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(54) **Professional grande cuisine oven with heating using direct steam, and method for operating the oven**

(57) In a cavity (2) the oven comprises at least one gas burner (11), a water inlet, means (50) arranged in order, in cooperation with the burner (11), to cause vaporization of the water, means (146) for measuring the temperature inside the cavity (2). Provision is made for means (100) for varying the flow rate of water that are controlled by the means (146) for measuring the temperature and means (4) for controlling the oven.

During the cooking of the food, and without stopping the burner (11), the amount of water injected into the cavity is increased (140) when the temperature in the cavity exceeds a reference temperature (θc) in order to cause the temperature in the cavity (2) to drop.

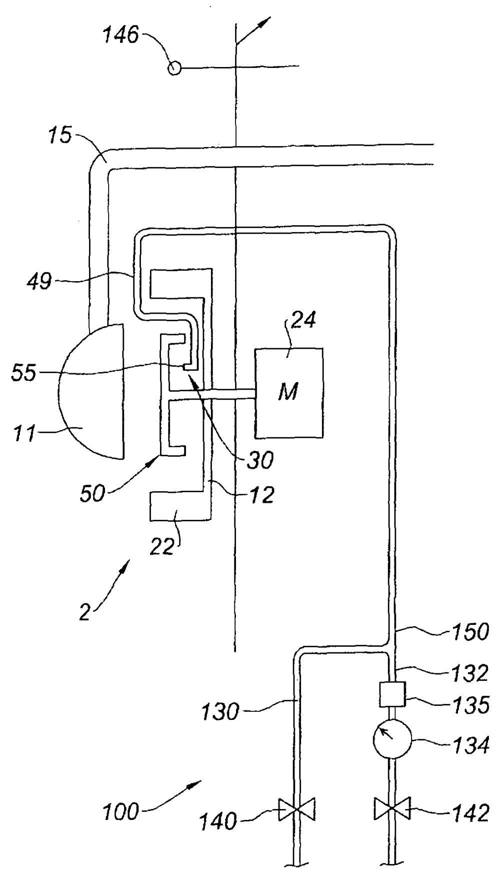

Fig. 3

Description

[0001] The invention relates to what are known as professional grande cuisine ovens. This designation applies to ovens with an internal capacity of at least approximately 0.15 m^3. There are a number of types of grande cuisine ovens.

[0002] Ovens, in which heating and cooking take place by means of convection, include, inside the cavity of the oven, a gas burner or one or more heating resistance elements and one or more convection fans.

[0003] Certain ovens, in which heating and cooking take place using indirect steam, comprise a steam generator outside the cavity. These are indirect steam production ovens.

[0004] Other ovens with heating and cooking using direct steam comprise, inside the cavity, at least one fan associated with a heating resistance element or a gas burner onto which or near to which water is sprayed in order to produce the steam directly inside the oven.

[0005] Hybrid - or combination - ovens with dual heating and cooking by convection and using steam are known, such as, furthermore, certain examples referred to above. Combination ovens have already been tending to replace the others for a number of years.

[0006] Lastly, a further category of professional grande cuisine ovens is also known, which ovens combine at least one of the modes using convection and steam with heating and cooking by means of microwaves.

[0007] The invention of the present application relates more particularly to a professional grande cuisine oven at least with a heating and cooking mode using steam produced directly inside the oven.

[0008] Naturally, the invention also applies to dual-mode ovens, at least one mode using convection and one mode using direct steam, it being possible to function in convection mode, in steam mode and in mixed mode, functioning in direct steam mode generally involving functioning in mixed mode.

[0009] In steam mode, water is injected inside the oven. Above 100°C this is no longer saturated steam and the food can dry out. This is why the ovens in question include a regulator that normally cuts off the heating source when the temperature reaches 100°C. In the case of a gas burner, a mixture of air and gas forms the fuel, the air being conveyed to the burner by a pressure booster. If, in order to cut off the burner, the gas inlet were to be cut off without the air inlet being cut off, cold, dry air would be injected into the cavity of the oven and the food would dry out.

[0010] However, if the air inlet were cut off, stopping the pressure booster, the pressure in the burner would drop below that prevailing in the cavity and the steam in the cavity could then rise up into the air inlet pipe, which would cause damage to much of the equipment.

[0011] If the intention were not to stop the pressure booster, a valve could be fitted to the pipe. However, this would be a costly solution that would be complicated to implement, a valve of this type taking a long time to close and a long time to open.

[0012] With a professional grande cuisine oven functioning at least by means of heating with the direct steam produced inside the oven using a gas burner, the burner therefore no longer has to be stopped.

[0013] It will be noted that with a combination oven, in convection mode, there is no problem because water is not injected.

[0014] It is therefore on the basis of the observation made above - which is already interesting *per se* - that the applicant addressed the problem of maintaining saturated steam in the cavity of the oven without cutting off the burner.

[0015] It is on the basis of a later observation that the applicant finally proposes its invention, an observation whereby the reference temperature *a priori* 100°C, may be slightly exceeded because, at the end of cooking, food is practically unable to absorb any more water.

[0016] Thus, the invention relates firstly to a method for operating a grande cuisine professional oven, for cooking food, functioning at least by means of heating with the direct steam produced inside a cavity of the oven using a gas burner and water injected into the cavity, characterized in that, during the cooking of the food and without stopping the burner, the amount of water injected into the cavity is increased when the temperature in the cavity exceeds a reference temperature in order to cause the temperature in the cavity to drop.

[0017] It will be noted that any solution consisting in causing the temperature of a cooking oven to drop is *a priori* a bold move. In any event, the solution of the invention has the great merit of preventing any drying-out of the food.

[0018] It is possible to inject more water by increasing the flow rate of a water supply. It is also possible to open a second water supply.

[0019] Preferably, the amount of water injected is reduced when the temperature in the cavity again drops below the reference temperature.

[0020] In a preferred embodiment of the method of the invention, before the temperature in the cavity reaches the reference temperature, the power of the oven is reduced, for example by reducing the flow rate of the gas/air mixture.

[0021] It will be noted that if the amount of water injected into the cavity is increased only at the reference temperature the temperature in the cavity will exceed it slightly, but it was observed above that this was not prejudicial. In the case in point, the applicant considered that a temperature of 104°C could be tolerated perfectly well. However, this is only an example.

[0022] The invention also relates to a professional grande cuisine oven, for cooking food, functioning at least by means of heating with direct steam, comprising, in a cavity of the oven, at least one gas burner, a water inlet, means arranged in order, in cooperation with the burner, to cause vaporization of the water, means for measuring the temperature inside the cavity, the oven also comprising control means and means for controlling the burner, which oven is characterized in that it further includes means for varying the flow rate of the water inlet that are controlled by the means for measuring the temperature and the means for controlling the oven.

[0023] In an advantageous embodiment of the oven of the invention, the water inlet includes two pipes with flow rates controlled, respectively, by two valves controlled by the control means of the oven.

[0024] It would also be possible to envisage only one inlet pipe controlled by a valve with variable flow rate.

[0025] Advantageously, the oven includes means for varying the power of the oven that are controlled by the means for controlling the oven.

[0026] Preferably, the oven is a combination oven that also includes means for heating by convection.

[0027] The invention will be better understood with the aid of the following description of a preferred embodiment of the oven and of its operating method, with reference to the appended drawing, in which:

- Figure 1 is a perspective view of a first embodiment of the oven of the invention;
- Figure 2 is a diagrammatic representation of the oven of Figure 1, in which the chamber of the oven is shown in vertical section;
- Figure 3 is a diagrammatic representation of the system for varying the water flow rate; and
- Figure 4 is a representation of the temperature curve of the cavity of the oven.

[0028] With reference to Figures 1 and 2, the oven 1 according to the invention comprises a cavity or chamber 2 contained in a frame 3. This frame 3 includes means 4 for regulating the temperature in the chamber 2 and also a door 5 designed for the introduction of the food to be heated and/or to be cooked in the chamber 2. The means 4 are, in fact, the means for controlling the oven.

[0029] The chamber 2 has a substantially parallelepipedal shape delimited by a front face 6, opened or closed by the door 5, a back wall 7 (Figure 2) opposite the front face 6, two vertical lateral walls 8, between the front face 6 and the back wall 7, and also a floor 9 and a roof 10 that form two horizontal walls. All these walls are made from metal sheets.

[0030] The chamber 2 also includes a heating device, which in this case is a gas burner 11, a turbine 12, a protective screen 13 and, in this case, lateral slides 14.

[0031] The burner 11 is arranged inside the chamber 2, opposite the turbine 12. It is supplied with a combustible gas/air mixture by a conduit 15. This burner 11 is ignited by an electrode 16 powered electrically by a wire 17 arriving in the burner 11 via the conduit 15. This burner 11 also includes a device 16a for controlling the flame, in this case by ionization, connected to a control box (not shown) by a wire 17a. The wires 17 and 17a leave the conduit 15 at a packing box.

[0032] The combustible mixture is produced at a mixer 18. The air supply is provided by a pressure booster 19. Thus, the gas/air mixture arrives at the burner 11 at a slight overpressure. The gas supply is managed by electronic means (not shown). In the event that the burner 11 is stopped, for example when a reference temperature is reached in the chamber 2, a slight pressure is maintained by the pressure booster 19 in order to prevent any steam rising up into the mixer 18. The gas supply may also be modified with the aid of a valve 60.

[0033] The turbine, or fan, 12 is fitted substantially in the centre of the back wall 7. It includes a disc 20 centred on an axis of rotation 21. On the periphery of this disc 20, the turbine 12 includes a plurality of blades 22 distributed at regular angular intervals about the axis of rotation 21. These blades 22 consist, for example, of planar rectangular plates extending in a plane substantially perpendicular to the disc 20 and passing through the axis of rotation 21. This symmetry relative to the axis of rotation 21 makes it possible to rotate the blades in the clockwise and anticlockwise direction, without distinction. The turbine 12 is entrained in rotation, about the axis of rotation 21, by a motor 24. The direction of rotation of the turbine 12 is advantageously periodically alternated. The turbine 12 makes it possible to distribute the thermal energy in the chamber 2.

[0034] When they rotate, the blades 22 follow a circular trajectory centred on the axis of rotation 21 and delimit a central space 23.

[0035] The burner 11 is arranged opposite the central space 23. Part of this burner 11 possibly penetrates this central space 23.

[0036] The protective screen 13 extends in a vertical plane opposite the disc 20, in front of the burner 11 and the turbine 12, relative to the cooking space 25 designed to receive the food to be heated and located between this burner 11 and the opening for the door 5.

[0037] The chamber 2 communicates with the outside by means of an evacuation opening 28. This evacuation opening 28 allows the cooking atmosphere contained in the chamber 2 to escape when this atmosphere is at overpressure relative to the pressure outside the chamber 2. This evacuation opening 28 is provided at the approximately lowest point of the floor 9. In fact, in the embodiment described here, the floor 9 includes panels that slope down towards a point located substantially at its centre.

[0038] The condensates formed in the chamber 2 flow along the sloping panels towards the evacuation opening 28, from which they are evacuated to the outside of the chamber 2. To this end, the evacuation opening 28 communicates with a siphon 29. When the siphon 29 is full, i.e. under normal use conditions, the liquid held in the bottom of the siphon 29 prevents fresh air rising back towards the evacuation opening 28 and thus towards the chamber 2, thereby contributing to the stability and to the homogenization of the temperature in this chamber 2, preventing the introduction of fresh air via the evacuation opening 28.

[0039] These condensates may originate from the food during cooking in the chamber 2 and/or from steam production means 30 provided to supply steam in the chamber 2.

[0040] The oven 1 includes a hygrometry and pressure regulation box 31. This regulation box 31 includes an evacuation chamber 32 and a regulation chamber 33. The evacuation chamber 32 and the regulation chamber 33 communicate with one another via a restricted passage 51.

[0041] The regulation box 31 is located in the frame 3, behind the back wall 7, with which it communicates by means of an air entry 44.

[0042] The regulation box 31 is partly filled with water by a water pipe 34 connected to a water supply 149. The level of water in the regulation box 31 is controlled by a first overflow 35 that flows as far as into the siphon 29. Thus, even when the condensates are insufficient to prevent fresh air rising back via the siphon 29, the latter may be filled directly by the water pipe 34, via the first overflow 35.

[0043] The level of water in the regulation box 31 may also be controlled by a drain valve 36. This drain valve 36 controls the flow rate of water in a drain conduit 37 connecting the base of the regulation box 31 to the siphon 29.

[0044] The volume of water in the regulation box 31 and thus in the evacuation chamber 32 varies between a high level - corresponding to the height of the first overflow 35 - and a low level - corresponding to the height of the junction of the drain conduit 37 and the regulation box 31.

[0045] An evacuation tube 38 extends between the evacuation opening 28 and a high end 39 opening out in the evacuation chamber 32 above the high and low levels of the water in the evacuation chamber 32. This evacuation tube 38 opens out between the evacuation opening 28 and the siphon 29.

[0046] The evacuation chamber 32 also communicates with a shaft 40. This shaft 40 extends between a first end 41 located outside the evacuation chamber 32 and a second end 42 located above the high level of the water. When the pressure increases in the chamber 2, the gases contained in the chamber 2 escape via the evacuation opening 28, then via the evacuation conduit 38 and the shaft 40.

[0047] The regulation chamber 33 is, in this case, adjacent to the evacuation chamber 32. The regulation chamber 33 and the evacuation chamber 32 are separated by a partition 43. The partition 43 does not separate the evacuation 32 and regulation 33 chambers completely hermetically. In fact, this partition 43 limits, without preventing them completely, the gaseous and aqueous exchanges between these two chambers 32, 33, which take place via the restricted passage 51.

[0048] The regulation chamber 33 communicates with the chamber 2 via the air entry 44 opening out in the chamber 2 substantially at the level of a reduced-pressure zone created by the rotation of the turbine 12. The regulation chamber 33 also communicates with the outside via an inlet conduit 45 that makes it possible to cause air to penetrate the regulation chamber 33 if the water level is below the inlet conduit 45.

[0049] However, in the event of overpressure in the chamber 2, even if the evacuation opening 28 or the evacuation tube 38 is blocked, the burnt gases can escape via the inlet conduit 45 irrespective of the level of water, between its high level and its low level, in the regulation chamber 33. If the inlet conduit 45 is immersed under the water level in the regulation chamber 33, the burnt gases are able to escape. The regulation chamber 33 thus makes it possible not only to manage hygrometry, by the entry of drier, fresh air via the inlet conduit 45, varying the water level, but also the pressure in the chamber 2, and to do so without a mechanical system for opening or closing conduits. The regulation box 31 thus makes it possible to fulfil functions similar to mechanical systems, such as flaps, but has the advantage that it cannot become fouled and blocked, thus making the oven safer.

[0050] The oven also includes, above all, steam production means 30 for supplying steam in the chamber 2. These steam production means 30 comprise, in this case, a bottom outlet 55 of a tube 49 connected to the water supply 149 via a system 100 for varying the water flow rate and a diffuser 50. This diffuser is a metal disc with two faces.

[0051] The diffuser disc 50 is fitted so as to rotate with the turbine 12. The diffuser disc 50 is located in the central space 23 and is arranged substantially perpendicularly to the axis of rotation 21. The burner 11 is arranged opposite the first face of the diffuser disc 50. The diameter of the diffuser disc 50 is substantially equal to that of the burner 11. Thus, the burner 11 heats up the disc 50.

[0052] The water flowing from the tube 49 in the vicinity of the second face of the diffuser disc 50 falls onto that face. The disc 50, heated by the heat produced by the burner 11, therefore partially vaporizes this water.

[0053] Another portion of the water, which is not vaporized in contact with the disc 50, is sprayed by the latter and is vaporized in the flames of the burner 11. Yet a further portion of the water, which is not vaporized in contact with the disc 50 nor in the flames of the burner 11, is sprayed onto the walls 7, 8, 9 and 10 and, in particular, on the roof 10.

[0054] A temperature probe 146 (Figure 3) makes it possible to measure the temperature within the cavity 2. The probe 146 is connected to the means 4 for controlling the oven.

[0055] With reference to Figure 3, the system 100 for varying the flow rate of water comprises, in this case, a first branch, or pipe, 132 for supplying cooling water, communicating with the tube 49. The branch 132 comprises a pressure regulator 134 designed to deliver a fixed outlet pressure (of 1 bar, for example), a first solenoid valve 142, preferably of the all-or-nothing type, and also, optionally, at least one device 135 for regulating the flow rate, upstream or downstream of the pressure regulator 134.

[0056] Variation of the flow rate is obtained by a second branch, or pipe, 130 for supplying water, connected at 150 to the first branch 132, downstream of the regulator 134 and of the regulation device 135.

[0057] The second branch 130 for supplying water comprises a second solenoid valve 140 controlled by the means 4 for controlling the oven. The second solenoid valve 140 is also of the on/off type. The two solenoid valves 142 and 140 form openings for the first and second branches for supplying water, respectively.

[0058] Having described the various components of the combination oven of the invention, with, in the cavity 2, a gas burner, a water inlet 49, a diffuser disc 50 for causing vaporization of the water in cooperation with the burner 11, a temperature probe 146, means 4 for controlling the oven, means 110 for controlling the burner 11, comprising the air pressure booster 19, the valve 60 and the mixer 18, and means 100 for varying the flow rate of the water inlet, the method of operating the oven will now be addressed.

[0059] It is desired to maintain saturated steam inside the oven, in the cavity 2, i.e. it is necessary to keep the temperature inside the cavity below the reference temperature θc (= 100°C), exceeded by a few degrees Δθ, in this case 4°C, only if strictly necessary, as indicated above.

[0060] To this end, firstly, the burner 11 is not switched off during cooking or heating of the food. The temperature θ in the oven having been increased on a regular basis before it reaches the reference temperature θc of 100°C, at the instant t1, the power of the oven is reduced, in this case by half, by operating the valve 60 and the pressure booster 19. Next, at the instant t2, when the temperature in the cavity reaches and exceeds the reference value θc, the amount of water injected into the cavity is increased in order to cause the temperature to drop. To that end, the solenoid valve 140 is opened, in this case to a large flow rate. The temperature continues to rise a little but rapidly drops again, falling below θc at the instant t3 when the solenoid valve 140 is closed, in order to reduce the amount of water injected by leaving the water inlet supplied only by the solenoid valve 142 and the pipe 132. After a few moments, the temperature rises again in order once more, at the instant t4, to rise above the reference threshold θc and so on and so forth, the temperature oscillating around the reference threshold in a temperature range whose amplitude is substantially equal to 2Δθ, which can be perfectly well tolerated by the food at the end of its cooking period.

[0061] If the temperature were, however, to reach θc + Δθ, the burner would be switched off while maintaining water injection at a large flow rate until the temperature again dropped below θc, the burner then being restarted and the flow rate becoming small.

Claims

1. Method for operating a grande cuisine professional oven (1), for cooking food, functioning at least by means of heating with the direct steam produced inside a cavity (2) of the oven using a gas burner (11) and water injected into the cavity (149, 100, 49, 55), **characterized in that**, during the cooking of the food and without stopping the burner (11), the amount of water injected into the cavity is increased (140) when the temperature in the cavity exceeds (t2) a reference temperature (θc) in order to cause the temperature in the cavity (2) to drop.

2. Method for operating an oven according to Claim 1, in which more water is injected by increasing the flow rate of a water supply.

3. Method for operating an oven according to Claim 1, in which more water is injected by opening (140) a second water supply (130).

4. Method for operating an oven according to one of Claims 1 to 3, in which the amount of water injected is reduced when the temperature in the cavity (2) again drops (t3) below the reference temperature (θc).

5. Method for operating an oven according to one of Claims 1 to 4, in which, before the temperature in the cavity reaches the reference temperature (θc), the power of the oven is reduced (t1).

6. Method for operating an oven according to Claim 5, in which, in order to reduce the power of the oven, the flow rate of the combustible gas/air mixture of the burner (11) is reduced.

7. Professional grande cuisine oven, for cooking food, functioning at least by means of heating with direct steam, comprising, in a cavity (2) of the oven, at least one gas burner (11), a water inlet (149), means (50) arranged in order, in cooperation with the burner (11), to cause vaporization of the water, means (146) for measuring the temperature inside the cavity (2), the oven also comprising control means (4) and means (110) for controlling the burner, which oven is **characterized in that** it further includes means (100) for varying the flow rate of the water inlet (149) that are controlled by the means (146) for measuring the temperature and the means (4) for controlling the oven.

8. Oven according to Claim 7, in which the water inlet (149) includes two pipes (132, 130) with flow rates controlled, respectively, by two valves (140, 142) controlled by the control means (4) of the oven.

9. Oven according to Claim 7, in which the water inlet includes a single inlet pipe controlled by a valve with variable flow rate.

10. Oven according to one of Claims 7 to 9, in which provision is made for means (110) for varying the power of the oven that are controlled by the means (4) for controlling the oven.

11. Oven according to one of Claims 7 to 10, in which the vaporization means comprise a rotary diffuser disc (50) arranged opposite the gas burner (11).

12. Oven according to Claim 11, in which the water inlet (149) injects water onto the diffuser disc (50) so that the water is at least partly vaporized by virtue of the heat produced by the gas burner (11).

13. Oven according to one of Claims 7 to 12, which is a combination oven that also includes means (12) for heating by convection.

14. Oven according to one of Claims 7 to 13, in which provision is made for a turbine (12) arranged inside the cavity (2) and including at least blades (22) rotating with the diffuser disc (50) about one and the same axis of rotation (21).

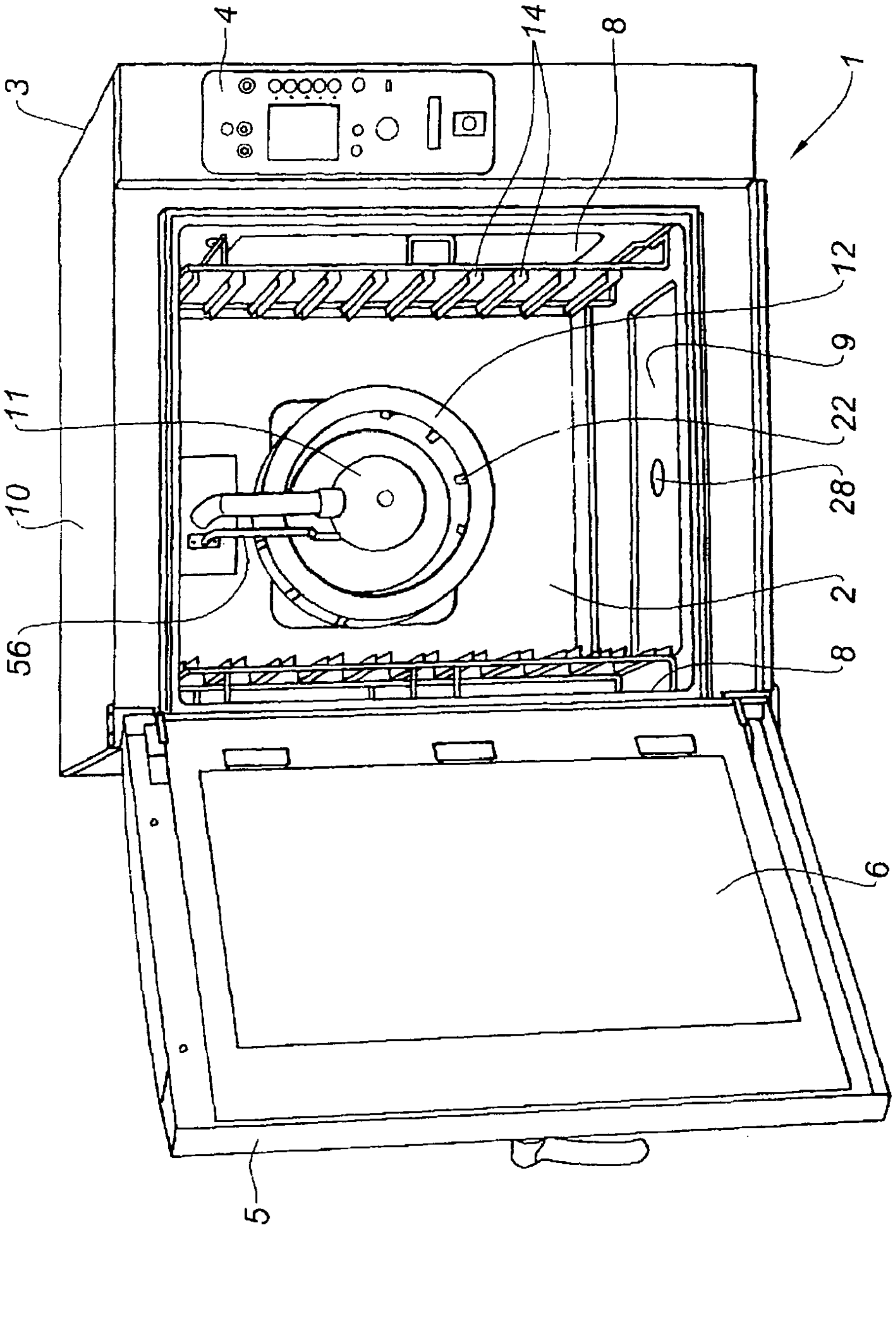

Fig. 1

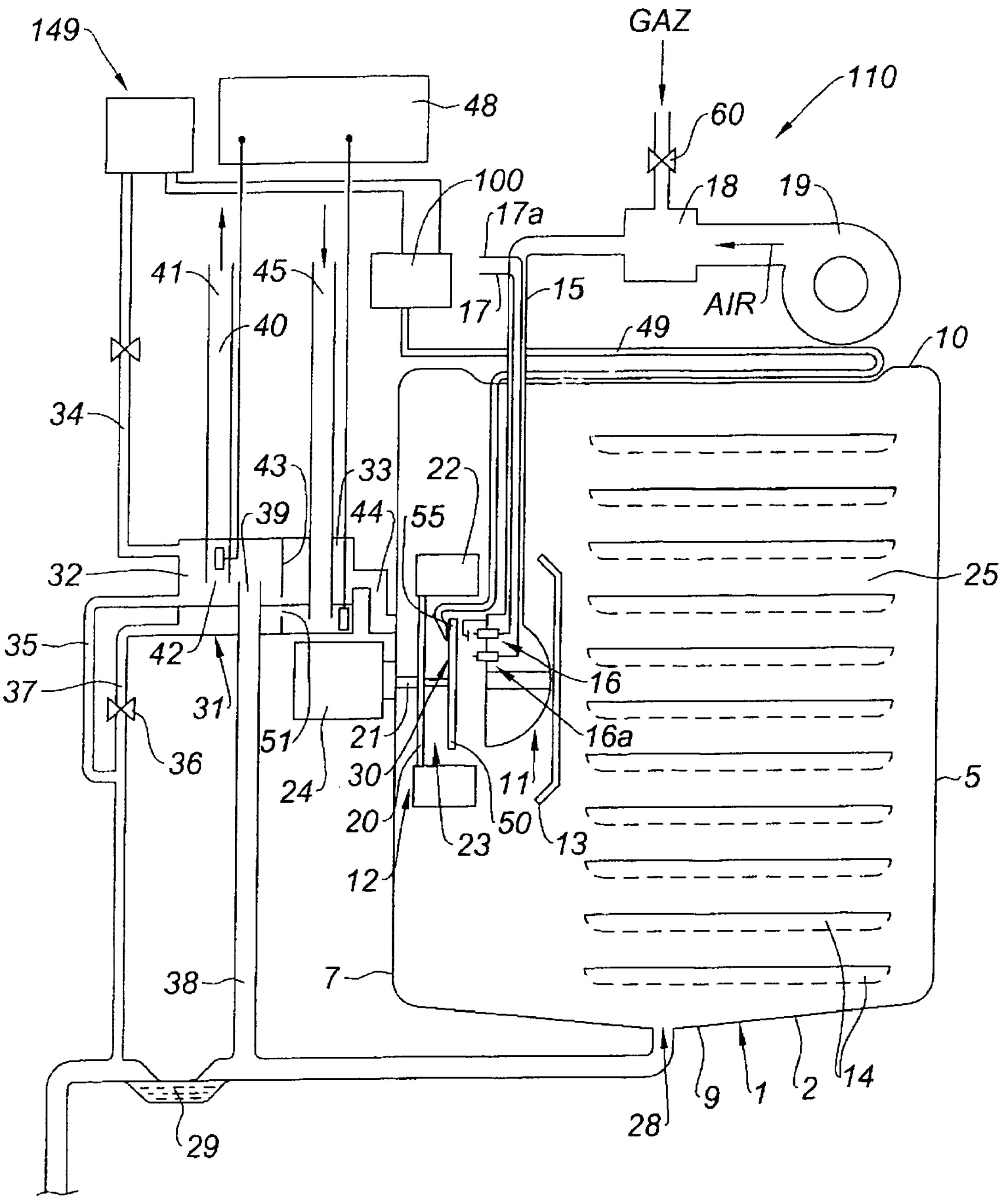
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Fig. 2

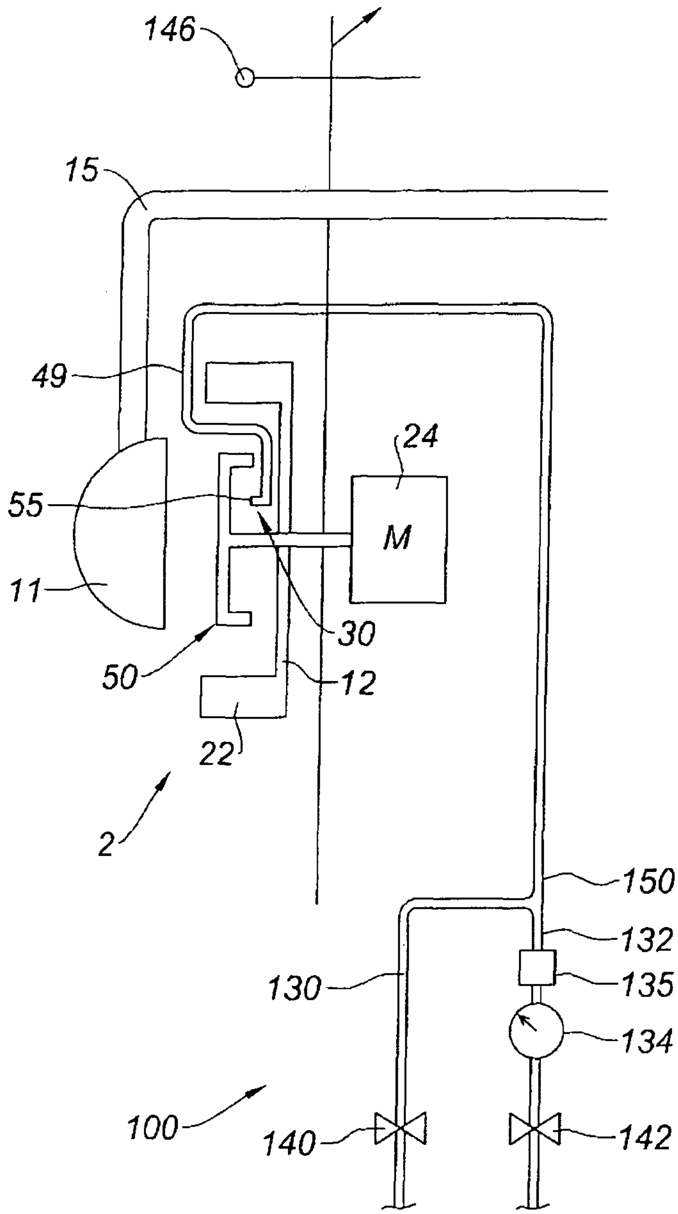

Fig. 3

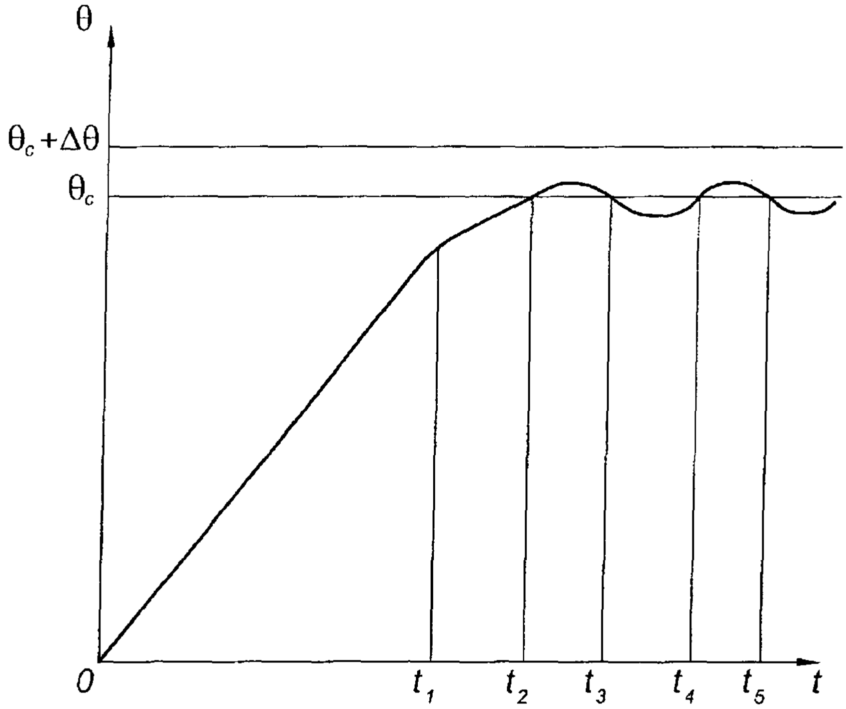

Fig. 4