(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 789 923 A1**

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
15.10.2014 Bulletin 2014/42

(51) Int Cl.:
F24C 15/32 *(2006.01)*

(21) Application number: **13162830.7**

(22) Date of filing: **09.04.2013**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

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(54) Household oven with an integrated water evaporator

(57) The invention relates to an oven comprising an oven cavity (10) with a closable opening (12) for receiving food to be cooked or baked, an evaporation cavity (26) in a bottom wall (24) of the oven cavity (10) and an evaporation heating element (28) being arranged for heating the evaporation cavity (26).

According to the invention the evaporation cavity (26) is formed as an embossment in the bottom wall (24) of the oven cavity (10) and the heating power of the evaporation heating element (28) is adapted to evaporate a volume of water to be evaporated that corresponds to the volume of such an embossment.

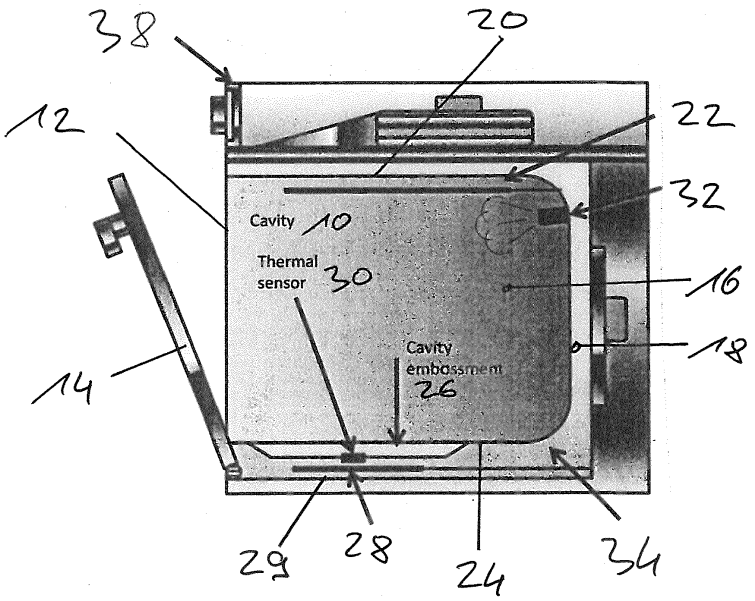

Fig. 1

EP 2 789 923 A1

Description

[0001] The present invention relates to an oven according to the preamble of claim 1.

[0002] Known household ovens comprise a cavity with a closable opening for receiving food to be cooked wherein the oven cavity is made of metal parts or sheets which are welded together to create the cavity. The internal sides of the cavity are often enameled. Heating elements are provided for heating the cavity. Top and grill heating elements are placed inside the cavity in the upper region, a ring heating element surrounds a convection cooking fan, whereas bottom heating elements are placed outside and underneath the cavity.

[0003] EP 0 279 065 A2 discloses an oven comprising in addition a steam generator. The steam generator comprises a pot which is mounted into an opening in the bottom wall of the oven cavity. A heating element is provided for heating water that is filled into the pot in order to generate steam which enters the oven cavity.

[0004] It is a disadvantage of such known ovens that the integration of a separate pot into the bottom wall of the oven cavity leads to an increase in production complexity and hence to additional costs. The insertion of a separate pot requires a corresponding hole in the bottom wall as well as a connection between pot and cavity like seam welds. Hence, the production of the parts and the assembly is not only rather complex, but such a solution also leads to possible cleanability issues. In addition, a separate pot defines a larger volume corresponding to larger amount of water to be received. Hence, corresponding heating elements are provided which supply a significant amount of heating power. As a result more steam is generated. In addition, steam outlets have to be provided for discharging excessive steam from the oven cavity.

[0005] It is therefore an object of the present invention to provide an oven with an evaporation cavity for water wherein the aforementioned disadvantages are overcome.

[0006] The invention is defined in claim 1.

[0007] Particular embodiments are set out in the dependent claims and are described with reference to the enclosed drawings in the following.

[0008] According to the invention the evaporation cavity is formed as an embossment in the bottom wall of the oven cavity, and the evaporation cavity has a maximum volume that is limited by the formation of the evaporation cavity as an embossment in the bottom wall of the oven cavity.

[0009] An advantage of an oven according to the present invention is the fact that such an oven is easy to produce and does not require complicated procedures during assembly. This is based on the fact that the evaporation cavity is a deep drawn impression in the bottom of the oven cavity. Such a deep drawing process is less complex and less expensive than the integration of a separate pot into the bottom of the oven cavity. The evaporation cavity can be defined during the deep drawing simultaneously with other reinforcement structures (against buckling) and can act itself as such a reinforcement structure since such an embossment also reinforces the bottom of the oven cavity against buckling issues. The resulting evaporation cavity can be cleaned easily since it is integrated in one piece and hence in a seamless manner into the bottom wall of the oven cavity. In addition, the volume of an embossment in the bottom of the oven cavity is smaller than the volume of known evaporation cavities.

[0010] In a preferred embodiment of the invention the evaporation cavity is integrally formed into the bottom wall of the oven cavity wherein the bottom wall of the oven cavity preferably is a sheet of metal and the evaporation cavity is embossed into this metal sheet.

[0011] Direct storage of the water in the embossment also allows ensuring condensation reflow in the embossment itself, which is helped by the typical shape of a cavity bottom including the embossment itself.

[0012] Moreover, no additional components are requested, and no further efficiency reduction due to an additional heat exchange occurs.

[0013] In a further preferred embodiment of the invention the evaporation heating element has a maximum heating power that is adapted to heat a volume of water to be evaporated that corresponds to the volume of said evaporation cavity. Thus, according to the present invention an evaporation heating element with reduced power can be used.

[0014] Since the present invention provides an oven with an evaporation cavity of a reduced size, also a reduced quantity of water is evaporated. Hence, an evaporation cavity according to the present invention which has a volume which is limited by its formation as an embossment in the bottom wall of the oven cavity, and in particular said evaporation cavity with an evaporation heating element with a corresponding power, cannot only be used as primary steam generator in case only a smaller amount of steam is required but also as a supplementary evaporator in case that a primary steam generator is already provided. In addition it can also be used in combination with a primary steam generator as a condensate evaporator only where condensed water shall be re-evaporated, or for baking or cooking where only a small amount of steam and humidity is desired.

[0015] In a further preferred embodiment the evaporation heating element is provided in an area underneath the evaporation cavity, preferably without having a direct mechanical contact to the evaporation cavity. Avoiding a direct contact reduces the thermal stress applied to the bottom wall of the cavity and reduces the danger of damaging an enamel coating since hot spots and critical thermal gradients are avoided.

[0016] Further preferably, the oven comprises a bottom heating element comprising a primary heater loop and a secondary heater loop, wherein the primary heater loop is arranged underneath the oven cavity in an area

that at least partially surrounds the area underneath the evaporation cavity and the evaporation heating element comprises said secondary heater loop, preferably wherein the primary heater loop at least partially surrounds the secondary heater loop. Hence bottom heat and evaporation are induced and controlled by different heater loops.

[0017] The primary heater loop and the secondary heater loop can be are arranged between the bottom wall of the oven cavity and a cover plate covering the heater loops. The bottom wall of the oven cavity and the cover plate hence define a box comprising the heater loops. This is particularly advantageous for the overall oven assembly process, and it allows a precise positioning of the loops in terms of distance from the bottom wall where a mandatory minimum distance is requested to ensure enamel integrity. This is due to the fact that an insulation blanket can be continuous (avoiding cutouts) and arranged outside and below the cover plate without touching or pushing the loops. This also ensures a more homogeneous irradiation, resulting in an even heat flow towards the whole cavity bottom. This effect is also based on reflection effects of the cover plate. The presence of the cover plate along with a continuous insulation blanket also minimizes the heat loss toward the outside of the cavity, optimizing the performances in terms of energy consumption.

[0018] Preferably the primary heater loop and the secondary heater loop are arranged on two different, essentially parallel planes, such that both heater loops maintain essentially the same distance from the bottom wall of the oven cavity, respectively in the area surrounding the area underneath the evaporation cavity and in the area underneath the evaporation cavity.

[0019] The primary heater loop and the secondary heater loop can preferably be arranged in a distance from the respective nearest point of the bottom wall of 5 to 25 mm, more preferably of 2 to 12 mm. This reflects a balance between the thermal stress applied to the bottom wall and a sufficient heat transfer.

[0020] The primary heater loop and the secondary heater loop can be controllable such that the primary heater loop can be activated together with or without the secondary heater loop. This offers the possibility to use the oven in a standard mode with bottom heat only (or in combination with top heat) or alternatively with additional steam generation. When heating both loops, the heat distribution is evened over the whole cavity bottom, avoiding thermal gradients which could lead to enamel damages.

[0021] Preferably, the primary heater loop and the secondary heater loop can be activated together by switching them into a series electrical connection wherein the primary heater loop and the secondary heater loop preferably are in an ohmic value ratio between 1/1 to 1/3, wherein the secondary heating element has higher ohmic value.

[0022] In a preferred embodiment the evaporation cavity is adapted to receive a volume of water to be evaporated which is preferably a volume between 10 and 300 ml, more preferably between 50 to 250 ml and the heating power of the evaporation heating element is adapted to evaporate such a volume of water. This supports use cases where rather small amount of steam are desired or where the evaporation cavity acts as a secondary steam generator together with an e.g. external primary steam generator.

[0023] At least an area of the bottom wall adjacent to the evaporation cavity can have a down-grade towards the evaporation cavity in order to direct a condensate towards and into the evaporation cavity and / or to stiffen the bottom wall wherein preferably the angle of the down-grade is in a range between 1 and 7 degrees with respect to the horizontal. Hence condensed water is guided towards the evaporation cavity and is evaporated again in order to control the humidity in the cavity or to maintain the bottom wall dry.

[0024] The evaporation cavity preferably has a diameter between 5 cm to 25 cm, more preferably between 7 cm and 17 cm and / or the embossment of the evaporation cavity has a maximum depth between 2 and 20 mm, more preferably between 5 and 10 mm.

[0025] In preferred embodiments the embossment defines the evaporation cavity by means of two consecutive bends leading to a downwardly orientated step in the bottom wall of the oven cavity wherein the bends have a respective radius between 5 and 20 mm, more preferably between 6 and 8 mm. Such radii turned out to provide a good base layer for enamel coatings since the risk of enamel damages is reduced. According edges are mild enough to prevent stresses on the enamel, avoid water flow blockage, and permit an effective cleaning action thanks to the absence of hindering areas where dirt or limestone can get stuck.

[0026] A bottom of the evaporation cavity can have a down-grade towards a center of the bottom of the evaporation cavity. This stiffens the evaporation cavity and improves the flow of condensate towards the center of the cavity.

[0027] In a further preferred embodiment the evaporation cavity or a bottom of the evaporation cavity is concave when seen from the inner side of the oven cavity, wherein preferably a curvature of the evaporation cavity or of the bottom of the evaporation cavity defines a radius between 200 and 500 cm, more preferably between 300 and 400 cm.

[0028] Preferably a temperature sensor is provided which is adapted to measure the temperature in the area of the evaporation cavity and to preferably control an electrical power provided towards the evaporation heating element.

[0029] In a further preferred embodiment the bottom of the oven cavity and the evaporation cavity is enameled at least on the side facing towards the oven cavity.

[0030] Preferably evaporation cavity is provided with a dirt cover, permeable to steam and shaped to allow

water and condensate flow from the cavity walls and bottom into the evaporation cavity.

[0031] An example of an oven according to the present invention is described below by reference to the accompanying schematic drawings in which:

Fig. 1 shows a cross-sectional side view of an oven according to the present invention, and

Fig. 2 shows a cross-sectional view from below,

Fig. 3 shows a view from below onto a bottom heating element,

Fig. 4 shows a side view of the bottom heating element of Fig. 3,

Fig. 5 shows a cavity bottom wall, heater loops and a cover plate in an exploded view,

Fig. 6 shows a circuit diagram of an evaporation heating element and a bottom heating element where both heating elements are activated, and

Fig. 7 shows the heating element of Fig. 3 in a switching state where only the bottom heating element is activated.

[0032] Fig. 1 shows an oven comprising a cavity 10 with a closable opening 12 for receiving food to be cooked or baked within the oven cavity 10. The opening 12 can be closed by means of a front door 14. The oven cavity 10 is defined by sidewalls 16, a rear wall 18, a top wall 20 and a bottom wall 24. A top heating or grill element 22 is mounted in the upper region of the oven cavity 10. The bottom wall 24 comprises an evaporation cavity 26 which is a deep drawn embossment. The embossment defining the evaporation cavity 26 is worked into a steel sheet constituting the bottom wall 24 during a shaping operation where the bottom wall 24 of the oven cavity 10 is defined. Like the bottom wall 24 also sidewalls 16, rear wall 18 and top wall 20 are made of steel sheets and are enameled. An evaporation heating element 28 is provided for heating the evaporation cavity 26 in an area 29 underneath the evaporation cavity 26. The heating power of the evaporation heating element 28 is adapted to evaporate a volume of water to be evaporated that corresponds to the volume of the evaporation cavity 26. The evaporation cavity 26 together with the evaporation heating element 28 act as a steam generation system. Water can be conveyed into the evaporation cavity 26 either by direct pouring or by means of a pipe or a channel. By activation of the evaporation heating element 28 the water is evaporated. The evaporation heating element 28 is arranged in an area 29 underneath the evaporation cavity 26 and can be a second branch of an also provided standard bottom heating element with independent control. This will be explained in more detail in connection with the following Figures. The evaporation heating element 28 is self-supporting and not in direct contact with the bottom wall 24 and the embossment defining the evaporation cavity 26. As an alternative, such an evaporating heating element can be a heating device directly fixed onto the external surface of the embossment defining the evaporation cavity 26 (e.g. a standard heater, a thick film heater, welded, glued or fixed by other means directly onto the external surface of the evaporation cavity 26). A thermostat or temperature sensor 30 is applied to the external surface of the evaporation cavity 26 to prevent overheating (e.g. upon run-out of water) or to control the power delivery and hence the evaporation. The oven can also comprise a steam inlet 32 which is connected to an (not shown) external steam generator so that the evaporation cavity 26 together with the evaporation heating element 26 acts as auxiliary generator or condensation re-evaporator collecting condensate and re-evaporating it. But of course the evaporation cavity 26 and the evaporation heating element 28 can also be used as the only source of steam and / or humidity without an additional steam generator. The evaporation cavity 26 can be protected by a cover, shaped to fit onto it in order to prevent food debris to get in contact with the hot evaporation cavity 26 which would lead to cleanability issues. Since the evaporation cavity 26 is preferably designed to receive a volume of water between 10 and 300 ml, more preferably between 50 to 100 ml, the evaporation heating element 28 preferably provides a heating power between 300 and 800 W so as to be adapted to evaporate an according volume of water during a typical cooking or baking time. A user interface 38 is provided for controlling the oven.

[0033] Fig. 2 shows the oven of Fig. 1 in a sectional view from below. A cover plate which normally covers heater loops, is removed. As can be seen from Fig. 2, the oven comprises an electrical bottom heating element 27 which in turn comprises a primary heater loop 40 for providing bottom heat to the oven cavity 10. This primary heater loop 40 is surrounded by a secondary electrical heater loop 42 which relates to the evaporation heating element 28. The secondary heater loop 42 is provided in an area 29 underneath the evaporation cavity 26 whereas the primary heater loop 40 is arranged in an area 31 that excludes the area 29 underneath the evaporation cavity 26. Primary heater loop 40 is arranged underneath the oven cavity 10 too.

[0034] Figures 3 and 4 show a primary heater loop 40 and a secondary heater loop 42 which are arranged in two different, essentially parallel planes 40b and 42b, respectively. These heater loops 40 and 42 can be installed in the oven according to Figures 1 and 2 (where the corresponding loops 40 and 42 are shown more schematically). Both planes 40b and 42b are arranged in a distance D to each other wherein the plane 42b comprising the secondary heater loop 42 is above the plane 40b of the primary heater loop 40, wherein "above" refers to an assembled condition of the oven. The distance D be-

tween both planes 40b and 42b is such that both heater loops 40 and 42 maintain essentially the same distance from the bottom wall 24 of the oven cavity, respectively in the area 31 surrounding the area 29 underneath the evaporation cavity 26 and in the area 29 under the evaporation cavity 26.

[0035] Fig. 5 shows the cavity bottom wall 24 with the evaporation cavity 26 the heater loops comprising the primary heater loop 40 and the secondary heater loop 42 and a cover plate 50 in an exploded view. The cover plate 50 is designed for protecting the primary heater loop 40 and the secondary heater loop 42. In addition to the evaporation cavity 26 also additional reinforcing structures 36 are embossed or deep drawn into the bottom wall 24. A heat insulating layer e.g. of a fibrous material will be arranged below the cover plate 50.

[0036] Figs. 6 and 7 show a schematic connection diagram comprising the primary heater loop 40 and a secondary heater loop 42 of Figures 2 and 5. According to Fig. 6 a first end 42a of secondary heater loop 42 is connected to electrical ground 64. A second end 42b of secondary heater loop 42 is connected to a first end 40a of primary heater loop 40 which in turn is also connected via a breaker 62 to electrical ground 66. A second end 40b of primary heater loop 40 is connected via breaker 68 to a source of electrical power 70. When, as shown in Fig. 6, breaker 68 is closed (conducting) and breaker 62 is open, both heater loops 40 and 42 are switched into a series electrical connection and are activated by a current running from the source of electrical power 70 to electrical ground 64.

[0037] In the configuration of Fig. 7 where both breakers 62 and 68 are closed the electrical current is running from the source of electrical power 70 through the primary heater loop 40 and through the closed breaker 62 to electrical ground 66 (due to the low resistance of breaker 62 in comparison to secondary heater loop 42). In this case only primary heater loop 40 is activated (heated) whereas secondary heater loop 42 is basically switched off so that the evaporation cavity 26 is not heated directly. Therefore, the second configuration of Fig. 5 relates to the case where the oven is used with bottom heating only and without steam generation.

Claims

1. Oven comprising
   an oven cavity (10) with a closable opening (12) for receiving food to be cooked or baked,
   an evaporation cavity (26) arranged in a bottom wall (24) of the oven cavity (10),
   an evaporation heating element (28) being arranged for heating the evaporation cavity (26),
   characterized in that,
   the evaporation cavity (26) is formed as an embossment in the bottom wall (24) of the oven cavity (10) and the evaporation cavity has a maximum volume that is limited by the formation of the evaporation cavity as an embossment in the bottom wall of the oven cavity.

2. Oven according to claim 1, **characterized in that** the evaporation heating element (28) has a maximum heating power that is adapted to heat a volume of water to be evaporated that corresponds to the volume of said evaporation cavity (26).

3. Oven according to claim 1 or 2, **characterized in that** the evaporation cavity (26) is integrally formed into the bottom wall (24) of the oven cavity (10) wherein the bottom wall (24) of the oven cavity (10) preferably is a sheet of metal and the evaporation cavity (26) is embossed into this metal sheet.

4. Oven according to any of the preceding claims, **characterized in that** the evaporation heating element (28) is provided in an area (29) underneath the evaporation cavity (26), preferably without having a direct mechanical contact to the evaporation cavity (26).

5. Oven according to claim 4, **characterized in that** the oven comprises a bottom heating element (27) comprising a primary heater loop (40) and a secondary heater loop (42), wherein the primary heater loop (40) is arranged underneath the oven cavity (10) in an area (31) that at least partially surrounds the area (29) underneath the evaporation cavity (26) and the evaporation heating element (28) comprises said secondary heater loop (42), preferably wherein the primary heater loop (40) at least partially surrounds the secondary heater loop (42).

6. Oven according to claim 5, **characterized in that** the primary heater loop (40) and the secondary heater loop (42) are arranged between the bottom wall (24) of the oven cavity (10) and a cover plate (50) covering the heater loops (40, 42).

7. Oven according to claim 5 or claim 6, in that the primary heater loop (40) and the secondary heater loop (42) are arranged in two different, essentially parallel planes (40b, 42b), such that both heater loops (40, 42) maintain essentially the same distance from the bottom wall (24) of the oven cavity, respectively in the area (31) surrounding the area (29) underneath the evaporation cavity (26) and in the area (29) underneath the evaporation cavity (26).

8. Oven according to any of the preceding claims 5 to 7, **characterized in that** the primary heater loop (40) and the secondary heater loop (42) are controllable such that the primary heater loop (40) can be activated together with or without the secondary heater loop (42), in particular wherein the primary heater loop (40) and the secondary heater loop (42) can be

activated together by switching them into a series electrical connection.

9. Oven according to any of the preceding claims, **characterized in that** at least an area of the bottom wall (24) adjacent to the evaporation cavity (26) has a down-grade towards the evaporation cavity (26) in order to direct a condensate towards and into the evaporation cavity (26) and / or to stiffen the bottom wall (24).

10. Oven according to any of the preceding claims, **characterized in that** the embossment defines the evaporation cavity (26) by means of two consecutive bends leading to a downwardly orientated step in the bottom wall of the oven cavity.

11. Oven according to any of the preceding claims, **characterized in that** a bottom of the evaporation cavity (26) has a down-grade towards a center of the bottom of the evaporation cavity (26).

12. Oven according to any of the preceding claims, **characterized in that** the evaporation cavity (26) or a bottom of the evaporation cavity is concave when seen from the inner side of the oven cavity (10).

13. Oven according to any of the preceding claims, **characterized in that** a temperature sensor (30) is provided which is adapted to measure the temperature in the area of the evaporation cavity (26) and to preferably control an electrical power provided towards the evaporation heating element (28).

14. Oven according to any of the preceding claims, **characterized in that** the bottom wall (24) of the oven cavity (10) and the evaporation cavity (26) are enamelled at least on the side facing towards the oven cavity (10).

15. Oven according to any of the preceding claims, **characterized in that** the evaporation cavity (26) is provided with a dirt cover, permeable to steam and shaped to allow water and condensate flow from the cavity walls and bottom into the evaporation cavity (26).

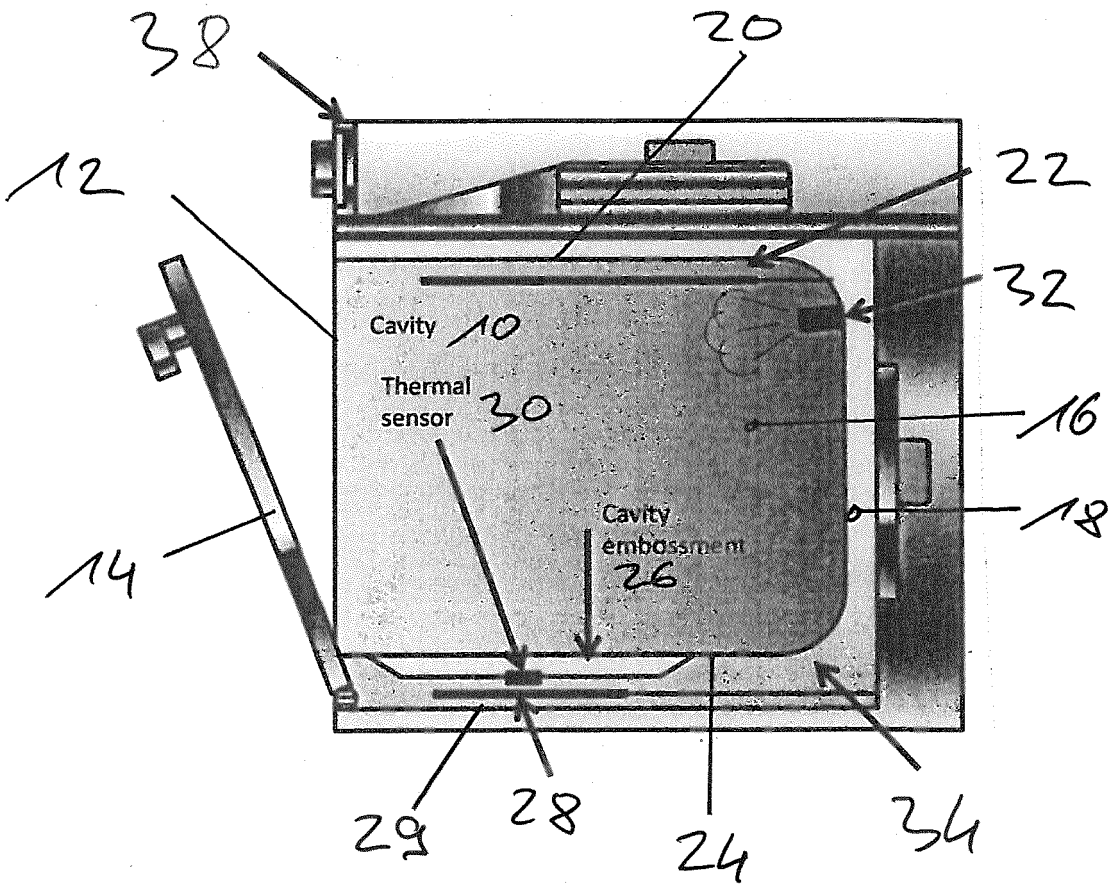
38
20
12
22
32
Cavity 10
Thermal sensor 30
16
18
Cavity embossment 26
14
29
28
24
34

Fig. 1

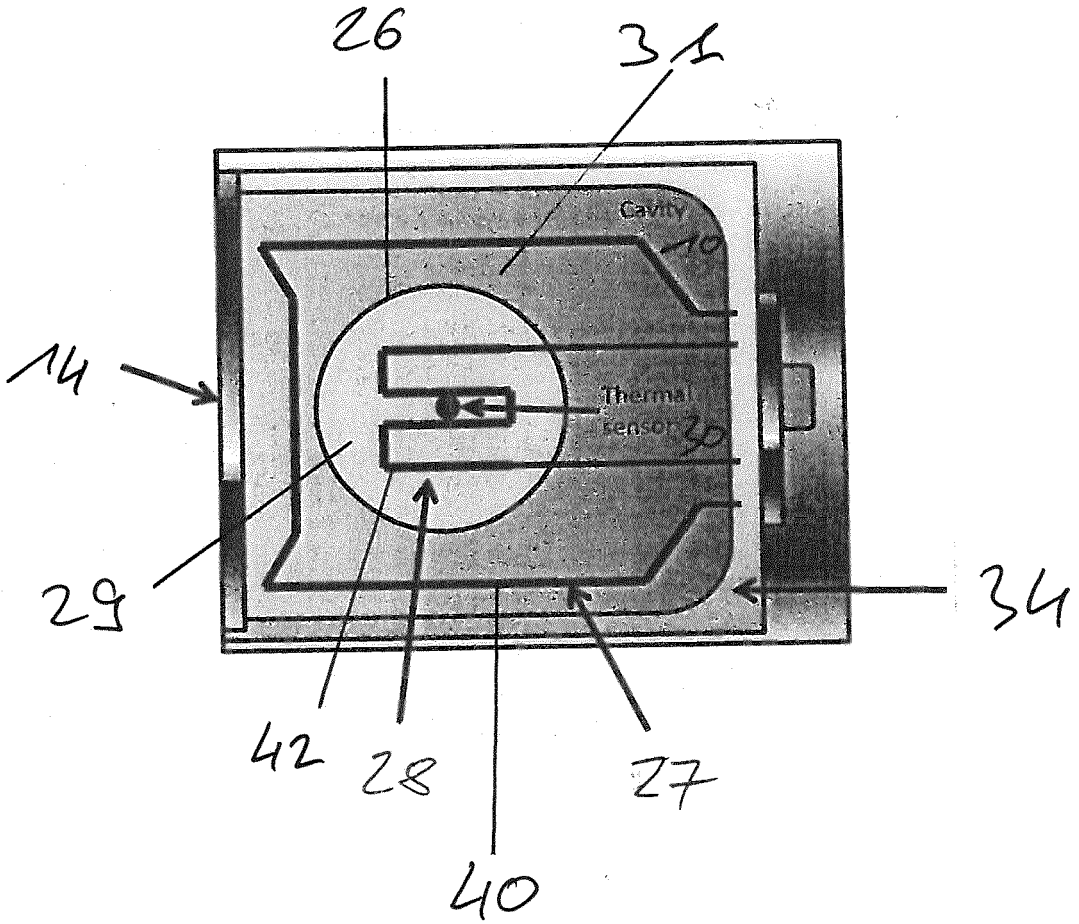

Fig. 2

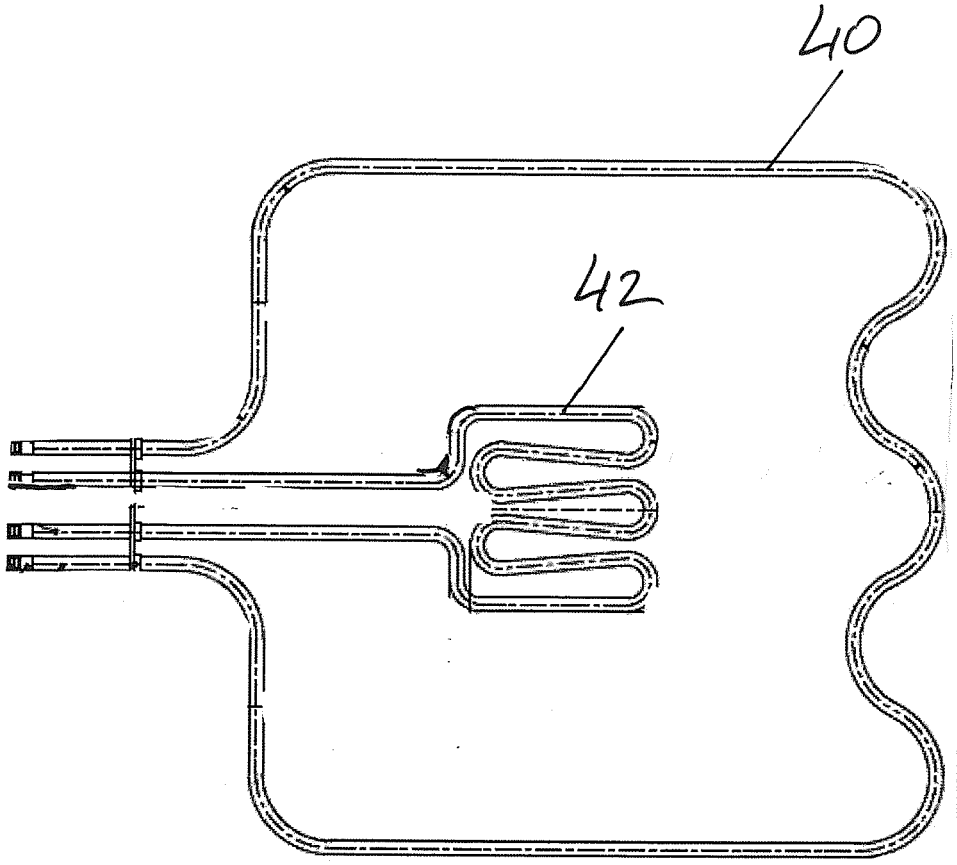

Fig. 3

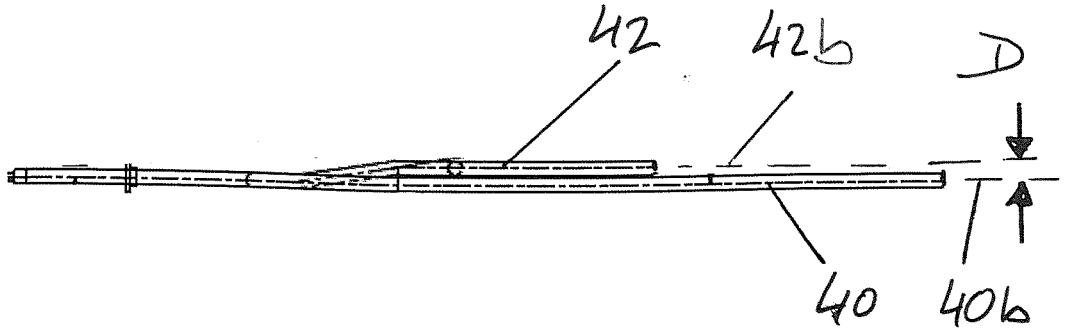

Fig. 4

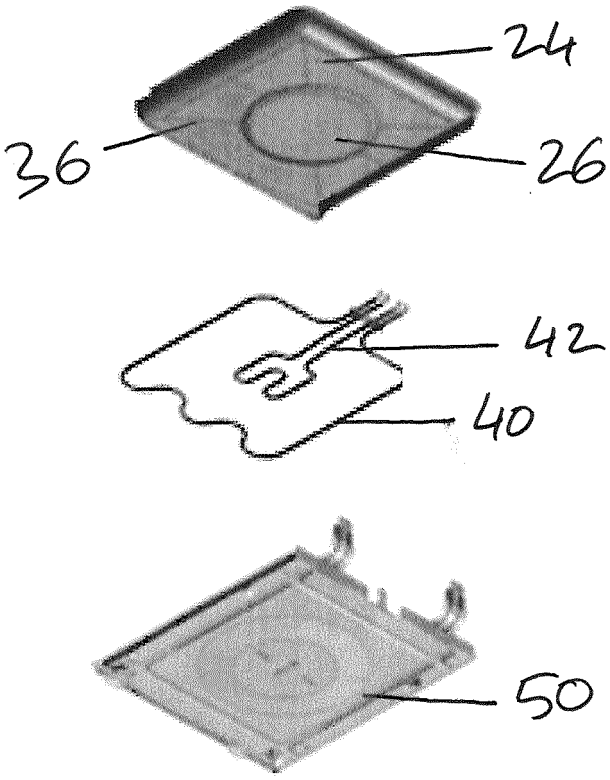

Fig. 5

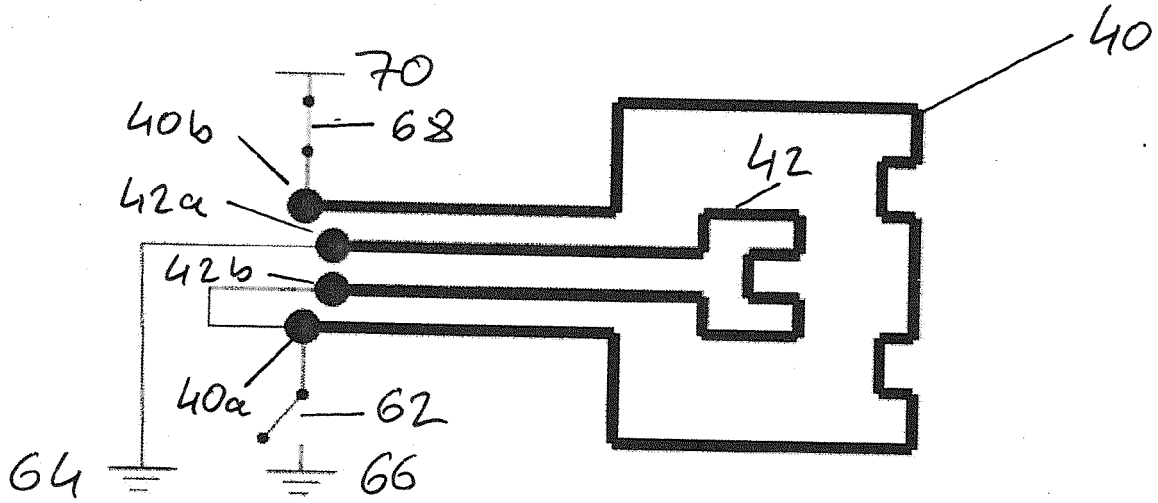

Fig. 6

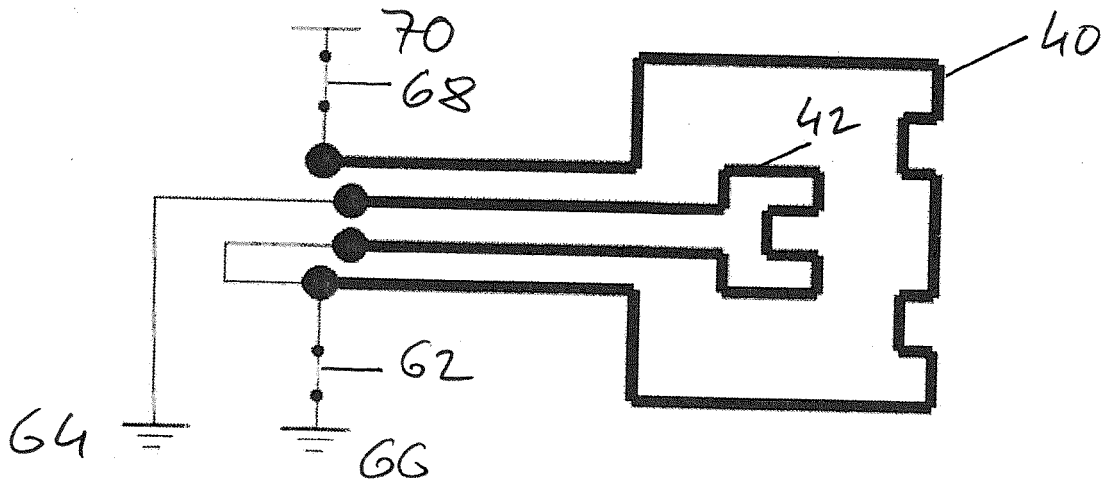

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 13 16 2830

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	11 June 2013	Fest, Gilles

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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