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(54) **Microwave oven with radiant heating element**

(57) A microwave oven has a radiant heating element (139) in its cooking chamber (101). The heating element (139) can be pivoted between a horizontal position above a turntable (138) and a vertical position to one side of the turntable (138). The horizontal position

is used for grilling and the vertical position is used for fan-assisted convection heating. A shield (150) is mounted to the heating element (139) so that infrared radiation is not radiated directly to food (F) on the turntable (138) when fan-assisted convection heating is taking place.

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Description

[0001] The present invention relates to a microwave oven having a cooking chamber and an electric heating element mounted in the cooking chamber for movement between horizontal and vertical configurations.

[0002] Microwave ovens and their mode of operation are well known. Recently, radiant heating elements have been added to microwave ovens. The radiant heating elements can be used for two modes of cooking: grilling mode and fan-assisted convection mode.

[0003] In the grilling mode, food is heated by infrared radiation from the heating element directly so that browning of the food can occur. In the convection mode, the heating element is used to heat the air in the cooking chamber which then heats the food.

[0004] Referring to Figure 5, which is a cross-sectional view a known microwave oven having a grill heating element and a separate convection heating element, a grill heating element 22 is mounted horizontally at the top of a cooking chamber 12 and a convection heating element 24 and a fan assembly 26 are mounted behind a rear panel 13 of an inner case 11 which forms the cooking chamber 12. The fan assembly 26 has a motor 27, a fan 28, and a motor cooling fan 29. An insulation plate 19 is mounted on the rear panel 13 and disposed between the fan 28 and the motor cooling fan 29, so that the insulation plate 19 prevents transmission of heat generated from the heating element 24 to the motor 27. A back panel 18 is fixed to the rear panel 13, enclosing the fan assembly 26. The rear panel 13 has a plurality of inlet holes 14 and outlet holes 15 in order for air to flow in and out of a rear space 16 between the cooking chamber 12 and the rear panel 13.

[0005] In the grill mode, electric power is applied to the grill heating element 22 and infrared radiation irradiates the F from the grill heating element 22. In the convection mode, electric power is applied to the convection heating element 24 and the fan 28 of the fan assembly 26. As the fan 28 rotates, air in the cooking chamber 12 flows into the space 16 between the rear panel 13 and the insulation plate 19 through the plurality of inlet holes 14 of the rear panel 13. The air that has flowed into the space 16 is heated by the convection heating element 24, and the heated air is driven into the cooking chamber 12 through the plurality of outlet holes 15 of the rear panel 13. While the air circulates in the cooking chamber 12 and the rear space 16 behind the rear panel 13, the food F is heated by air heated by the convection heating element 24.

[0006] Recently, it has been proposed to install a single pivoting heating element, as shown in Figure 6. Referring to Figure 6, a heating element 22' for both grilling mode and convection mode is rotatably mounted so that it can be pivoted between a horizontal position at the top of the cooking chamber 12' and a vertical position at the back of the cooking chamber 12'. A fan assembly 26' and a back panel 18' are mounted behind a rear panel

13'. The rear panel 13' has a plurality of inlet holes 14' and a plurality of outlet holes 15' in order for air to flow into and out of a rear space 16' between the cooking chamber 12' and the rear panel 13'. An insulation plate 19' is mounted along the perimeter of the rear panel 13'. Since, the heating element 21' is mounted in the cooking chamber 12', there is a relatively long distance between the heating element 22' and a motor 27' of the fan assembly 26', so that the insulation plate 19' is smaller than the insulation plate in the microwave oven shown in Figure 5.

[0007] In the grilling mode, the heating element 22' is horizontally disposed at the top of the cooking chamber 12' and the fan assembly 26' is not driven. The food F is irradiated directly with infrared radiation produced by the heating element 22'. In the convection mode, the heating element 22' is rotated by a rotator into its vertical position. In this case, when the fan assembly 26' is driven, air in the cooking chamber 12' is circulated between the cooking chamber 12' and the rear space 16' by the fan 28', and heat from the heating element 22' is transmitted to the food F by the circulating air so that the food F is heated.

[0008] However, the above-described microwave oven having the dual use heating element 22' ('dual use heating element' refers to a "heating element for both the grilling mode and the convection mode") has the following drawback. Since the heating element 22' is vertically positioned at the back of the cooking chamber 12' in the convection mode, food is subject to infrared radiation directly from the heating element 22'. Accordingly, the microwave oven has a drawback in that the food F is not heated evenly in the convection mode. Furthermore, as a user removes cooked food from the microwave oven, it is possible that the user's hand could be burnt by the heating element 22'.

[0009] A microwave oven according to the present invention is characterised by shield means for preventing direct irradiation of food by the heating element when the heating element is in said vertical configuration.

[0010] Preferably, the heating element is above a food receiving part of the cooking chamber when in its horizontal configuration.

[0011] Conveniently, the heating element is to one side of a food receiving part of the cooking chamber when in its vertical configuration.

[0012] Preferably, the shield means is mounted for movement with the heating element. More preferably, when the heating element is in its horizontal configuration, the shield means is above the heating element. Still more preferably, the shield means comprises a panel coupled to the heating element. The panel is preferably perforated but substantially free of perforations aligned with the heating element which would allow direct irradiation of food with the heating element in its vertical configuration.

[0013] Preferably, a fan is included for circulating air through the chamber, during which operation the air is

drawn past the heating element out of the cooking chamber when the heating element is in its vertical configuration.

[0014] An embodiment of the present invention will now be described, by way of example, with reference to Figures 1 to 4 of the accompanying drawings, in which: -

Figure 1 is an exploded perspective view of a microwave oven according to the present invention;
Figure 2 is a bottom perspective view showing the radiation shield and a heating element of the microwave oven of Figure 1;

Figure 3 is a side cross-sectioned view showing the heating element of Figure 1 in the grilling mode position;

Figure 4 is a side cross-sectioned view showing the heating element of Figure 1 in the convection mode position;

Figure 5 is a side cross-sectioned view showing a known microwave oven having a grill heating element and a convection heating element separately mounted; and

Figure 6 is a side cross-sectioned view showing a known microwave oven having a single heating element for both a grilling mode and a convection mode.

[0015] Referring to Figure 1, a microwave oven has inner and outer bodies 120, 112, and various electric components mounted between the inner and outer bodies 120, 112. The inner body 120 is divided by a partition 126 into a cooking chamber 101 and an electrical component chamber 102. An upper panel 124 of the inner body 120 forms the top of the cooking chamber 101. A door 114 is mounted at the front of the cooking chamber 101 and a control panel 116 is mounted at the front of the electric component chamber 102.

[0016] A fan assembly 141 and a back panel 118 are mounted behind a rear panel 122 of the inner body 120. A rectangular insulator 119 (Figure 3) is mounted along the perimeter of the rear panel 122. The rear panel 122 has a plurality of holes 123 so that air can easily flow into and out of the cooking chamber 101 and a rear space 103 behind the rear panel 122. The fan assembly 141 has a fan 142 for generating an air current between the cooking chamber 101 and the rear space 103 behind the rear panel 122, a motor 143 for driving the fan 142, a motor cooling fan 144 mounted coaxially to the fan 142 in order to cool the motor 143, and a bracket 145 for attaching the motor 143 to the back panel 118.

[0017] The electric component chamber 102 includes microwave generating parts for radiating microwaves into the cooking chamber 101, including a magnetron 132 for generating microwaves, a high-voltage transformer 134, a high-voltage diode 135, and a high-voltage capacitor 136 for driving the magnetron 132, a waveguide for guiding the generated microwaves to the cooking chamber 101 from the magnetron 132, and a cooling fan

137 for cooling the parts in the electric component chamber 102, and so on.

[0018] A turntable 138 for holding food F and a motor 146 for rotating the turntable 138 are mounted at the bottom of the cooking chamber 101 and a heating element assembly is mounted at the top of the cooking chamber 101. The heating element assembly has a rotator (not shown) for rotating the heating element 139 and a radiation shield 150. The heating element 139 is mounted for rotation between a horizontal position by the roof of the cooking chamber 101 and a vertical position by the rear panel 122 of the cooking chamber 101. The rotator rotates the heating element 139 between the horizontal position and the vertical position according to the cooking mode and could be automatically or manually operable. The rotator may be as described in US-A-5793023 or US-A-5534681. The shield 150, as shown in Figure 2, is mounted to one side of the heating element 139 by a plurality of fasteners 152. Each one of the fasteners is ring-shaped and is fixed to one side of the shield 150. Each of the fasteners 152 has a slit through which the heating element 139 is pressed. The shield 150 has a plurality of inlet holes 154 formed on the centre portion thereof and a plurality of outlet holes 156 formed in its margin. When the heating element 139 is horizontally positioned, the shield 150 is positioned between the heating element 139 and the upper panel 124 of the inner body 120. In this state, the shield 150 reflects the radiation from the heating element 139 downwards.

[0019] When the heating element 139 is rotated to be vertically positioned, the heating element 139 fixed to the shield 150 is positioned by the rear panel 122 of the inner body 120. Air, which is circulated by the fan assembly 141, flows into and out of the cooking chamber 101 and the rear space 103 through the inlet holes 154 and outlet holes 156 in the shield 150.

[0020] The operation of the microwave oven in the grilling and convection modes will now be described.

[0021] When food F is cooked using the grilling mode, the heating element 139, as shown in Figure 3, is horizontally positioned at the top of the cooking chamber 101 and the shield 150 is positioned between the roof of the cooking chamber 101 and the heating element 139. Accordingly, infrared radiation generated by the heating element 139 is transmitted to the food F located on the turntable 138. The surface of the food F is browned by the infrared radiation.

[0022] When food F is cooked in the convection mode, the heating element 139, as shown in Figure 4, is vertically positioned by the rear panel 122 of the inner body 120. In this state, the heating element 139 is positioned between the shield 150 and the rear panel 122. The fan 142 of the fan assembly 141 is operated together with the heating element 139. Air in the cooking chamber 101 is drawn into the rear space 103 through the inlet holes 154 in the insulation plate 150 and holes 123 in the rear panel 122 by the fan 142 and the air in the

rear space 103 is driven into the cooking chamber 101 through holes 123 in the rear panel 122 and the outlet holes 156 in the shield 150, thereby circulating as shown by the arrows in Figure 4. The air is heated by the heating 139 when passing between the shield 150 and the rear panel 122, and the heated hot air transmits thermal energy to the food F in the cooking chamber 101 to heat the food F.

[0023] The infrared radiation generated by the heating element 139 is not transmitted to the cooking chamber 101 because of the shield 150 but reflected towards the rear panel 122. Accordingly, the infrared radiation from the heating element 139 is not directly transmitted to the food F in the cooking chamber 101, but heats the ambient air around the heating element 139. As a result, since the food F is heated by a flow of hot air, the food F is evenly and entirely heated. As stated above, the grilling and convection modes may be performed alone or with microwave heating by means of the magnetron.

Claims

1. A microwave oven having a cooking chamber (101) and an electric heating element (139) mounted in the cooking chamber (101) for movement between horizontal and vertical configurations, characterised by shield means (150) for preventing direct irradiation of food by the heating element (139) when the heating element (139) is in said vertical configuration.
2. A microwave oven according to claim 1, wherein the heating element (139) is above a food receiving part (138) of the cooking chamber (101) when in its horizontal configuration.
3. A microwave oven according to claim 1 or 2, wherein the heating element (139) is to one side of a food receiving part (138) of the cooking chamber when in its vertical configuration.
4. A microwave oven according to claim 1, 2 or 3, wherein the shield means (150) is mounted for movement with the heating element (139).
5. A microwave oven according to claim 4, wherein, when the heating element (139) is in its horizontal configuration, the shield means (150) is above the heating element (139).
6. A microwave oven according to claim 4 or 5, wherein the shield means (150) comprises a panel (150) coupled to the heating element (139).
7. A microwave oven according to claim 6, wherein the panel (150) is perforated.
8. A microwave oven according to claim 7, wherein the panel (150) is substantially free of perforations (156, 154) aligned with the heating element (139).
9. A microwave oven according to any preceding claim, including a fan (122) for circulating air through the cooking chamber (101), wherein the fan (122) draws air past the heating element (139) out of the cooking chamber (101) when the heating element (139) is in its vertical configuration.
10. A microwave having a heater, comprising:
 - a body having a cooking chamber for cooking food, and a rear panel forming the cooking chamber and having a plurality of through holes;
 - means for generating and radiating a microwave toward the cooking chamber;
 - a heater assembly having a heater rotatably mounted between a horizontal position on an upper portion of the cooking chamber and a vertical position opposite to the rear panel, and a rotator for rotating the heater;
 - a convection fan assembly mounted behind the rear panel for generating an air convection current in the cooking chamber through the plurality of through holes of the rear panel; and
 - means for preventing a direct transmission of a radiation heat of the heater to the food in the cooking chamber.
11. The microwave as claimed in claim 10, wherein the preventing means includes:
 - an insulation plate having a plurality of inlet holes and a plurality of outlet holes for enabling air to pass through when the air is flown by the convection fan assembly, in a manner that the heater is between the insulation plate and the rear panel and is opposite to the rear panel; and
 - a plurality of fastening members for connecting the insulation plate to the heater so that the insulation plate can be rotated together with the heater.
12. The microwave as claimed in claim 11, wherein the plurality of inlet holes are formed at a center portion of the insulation plate and a plurality of outlet holes are formed along a perimeter of the insulation plate.
13. The microwave as claimed in claim 11, wherein each of the plurality of fastening members is fixed to the insulation plate, while each of the fastening members is ring-shaped with an opening to fit one portion of the heater.

FIG. 1

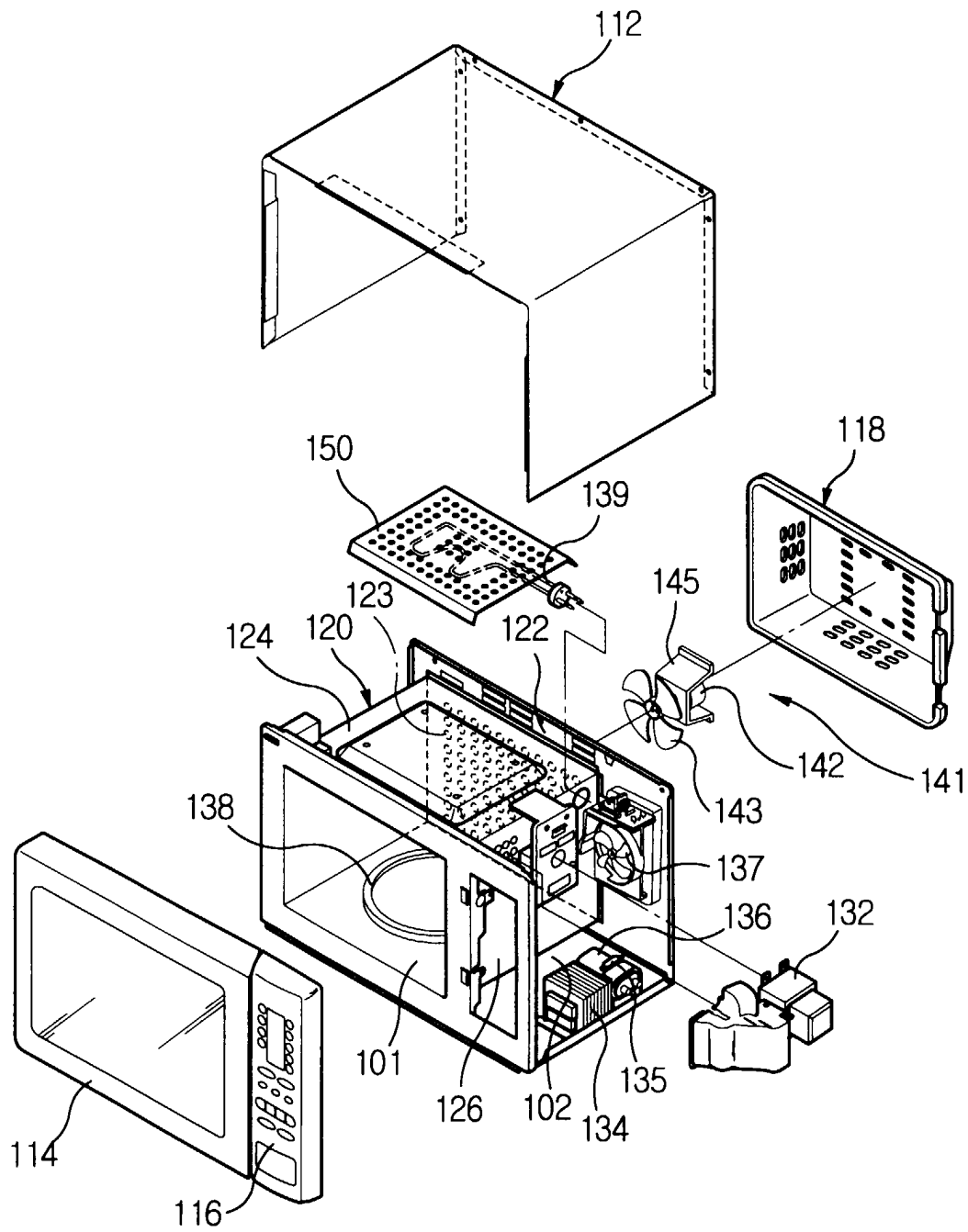


FIG.2

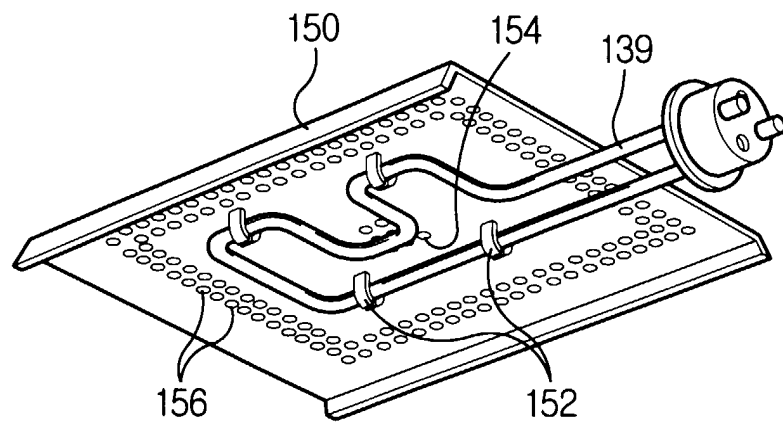


FIG.3

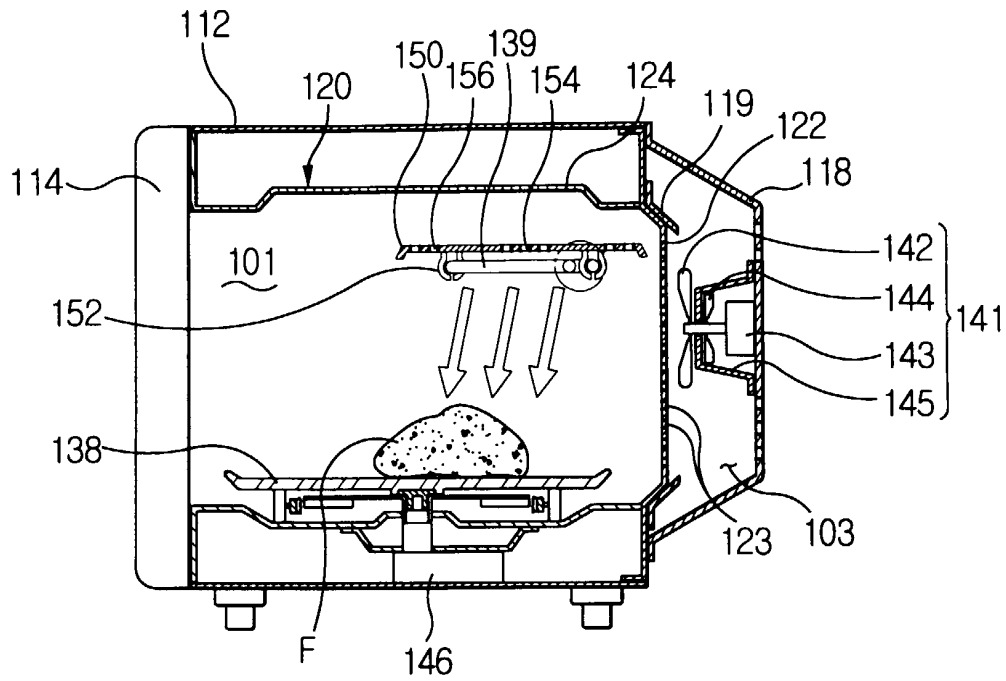


FIG.4

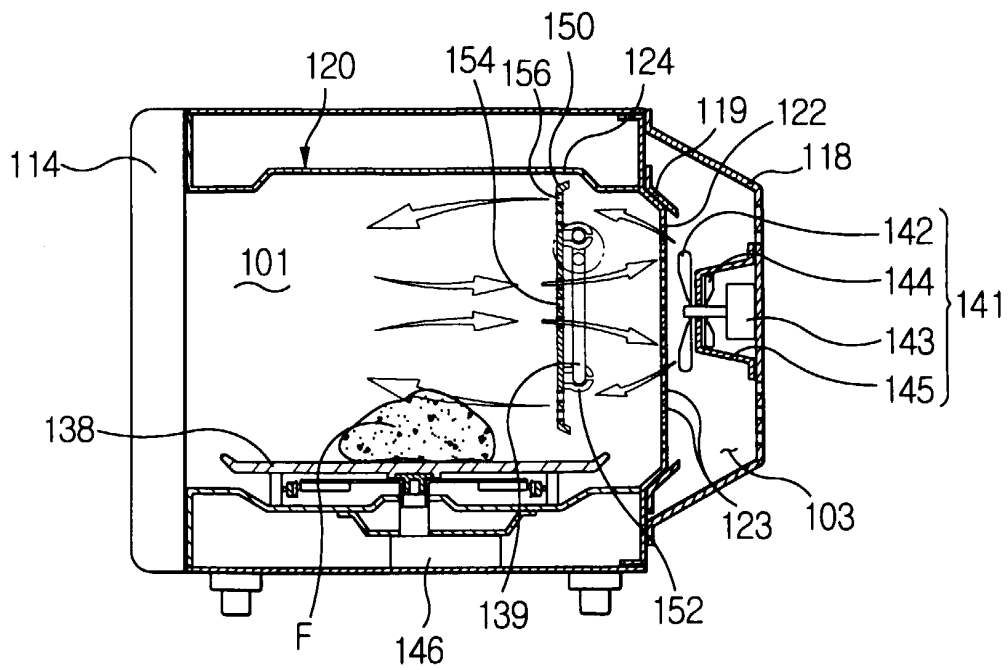


FIG.5

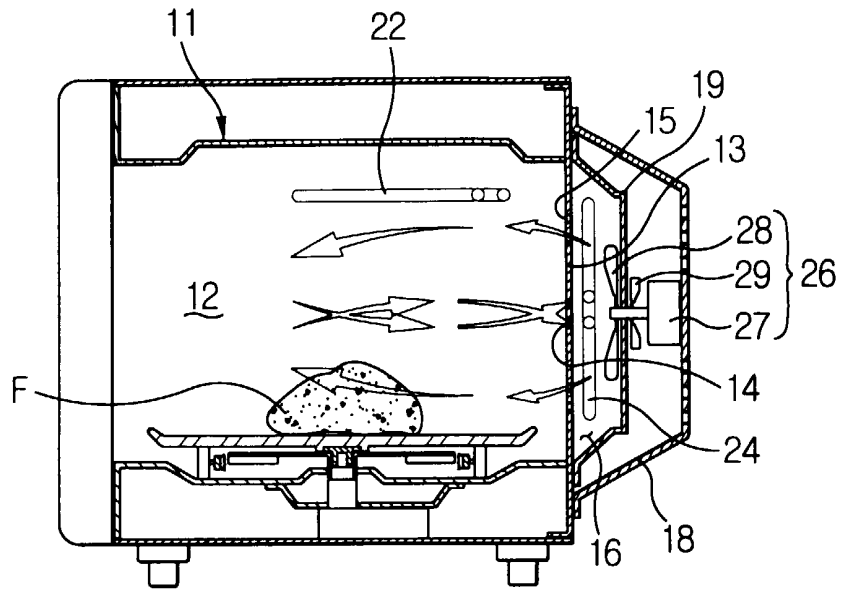
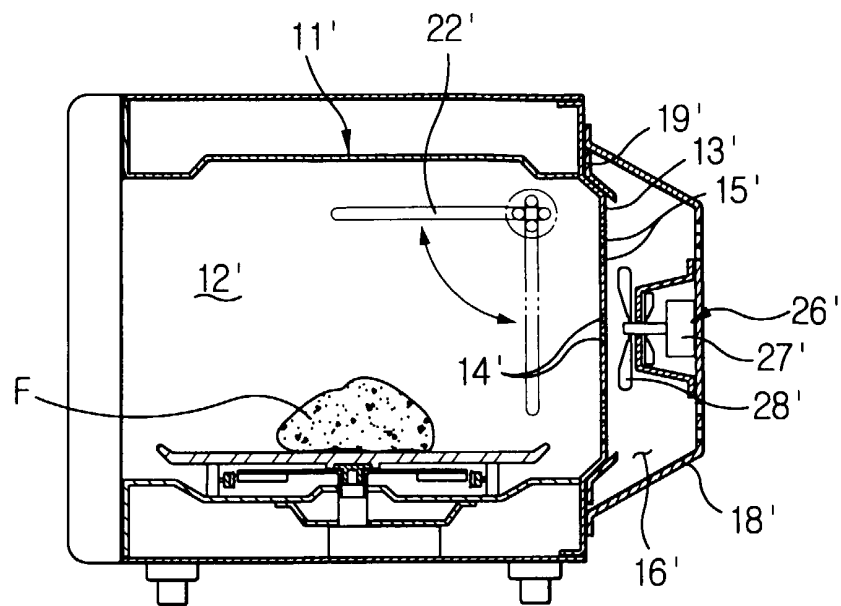


FIG.6





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EUROPEAN SEARCH REPORT

Application Number
EP 99 30 8444

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The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 26 July 2000	Examiner Filtri, G
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EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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26-07-2000

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