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(71) Applicant: **Hermann S.r.l.**
29010 Pontenure PC (IT)

(72) Inventor: **Mazzoni, Paolo**
29100 Piacenza (IT)

(74) Representative: **La Ciura, Salvatore**
Via Francesco Sforza 3
20122 Milano (IT)

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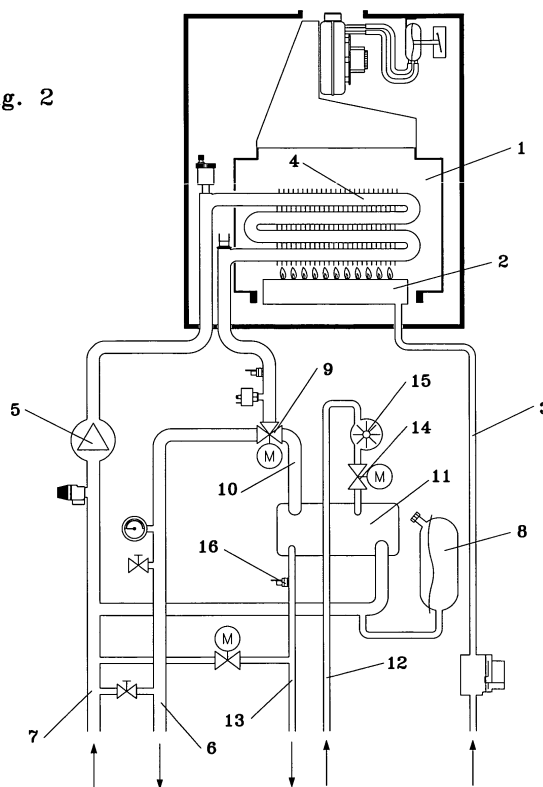
(54) **Boiler with devices for optimising the supply of hot water for sanitary purposes, and the corresponding method**

(57) This invention relates to a boiler for instant heating and production of sanitary water with a double heat exchanger (1, 11) or a single integrated bithermal heat exchanger, containing devices (14) able to optimise the supply of sanitary hot water by regulating the flow rate in such a way as to limit the flow until it reaches the required temperature, and then increasing the flow as it approaches the selected temperature. Waiting times are therefore considerably reduced, and the wastage of water that normally takes place at the start of each use is almost entirely eliminated.

In the boiler according to the invention, the flow of hot water is also constantly monitored when the boiler is in full operation, and the devices (14) may intervene to limit it, depending on the characteristics of the boiler and the input parameters such as the water temperature and pressure, so as to guarantee the maximum possible flow at the required temperature, depending on the type of boiler and the operating conditions.

The invention also relates to the method of management of the appliance.

Fig. 2



Description

[0001] This invention relates to a boiler for instant heating and production of sanitary water with a double heat exchanger or a single integrated bithermal heat exchanger, containing devices able to optimise the supply of sanitary hot water by regulating the flow rate in such a way as to limit the flow until it reaches the required temperature, and then increasing the flow as it approaches the selected temperature.

[0002] Waiting times are therefore considerably reduced, and the wastage of water that normally takes place at the start of each use is almost entirely eliminated.

[0003] In the boiler according to the invention, the flow of hot water is also constantly monitored when the boiler is in full operation, and the devices may intervene to limit it, depending on the characteristics of the boiler and the input parameters such as the water temperature and pressure, so as to guarantee the maximum possible flow at the required temperature, depending on the type of boiler and the operating conditions.

[0004] The invention also relates to the method of management of the appliance.

[0005] In instant boilers, when sanitary hot water is required, the water that circulates in the primary heat exchanger is diverted to a second or secondary heat exchanger, into which the sanitary water flows and absorbs heat by conduction, after which it is conveyed to the point of use.

[0006] However, this takes some time, especially in summer when the central heating installation is switched off; when the burner is lit it must first heat the water that circulates in the primary heat exchanger, after which said water, in the secondary heat exchanger, must transfer its heat to the water conveyed to the point of use.

[0007] All this involves a waiting time of a minute or a little more.

[0008] The water that flows during this time is generally not used, because it is still cold, which means a certain wastage of both water and gas in addition to the waiting time at the boiler outlet.

[0009] To limit this drawback, boilers have been designed wherein it is possible to limit the flow rate of the sanitary water at the start of use; the water thus remains in the circuit for a longer time and is heated more.

[0010] However, the solution offered by these systems is not entirely satisfactory, because they do not allow precise, and above all continuous control of the water temperature, but merely intervene in such a way as to partly increase the temperature at the start without any other control, and subsequently deliver the maximum flow, leading to a sudden reduction in temperature, which then rises as the installation comes into full operation.

[0011] This problem is now solved by the present invention, which relates to a boiler with devices able to optimise the supply of sanitary hot water, wherein the temperature of the water supplied is continuously monitored and means are present which act continuously on

a flow-limiting valve, so as to gradually increase the cross-sectional area through which the sanitary water passes, and consequently its flow rate as the temperature approaches the pre-set value.

[0012] Once in full operation, these means continue to monitor the water temperature and if necessary limit the flow rate, depending on the potential of the boiler and the input parameters such as pressure, temperature, variations in flow rate due to the opening of other points of use and so on, so as to provide a constant output flow of water having a substantially constant temperature, corresponding to the temperature selected by the user.

[0013] This invention will now be described in detail, by way of example but not of limitation, by reference to the annexed figures wherein:

- figure 1 schematically illustrates a boiler according to the invention;
- figure 2 is a functional diagram of the boiler according to the invention;
- figure 3 schematically illustrates, in cross-section, a possible configuration of a flow-limiting valve in a boiler according to the invention;
- figure 4 is a flow chart illustrating the method of management of the boiler according to the invention.

[0014] As shown in figures 1 and 2, no. 1 indicates the combustion chamber of a boiler according to the invention, wherein a burner 2, supplied with gas through a pipe 3, supplies heat to a first or primary heat exchanger 4, inserted in a circuit wherein a pump 5 circulates heating water.

[0015] The water exits through a delivery pipe 6, and then returns through a return pipe 7.

[0016] An expansion tank 8 is connected to the circuit of the primary exchanger. Said circuit is fitted with a diverter valve 9 that diverts the hot water from delivery pipe 6 to a branch 10 directed to a second or secondary heat exchanger, shown as 11.

[0017] The sanitary water circuit leads to exchanger heat 11, with an inlet pipe 12 and an outlet 13.

[0018] A flow-limiting valve 14, a flow rate measuring device 15 of known type, and a probe 16 for detecting the temperature of the water output are inserted in this circuit.

[0019] Flow-limiting valve 14, illustrated schematically in cross-section in figure 3, is a solenoid valve wherein a coil 17 controls the movements of a rod 18, at the ends of which is fitted a disc 19 which is inserted into input pipe 12 for sanitary water directed to heat exchanger 11.

[0020] Even in the maximum closing position, disc 18 does not fully close pipe 12, because it presents a small slot or opening 20 at one end through which a minimum quantity of water can always pass.

[0021] Flow-limiting valve 14, like the other components of the boiler, is controlled by an electronic unit not illustrated in the figure.

[0022] The operation of the boiler will now be de-

scribed, and in particular the method of management of the sanitary water heating system, which said method is schematically illustrated in the flow chart in figure 4.

[0023] When drawing of sanitary water begins, for example when the user turns on a tap, the system brings flow-limiting valve 14 to the maximum closing position, thus allowing only a minimal amount of water to flow into pipe 12.

[0024] The sanitary water then moves in pipe 12, and consequently in heat exchanger 11, at a lower speed, thus absorbing a larger amount of heat and reaching the selected temperature in a shorter time, without any wastage of water which the user does not use because it is still cold.

[0025] When the temperature of the sanitary water reaches a value close to that set by the user, the control unit controls the start of reopening of the proportional valve, controlling the movement of disc 19 in such a way as to maintain the heat balance in the secondary exchanger, thus guaranteeing the stability of the output temperature as the flow rate increases.

[0026] The temperature of the output water is constantly controlled by probe 16, and when this temperature approaches the set value, the control system starts to open valve 14 gradually until the flow rate value determined by the user's requirements is reached.

[0027] Simultaneously, the system also regulates the quantity of gas sent to the burner, in order to limit it if the temperature tends to exceed the required value, for example if a low flow rate is requested.

[0028] When, shortly after the tap is turned on, the supply of hot water reaches full operation with delivery of the flow rate desired by the user, the system modulates the amount of gas supplied, in order to keep this temperature stable.

[0029] The control system also performs a kind of autocalibration in order to guarantee the maximum heat exchange available when the supply required by the user is such as to reach the maximum flow rate.

[0030] For this purpose the system checks the state of opening of the proportional valve and the heating power supplied, so as to gradually identify the maximum sanitary water flow rate which can be delivered, depending on the power of the boiler and the input conditions, especially the water pressure and temperature, to maintain a constant output temperature.

[0031] Once the maximum value of the optimum flow rate has been identified, it is stored together with the degree of opening of the proportional valve which determines that flow rate value, and is taken as the maximum flow rate value for the current supply and the initial stage of subsequent drawing, until the subsequent autocalibration stage.

[0032] The boiler according to the invention also includes a system of continuous control of the sanitary water temperature and flow rate, the characteristics of which are constantly monitored after the initial stage so as to limit the maximum flow rate according to the character-

istics of the boiler and the input parameters, in order to guarantee that the sanitary water supplied will always be at the required temperature, making the maximum use of the performance of the boiler.

[0033] The conditions of use of the boiler can vary during use. For example if, during drawing of hot water by a first user, a second drawing of sanitary water is generated by another user, this leads to a considerable increase in the heating power required to satisfy both users.

[0034] These variations in water supply conditions lead to an imbalance which may cause a reduction in the temperature of the output flows of sanitary water if the boiler does not have sufficient power to heat the water required by both users, leading to a deterioration in comfort, and above all considerable use of water and energy, in the attempt to reach a set temperature which is impossible to reach in view of the sanitary water flow rate involved.

[0035] For this reason, depending on the input parameters, the power of the boiler and the demand for sanitary water, the control system acts on valve 14 to limit this flow rate to the maximum flow rate value obtained during autocalibration, so as to supply an overall output flow which, though partly reduced below the users' demand, corresponds to the maximum quantity which the boiler is able to provide at the desired temperature, thus exploiting all the heating power available and guaranteeing continuous maintenance of comfort, though with a partly reduced flow of water, said comfort being of crucial importance as the water leaving the tap comes into direct contact with the user.

[0036] The system also constantly checks the operating conditions, including when it is in full operation, and in the event of variation in one of the parameters in question (input water temperature, reduction in pressure of installation, or demand for an excessive flow of heated water) it operates the flow-limiting valve so as to limit said flow rate to a value, based on the power of the boiler, which allows the sanitary water to reach and maintain the temperature required by the user, possibly partialising the flow if the boiler does not have enough power to meet this demand.

[0037] Thus not only is the waiting time required to heat the water to the required temperature reduced, but continuous control is exercised which guarantees that the temperature of the sanitary water output will remain constant, even if the input parameters vary.

Claims

1. Boiler for heating and for production of water for sanitary purposes, **characterised in that** it includes:

- flow-limiting devices (14) designed to limit the flow rate of the sanitary water when the user begins to draw it;
- means (16) designed to detect the temperature

- of said water;
 • means designed to deactivate said flow-limiting devices gradually as the temperature of the sanitary water approaches the pre-set value.
2. Boiler as claimed in claim 1, wherein said flow-limiting devices (14) are designed to limit the flow rate of the sanitary water when the user begins to draw it.
3. Boiler for heating and for production of water for sanitary purposes, **characterised in that** it includes:
- means (15) designed to measure the flow rate of the sanitary water supplied;
 - means (16) designed to measure the temperature of the sanitary water supplied;
 - means (14) designed to vary the flow rate of the sanitary water when in full operation, on the basis of said measured quantities, the power of the boiler and the input conditions of the sanitary water, so as to maintain the temperature of said water at the pre-set value.
4. Boiler as claimed in claim 1, 2 or 3 wherein said flow-limiting means (14) are constituted by a diverter solenoid valve fitted to the sanitary water pipe (12), which said valve can be continually regulated between a pipe-closing position, in which it leaves a small space for the passage of sanitary water, and a fully-open position of the pipe.
5. Boiler as claimed in any of the preceding claims, **characterised in that** it includes:
- means designed to modulate the flow of gas that supplies the burner (1);
 - means designed to detect the flow rates of the gas and sanitary water (15) and the temperature of the latter (16), and to operate on said flow-limiting means (14) to regulate the sanitary water flow rate on the basis of the flow of gas supplied to the burner and the water temperature.
6. Boiler as claimed in claim 3 or 5, **characterised in that** it includes means (16) designed to monitor the temperature of the sanitary water when in full operation, compare it with a preset value, increase the flow rate of the gas if said temperature decreases, or limit the flow rate of the sanitary water if the temperature decreases and the flow rate of the gas is already at the maximum value.
7. Boiler as claimed in any of the preceding claims, **characterised in that** it includes means designed to store the sanitary water temperature and flow rate data when in full operation.
8. Method for optimising the supply of sanitary water in a boiler fitted with means designed to limit the sanitary water flow rate, **characterised in that** it includes monitoring of the input conditions of the sanitary water, the state of opening of the means used to limit the sanitary water flow rate, and the state of the heating power supplied, and regulation of said flow-limiting means on the basis of the data found and the available power, to maintain the temperature of the water output at a preset value.
9. Method as claimed in claim 8, **characterised in that** it includes continuous detection of the sanitary water temperature, and limitation of the flow rate in the event of a temperature reduction if the boiler is already at maximum power, until the set temperature is restored.
10. Method for optimising the supply of sanitary water in a boiler for heating and for production of water for sanitary purposes, **characterised in that** it includes the following stages:
- limitation of the sanitary water flow rate at the start of drawing, until a pre-determined temperature value is reached;
 - gradual increase in said flow rate, as the temperature approaches said pre-determined value, until the specified flow rate and temperature are reached;
 - monitoring of the input conditions of the sanitary water, the state of opening of the means used to limit the sanitary water flow rate, and the state of the heating power supplied, and storage of said maximum optimum flow rate data and degree of opening of said flow-limiting means that determine said flow rate value, for the use thereof during the initial stage of subsequent water drawing.
11. Method as claimed in claim 10, **characterised in that** it includes a stage of continuous control of the sanitary water flow rate when fully operational.
12. Method as claimed in claim 10, **characterised in that** said flow rate control stage includes continuous monitoring of the sanitary water temperature and limitation of the flow rate in the event of a temperature reduction if the boiler is already at maximum power, until the set temperature is restored.
13. Method according to claims 10-12, **characterised in that** it includes:
- continuous monitoring of the sanitary water temperature when fully operational;
 - regulation of the power supplied on the basis of the value detected;
 - limitation of the sanitary water flow when the

maximum available power is reached, so as to maintain the temperature at the pre-set value.

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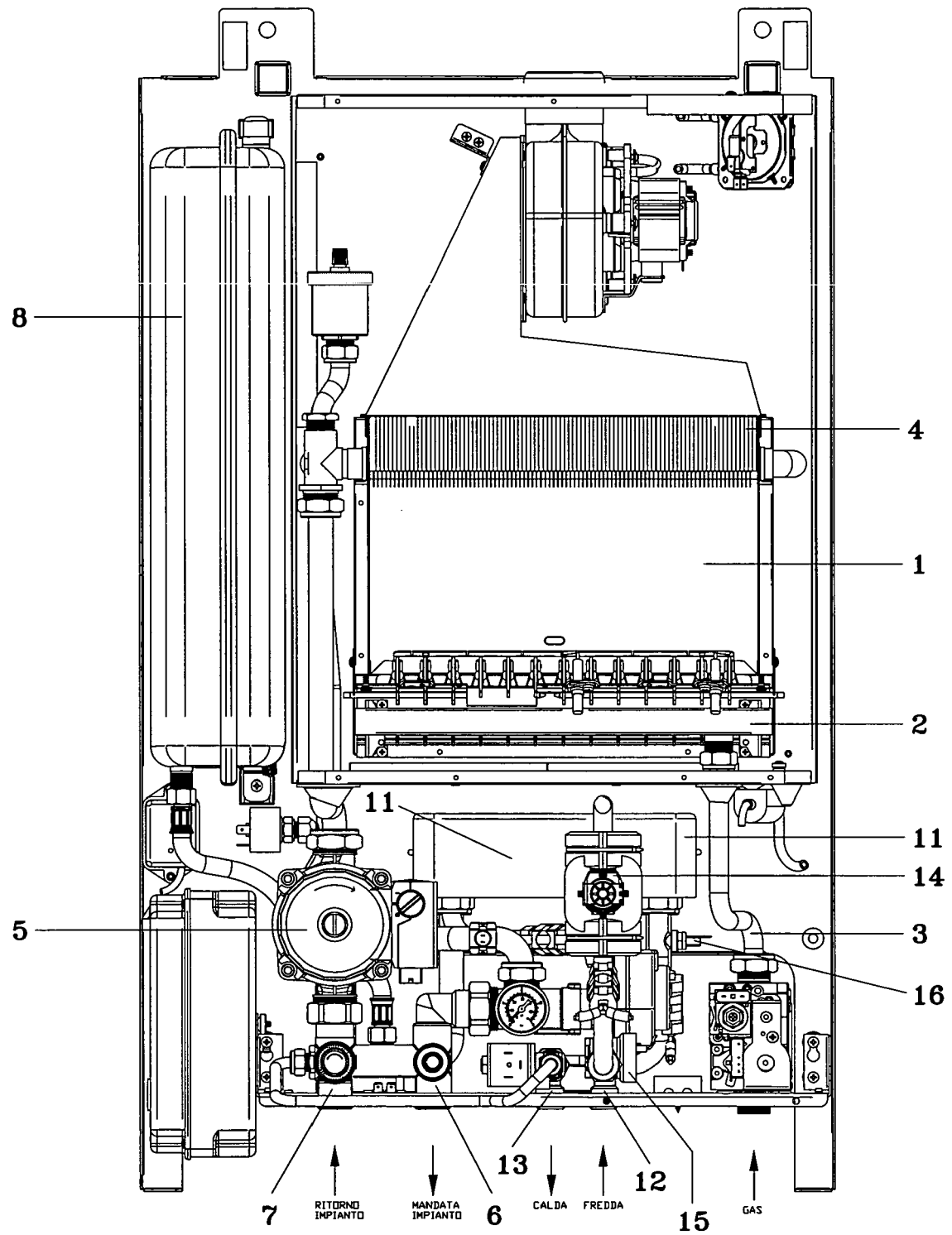
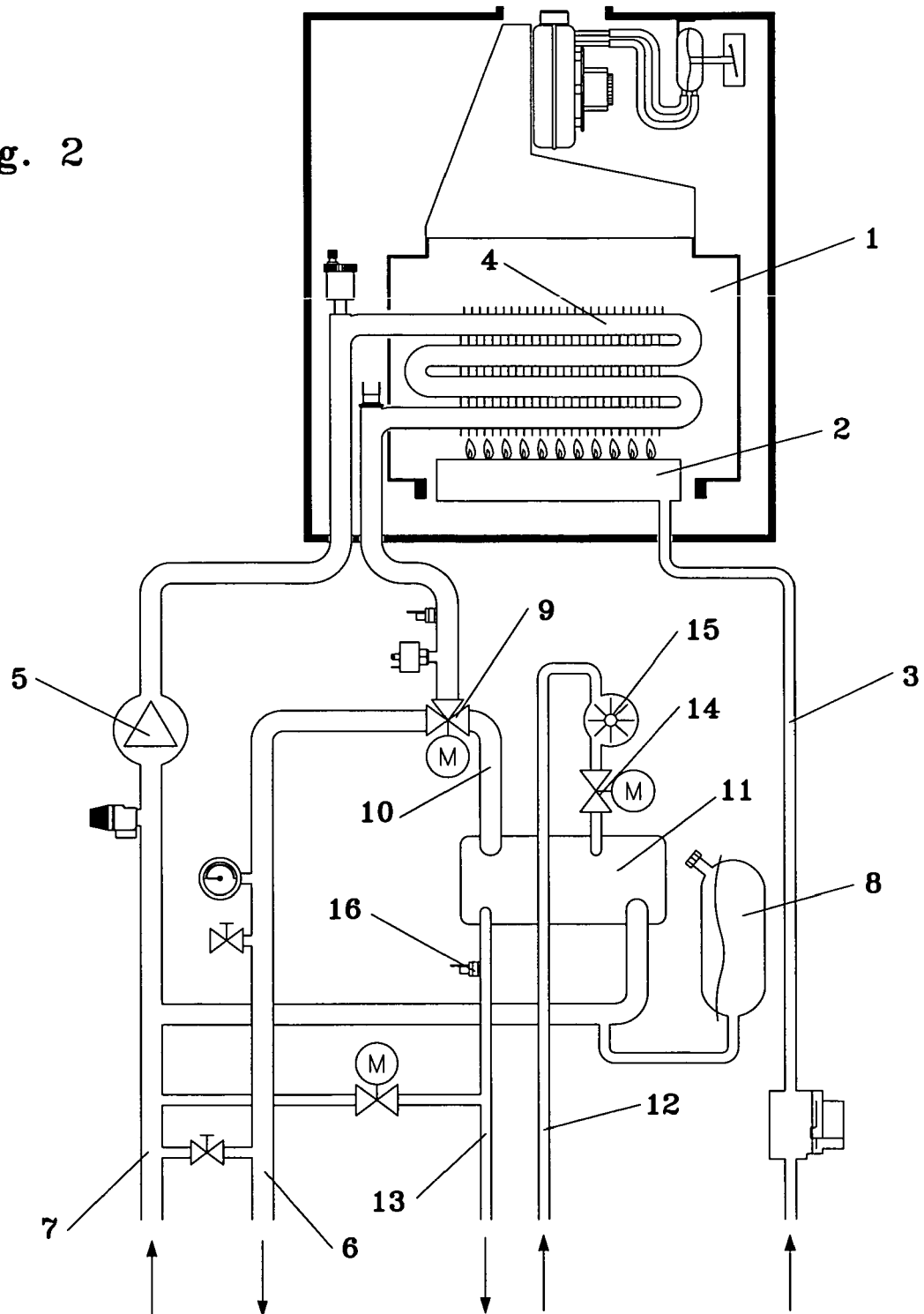


Fig. 1

Fig. 2



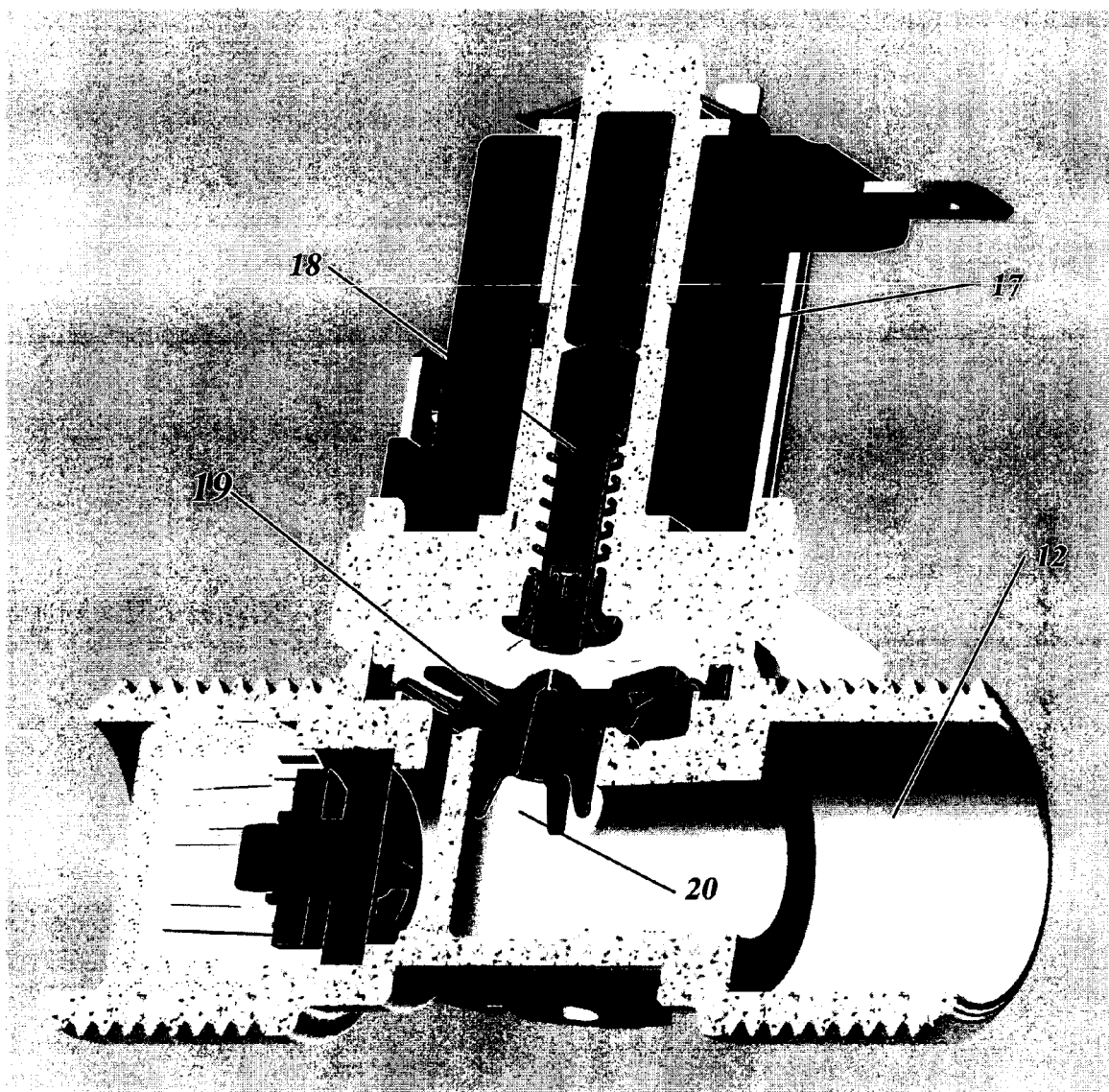


Fig. 3

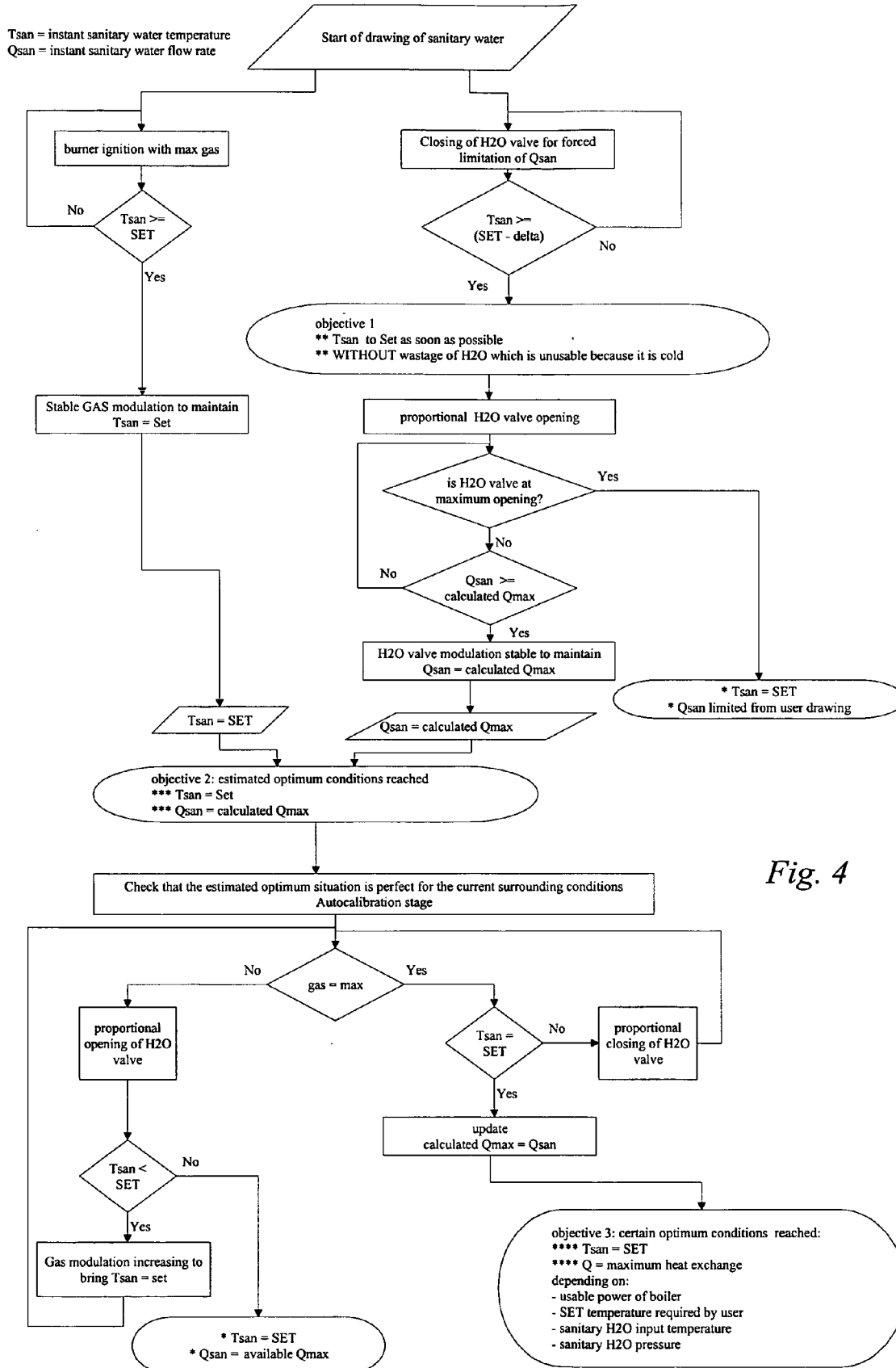


Fig. 4