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(54) **COOKING APPLIANCE HAVING THERMAL DECOMPOSITION FUNCTION**

(57) The cooking device with pyrolysis function includes a cooking cavity, a heating means located within the cooking cavity for emitting heat, a combustion tube having a hollow portion formed to surround the heating means, the combustion tube being heated by the heating means and radiates its heat to the center of the cooking cavity, a combustion space formed between the heating means and the combustion tube in which cooking fumes are decomposed by the heat from the heating means, a fan adapted to withdraw air from the cooking cavity and to discharge a part or all of the air through the connection tube into the combustion space, a connection tube for connecting fluid communication between the combustion tube and the fan, and a gas outlet for venting the steam and air in the combustion space to the outside of the cooking device.

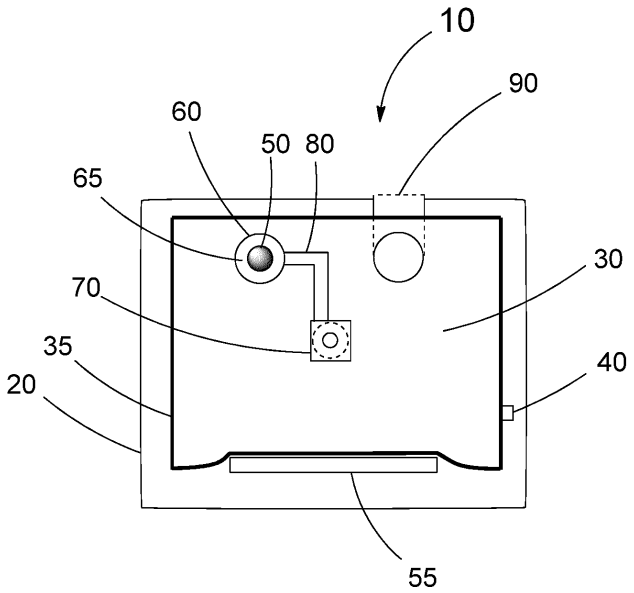

FIG. 3

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Description

[Field of the invention]

[0001] The present invention relates to a combustion device that can remove odor-producing materials in the cooking cavity. Specifically, the present invention relates to a heating means in the cooking cavity that can cause thermal decomposition of odor-producing materials, in addition to cooking the food by radiation of its heat.

[Description of related arts]

[0002] When food is heated in a cooking device, steam and volatile fumes are generated from the food. These volatile fumes may contain carcinogenic formaldehyde and a variety of toxic materials which may be harmful to human health. To minimize the adverse effects of using the cooking device, these toxic contaminants should be prevented from spreading into the living area of the user. Although range hoods are installed in many homes to vent cooking fumes, only a portion of the cooking fumes are discharged outside and the rest may diffuse into the kitchen and other living areas.

[0003] A number of different ways for disposing cooking fumes such as adsorption method using activated carbon filters, a combustion method, a catalytic converter method, an ionic precipitation method, and a plasma discharging method are well known. Among these, the combustion method is highly effective in removing cooking fumes, which are oxidized at high temperature to yield harmless carbon dioxide and water. Also, the combustion method is proven to be economical and reliable enough to be used for the incineration of toxic chemical and biological wastes.

[0004] Some of the cooking ovens have self-cleaning functions to cause pyrolysis at temperatures of about 400 - 500°C in order to remove food contaminants accumulated on the wall of the cooking cavity. However, the above case adopts a method of re-heating the cooking cavity after taking out the food and cannot solve the problem of diffusing fumes during cooking. Therefore, a device for effectively removing contaminants generated during cooking is desired.

[0005] To solve the above problems, the present invention provides cooking device for effectively removing cooking fumes in the cooking cavity. An object of the present invention is to provide an energy efficient combustion device which includes a heating means adapted to heat up food in the cooking cavity and to provide a cleaning effect. Another object of the present invention is to keep the user safe from the harmful cooking fumes by removing the fumes immediately as soon as they are generated in the cooking cavity.

[0006] The following patents are known in the art and are incorporated by reference herein: Korean Pat. Nos. 10-0518444; 10-0555420, 10-1203444; and U.S. Pat. Nos. 6,316,749; 6,318,245; 7,878,185; 8,101,894.

SUMMARY OF THE INVENTION

[0007] The cooking device with pyrolysis function includes a cooking cavity surrounded by cavity walls and an oven door, a heating means located within the cooking cavity for emitting heat therefrom, a combustion tube having a hollow portion formed to surround the heating means, the combustion tube being heated by the heating means and radiating its heat to the center of the cooking cavity, a combustion space formed between the heating means and the combustion tube in which cooking fumes are decomposed by the heat from the heating means, a fan adapted to withdraw air in the cooking cavity and to transfer a part or all of the air through the connection tube into the combustion space, a connection tube for connecting fluid communication between the combustion tube and the fan, and a gas outlet for venting out the steam and air in the combustion space to the outside of the cooking device.

[0008] The heating means located on the upper portion of the cooking cavity comprises any source selected from flame generated by the oxidation of fuel or a heater connected to power source.

[0009] The combustion tube has a hollow tube-type structure with a gas outlet formed at one end of the combustion tube and a combustion tube inlet formed at the opposite end where the heating means is connected. The heating means is enclosed by the combustion tube. A combustion space is formed between the heating means and the combustion tube. The combustion space and the combustion tube are heated by the heating means. When heated, the combustion tube radiates its heat to the center of the cooking cavity. The fumes generated during cooking are introduced to the combustion tube to be thermally decomposed. Therefore, high energy efficiency is achieved by the heating means which has the dual function of warming food via the combustion tube, which radiates its heat to the cooking cavity, as well as causing thermal decomposition of cooking fumes.

[0010] The fan receives power generated from a motor and forcibly convects the air within the cooking cavity. The fan is connected to the combustion tube through the connection tube and introduces the air and cooking fumes into the combustion space. The fan prevents the cooking fumes from spreading out of the cooking cavity by maintaining a lower-than-the-atmospheric pressure within the cooking cavity.

[0011] The connection tube is installed between the combustion tube and the fan and functions as a passage for a part or all of the air inhaled by the fan into the combustion space. It is desirable that the connection tube is connected to the combustion tube near the connection tube inlet, maximizing the contacting distance of cooking fumes with the heating means to improve the efficiency of the pyrolysis process.

[0012] The gas outlet is formed at one end of the combustion tube and functions as a passage for the steam and mixed gas in the combustion tube to the outside of

the cooking device.

[0013] The cooking device further includes a temperature sensor for sensing the operating temperature of the cooking cavity, a bottom heating means adapted to warm the bottom portion of the cooking cavity, and an air supply adapted to accelerate the oxidation of cooking fumes by injecting air into the combustion space.

[0014] The combustion process of contaminants in the cooking cavity is as follows. When a heat source is supplied to the heating means to emit heat, the temperature of the combustion space and the combustion tube increases. As the food is warmed by the radiant heat from the combustion tube to the center of the cooking cavity, steam and fumes from the food are generated in the cooking cavity. The fan withdraws air and fumes in the cooking cavity, and transfer a part or all of the air and fumes through the connection tube into the combustion space. The cooking fumes undergo thermal decomposition (pyrolysis) in the combustion space maintained at 700°C or higher temperature, and become carbon dioxide and water. The mixed gas in the combustion space travels towards the gas outlet to be vented out of the cooking device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

FIG. **1** is a front view showing a cooking device **10** according to the present invention.

FIG. **2** is a sectional view taken along the line **2-2** of FIG. **1**.

FIG. **3** is a side sectional view taken along the line **3-3** of FIG. **2**.

FIG. **4** is a perspective view of some components showing a flow of air for thermal decomposition.

DETAILED DESCRIPTION OF THE INVENTION

[0016] The objects and features of the present invention will be now made in detail to the preferred embodiments of the present invention with reference to the attached drawings.

[0017] FIG. **1** is a front view showing a cooking device **10** according to the present invention. An oven door **25** having a door knob **28** is rotatably attached to an oven body **20** forming the outward appearance of the oven **10**. The oven door **25** seals the front side of a cooking cavity **30** to prevent volatile compounds or smells from escaping from the cooking cavity **30**, to make racks easily go in and out of the cooking cavity, and to allow a user to check the progress of cooking. A control panel **22** is disposed at one side of the front face of the oven body **20**. The control panel **22** includes at least one controlling means for setting temperature and time so that the inside of the cooking cavity **30** can keep a preset temperature for an appropriate period of time.

[0018] FIG. **2** is a sectional view taken along the line **2-2** of FIG. **1** showing the inside configuration of the cooking cavity **30** and the oven body **20**, and FIG. **3** is a sectional view taken along the line **3-3** of FIG. **2**. Referring to the drawings, the present invention will be described in detail as follows. The cooking cavity **30** is surrounded by a cavity wall **35** and has an open front face with an interior cooking space. The cooking cavity **30** further includes a heating means **50** mounted at the upper part of the cooking cavity **30** and a combustion tube **60** having a hollow portion formed to surround the heating means **50**. The "upper part" indicates that the heating means **50** and the combustion tube **60** are located at the higher position than the center of the cooking cavity **30**.

[0019] The combustion tube **60** has a hollow tube-type structure with a gas outlet **90** formed at one end of the combustion tube **60** and a combustion tube inlet **62** formed at the opposite end where the heating means **50** is connected. The heating means **50** comprises any heating source selected from a flame generated by the oxidation of fuel or a heater connected to a heat source **100**. A combustion space **65** is formed between the heating means **50** and the combustion tube **60**. The cooking fumes can undergo thermal decomposition (pyrolysis) in the combustion space **65** maintained at 700°C or higher by the heating means **50**.

[0020] As the combustion tube **60** is heated by the heating means **50**, the radiant heat of the combustion tube **60** is applied to the center of the cooking cavity **30** to warm the food. Therefore, it is preferable that the combustion tube **60** is configured to extensively circulate air in the upper portion of the cooking cavity **30** to effectively radiate its heat to the center of the cooking cavity **30**.

[0021] The combustion tube **60** is selected from a group consisting of ceramics, heat-resisting metals, and a combination of both in order to withstand the heat generated by the heating means **50**. It is preferable that the combustion tube **60** made of ceramics be enclosed by a heat resisting metallic cover (not shown) in order to protect it from external physical impacts.

[0022] The cooking cavity **30** further includes a fan **70** driven by a motor for forcibly convecting the air within the cooking cavity **30**. The fan **70** is a centrifugal fan and is connected in fluid communication to the combustion tube **60**. The fan **70** withdraws air from the cooking cavity and discharges a part or all of the air into the combustion space **65**. When a part of the withdrawn air is discharged back into the cooking cavity **30**, the air is forcibly convected around the hot combustion tube **60** resulting in a rapid increase of temperature in the cavity and cooking speed.

[0023] The fan **70** also prevents the cooking fumes from spreading out of the cooking cavity **30** by maintaining a lower than atmospheric pressure within the cooking cavity **30**. It is possible that the amount of air introduced into the combustion space **65** to be controlled by the fan **70** to adjust the pressure of the cooking cavity **30**. The amount of cooking fumes to be pyrolyzed can also be controlled.

[0024] The connection tube **80** is installed between the combustion tube **60** and the fan **70** and functions as a passage for a part or all of the air inhaled by the fan **70** into the combustion space **65**. It is desirable that the connection tube **80** is connected to the combustion tube **60** near the connection tube inlet **62**, maximizing the contacting distance of cooking fumes with the heating means **50** to improve the efficiency of the pyrolysis process.

[0025] The gas outlet **90** is formed at one end of the combustion tube **60** and functions as a passage for the steam and mixed gas in the combustion space **65** to the outside of the cooking device **10**.

[0026] An air supply **68** and heat source **100** are installed at the connection tube inlet **62**. The air supply **68** provides fresh air into the combustion space **65** to accelerate the oxidation of cooking fumes. The air supply **68** also provides fresh air required for the oxidation of fuel in the case the heating means **50** comprises a flame. The heat source **100** comprises any source selected from fossil fuel or a wire connected to a power source.

[0027] The cooking device **10** further includes a bottom heating means **55** adapted to warm the bottom portion of the cooking cavity **30** and expedite the cooking of the food. The bottom heating means **55** comprises any heating source selected from flame generated by the oxidation of fuel or a heater connected to power source. It is desirable that the bottom heaing means **55** be located outside of the cooking cavity **30** as illustrated in FIG. **3** if the bottom heating means **55** comprises a flame. In the case the bottom heating means **55** comprises a heater, it is preferred that the bottom heating means **55** be installed inside of the cooking cavity **30**.

[0028] The cooking device **10** further includes a temperature sensor **40** for sensing the operating temperature of the cooking cavity **30**. Located at the cavity wall **35**, the temperature sensor **40** detects the changes of temperature in the cooking cavity **30** and may turn off the operation of the heating means **50** or the bottom heating means **55** in the case the cooking cavity **30** is significantly above the preset temperature.

[0029] FIG. **4** is a perspective view of some components showing a flow of air for thermal decomposition. Referring to the drawings, the combustion process of contaminants in the cooking cavity will be described in detail as follows.

[0030] When the heat source **100** is supplied to the heating means **50** to emit heat, the temperature of the combustion space **65** and the combustion tube **60** increases. As the food is warmed by the radiant heat from the combustion tube **60** to the center of the cooking cavity **30**, steam and fumes from the food are generated in the cooking cavity **30**. The fan **70** withdraws air and fumes from the cooking cavity **30** and discharges a part or all of the air and fumes through the connection tube **80** into the combustion space **65**. The cooking fumes undergo thermal decomposition (pyrolysis) in the combustion space **65** maintained at 700°C or higher temperature and become carbon dioxide and water. The mixed gas in the combustion space **65** travels towards the gas outlet **90** to be vented out of the cooking device **10**. During the preset cooking time, the heating means **50** and the fan **70** are turned on so as to thermally decompose the contaminants generated during cooking. The combustion cycle comes to an end when the heat source **100** to the heating means **50** and electricity to the fan **70** is terminated.

[0031] As described above for the pyrolysis process of the cooking fumes, the cooking device **10** according to the present invention is efficient in use of energy because the heating means **50** has the dual function of warming food via the combustion tube **60**, which applies its radiant heat to the cooking cavity **30**, as well as causing the thermal decomposition of the cooking fumes.

[0032] While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims.

LIST OF NUMERALS

10: Cooking device	**20**: Oven body
22: Control means	**25**: Oven door
28: Door knob	**30**: Cooking cavity
35: Cavity wall	**40**: Temperature sensor
50: Heating means	**55**: Bottom heating means
60: Combustion tube	**62**: Combustion tube inlet
65: Combustion space	**68**: Air supply
70: Fan	**80**: Connection tube
90: Gas outlet	**100**: Heat source

Claims

1. A cooking device comprising:

a cooking cavity surrounded by cavity walls and an oven door;

a heating means located within the cooking cavity for emitting heat therefrom;

a combustion tube having a hollow portion formed to enclose the heating means, the combustion tube being heated by the heating means and radiates its heat to the center of the cooking cavity;

a combustion space formed between the heating means and the combustion tube in which cooking fumes are decomposed by the heat from the heating means;

a fan adapted to withdraw air from the cooking cavity and to discharge a part or all of the air through the connection tube into the combustion space;

a connection tube for connecting fluid commu-

nication between the combustion tube and the fan; and
a gas outlet for venting the steam and air in the combustion space to the outside of the cooking device.

2. The cooking device of claim **1**, wherein the heating means has the dual function of warming food via the combustion tube, which applies radiant heat to the cooking cavity, as well as causing thermal decomposition of cooking fumes.

3. The cooking device of claim **1**, wherein the fan prevents the cooking fumes from spreading out of the cooking cavity by maintaining a lower-than-the-atmospheric pressure within the cooking cavity.

4. The cooking device of claim **1**, wherein the heating means comprises any heating source selected from a flame generated by the oxidation of fuel or a heater connected to the heat source.

5. The cooking device of claim **1**, wherein the combustion tube is selected from a group consisting of ceramics, heat-resisting metals, and a combination of ceramics and heat-resisting metals.

6. The cooking device of claim **1**, further comprising an air supply adapted to inject fresh air into the combustion space.

7. The cooking device of claim **1**, wherein the connection tube is connected to the combustion tube near the connection tube inlet, maximizing the contacting distance of cooking fumes with the heating means to improve the efficiency of the pyrolysis process.

8. The cooking device of claim **1**, wherein the fan is a centrifugal fan.

9. The cooking device of claim **1**, further comprising a temperature sensor for sensing the operating temperature of the cooking cavity.

10. The cooking device of claim **1**, wherein the amount of air introduced into the combustion space is controlled by the fan to adjust the pressure of the cooking cavity or the amount of cooking fumes to be pyrolyzed.

11. The cooking device of claim **1**, wherein the combustion tube is located at the higher position than the center of the cooking cavity.

12. The cooking device of claim **1**, further comprising a bottom heating means adapted to warm the bottom portion of the cooking cavity.

13. The cooking device of claim **12**, wherein the bottom heating means comprises any heating source selected from flame generated by the oxidation of fuel or a heater connected to power source.

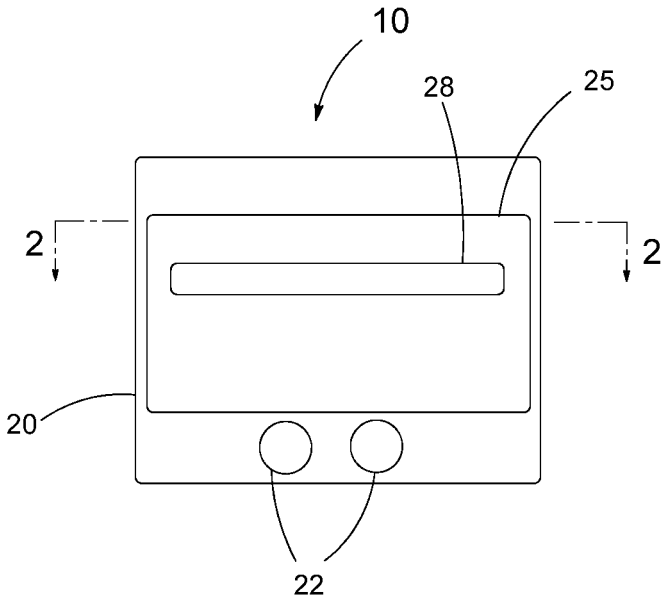

FIG. 1

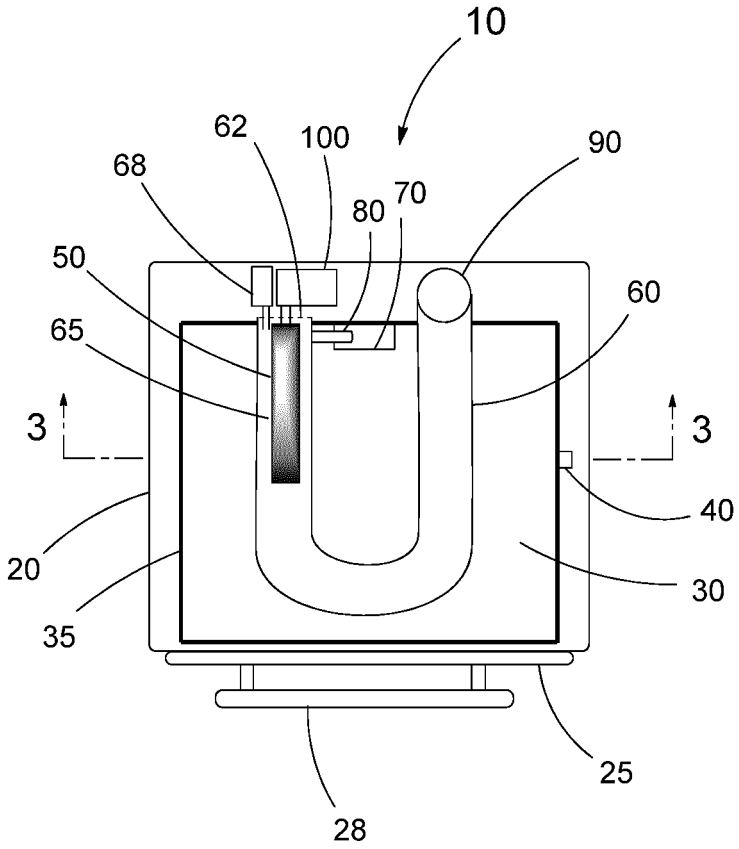

FIG. 2

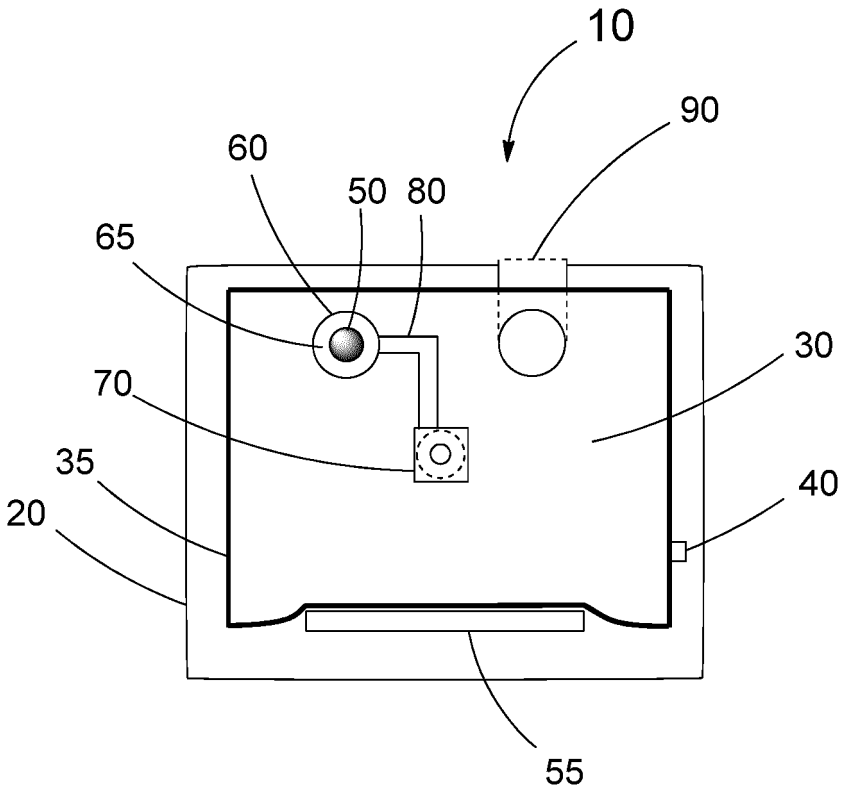

FIG. 3

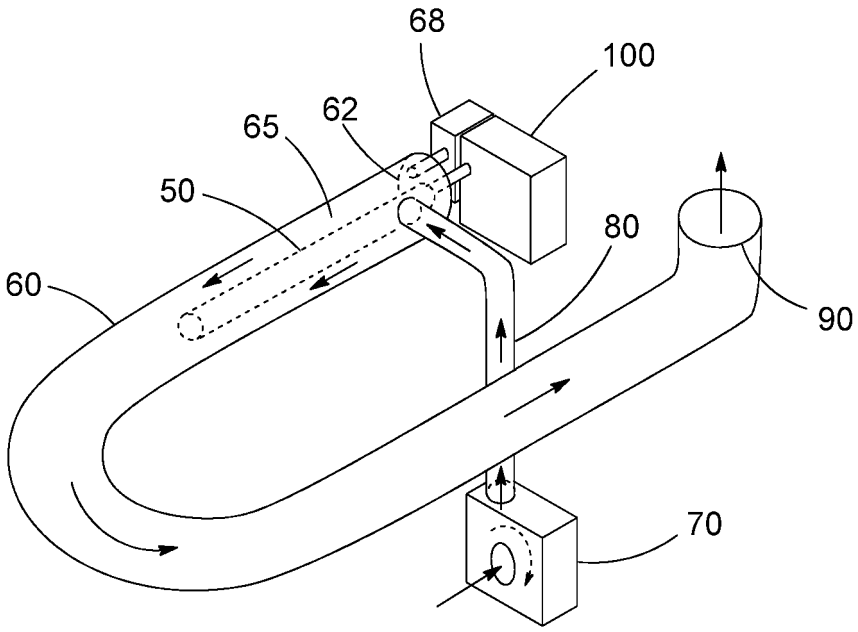

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2013/008770

A. CLASSIFICATION OF SUBJECT MATTER

F24C 9/00(2006.01)i, F24C 15/00(2006.01)i, F24C 15/20(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F24C 9/00; A21B 1/40; A21B 1/26; F24C 7/00; F24C 7/08; F24C 14/00; F24C 7/02; F24C 15/00; F24C 15/20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models: IPC as above
Japanese Utility models and applications for Utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & Keywords: cooking appliance, deodorization, catalyst

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 10-1993-0001174 B1 (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 20 February 1993 See figures 1,4 and 6	1-13
A	KR 10-0518444 B1 (LG ELECTRONICS INC.) 29 September 2005 See abstract and figures 1-3	1-13
A	KR 10-2008-0008140 A (LG ELECTRONICS INC.) 23 January 2008 See abstract and figures 1-6	1-13
A	KR 10-0555420 B1 (LG ELECTRONICS INC.) 24 February 2006 See abstract and figures 1-4	1-13
A	US 6316749 B1 (BALES, Michael E. et al.) 13 November 2001 See abstract and figures 1-3	1-13

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 JANUARY 2014 (29.01.2014)	**29 JANUARY 2014 (29.01.2014)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex-Daejeon, 189 Seonsa-ro, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2013/008770

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KR 10-1993-0001174 B1	20/02/1993	NONE	
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Form PCT/ISA/210 (patent family annex) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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- KR 100555420 **[0006]**
- KR 101203444 **[0006]**
- US 6316749 B **[0006]**
- US 6318245 B **[0006]**
- US 7878185 B **[0006]**
- US 8101894 B **[0006]**