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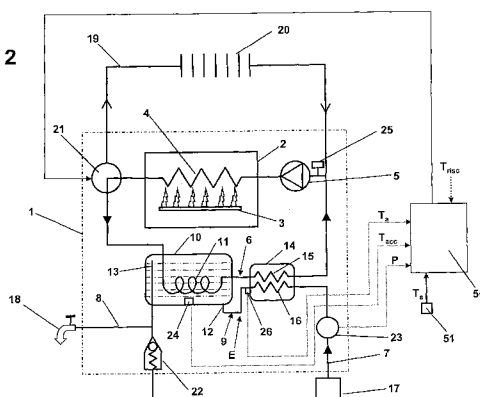
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(54) Title: PROCESS FOR THE PRODUCTION OF DOMESTIC HOT WATER AND WATER FOR AMBIENT HEATING, AND RELATIVE BOILER SYSTEM

FIG. 2



(57) Abstract: A process for the production of domestic hot water and ambient heating water, comprising the steps of: - drawing cold water from a domestic water tapping circuit (17, 7), - providing a hydraulic circuit combined and exchanging heat with a burner (3), said hydraulic circuit comprising a first branch (19, 20) for the ambient heating water and a second branch (11, 6, 15) for heating the domestic water, parallel to the first branch (19, 20), - storing in a tank (10) which exchanges heat (E) with the second branch (11, 6, 15) a quantity of domestic water drawn from the tapping circuit (17, 7), - heating the water in the hydraulic circuit by means of the burner (3) according to the demand for ambient heating water and/or domestic hot water, - diverting the water in the hydraulic circuit towards the first branch (19, 20) or towards the second branch (11, 6, 15) according to the demand for ambient heating water and/or domestic hot water. The step for heating the water in the hydraulic circuit and/or the diversion step are controlled according to values representative of the domestic water temperature (T_{acc} , T_s) and/or of the flow rate (P) of the domestic water drawn from the tapping circuit (17, 7).

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**PROCESS FOR THE PRODUCTION OF DOMESTIC HOT WATER AND
WATER FOR AMBIENT HEATING, AND RELATIVE BOILER SYSTEM**

DESCRIPTION

The present invention refers to techniques for the production of domestic hot water in boiler systems.

The invention has been developed paying particular attention to possible application of the same in storage type boilers, specifically in boilers comprising a storage tank
5 and a plate exchanger positioned downstream of the tank.

For the sake of simplicity of illustration, this description will refer almost constantly to said possible field of application, but the scope of the invention is general and therefore not limited to said specific application context.

By way of general preamble to the description of the known art, the problems
10 underlying the invention and the solution proposed here, it is useful to summarise some essential characteristics of the technical sector of the invention.

Boiler systems for domestic type installations, as known, are usually able to supply heated water to a hydraulic circuit for ambient heating and heated water to the sanitary fixtures, when required by the latter.

15 For said purpose, boilers with so-called instantaneous heating are mainly used, i.e. boilers which, via burners, heat the domestic water as and when it is required.

In said boilers, when the water is tapped, a pump is activated and a burner is switched on, with consequent heating of the water conveyed into the domestic water circuit via the pump.

20 However, said boilers can only supply a limited quantity of water at the required

temperature. Furthermore the water tapped is not hot right from the start, and the user has to run a certain amount of water before obtaining water at the desired temperature. Therefore storage boilers are also used, in which water is conveyed to a tank where it is kept warm, in order to provide a larger amount of water ready for use
5 when required.

By way of example, the European patent EP 0 778 450 describes a storage boiler, operating according to the process known as "Delta", which functions with a small storage tank (roughly with a volume of less than 10 litres).

Said boiler system, shown in Figure 1, comprises a heat generator 1, having a
10 combustion chamber 2, a gas burner 3 and a pipe 4 exposed to flames and/or gases generated by the burner. The water to be heated runs through the pipe 4 which constitutes with the burner 3 a main heat exchanger.

A circulation pump 5 is provided, connected to the pipe 4, while a duct 6 forms, together with the pipe 4 and the pump 5, a closed domestic water heating circuit. A
15 stretch of this duct 6 constitutes the primary circuit of an auxiliary heat exchanger E. A flow rate safety device 25 is located upstream of the pump 5.

The boiler system of Figure 1 furthermore comprises a tapping circuit, having a cold water inlet 7, a hot water outlet 8, equipped with a tap 18, and a section of duct 9 which constitutes the secondary circuit of the auxiliary heat exchanger E.

Said auxiliary heat exchanger E comprises a tank 10 to contain a small supply of
20 domestic water. The tank 10 is crossed by a coil 11 forming part of the above-mentioned section of duct 6. The tank 10 is connected at a low point 12 to the cold water inlet 7 and, at a higher point 13, to a branch of the hot water outlet 8. The auxiliary heat exchanger E furthermore comprises a direct plate heat exchanger 14
25 having two channels 15 and 16, part of the sections of duct 6 and 9 respectively, in reciprocal thermal contact and counterflow.

The tank 10 and the direct heat exchanger 14 are therefore mounted in series, the water circulated via the pump 5 passing through the coil 11 and the channel 15 in the domestic water heating circuit in the above order. Furthermore, in section 9 of the
30 tapping circuit, the water drawn off by the tap 18 passes through the channel 16 and

the volume of the tank 10 in the above order.

Figure 1 also shows a source of domestic cold water under pressure 17, connected to the cold water inlet 7, a section of ambient heating circuit 19, comprising radiators 20, which is fitted in parallel on the assembly consisting of the pipe 4 and pump 5, one of the connections of said section 19 to this assembly consisting of a three-way valve 21 with two positions, which allows said assembly to be selectively connected to the section of duct 6, i.e. to the domestic water heating branch, and to the section of circuit 19, i.e. to the ambient heating. A safety valve 22, connected to the hot water outlet 8, a flow meter 23 mounted on the cold water inlet 7 and a temperature probe 24 mounted in the tank 10 are also provided.

This type of boiler differs from the others due to its particular method of producing domestic hot water, which entails the simultaneous use of a plate exchanger 14 and a small storage unit, i.e. the tank 10 with low exchange power coil 11.

The use of both such components offers the following advantages:

- when domestic water is drawn off via the tap 18, the hot water in the tank 10 is immediately available for use: this eliminates the waiting times of an instantaneous system, i.e. a system equipped with plate exchanger only;
- the presence of the plate exchanger 14 allows the domestic hot water tapped to be immediately replenished (with water heated by said exchanger); in this way it is possible to use a small storage tank, resulting in reduced overall dimensions and costs of the boiler, and obtain a continuous production of water in the case of prolonged tapping.

The basic operating logic, implemented via an electronic board for control of the boiler, comprises two modes:

- Tapping: each time domestic hot water is drawn, detected by the flow meter 23, the burner 3 comes on and the hot water in the circuit 19-20 is diverted by the valve 21 towards the tank 10 and the plate exchanger 14. The domestic cold water, coming from the source 17, passes first through the exchanger 14 and then into the storage tank 10. In the meantime, as mentioned, a certain amount of domestic hot water is already immediately available for use

inside the storage tank 10. Control of the domestic hot water temperature T_a , the value of which is set by the user, is performed by means of a temperature probe 26, positioned at the outlet of the plate exchanger 14. The measuring signal of said probe 26 is sent to the above-mentioned control board, in which a control system is implemented, preferably of the P-I-D (Proportional-Integral-Derivative) type, which modulates the power of the burner 3 so that the temperature of the hot water T_a reaches the value set by the user;

– Restore: if no water is required, the temperature T_{acc} inside the storage tank 10 is monitored by the probe 24; if the temperature T_{acc} read by the probe 24 drops below the value set by the user (due to the inevitable heat losses towards the environment), the burner 3 comes on at minimum power; the “temperature restore” operation of the storage tank 10 terminates when the temperature T_{acc} of the water in the tank 10, read by the probe 24, is restored to the set value.

The system described here, which for the domestic water heating circuit employs an exchanger and a small storage tank in series, is known, as mentioned above, under the system name "Delta", used by the company Chaffoteaux et Maury.

Although said Delta system provides a ready supply of hot water, it is not optimised in terms of energy consumption.

The object of the present invention is to provide a solution to improve boiler management in terms of user interaction and control for the purposes of energy saving.

According to the present invention, said object is achieved via the method specified in the following claims.

In particular, the present invention can be proposed in terms of both process and system.

The invention will now be described, purely by way of non-limiting example, with reference to the accompanying drawings, in which:

– Figure 1 schematically represents a boiler system with storage tank of known type;

- Figure 2 schematically represents a boiler system with storage tank configured to implement the process according to the invention;
- Figure 3 represents a flow chart illustrating a first procedure for management of the boiler system included in the process according to the invention;
- Figure 4 represents a flow chart illustrating a second procedure for management of the boiler system included in the process according to the invention;
- Figure 5 represents a flow chart illustrating a third procedure for management of the boiler system included in the process according to the invention;
- Figure 6 schematically represents a variation of the boiler system with storage tank of Figure 2;
- Figure 7 schematically represents another boiler system with storage tank suitable for implementing the process according to the invention.

The present invention will be described referring essentially to a diagram of a storage boiler similar to that of Figure 1.

The process and system proposed are based essentially on the implementation of procedures based on the management, in the boiler system electronic control unit, of signals determined by the system measuring devices and by setting signals determined by devices of selection that can be performed by the user.

For said purpose, Figure 2 shows a base drawing of a boiler system analogous to the system of Figure 1 in which, therefore, the same references indicate components with equal or analogous function. In said figure 2, the reference number 50 highlights an electronic control unit for control of the boiler system; said unit is configured to implement the process according to the invention, which will be described in detail below. In particular, Figure 2 highlights the flow rate and temperature measurement signals provided by the flow meter 23 and by the probe 24 respectively to said control unit, and the selection means 51 to enter a temperature set by the user T_s , as

set point for the domestic water temperature control T , at the outlet 18. The outlet of the control unit 50 which controls the diverter valve 21 is also shown. Said devices exchange signals with the electronic control unit 50 in order to adapt the calorific power generated by the boiler to the flow rates and temperatures detected.

- 5 Said control unit 50 preferably comprises a microprocessor and implements PID type temperature controls.

According to a first innovative aspect of the solution described here, the control unit 50 is configured to implement an energy recovery process in the boiler system of Figure 2.

- 10 During operation of said boiler system in heating mode, the three-way valve 21 is positioned so as to convey the hot water to the circuit 19, and then to the radiators 20. In the standard operating mode, once the radiators 20 no longer require ambient heating water, the burner 3 is switched off, the three-way valve 21 remains set towards the ambient heating circuit 19 and the pump 5 remains on for a certain time
15 (a few minutes) in order to dissipate towards the radiators 20 the heat still stored in the combustion chamber of the burner 3.

- The energy recovery process proposed, which is schematised in the flow chart shown in Figure 3 and indicated overall by the reference number 100, begins at the end of the heating demand 103, i.e. when the burner is switched off after bringing the
20 heating water for the radiators 20 to a sufficient temperature to obtain the desired ambient temperature, set for example via the selection means 51. In the first step 105 a check is therefore performed to ascertain whether the three-way valve 21 is set towards the section 19 and therefore towards the heating circuit. Subsequently, step 110 represents acquisition of the desired ambient heating temperature T_{risc} in the
25 control unit 50. Said temperature T_{risc} is usually set and controlled by means of the thermostat system normally available for control of the ambient heating temperature, with which the control unit 50 therefore communicates. It should be noted that said thermostat system can be conveniently integrated with the control unit 50 in one single control board. Step 115 represents acquisition of the temperature T_{acc} of the
30 domestic water in the storage tank 10 by the probe 24. In a subsequent step 120 for

- comparison of said temperatures T_{risc} and T_{acc} , if the water inside the heating circuit 19 has a heating temperature T_{risc} greater or greater by a preset temperature difference n , for example n degrees °C (where n is not necessarily a whole number), than the temperature T_{acc} of the storage tank 10, in step 130 the three-way valve 21 is
- 5 immediately set towards the domestic water heating circuit 6. The heat still stored in the combustion chamber of the burner 3 is thus conveyed into the storage tank 10. This avoids multiple ignitions of the burner 3 to restore the temperature of the storage tank 10, as the heat already present inside the boiler is exploited without switching on the burner 3.
- 10 Due to one or more energy recovery operations, the temperature T_{acc} of the storage tank 10 may rise to unacceptable values. The control unit 50 is therefore furthermore configured to perform a subsequent step 140 in order to check that the temperature T_{acc} of the storage tank 10 does not exceed a temperature limit value T_{lim} . In said case, in step 150, the control unit 50 deactivates the energy recovery process 100, re-
- 15 setting the valve 21 towards the section 19 of the ambient heating circuit. Said energy recovery process 100 is suited not only to the system of Figure 2, but can also be applied to ordinary boilers with storage tank, including large-size boilers. A second innovative aspect of the solution described here concerns implementation, in the control unit 50, of a process for management of the tapping of small amounts
- 20 of domestic water from the boiler system of Figure 2. In general, with boiler systems of the type shown in Figure 2, following tapping of domestic hot water detected by the flow meter 23, the burner 3 always comes on, regardless of the amount of water tapped, detected by the flow meter 23. Therefore, if a small amount of domestic water is tapped, for a short period of time
- 25 and at a low flow rate, the burner 3 may come on unnecessarily, as the hot water contained in the storage tank 10 could be sufficient to meet the small tapping. A process is therefore scheduled, shown schematically in the flow chart of figure 4, indicated overall by the reference number 200. Said process for management of the tapping of small amounts of domestic water entails measurement, in step 205, of the
- 30 flow rate P by means of the flow meter 23. Said measurement step 205 is performed

continuously at periodic intervals. Test step 210 then checks whether the flow meter 23 detects tapping at a low flow rate and for a short period of time, i.e. whether the measurement performed by the flow meter 23 records flow rate and duration values – understood as duration of the signal generated by the flow meter – lower than pre-set reference values. By way of example, the tapping flow rate indicated by the flow meter 23 below which the function is active can be 4 litres/minute and lasts until the temperature T_{acc} of the water in the tank 10, read by the probe 24, drops to a value lower by a pre-set temperature difference (e.g. 2°C) than the temperature value set by the user T_s . If not, in step 220 the burner 3 is switched on. If so, instead of proceeding immediately with switch-on of the burner 3, measurement of the temperature T_{acc} of the tank 10 by the probe 24 and the temperature T , set by the user in the control unit 50 as the desired domestic hot water temperature, are acquired in respective acquisition steps 212 and 214; comparison step 230 checks whether the temperature T_{acc} of the tank 10 is lower, or lower by a given temperature difference m (where m is not necessarily a whole value), for example m degrees $^{\circ}\text{C}$, than the temperature T_s set by the user. If so, the system proceeds to step 220 for switch-on of the burner 3. If not, i.e. if the domestic water in the tank 10 is hot enough, the control returns to step 205 to check the flow rate.

This is due to the fact that, during tapping of domestic water, with burner 3 off, cold water enters the storage tank 10 and the temperature T_{acc} of the tank 10 can drop if the tapping is small but lasts for a long period.

Said procedure for management of small tapplings of domestic water therefore avoids unnecessary ignitions of the burner, neutralising consequences on the quantity of hot water available to the user.

The procedure for management of small tapplings of domestic water is suitable not only for the system of Figure 2, but can be applied to all systems that comprise a flow meter and accumulation tank.

According to a third innovative aspect of the solution described here, a stand-by operating mode is implemented in the control unit 50.

As already mentioned, the storage tank 10 in boiler systems of the type shown in

Figure 1 is kept at a temperature T_{acc} equal to a temperature T , set by the user, by means of a selection knob 51 or other similar selection means. This means that, for twenty-four hours a day, the storage tank 10 contains water at the temperature T , considered optimal for use.

- 5 This way of operating is wasteful in terms of energy, however, since during the night or when there is no-one in the house, it is not necessary to maintain the storage tank 10 at the temperature T , set by the user.

The control unit 50 is therefore equipped, in a known way, with a timer function which can be set by the user.

- 10 Said timer function allows the user to set the timebands in which he wishes to maintain the storage tank 10 at optimal temperature, i.e. the temperature T , set by the user, and the timebands, typically at night, when this is not necessary, permitting adoption of a "reduced" temperature T_{rid} for the domestic water in the storage tank 10.

- 15 Figure 5 shows schematically, via a flow chart, a stand-by mode operating procedure, indicated overall by reference number 300, in which the electronic control unit 50 is configured to monitor, via the flow rate measured by the flow meter 23, the water tapped by the user. Step 305 indicates control of the temperature T_{acc} of the tank 10 according to the timing procedure, i.e. at the temperature T_s or T_{rid} depending on the
20 time of day. In step 310 the flow rate P is acquired by the flow meter 23. Comparison step 315 checks whether said flow rate P is equal to zero. If so, a check 317 is performed to ascertain whether the flow rate P remains zero for a time t greater than or equal to a pre-set time t , for example twenty-four hours. The check 317 is schematised here very summarily, but in further detail it can naturally comprise the
25 start-up of a timer or a counter in the control unit 50 the first time a nil flow rate is detected in step 315, in order to count the period of time that elapses in the flow rate condition $P=0$, running a cycle via the steps 310, 315, 317.

- If no tappings are detected for the pre-set time, an operation 320 is performed to disable the timing function and, in step 325, the temperature of the storage tank 10 is
30 set so as to maintain the water contained in it at the reduced temperature T_{rid} ,

regardless of the hourly programming set by the user for the temperature T_s of the tank 10.

In this way, in the periods when the house is not inhabited, and therefore no domestic water is tapped, the storage tank 10 is set to stand-by mode, minimising the losses and therefore the ignitions of the burner 3.

According to the stand-by mode operating procedure, furthermore, from step 325 the control is re-set to step 310 to check the flow rate P , so that when the flow meter 23 measures a first tapping, after the timer function has been disabled, this can be considered an indication that the house is inhabited again; the control then returns to step 305 for control of the temperature T_{acc} according to the timing function, and the control unit 50 is then enabled to restore the timebands set by the user. According to a fourth aspect of the solution described here, an intelligent restore (or “smart charge”) procedure is implemented in the control unit 50.

As illustrated previously, during normal operation, the process for restoring the temperature of the storage tank 10 involves the burner 3 being switched on to rapidly increase the temperature T_{acc} of the tank and therefore rapidly reach the temperature T_s set by the user.

This means that the water circulating in the coil 11 of the storage tank 10, in the section of duct 6 and in the channel 15 of the exchanger 14, is at a fairly high temperature, determining a drop in the efficiency of the boiler system and a high number of switch-on/switch-off cycles of the burner 3, regardless of the temperature T_s set for the domestic water in the storage tank 10.

According to the intelligent restore process proposed, the control unit 50 is suitable for performing at least two modes for restoring the temperature in the storage tank 10, i.e.:

- i) a first quick mode, characterised by high temperatures in the hydraulic circuit 11, 6, 15, when rapid restoring of the temperature is the main concern;
- ii) a second optimised mode, with temperatures inside the hydraulic circuit 11, 6, 15 depending on the temperature T_s set for the storage tank 10, when efficiency is the main concern.

Said modes can be selected by the user, for example via appropriate selector means available in the control unit 50, according to whether he wishes to rapidly restore the temperature of the storage water or whether he wishes to operate the boiler system efficiently and save on consumption. By way of example only, the temperature in the primary hydraulic circuit can be determined by a formula of type $(T_s + 15) + k * (T_s - T_{acc})$, where k represents a simple constant of proportionality.

Said intelligent restore process is suitable not only for the system of Figure 1 or 2, but can be applied to all boiler systems with storage, including large-size systems.

Figure 6 shows a base drawing of a boiler system which is a variation on the system of Figure 2, in which equal references indicate components with equal or analogous function.

Said boiler system is characterised by the adoption of a mixer valve 30. Said valve 30 is a three-way valve, the outlet of which is connected to the hot water outlet 8; an inlet of the valve 30 is connected to the high point 13 of the tank 10, while the other inlet is connected to a coupling 31, which is connected to the cold water inlet 7.

The mixer valve 30, which can be of any known type, is provided to maintain the water inside the tank 10 at a temperature higher than that required by the user at the tap 18. In practice this permits "multiplication" of the storage capacity since, during tapping, the very hot water present in the tank 10 can be mixed by the valve 30 with cold water coming from the source of cold water 17. For a more immediate understanding of the concept, reference should be made to the following example:

temperature T_{acc} of the water in the tank 10 = 70°C;
 temperature T_a required by the user at the tap 18 = 40°C;
 temperature of the inlet water from the source 17 = 15°C.

In these conditions, with water tapped at a flow rate of 10 l/minute, 4.5 l/minute are drawn from the tank 10 and 5.5 l/minute are drawn from the source 17. In this way the contents of the storage tank can be exploited to supply an increased amount of hot water, at the required temperature, to the tap 18.

In theory, however, an approach of this type has the effect of increasing the storage

heat losses towards the environment (due to the high storage temperature of the water) and increasing energy consumption. In order to remedy said drawback, according to a *per se* inventive solution, an auto-learning mode is proposed, which allows the boiler system to be controlled in an auto-adaptive manner.

- 5 With reference to the diagram of Figure 6, ΔT is considered a temperature difference between the temperature T_{acc} of the tank 10 and the temperature T_a of the domestic water required by the user at the tap 18, said difference ΔT - in the above example - being $(70-40) = 30^\circ\text{C}$.

According to the auto-learning control process, the value of the difference ΔT , which
10 permits "multiplication" of the water storage capacity, is not fixed *a priori* but is adapted (or modified) according to the consumption of water by the user.

The consumption (for example daily) of domestic hot water by the user can be estimated, for example, on the basis of the information provided by the flow meter 23 (flow rate) and the probe 24 (tapping temperature).

- 15 This datum can be compared with the standard daily consumption values, established by law, and different "classes" of consumption of domestic water can be created.

According to the class of a certain utility, the parameter that regulates the temperature difference ΔT of the water between tank 10 and tapping point 18 can be modified: for example, the more hot water consumed by the user, the more the value
20 of the difference ΔT can be increased, and vice versa. In other words, standard daily consumption is organised into "classes" of consumption of domestic water and the temperature difference ΔT is modified according to the consumption class into which said estimated consumption falls, the consumption class of the user being learnt via the information on the flow rate and tapping temperature.

- 25 Adaptation of the value of ΔT can be performed directly by the boiler control system, programmed for the purpose, which will be provided with non-volatile memory means which store, in a *per se* known manner, the information relating to the above-mentioned various domestic water consumption classes, which express different tapping profiles corresponding to the typical requirements of more or less numerous
30 groups of persons.

The control and auto-learning process described are also applicable outside the Delta system, i.e. in any system that comprises a storage tank, a flow meter and a mixer valve at the outlet.

- 5 As previously mentioned, some of the processes described above can also be applied to boilers with storage tank different from those using the Delta system. For said purpose, Figure 7 shows schematically a boiler system with storage tank suitable for implementing some of the above-mentioned processes. In this figure the same reference numbers are used as in the preceding figures to indicate elements
10 technically equivalent to those described previously, with the addition of the letter "a".

Unlike Figures 1, 2 and 6, the boiler according to the diagram of Figure 7 does not have a direct plate exchanger 14 and temperature probe 26, typical of the Delta system, and there is no flow meter 23, the latter not being strictly necessary, since the
15 boiler normally operates in domestic water mode only when the probe 24a relative to the storage tank 10a detects a value below the one required by the user.

Given the absence of the flow meter 23, the boiler of Figure 7 is not suitable for implementation of the small tapping control procedure and the stand-by mode operating procedure, but is suitable for implementing the other procedures described,
20 i.e. the energy recovery procedure, the smart charge procedure and the auto-learning mode.

With regard to the auto-learning control procedure, since there is no flow meter 23 in the boiler of figure 7, an alternative rationale is implemented for definition of the domestic water consumption class, based on recording of the gas consumption of the
25 boiler in domestic water mode, said consumption being indirectly measurable via modulation of the thermal power delivered and the delivery time. This type of measurement is possible since the boiler modulates (with PWM logic) its power according to known curves, between the maximum and minimum values, which are nominal data of the boiler.

- 30 The system and the process described above advantageously permit a more efficient

rational management of the boiler system, allowing considerable savings in consumption.

- Naturally, without prejudice to the principle of the invention, the production details and embodiments can be extensively varied with respect to what has been described
- 5 and illustrated, without departing from the context of the invention. Although the procedure and system have been described with reference to a Delta type storage boiler, said procedures and system can be applied to all boiler systems with the sensors and/or selection devices necessary for performance of the procedure described above.

CLAIMS

1. Process for the production of domestic hot water and ambient heating water, which comprises the steps of:

- drawing cold water from a domestic water tapping circuit (17, 7),
- 5 – providing a hydraulic circuit which is combined and exchanges heat with a burner (3), said hydraulic circuit comprising a first branch (19, 20) for the ambient heating water and a second branch (11, 6, 15) for heating the domestic water parallel to the first branch (19, 20),
- storing in a tank (10), which exchanges heat (E) with the second branch
- 10 (11, 6, 15), a quantity of domestic water drawn from the tapping circuit (17, 7),
- heating (4; 220) the water in said hydraulic circuit by means of said burner (3) according to the demand for ambient heating water and/or domestic hot water,
- diverting (21) the water of said circuit towards said first branch (19, 20)
- 15 or towards said second branch (11, 6, 15) according to said demand for ambient heating water and/or domestic hot water,
- the flow of domestic water drawn from the tapping circuit (16) and the flow of water circulating in said second branch (11, 6, 15) exchanging heat in counterflow in a direct exchanger (14) positioned upstream of said tank (10),
- 20 with reference to the flow of the domestic water,
- characterised in that
- it comprises the operation of controlling (50) the heating step (4; 220) for heating the water in said hydraulic circuit and/or the diversion step (21; 130) according to values representative of the temperature of the domestic water
- 25 (T_{acc} , T_s) and/or of the flow rate (P) of domestic water drawn from the tapping circuit (17, 7).

2. Process according to claim 1, characterised in that it comprises the steps of:

30

- measuring (24) the temperature (T_{acc}) of the domestic water stored in said tank (10) and the temperature (T_{risc}) of the water in said first branch (19, 20),
 - comparing (120) said temperature (T_{acc}) of the domestic water stored in said tank (10) and said temperature (T_{risc}) of the water in said first branch (19, 20),
- 5 said control operation (50) comprising a process for recovery of thermal energy (100), which includes the operation of diverting (130) the water of said circuit, undergoing heating, from said first branch (19, 20) to said second branch (11, 6, 15) towards said tank (10) if said temperature (T_{risc}) of the water in said first
- 10 branch (19, 20) is greater than said temperature (T_{acc}) of the domestic water stored in said tank (10).
3. Process according to claim 2,
- characterised in that
- said operation of diverting (130) the water undergoing heating from said first
- 15 branch (19, 20) to said second branch (11, 6, 15) towards said tank (10) is performed if said temperature (T_{risc}) of the water in said first branch (19, 20) is greater by a pre-set temperature difference (n) than said temperature (T_{acc}) of the domestic water stored in said tank (10).
4. Process according to claim 2 or 3,
- 20 characterised in that
- it furthermore comprises the operation of checking (140), after said diversion operation (130), whether said temperature (T_{acc}) of the domestic water stored in said tank (10) exceeds a temperature limit value (T_{lim}), if so de-activating said thermal energy recovery process (100) and diverting (21) the water of said
- 25 circuit towards said first branch (19, 20).
5. Process according to one or more of the preceding claims,
- characterised in that
- it comprises the operations of:
- measuring (205) the flow rate (P) of the water drawn from the tapping
- 30 circuit (17, 7),

- checking (210) whether the flow rate value (P) measured is lower than a pre-set flow rate value and whether the duration of the tapping is shorter than a pre-set duration time, and
 - if not, heating (220) the water in said hydraulic circuit (4),
 - 5 – if so,
 - measuring the temperature (T_{acc}) of the domestic water in the tank (10),
 - detecting the temperature (T_s) set by the user for the domestic water,
 - 10 – checking (230) whether the temperature (T_{acc}) of the domestic water in the tank (10) is lower than the temperature (T_s) set by the user and,
 - if so, performing said operation of heating (220) the water of said hydraulic circuit.
- 15 6. Process according to claim 5,
characterised in that
said operation of heating (220) the water of said hydraulic circuit (4) is performed if the temperature (T_{acc}) of the domestic water in the tank (10) is lower by a given temperature difference (m) than the temperature (T_s) set by the user.
- 20 7. Process according to one or more of the preceding claims,
characterised in that
it comprises the operations of:
- heating the domestic water stored in said tank (10) according to a timed procedure (305), which comprises timebands in which the water is heated to the temperature set by the user (T_s) and timebands in which the water is heated to a reduced temperature (T_{rid}),
 - 25 – measuring (310, 317) the flow rate (P) of the water drawn from the tapping circuit (17, 7),

30

- checking whether said flow rate (P) is equal to zero for a time (t) greater than or equal to a pre-set time (t_{lim}) and, if so,
- disabling (320) said timed procedure (305), maintaining (325) the temperature of the domestic water in the tank (10) at the reduced temperature (T_{rid}).

8. Process according to claim 7

characterised in that

it comprises the operation of restoring said timed procedure (305) if a flow rate (P) other than zero is measured after the disable operation (320).

9. Process according to one or more of the preceding claims, characterised in that

it comprises a procedure for restoring the temperature of the domestic water in the tank (10), said restore procedure providing for:

- a first rapid restore mode, characterised by high temperatures of the water in said second branch (11, 6, 15), when the main concern is to restore the temperature rapidly;
- a second optimised restore mode, with temperatures of the water inside said second branch (11, 6, 15) depending on the temperature (T_s) set by the user for the domestic water in the tank (10), when the main concern is energy efficiency;

wherein said first and second modes can be selected by the user.

10. Process according to one or more of the preceding claims,

characterised in that

it furthermore comprises an operation (30, 31) for mixing water drawn from the tapping circuit (17, 7) with water flowing out of said tank (10) upstream of an outlet (18) towards the user, said mixing operation (30, 31) entailing setting the temperature (T_{acc}) of the domestic water stored in said tank (10) to a temperature value higher by a temperature difference (ΔT) than the temperature of the domestic water (T_a) at the outlet (18) and regulating the flow rate of the water drawn from the tapping circuit (17, 7) and the flow rate of the water

drawn from said tank (10) according to said difference (ΔT) between the temperature (T_{acc}) of the domestic water stored in said tank (10) and the temperature of the domestic water (T_a) at the outlet (18), said process furthermore comprises learning the estimated consumption of the user, said temperature difference (ΔT) being variable according to said estimated consumption of the user.

11. Process according to claim 10,
characterised in that

said user consumption is learnt and estimated according to the flow rate measured (23) and the tapping temperature (24).

12. Process according to claim 10 or 11,
characterised in that

said estimated consumption is compared with standard daily consumption organised into "classes" of consumption of domestic water and said difference (ΔT) is modified according to the consumption class of said estimated consumption.

13. Boiler system for the production of domestic hot water and ambient heating water, comprising

- a tapping circuit (17, 7) for drawing domestic cold water to be heated,
- a hydraulic circuit combined and exchanging heat with a burner (3), said hydraulic circuit comprising a first branch (19, 20) for the ambient heating water and a second branch for heating the domestic water (11, 6, 15), the two branches being parallel,
- a tank for storing a quantity of domestic water (10), connected to the tapping circuit (17, 7) and exchanging heat with said second branch (11, 6, 15),
- means for diverting (21) the water of said circuit towards said first branch (19, 20) or towards said second branch (11, 6, 15),
- control means (50), for managing heating (220) of the water of said hydraulic circuit by means of said burner (3) and controlling said diversion means (21) according to the demand for ambient heating water and/or domestic hot water,

characterised in that

said control means (50) are configured to control heating (4; 220) of the water in said hydraulic circuit (4) and/or diversion (21; 130) of the water in said hydraulic circuit to said first or said second branch according to the process as claimed in one or more of the claims from 1 to 12.

14. System according to claim 13,
characterised in that

it comprises a flow meter (23) positioned in the tapping circuit (17, 7) to measure said flow rate (P).

15. System according to claim 13 or 14,
characterised in that

it comprises, combined and communicating with said control means (50), temperature measurement means (24) positioned to measure the temperature (T_{acc}) of the domestic water in the storage tank (10).

16. System according to one or more of the claims from 13 to 15,
characterised in that

it comprises, combined and communicating with said control means (50), means for measuring the temperature (T_{risc}) of the water of said first branch.

17. System according to one or more of the claims from 13 to 16,
characterised in that

it comprises, combined with said control means (50), means (51) for setting a temperature desired by the user (T_s) for the domestic water and/or for the ambient heating water.

18. System according to one or more of the claims from 13 to 17,
characterised in that

the tank (10) belongs to a heat exchanger (E) crossed by a section (11) of said second branch (11, 6, 15) together with a direct heat exchanger (14), particularly a plate exchanger, positioned upstream of said tank (10) with reference to the domestic water flow.

19. System according to claim 18,
characterised in that
said direct heat exchanger (14) is crossed by a duct (15) of said second branch
and by a duct (16) of the tapping circuit (7, 17), in reciprocal thermal contact
5 and counterflow.
20. System according to claim 13,
characterised in that
said control means (50) comprise selection means (51) to select said first rapid
temperature restore mode or said optimised temperature restore mode.
- 10 21. System according to claim 13 or one or more of the following claims,
characterised in that
said control means (50) comprise an electronic microprocessor control board.
22. System according to claim 21,
characterised in that
15 said board is configured to operate as a thermostat for the control of at least the
ambient temperature or the temperature (T_{risc}) of the water in said first branch
(19, 20).
23. System according to one or more of the claims from 13 to 21,
characterised in that
20 it comprises a mixer valve (30) having an outlet connected to the outlet of hot
water (8) towards the user, an inlet connected to an outlet (13) of the tank (10),
another inlet connected to a coupling (31) which connects it to the tapping
circuit (7, 17).
24. System according to claim 23,
25 characterised in that
said board is configured to vary the value of the temperature difference (ΔT)
between the domestic water stored in the tank (10) and the domestic water (T_a)
at the outlet (18), according to user consumption.
25. System according to claim 23,
30 characterised in that

said board is configured to store standard daily consumption rates organised into domestic water consumption "classes".

26. Process for the production of domestic hot water and ambient heating water, which comprises the steps of:

- 5 – drawing cold water from a domestic water tapping circuit (17, 7; 17a, 7a),
- providing a hydraulic circuit combined and exchanging heat with a burner (3; 3a), said hydraulic circuit comprising a first branch (19, 20; 19a, 20a) for the ambient heating water and a second branch (11, 6, 15; 11a, 6a) for heating the domestic water parallel to the first branch (19, 20; 19a, 20a),
- 10 – storing in a tank (10; 10a) which exchanges heat (E) with the second branch (11, 6, 15; 11a, 6a) a quantity of domestic water drawn from the tapping circuit (17, 7; 17a, 7a),
- heating (4, 220; 4a, 220) the water of said hydraulic circuit by means of said burner (3; 3a) according to the demand for ambient heating water and/or
- 15 domestic hot water,
- diverting (21; 21a) the water of said circuit towards said first branch (19, 20; 19a, 20a) or towards said second branch (11, 6, 15; 11a, 6a) according to said demand for ambient heating water and/or domestic hot water,
- characterised in that
- 20 it comprises the operation of controlling (50; 50a) the heating step (4, 220; 4a, 220) for heating the water of said hydraulic circuit and/or the diversion step (21, 130; 21a, 130) according to representative values of the domestic water temperature (T_{acc} , T_s) and/or of the flow rate (P) of the domestic water drawn from the tapping circuit (17a, 7a).

25 27. Process according to claim 26, characterised in that

it comprises the steps of:

- measuring (24; 24a) the temperature (T_{acc}) of the domestic water stored in said tank (10; 10a) and the temperature (T_{risc}) of the water in said first branch
- 30 (19, 20; 19a, 20a),

– comparing (120) said temperature (T_{acc}) of the domestic water stored in said tank (10; 10a) and said temperature (T_{risc}) of the water in said first branch (19, 20; 19a, 20a),
 said control operation (50; 50a) comprising a procedure for recovery of thermal energy (100), which includes the operation of diverting (130) the water of said circuit undergoing heating from said first branch (19, 20; 19a, 20a) to said second branch (11, 6, 15; 11a, 6a) towards said tank (10; 10a) if said temperature (T_{risc}) of the water present in said first branch (19, 20; 19a, 20a) is greater than said temperature (T_{acc}) of the domestic water stored in said tank (10; 10a).

28. Process according to claim 26 or 27,
 characterised in that

it comprises the operations of:

- measuring (205) the flow rate (P) of the water drawn from the tapping circuit (17, 7),
- checking (210) whether the flow rate value (P) measured is lower than a pre-set flow rate value and whether the duration of the tapping is shorter than a pre-set duration time, and
 - if not, heating (220) the water in said hydraulic circuit (4),
 - if so,
 - measuring the temperature (T_{acc}) of the domestic water in the tank (10),
 - detecting the temperature (T_s) set by the user for the domestic water,
 - checking (230) whether the temperature (T_{acc}) of the domestic water in the tank (10) is lower than the temperature (T_s) set by the user and,
 - if so, performing said operation of heating (220) the water in said hydraulic circuit.

29. Process according to one or more of the claims from 26 to 28,

characterised in that

it comprises the operations of:

- heating the domestic water stored in said tank (10) according to a timed procedure (305), which features timebands in which the water is heated to the temperature set by the user (T_s) and timebands in which the water is heated to reduced temperature (T_{rid}),
- measuring (310, 317) the flow rate (P) of the water drawn from the tapping circuit (17, 7),
- checking whether said flow rate (P) is equal to zero for a time (t) greater than or equal to a pre-set time (t_{lim}) and, if so,
- disabling (320) said timed procedure (305), maintaining (325) the temperature of the domestic water in the tank (10) at the reduced temperature (T_{rid}).

30. Process according to one or more of the claims from 26 to 29, characterised in that

it comprises a procedure for restoring the temperature of the domestic water in the tank (10; 10a), said procedure providing for:

- a first rapid temperature restore mode, characterised by high temperatures of the water in said second branch (11, 6, 15; 11a, 6a), when rapid restoration of the temperature is the main concern;
 - a second optimised temperature restore mode, with temperatures of the water inside said second branch (11, 6, 15; 11a, 6a) depending on the temperature (T_s) set by the user for the domestic water in the tank (10; 10a), when energy efficiency is the main concern;
- wherein said first and second modes can be selected by the user.

31. Process according to one or more of the claims from 26 to 30, characterised in that

it furthermore comprises a mixing operation (30, 31) for mixing water drawn from the tapping circuit (17, 7; 17a, 7a) with water coming out of said tank (10; 10a) upstream of an outlet (18; 18a) towards the user, said mixing operation

(30, 31; 30a, 31a) entailing setting the temperature (T_{acc}) of the domestic water stored in said tank (10; 10a) to a temperature value higher by a temperature difference (ΔT) than the temperature of the domestic water (T_a) at the outlet (18; 18a) and regulating the flow rate of the water drawn from the tapping circuit (17, 7; 17a, 7a) and the flow rate of the water drawn from said tank (10; 10a) according to said difference (ΔT) between the temperature (T_{acc}) of the domestic water stored in said tank (10; 10a) and the temperature of the domestic water (T_a) at the outlet (18; 18a); said process furthermore comprises an operation for learning the estimated consumption of the user, said temperature difference (ΔT) being variable according to said estimated consumption of the user.

32. Boiler system for the production of domestic hot water and ambient heating water, comprising

- a tapping circuit (17, 7; 17a, 7a) for drawing domestic cold water to be heated,
 - a hydraulic circuit combined and exchanging heat with a burner (3; 3a), said hydraulic circuit comprising a first branch (19, 20; 19a, 20a) for the ambient heating water and a second branch for heating the domestic water (11, 6, 15; 11a, 6a), the two branches being parallel,
 - a tank for accumulating a quantity of domestic water (10; 10a), connected to the tapping circuit (17, 7; 17a, 7a) and exchanging heat with said second branch (11, 6, 15; 11a, 6a),
 - means for diverting (21; 21a) the water of said circuit towards said first branch (19, 20; 19a, 20a) or towards said second branch (11, 6, 15; 11a, 6a),
 - control means (50; 50a), to manage heating (220) of the water of said hydraulic circuit by means of said burner (3; 3a) and to control said diversion means (21; 21a) according to the demand for ambient heating water and/or domestic hot water,
- characterised in that

said control means (50; 50a) are configured to control heating (4; 220; 4a, 220) of the water in said hydraulic circuit (4; 4a) and/or diversion (21, 130; 21a, 130) of the water in said hydraulic circuit to said first or said second branch according to the process as claimed in one or more of the claims from 26 to 31.

5 **33.** Process for the production of domestic hot water and ambient heating water, which comprises the steps of:

- drawing cold water from a domestic water tapping circuit (17, 7),
- providing a hydraulic circuit combined and exchanging heat with a burner (3), said hydraulic circuit comprising a first branch (19, 20) for the ambient heating water and a second branch (11, 6, 15) for heating the domestic water parallel to the first branch (19, 20),

10

- storing in a tank (10) which exchanges heat (E) with the second branch (11, 6, 15) a quantity of domestic water drawn from the tapping circuit (17, 7),

15

- heating (4; 220) the water of said hydraulic circuit by means of said burner (3) according to the demand for ambient heating water and/or domestic hot water,

- diverting (21) the water of said circuit towards said first branch (19, 20) or towards said second branch (11, 6, 15) according to said demand for ambient heating water and/or domestic hot water,

20

the flow of domestic water drawn from the tapping circuit (16) and the flow of water circulating in said second branch (11, 6, 15) exchanging heat in counterflow in a direct exchanger (14) positioned upstream of said tank (10), with reference to the flow of domestic water,

characterised in that

25

it comprises the operation of controlling (50) the heating step (4; 220) for heating the water in said hydraulic circuit and/or the diversion step (21; 130) according to values representative of the domestic water temperature (T_{acc} , T_s) and/or of the flow rate (P) of domestic water drawn from the tapping circuit (17, 7), said control operation (50) comprising one or more of the following

30

procedures:

a) a procedure for recovery of thermal energy (100) comprising:

- measuring (24) the temperature (T_{acc}) of the domestic water stored in said tank (10) and the temperature (T_{risc}) of the water in said first branch (19, 20),
- 5 – comparing (120) said temperature (T_{acc}) of the domestic water stored in said tank (10) and said temperature (T_{risc}) of the water in said first branch (19, 20),
- diverting (130) the water in said circuit undergoing heating from said first branch (19, 20) to said second branch (11, 6, 15) towards said tank (10), if said temperature (T_{risc}) of the water present in said first
10 branch (19, 20) is greater than said temperature of the domestic water stored in said tank (10);

b) a procedure for control of the tapping of small amounts of domestic water comprising:

- 15 – measuring (205) the flow rate (P) of the water drawn from the tapping circuit (17, 7),
- checking (210) whether the flow rate value (P) measured is lower than a pre-set flow rate value and whether the duration of the tapping is shorter than a pre-set time duration, and
- 20 – if not, heating (220) the water present in said hydraulic circuit (4),
- if so,
 - measuring the temperature (T_{acc}) of the domestic water in the tank (10),
 - 25 – detecting the temperature (T_s) set by the user for the domestic water,
 - checking (230) whether the temperature (T_{acc}) of the domestic water in the tank (10) is lower than the temperature (T_s) set by the user, and
 - 30 – if so, performing said heating operation (220) to

heat the water in said hydraulic circuit;

c) a stand-by mode operating procedure comprising:

- heating the domestic water stored in said tank (10) according to a timed procedure (305) featuring timebands in which the water is heated to the temperature set by the user (T_s) and timebands in which the water is heated to a reduced temperature (T_{rid}),
- measuring (310, 317) the flow rate (P) of the water drawn from the tapping circuit (17, 7),
- checking whether said flow rate (P) is equal to zero for a time (t) greater than or equal to a pre-set time (t) and, if so,
- disabling (320) said timed procedure (305), maintaining (325) the temperature of the domestic water in the tank (10) at the reduced temperature (T_{rid});

d) a procedure for restoring the temperature of the domestic water in the tank (10) comprising:

- a first rapid temperature restore mode, characterised by high temperatures of the water in said second branch (11, 6, 15), when restoration of the temperature is the main concern;
- a second optimised temperature restore mode, with temperatures of the water inside said second branch (11, 6, 15) depending on the temperature (T_s) set by the user for the domestic water in the tank (10), when energy efficiency is the main concern;

wherein said first and second mode can be selected by the user;

e) a control and auto-learning procedure which comprises:

- a mixing operation (30, 31) for mixing the water drawn from the tapping circuit (17, 7) with water coming out of said tank (10) upstream of an outlet (18) towards the user, said mixing operation (30, 31) entailing setting the temperature (T) of the domestic water stored in said tank (10) to a temperature value higher by a temperature difference (ΔT) than the domestic water temperature (T_a) at the outlet (18) and regulating the flow

rate of the water drawn from the tapping circuit (17, 7) and the flow rate of the water drawn from said tank (10) according to said difference (ΔT) between the temperature (T) of the domestic water stored in said tank (10) and the temperature of the domestic water (T_a) at the outlet (18); said
5 procedure furthermore comprises an operation for learning the estimated consumption of the user, said temperature difference (ΔT) being variable according to said estimated consumption of the user.

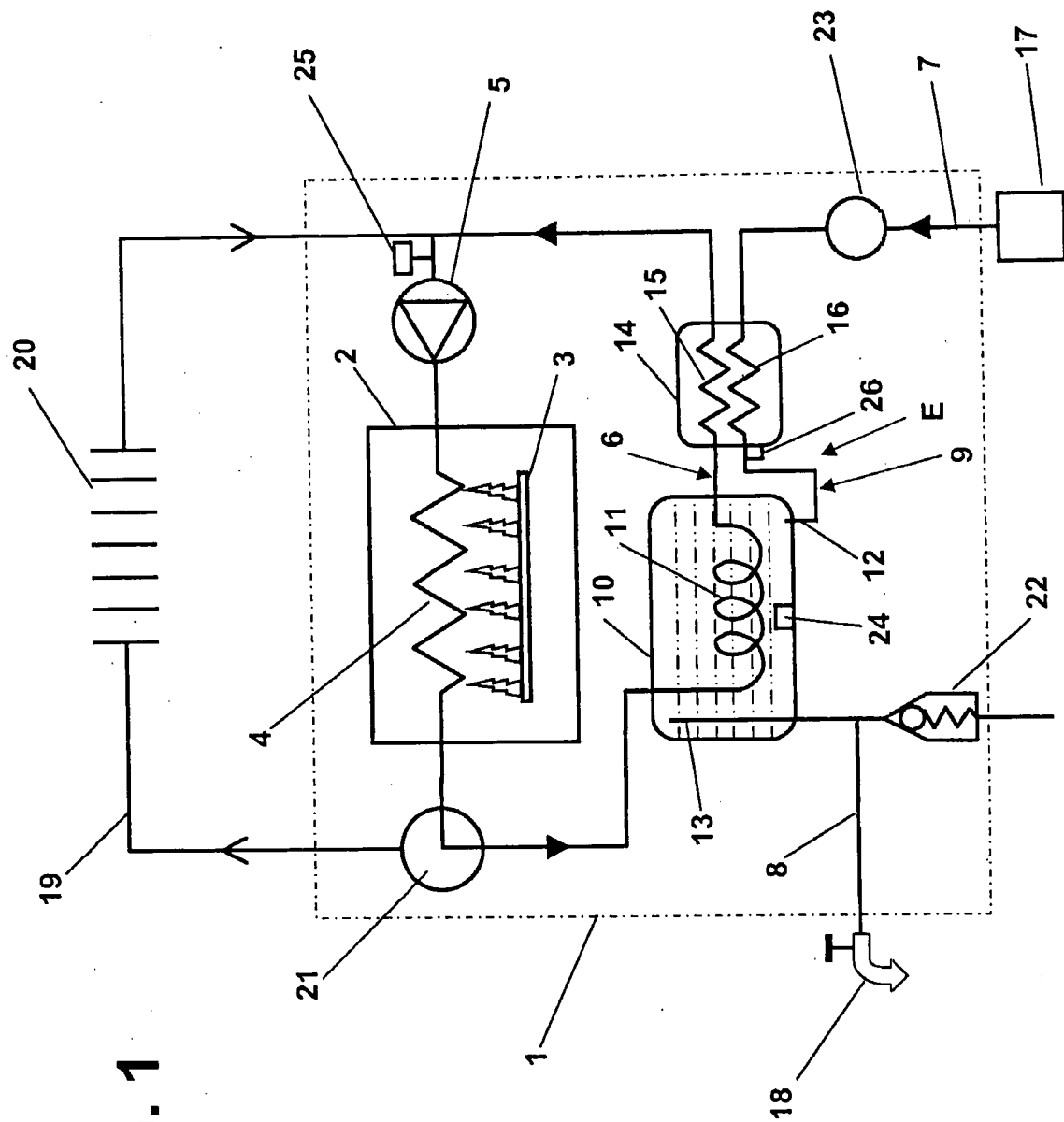
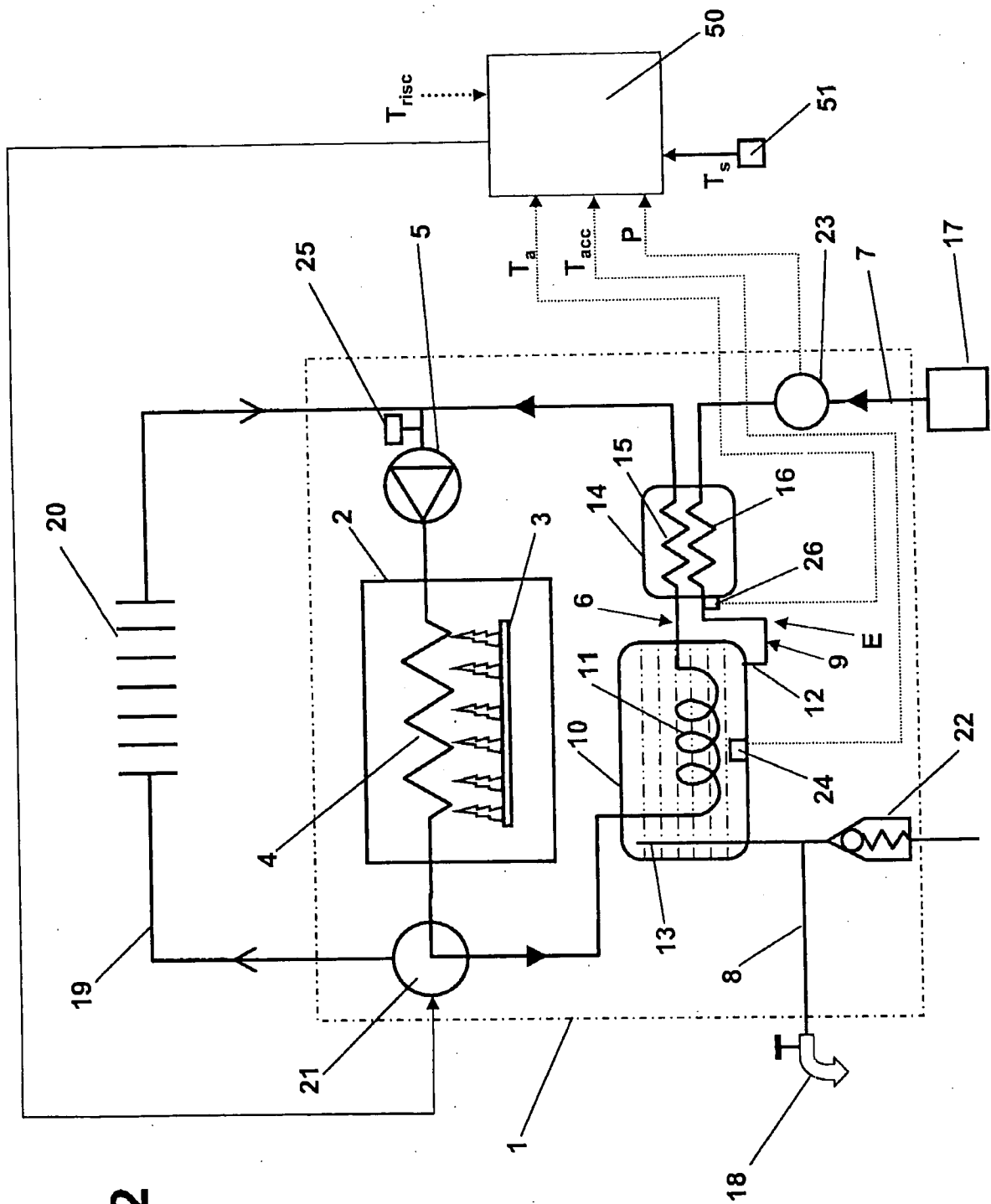


FIG. 1

FIG. 2



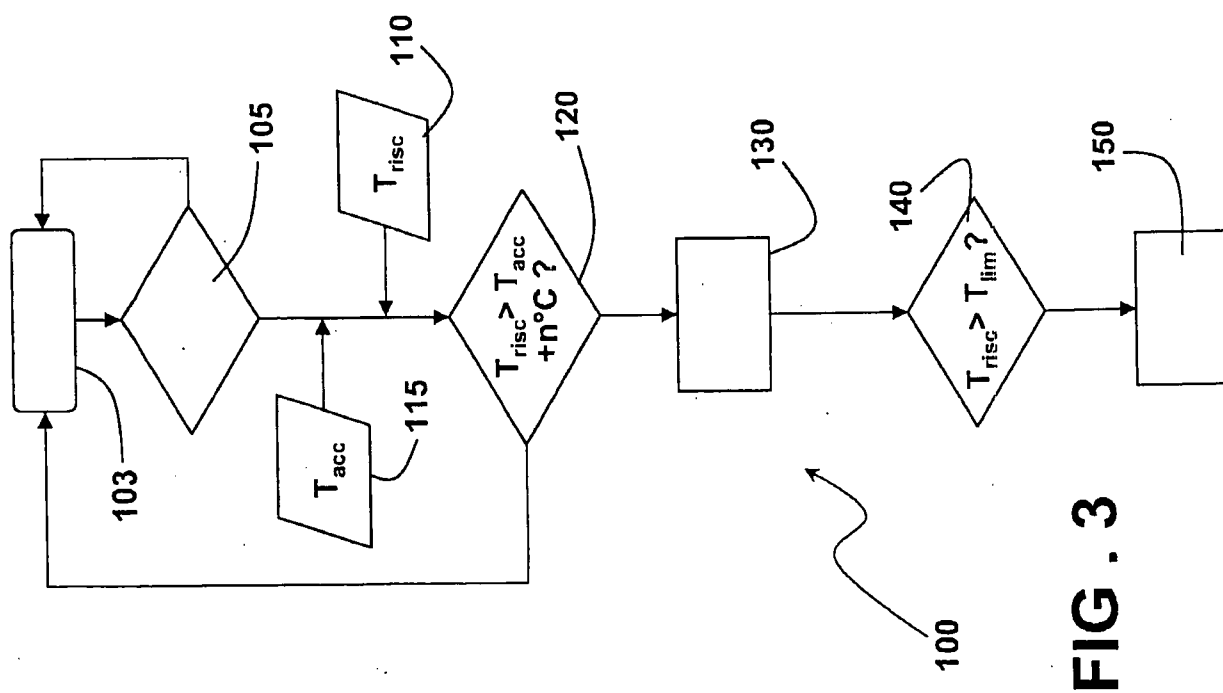


FIG. 3

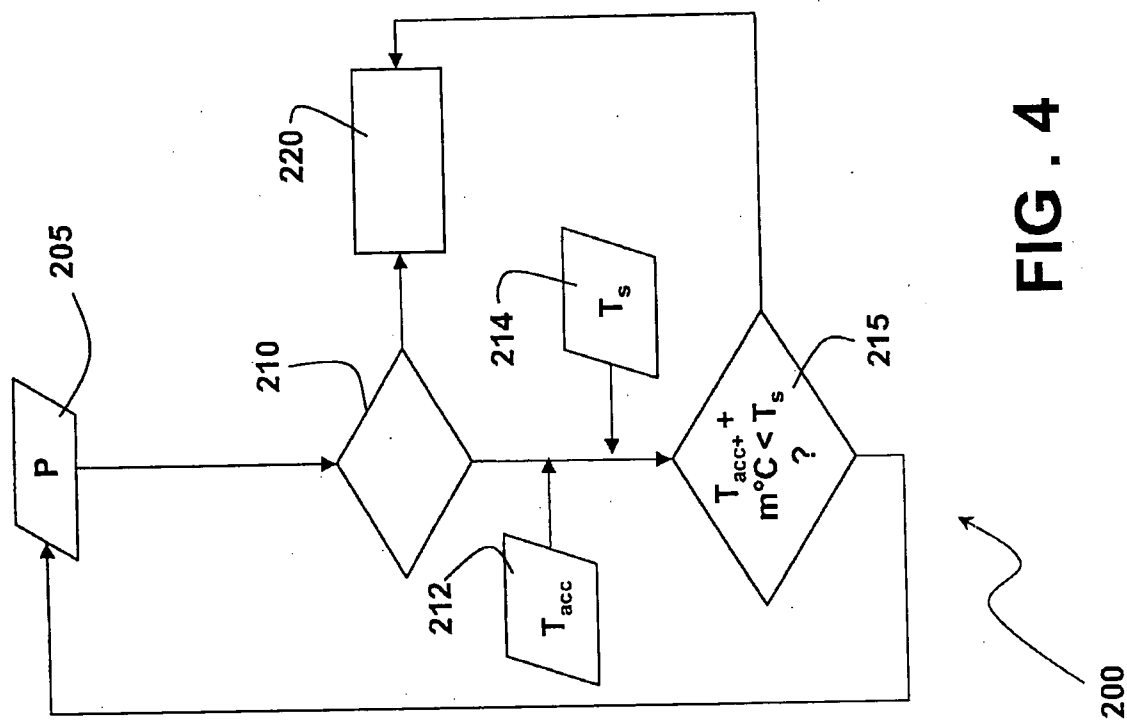


FIG. 4

FIG. 5

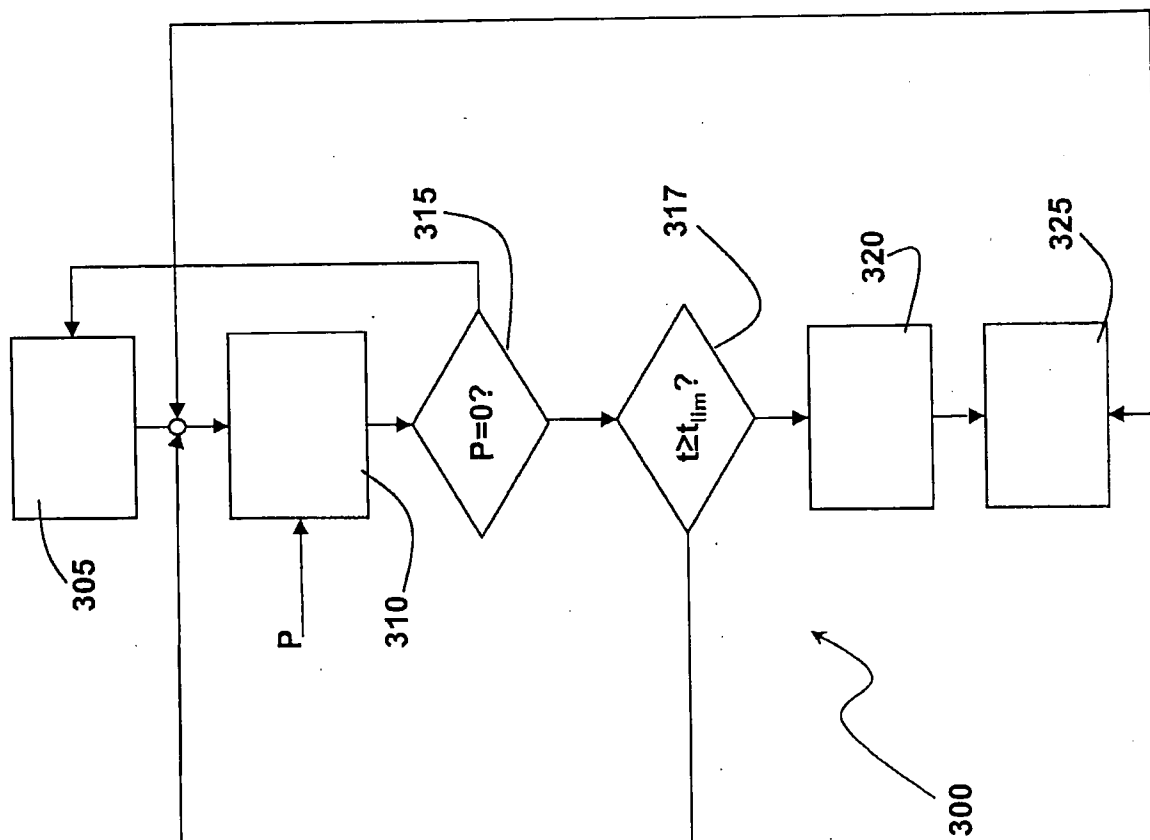
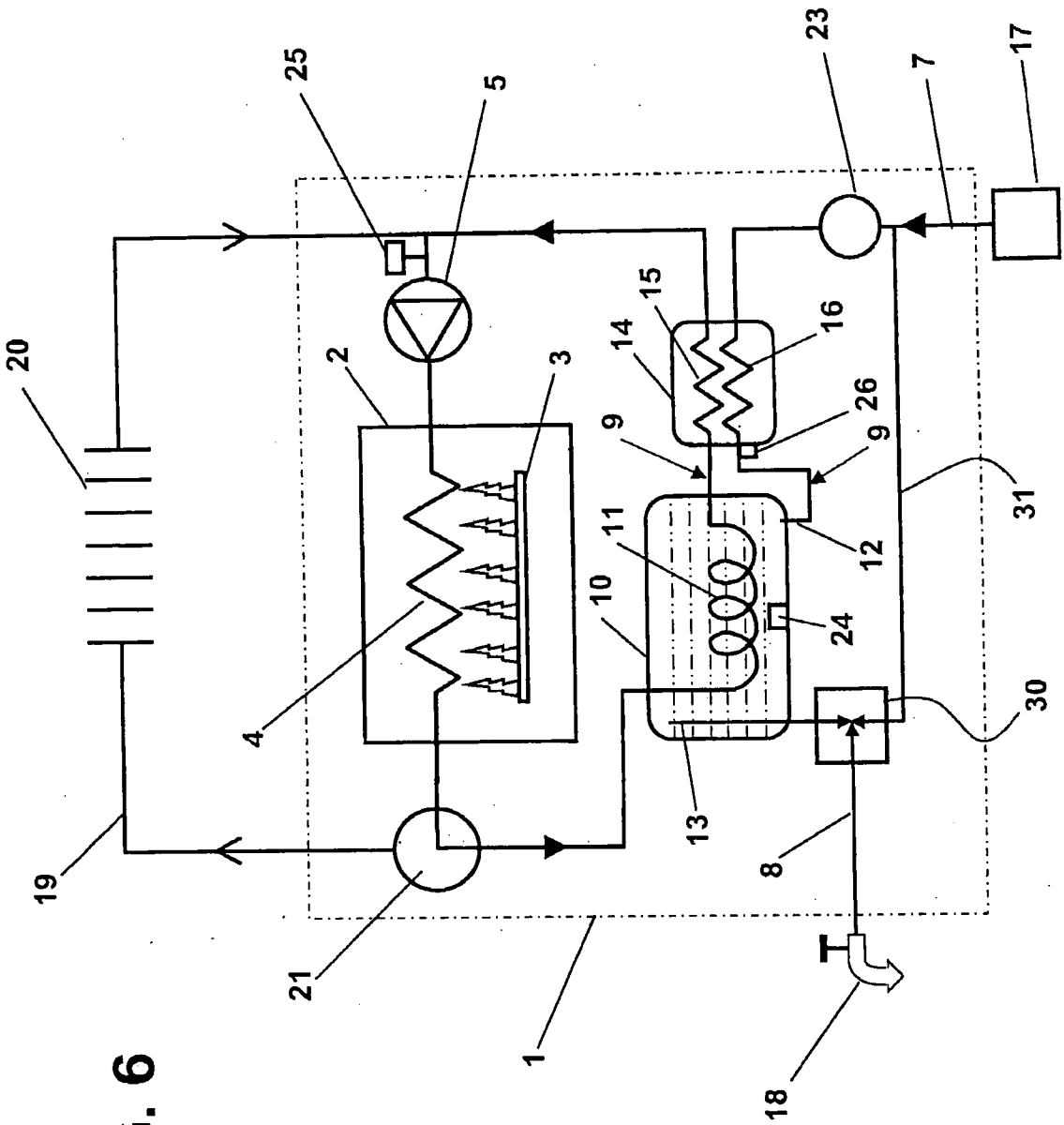


FIG. 6



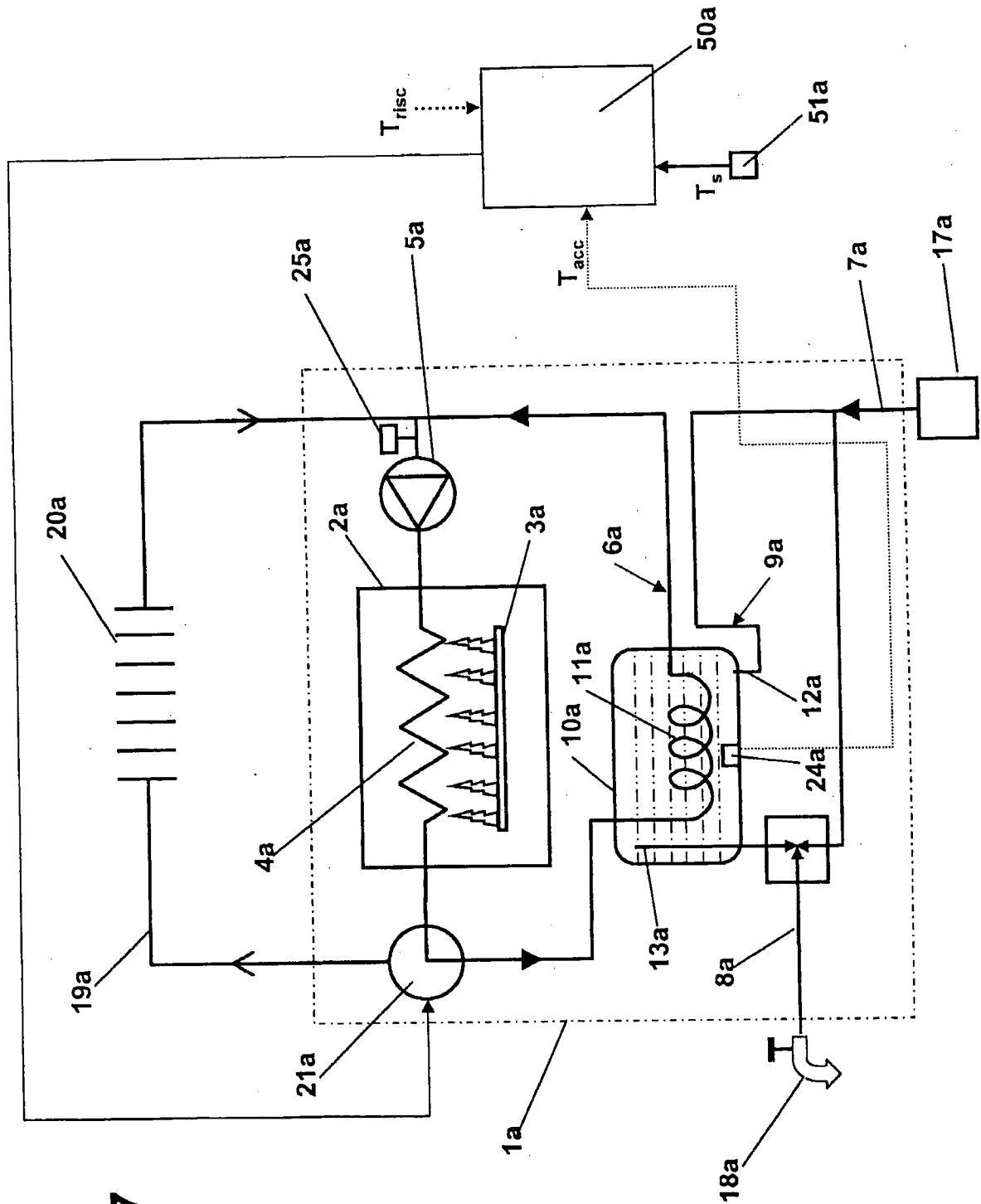


FIG. 7