following features:

- at least one primary energy heat exchanger from the group:

solar heat exchanger, air heat exchanger, geothermal heat exchanger,

- each primary energy heat exchanger has at least one supply line used to transport a cooled brine and at least one return line used to transport the heated brine,
- the return lines of the primary energy heat exchangers are directly or indirectly connectable fluidically to following heat exchangers:
- an evaporator of a heat pump, which evaporator is formed as a secondary energy heat exchanger, for transferring heat from the brine to a refrigerant,
- a condenser of the heat pump, which condenser is formed as a tertiary energy heat exchanger, for transferring heat from the refrigerant to water,
- an autarkic secondary energy heat exchanger for transferring heat from the brine to water, wherein
- the water flowing through at least one secondary or tertiary energy heat exchanger is transportable from a buffer tank into the respective heat exchanger and from there directly or indirectly back into the buffer tank,
- from the buffer tank water-conducting lines run to
- at least one heating circuit and/or to
- at least one heat exchanger for transfer to a fresh water circuit.

The term "autarkic secondary energy heat exchanger" describes a heat exchanger that is not part of the heat pump and thus not part of the refrigerant circuit.

The design of all heat exchangers is optional as far as possible according to the invention. Thus the heat exchangers can operate in co-current flow or in counter current flow. The heat exchangers can be tube heat exchangers, plate heat exchangers, spiral heat exchangers and/or rotary heat exchangers, for example.

The buffer tank is used to store the heated water, but also to return cooled water, for example from the heating circuit. Different temperature zones are formed in the buffer tank. The inflow of cold water will accordingly take place at the bottom and the extraction of hot water for radiators at the top in the buffer tank vessel.

To be able to adjust/control more easily the switching states and process variants described below, an embodiment of the invention provides for all return lines of the primary energy heat exchangers to be routed via a multiway valve. It is then possible to set via this valve, for example, whether the brine flow coming from the air heat exchanger is routed exclusively to the evaporator of the heat pump or whether this brine flow is conducted via the solar collector beforehand, for example.

In the latter case, the return line of a primary energy heat exchanger is connected fluidically to a supply line of another primary heat exchanger.

This connection can take place in said multiway valve.

For charging the system in particular, for example for filling the brine circuit with glycol, the invention provides for all primary energy heat exchangers and secondary heat exchangers located in the system and through which the brine can flow, including supply and return lines, to be connected simultaneously fluidically, for example via said multiway valve.

Similarly, all secondary energy heat exchangers and tertiary energy heat exchangers located in the system and through which the refrigerant can flow, including related supply and return lines, can be connected together fluidically.

Even the water circuit, thus all secondary energy heat exchangers and tertiary energy heat exchangers located in the system and through which water can flow, including related supply and return lines, can be connected fluidically in this way. This can be achieved via a further, common mixing valve, for example.

From this mixing valve a plurality of water-conducting lines can go off to the buffer tank and discharge into different sections of the buffer tank.

The buffer tank is part of a closed water circuit, from which at least one water line can run to at least one high-temperature heating circuit (for example to heat radiators) and/or from a section lying below this at least one water line can run to at least one low-temperature heating circuit (for example to a floor heating system).

Since the temperature of the return water from the high-temperature heating circuit is greater than the return temperature of the water used to heat a floor heating system, the latter is returned to the buffer tank at a point which lies below the area into which the return line from the high-temperature heating circuit discharges.

However, for indirect heating of the water in the buffer tank it is also possible to deviate from this system in that the return line of the high-temperature heating circuit, with an assumed temperature of 35°C, is conducted into a cold-water area of the buffer tank at an assumed 20°C, in order to heat the water there.

Further features of the invention are the subject of the features of the subordinate claims as well as the other application documents.

The invention is explained in greater detail below with reference to various embodiments.

Here the figures show, in an extremely schematized representation -

Fig. 1: a flow chart of a hot water and heating system according to the invention

Figs. 2a)-f): various system states

The reference sign 10 characterizes a group of solar collectors, and the reference sign 12 a group of air heat exchangers. Glycol flows through both as a heat carrier medium, wherein supply and removal lines 10a, 10b for the solar collectors 10 and 12a, 12b for the air heat exchangers 12 are connected to a multiway valve 14.

From the multiway valve 14 a line 16a runs to a plate heat exchanger 18; the corresponding return line is identified as 16b. Furthermore, a line 20a runs from the multiway valve 14 to a plate heat exchanger 22. The corresponding return line 20b discharges into the valve 14.

Also connected to the multiway valve 14 are a pressure and a suction side 24a, 24b of a pump, in order to be able to pump the glycol flow through the lines 10a, 10b, 12a, 12b, 16a, 16b, 20a, 20b, which together form the glycol circuit (= brine circuit).

The plate heat exchanger 22 is part of a heat pump, the related compressor of which is designated 26, the two-stage condenser of which is designated 28 and the expansion valve of which is designated 30. The flow paths inside the heat pump are indicated by arrows.

The first stage 28a of the condenser 28 is formed by a plate heat exchanger, like the second stage 28b. Both have water flowing through them in a counter current flow, the water being pumped (pump 36) from a buffer tank 34 via a line 32. Inside the condenser part 28a, partial flows of the heated water can be led away, which is symbolized by the reference signs 32a, 32b, wherein these lines discharge into a mixing valve 38. In the mixing valve 38, the water flows entering via the lines 32a, 32b at differing temperature are fed directly or following mixing via outlet lines 40a, 40b, 40c, depending on temperature, into different zones of the buffer tank 34.

The volume of the buffer tank 34 is divided by intermediate floors 42, 44 into zones, which are connected fluidically (at the edge). Accordingly the water with the highest temperature, for example 60°-90°, is at the top, in chamber 46, below this (between 42 and 44) is a storage chamber for water of medium temperature of 30°-60° for example (chamber 48) and finally below the intermediate floor 44 is a cold water chamber 50.

From the chamber 46 a hot water line 52a runs to a spiral heat exchanger 54 working in counter current flow. The return line into the chamber 50 of the plate storage device 34 bears the figure 52b. The fresh water flows carried through in the heat exchanger 54 are identified by 56a, 56b.

From the upper part of the chamber 48 a line 58a runs to a first heating circuit 60, to which radiators (not shown) are connected. The return line has the reference sign 58b.

A second heating circuit 62 for a low-temperature floor heating system is coupled to a supply line 64a and a return line 64b. The supply line runs from the middle part of the chamber 48 in the buffer tank 34, the return line 46b discharges into the lower section of chamber 48.

Figure 2a shows a possible set-up of the system according to figure 1 in winter, when outside temperatures are low and there is no sunshine.

The flow path of the heat carrier medium (glycol) is indicated by arrows. At the inlets and outlets of the related system components, temperatures are indicated by way of example for the glycol. In this mode of operation, the solar collectors 10 remain unused, as does the autarkic heat exchanger 18. The glycol flow is routed with the aid of the pump 24 exclusively between air heat exchanger 12 and evaporator 22.

On the other side of the evaporator 22 the refrigerant evaporates; vapour is then routed through the compressor 26 and heated in the process. It then passes into the condenser 28, is cooled there still at high pressure and finally condensed before being routed through the expansion valve 30. In parallel, water is heated in the condenser 28 (the plate heat exchangers 28a, 28b) in counter current flow and routed via the lines 32a and/or 32b and 40a, b, c respectively into the buffer tank 34.

Figure 2b shows a possible system setting in winter when there is solar radiation. The terminology for figure 2a applies. The solar collector 10 takes the place of the air heat exchanger 12, which now remains unused.

In winter it can happen that the air heat exchanger 12 ices up. For this eventuality the system offers the option of the reverse operating mode. Water is conducted from the buffer tank 34 via the heat exchanger 18 in order to heat the brine (glycol), which is then routed through the air heat exchanger 12 and thaws this out. The multiway valve 14 is used once more to set the desired flow path (figure 2c).

Figure 2d shows the system management in summer at high temperatures and with direct solar radiation. The heat pump, which requires external energy, now remains unused, as does the air heat exchanger 12. The solar collectors 10 are connected directly to the autarkic heat exchanger 18, so that a direct heat transfer takes place from the brine (glycol) to the water. The connection of the collectors to the heat exchanger 18 is again controlled/adjusted via the multiway valve 14.

Figure 2e shows an alternative mode of operation in winter. Here the brine flow taken from the air heat exchanger 12 is conducted via the valve 14 into the solar collector 10, before the brine, by analogy with figure 2b, is routed via the valve 14 and then the evaporator 22 of the heat pump.

This circuit can be used similarly in summer to avoid overheating of the solar collector 10 if no further energy supply to the water storage device is required, for example. In this operating mode, the brine flow is cooled by means of the air heat exchanger 12.

The brine flow can also be circulated past the evaporator 22 directly from the solar collector 10 to the air heat exchanger 12 and back to this end. To do this, a separate pump is activated.

In figure 2f the entire glycol circuit is shown, wherein all supply and removal lines are connected to one another with the aid of the multiway valve 14. This connection state is used for example to fill the glycol circuit.

The features described in the application can be used singly or in different combinations, even excluding individual features, for the invention.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. Hot water and heating system operating on the basis of renewable energy carriers and including a brine circuit, a refrigerant circuit and a water circuit, with the following features:

1.1 several primary energy heat exchangers from the group: solar heat exchanger, air heat exchanger, geothermal heat exchanger for transfer of primary energy to the brine,

1.2 each primary energy heat exchanger has at least one supply line used to transport a cooled brine and at least one return line used to transport the heated brine,

1.3. an evaporator of a heat pump, which evaporator is formed as a secondary energy heat exchanger, for transferring heat from the brine to a refrigerant,

1.4 a condenser of the heat pump, which condenser is formed as a tertiary energy heat exchanger, for transferring heat from the refrigerant to water,

1.5 an autarkic secondary energy heat exchanger for transferring heat from the brine to water,

1.6 a buffer tank, wherein

1.7 all primary energy heat exchangers and secondary energy heat exchangers within the system transporting the brine, including corresponding supply and return lines are fluidically connectable, wherein the connection is realized by a multiway valve, comprising the further features:

1.8 the return lines of the primary energy heat exchangers are connectable, directly or indirectly, to the tertiary energy heat exchanger,

1.9 the water flowing through at least one autarkic secondary or tertiary energy heat exchanger is transportable from a buffer tank into the respective heat exchanger and from there directly or indirectly back into the buffer tank

1.10 from the buffer tank water-conducting lines run to

1.10.1 at least one heating circuit and/or to

1.10.2 at least one heat exchanger for transferring heat to a fresh water circuit.

2. Hot water and heating system according to claim 1, in which at least one heat exchanger is configured as a plate heat exchanger.

3. Hot water and heating system according to claim 1, the buffer tank of which is divided into different sections by floors running horizontally.

4. Hot water and heating system according to claim 1, in which different sections of the buffer tank form different temperature zones of the water in the buffer tank.

5. Hot water and heating system according to claim 1, in which all secondary energy heat exchangers and tertiary energy heat exchangers that are located in the system and through which the refrigerant can flow, including related supply and return lines, are connectable fluidically.

6. Hot water and heating system according to claim 1, in which all secondary energy heat exchangers and tertiary energy heat

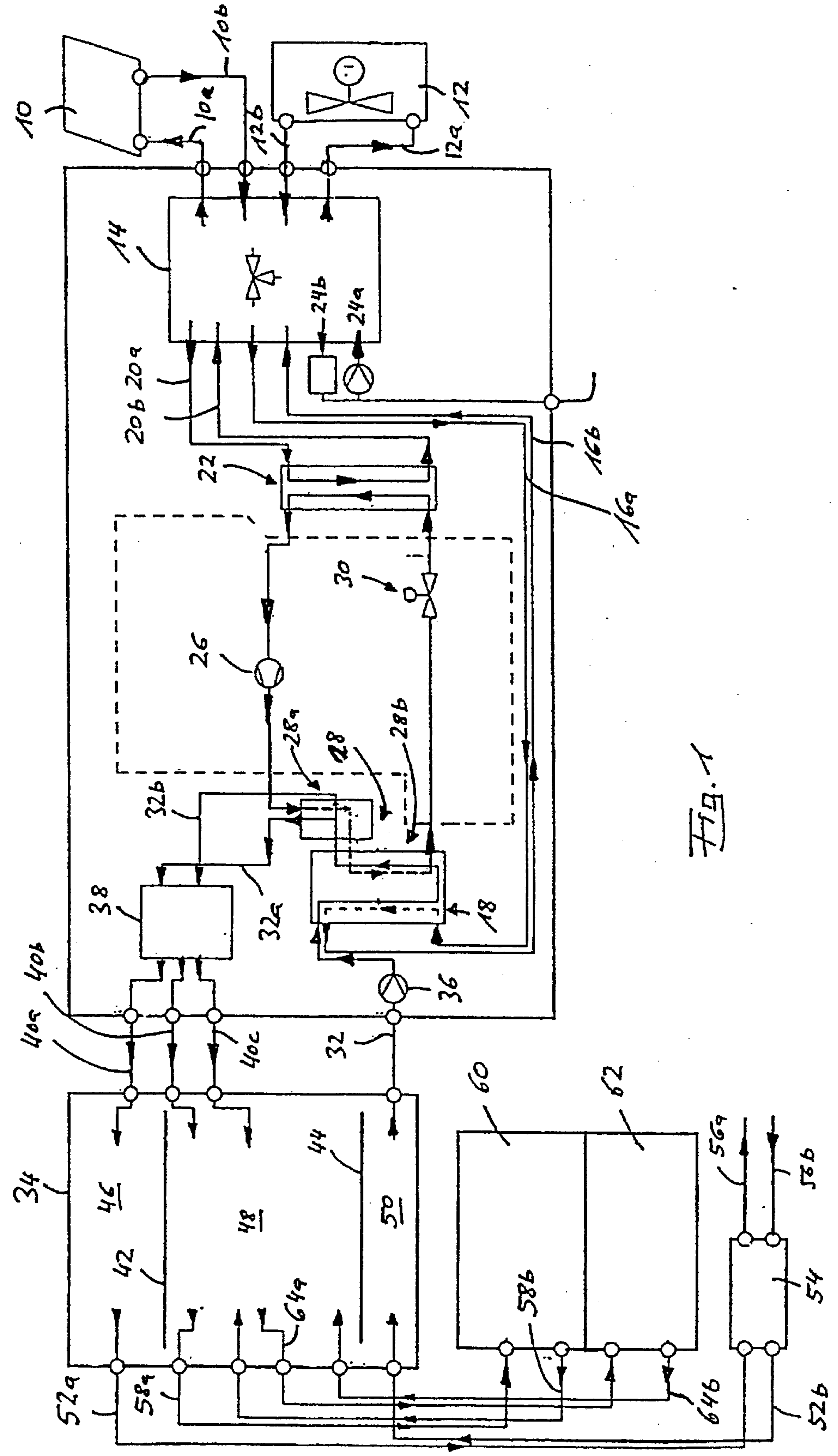
exchangers that are located in the system and through which water can flow, including related supply and return lines, are connectable fluidically.

7. Hot water and heating system according to claim 6, in which the connection of the secondary energy heat exchangers and tertiary energy heat exchangers through which water can flow, including related supply and return lines, is realized via a common mixing valve.

8. Hot water and heating system according to claim 3 and 7, in which a plurality of water-conducting lines extend from the mixing valve to the buffer tank, which lines discharge into different sections of the buffer tank.

9. Hot water and heating system according to claim 1, in which at least one water line runs from a section of the buffer tank to at least one high-temperature heating circuit and at least one water line runs from a section lying beneath to at least one low-temperature heating circuit.

10. Hot water and heating system according to claim 9, in which at least one return line of the high temperature heating circuit discharges into a section of the buffer tank and at least one return line of the low-temperature heating circuit discharges into a section of the buffer tank lying beneath.


10
10a
10b
12
12a
12b
14
24b
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16b
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26
28a
28
28b
32b
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40c
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64a
52a
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58b
64b
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62
56a
56b
54
52b

Fig. 1

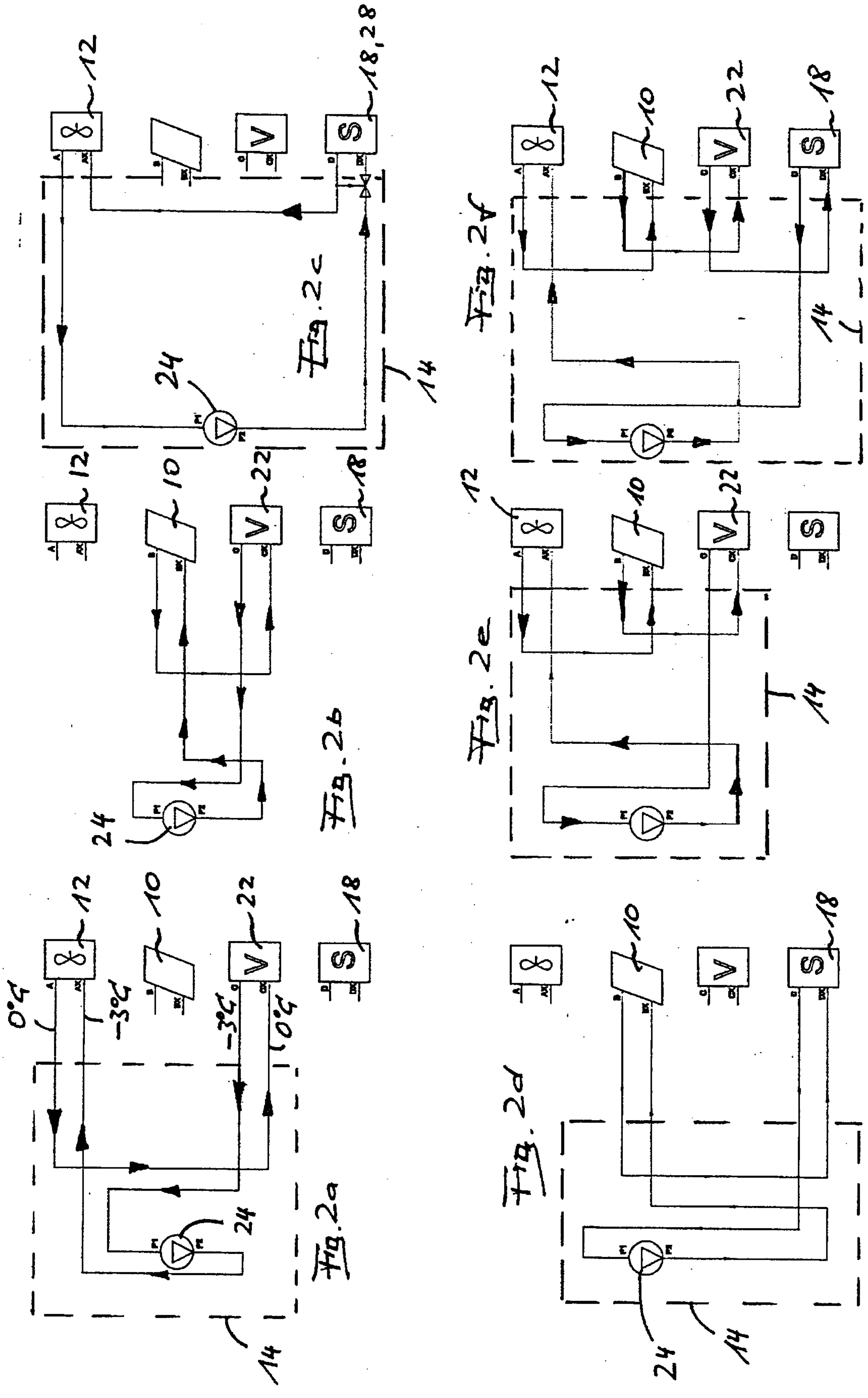

Fig. 2a
Fig. 2b
Fig. 2c
Fig. 2d
Fig. 2e
Fig. 2f
0°C
-3°C
-3°C
0°C
10
12
14
18
18,28
22
24
S
V


34
10
52a
40a
40b
46
38
14
42
58a
32b
20b
20a
26
22
10a
10b
48
12b
32a
28a
24b
40c
64a
28
24a
44
30
32
50
28b
36
18
12a
12
60
58b
16b
62
16a
64b
56a
52b
54
56b