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Yoshida et al.

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[54] **COMBINATION MICROWAVE AND GAS OVEN**

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[73] Assignee: **Sanyo Electric Co., Ltd.,** Osaka, Japan

[21] Appl. No.: **416,510**

[22] Filed: **Sep. 10, 1982**

Related U.S. Patent Documents

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Filed: **May 15, 1978**

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[51] **Int. Cl.**[3] **H05B 6/64**
[52] **U.S. Cl.** ..... **219/10.55 R;** 219/10.55 F; 126/39 C; 126/273 R
[58] **Field of Search** ..... 219/10.55 R, 10.55 B, 219/10.55 F, 10.55 M, 10.55 D, 400; 126/273 R, 275 E, 39, 39 BA, 39 C

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[57] **ABSTRACT**

A combination microwave and gas oven, in which an object to be heated is heat-treated by microwave energy and air heated by a gas burner inside a combustion chamber and forced to be circulated by a fan. A microwave introducing port to the heating cavity is covered with a heat insulating member provided with a film which can reflect the radiant energy transferred to the direction of the microwave introducing port. To prevent the leakage of microwave from the heating cavity especially related to a shaft of the fan which is connected to a driving motor located outside the heating cavity, a choke cavity for terminating leaked microwave from said cavity is provided.

18 Claims, 8 Drawing Figures

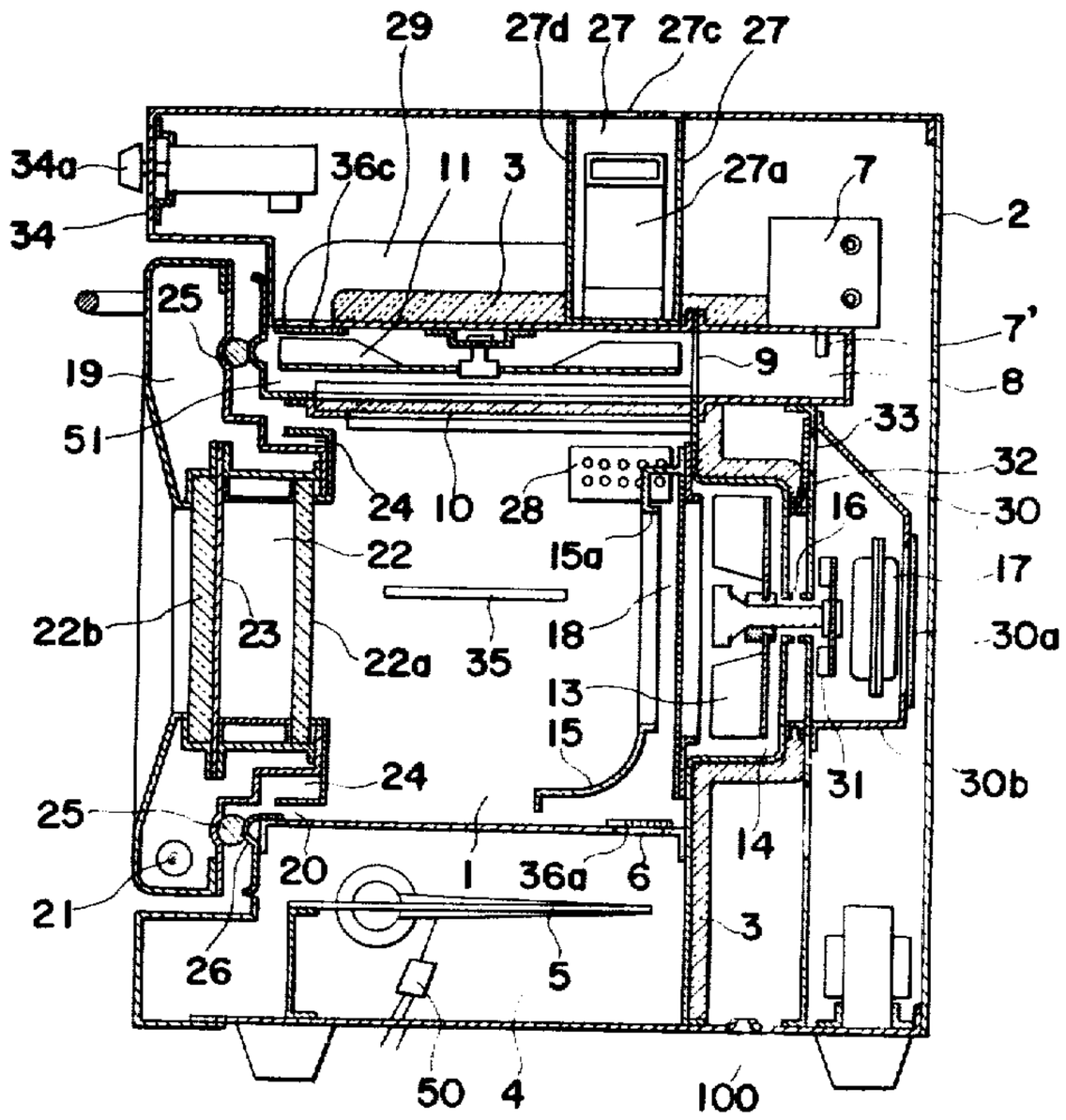


Fig. 1

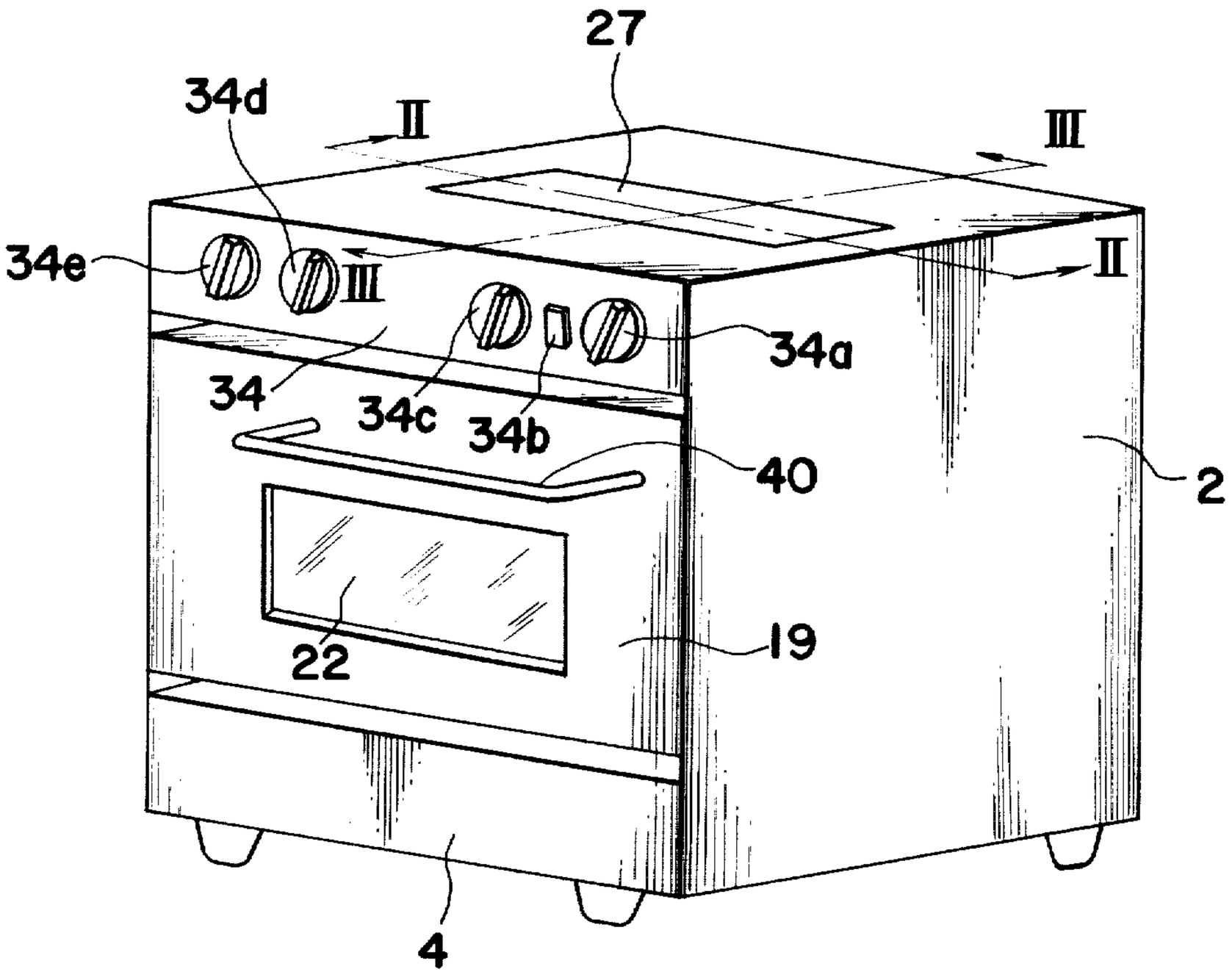
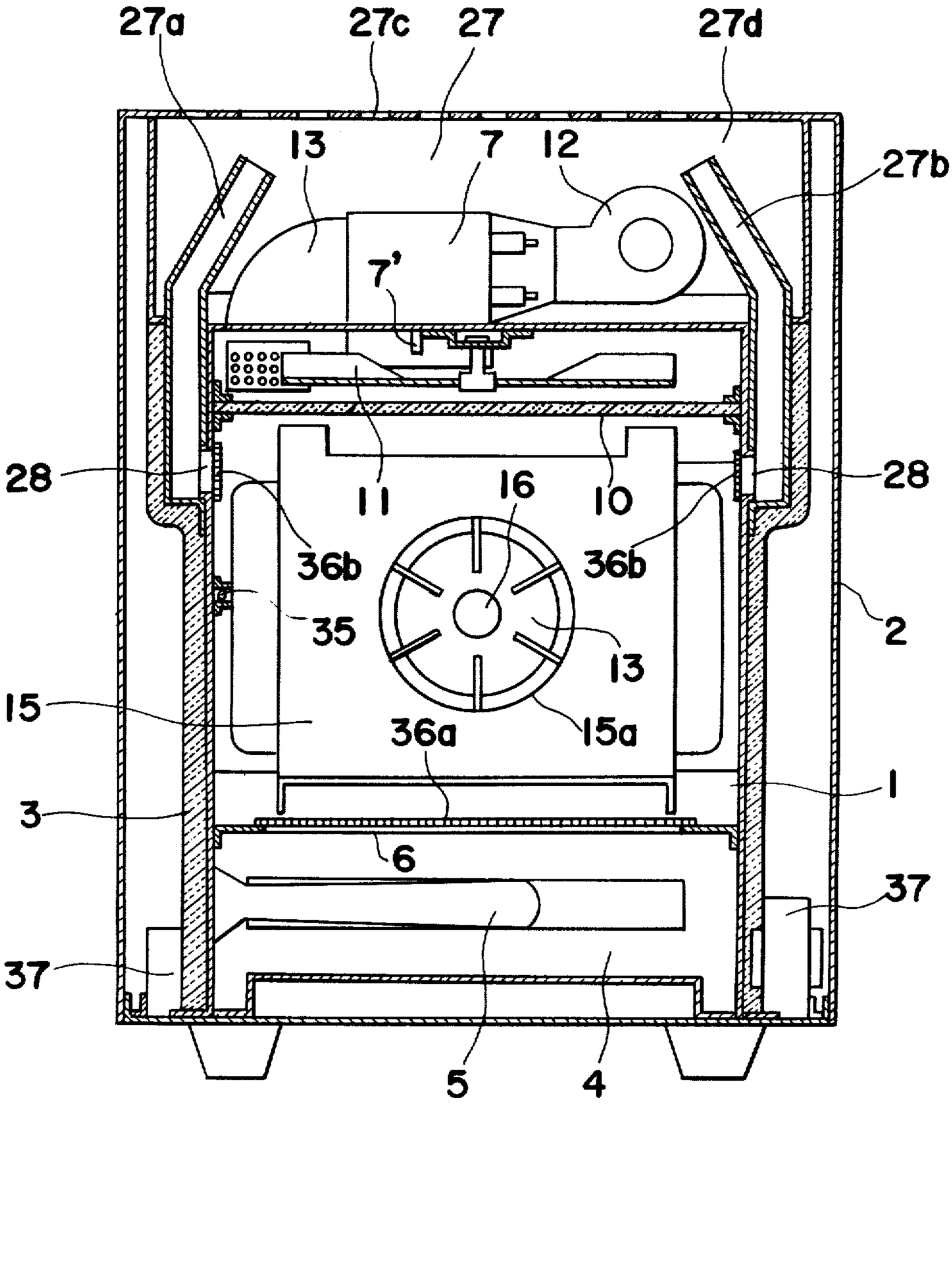


Fig. 2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27
27d
13
7
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36a
1
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37
37
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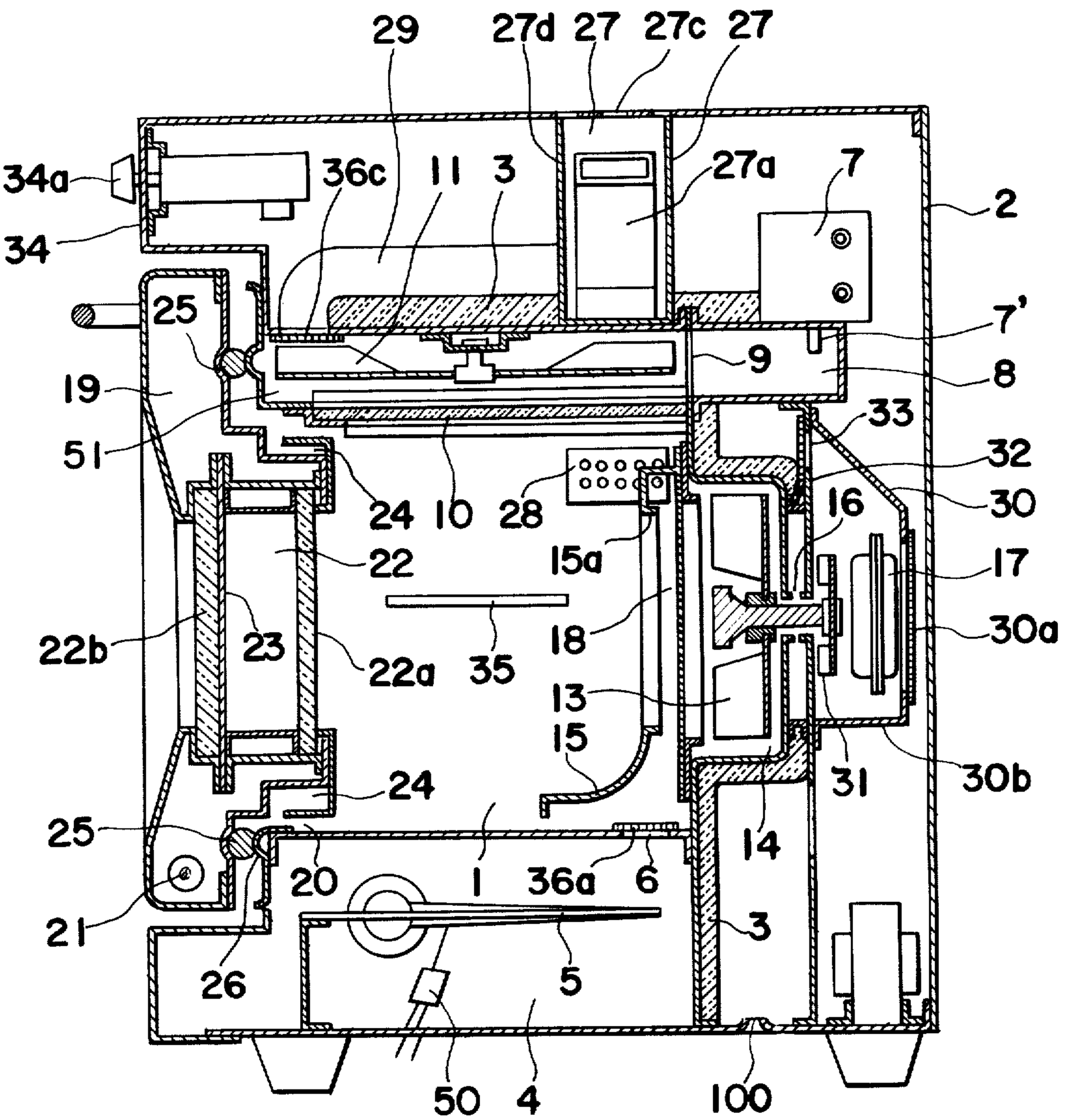
Fig. 3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27d
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27c
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34a
36c
11
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27a
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33
51
32
24
10
28
30
16
22
15a
17
18
30a
22b
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22a
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30b
25
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36a
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21
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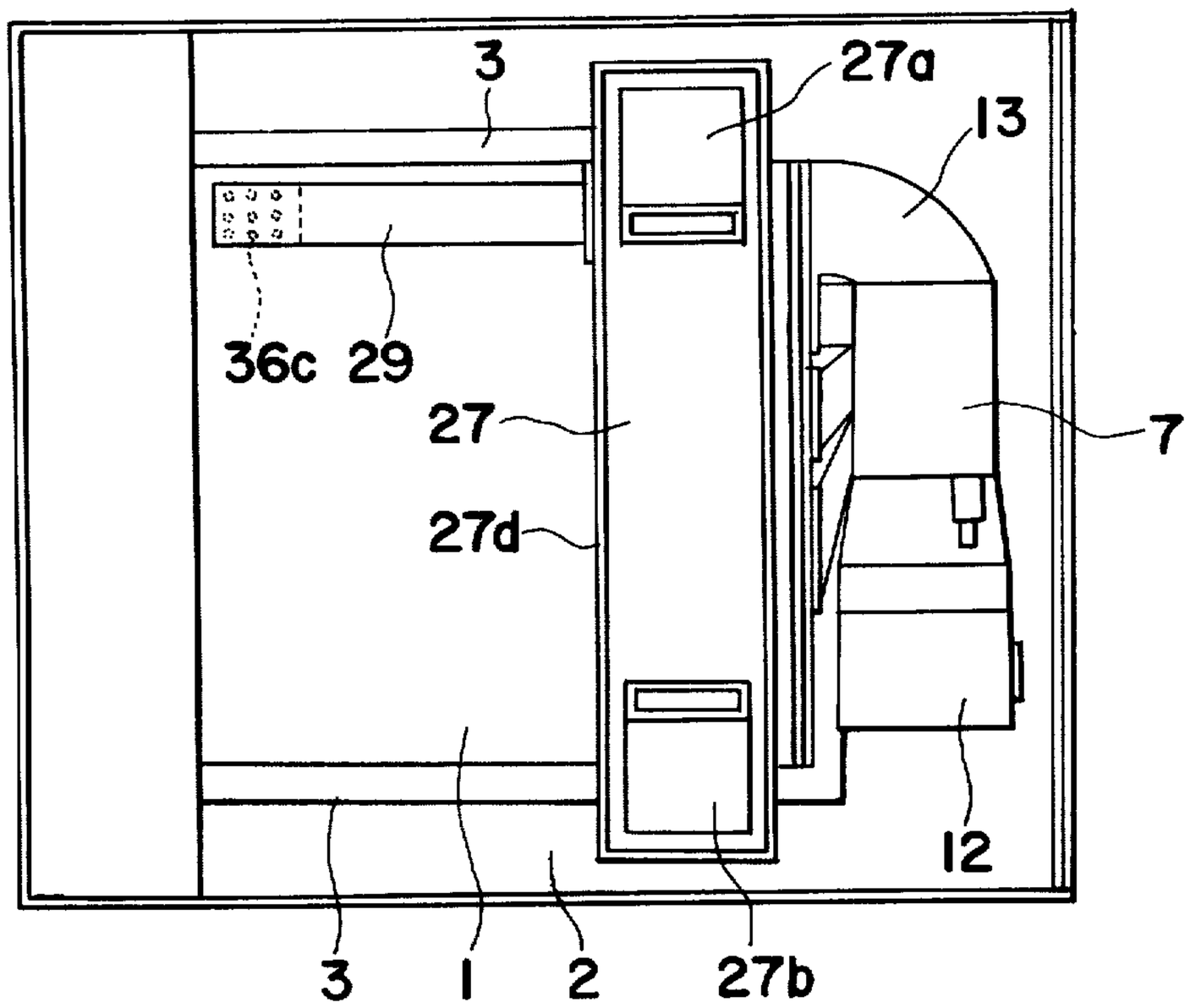
100

Fig. 4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27a
13
36c
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27
7
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12
3
1
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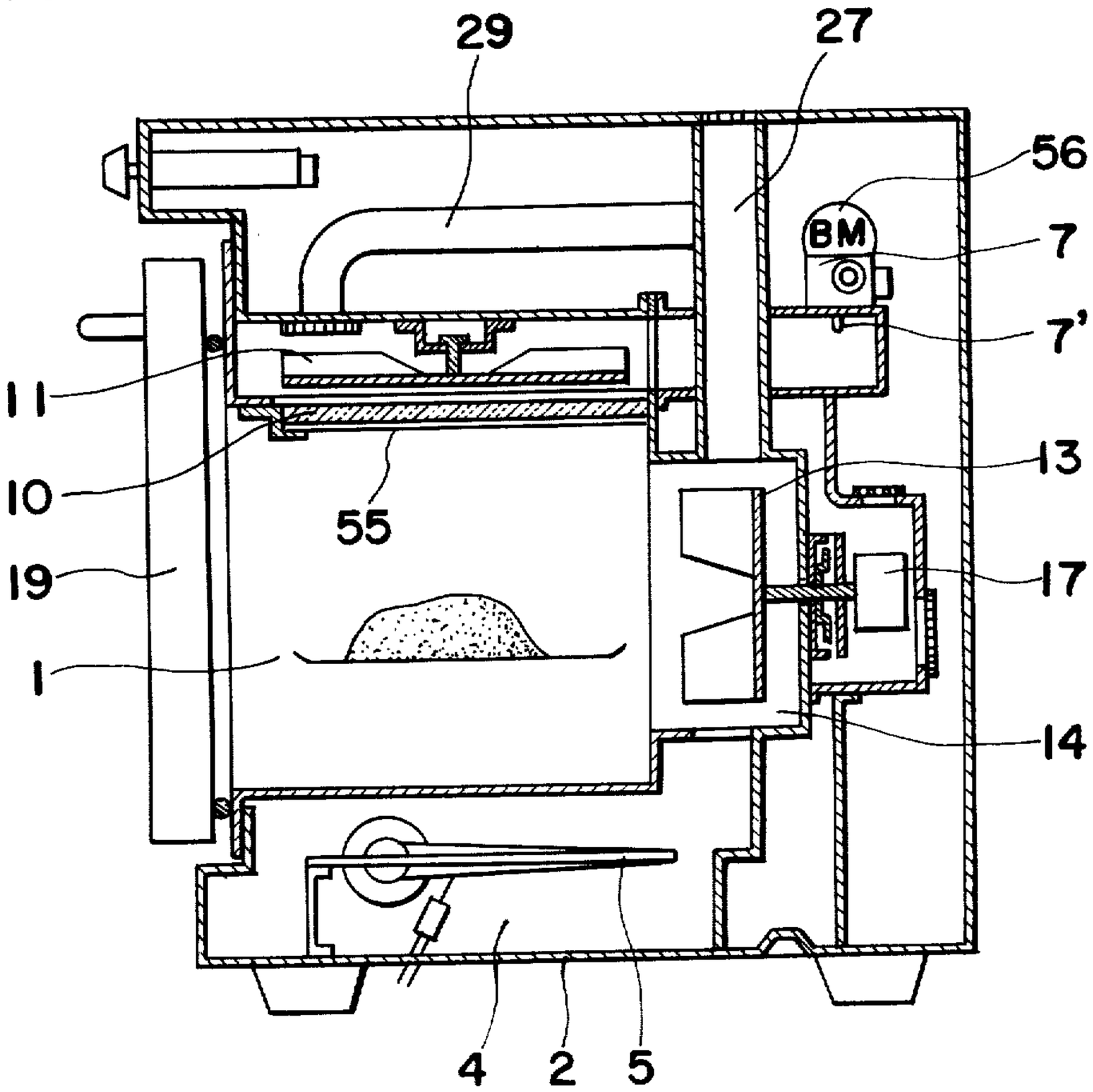
27b

Fig. 5


29
27
56
BM
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7'
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10
55
19
17
1
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4
2
5

Fig. 6

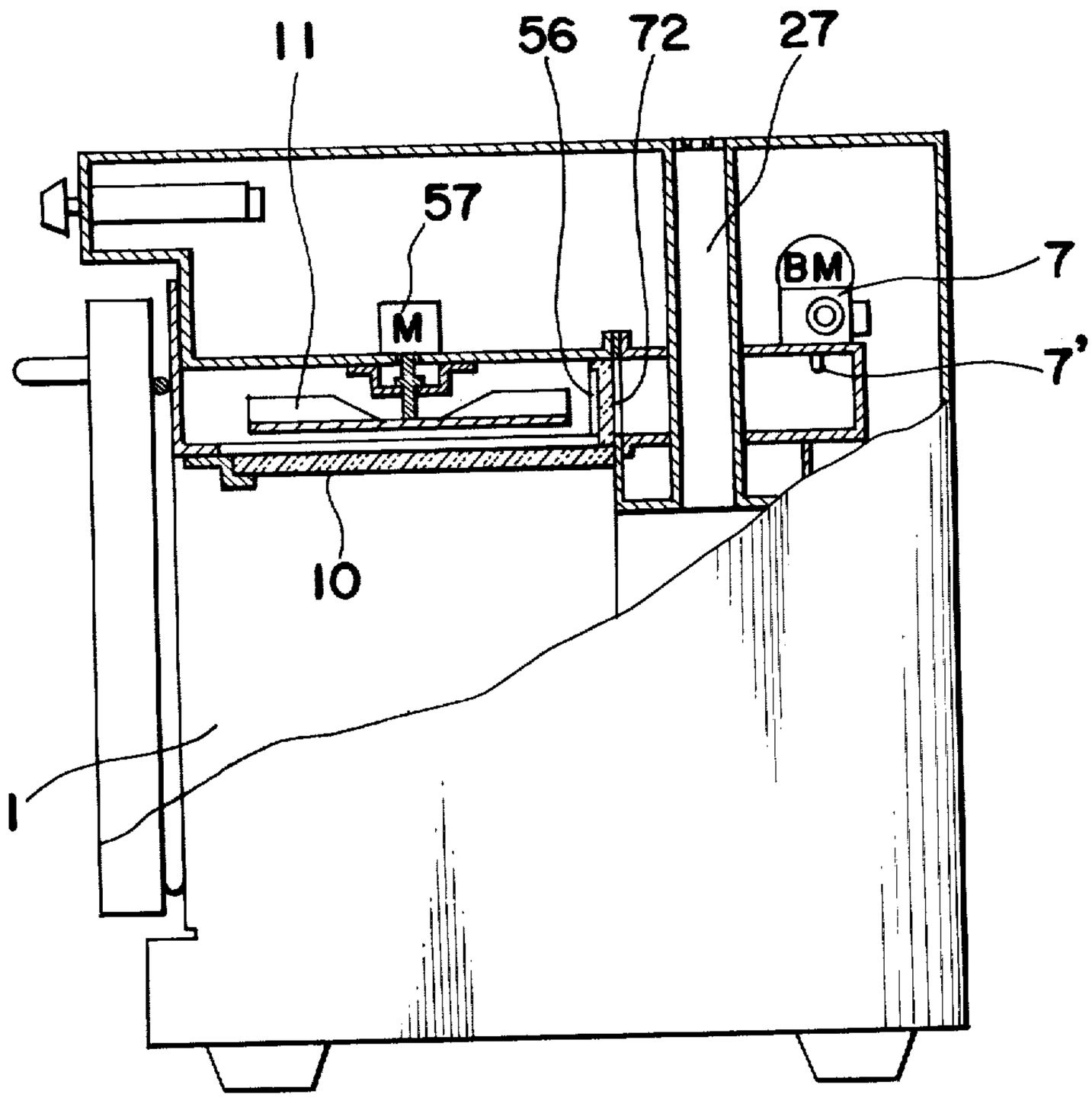


Fig. 7

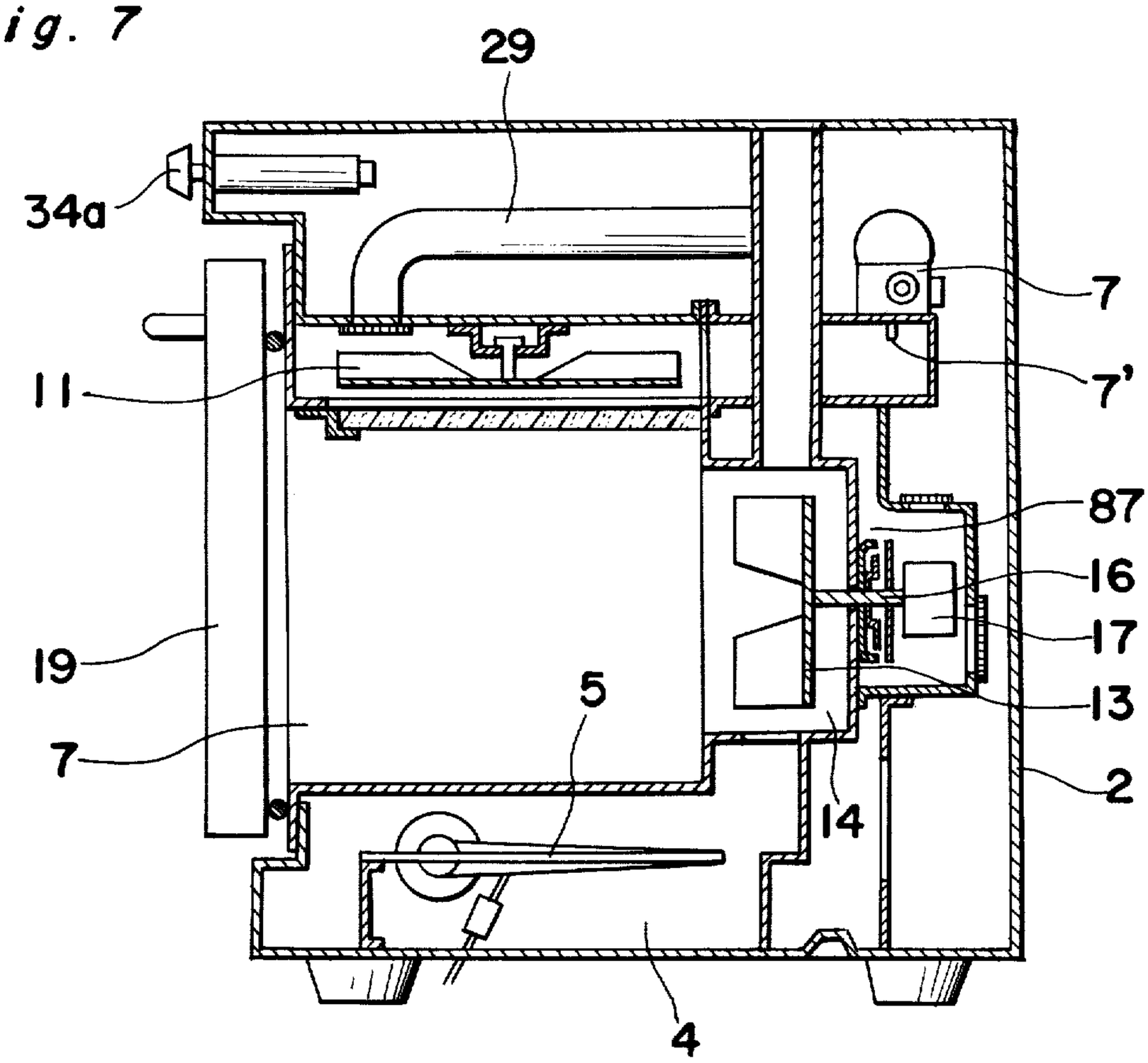
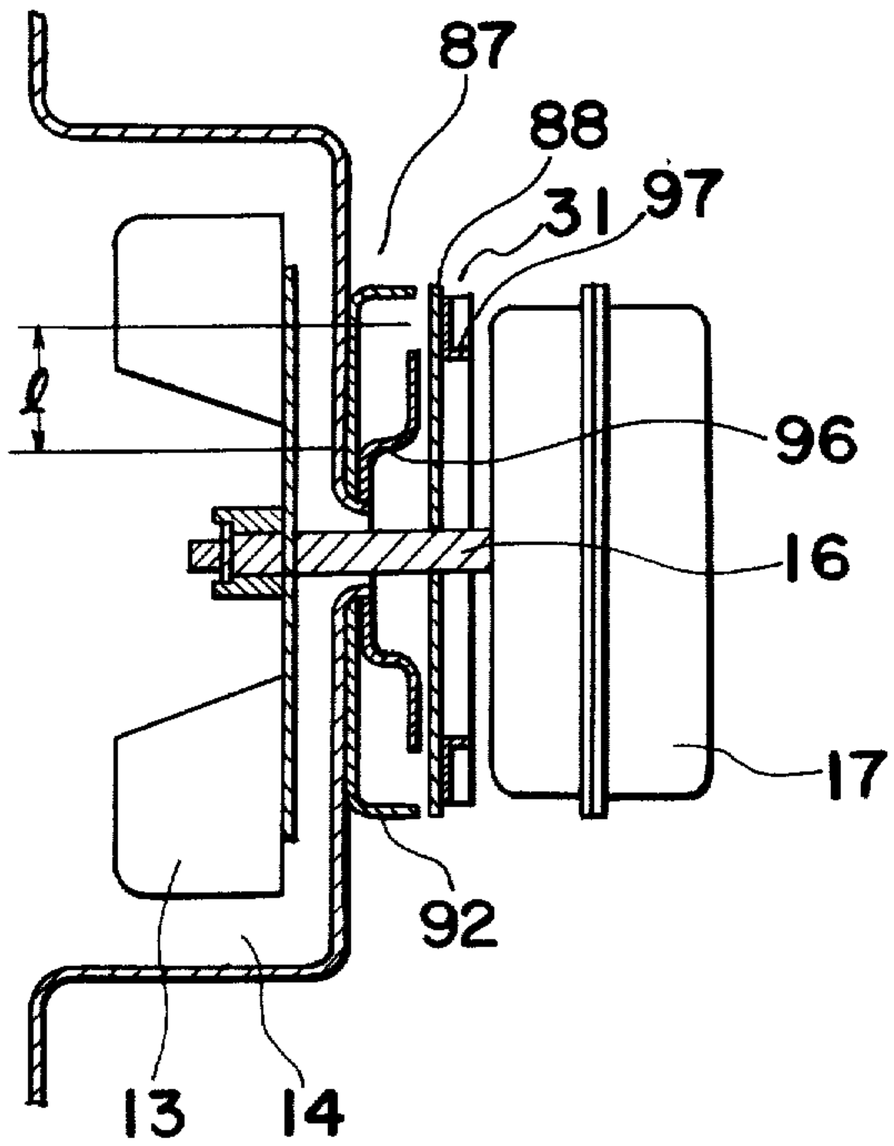


Fig. 8



COMBINATION MICROWAVE AND GAS OVEN

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

BACKGROUND OF THE INVENTION

This invention relates to an oven and more particularly, to a novel combination of microwave and gas oven for heat-treating foodstuff based on characteristics of high frequency heating through a source of microwave energy and heating by physical burning through a gas burner, with foodstuff being exposed in the atmosphere of said combined energy within an oven.

One of the difficulties in cooking encountered by using a conventional electronic oven, has been the inability of such microwave energy to scorch or brown surfaces of foodstuffs to such an extent as will stimulate appetite and, thus the oven of this type is mainly used for limited cooking purposes, such as reheating or defreezing of foodstuffs.

On the contrary to the heating characteristics of the electronic oven mentioned above, a gas oven is a handy cooking device especially for browning surfaces of foodstuffs due to its fundamental heating system while being not so effective for defreezing or reheating of foodstuffs, and thus, this type of cooking device is also available only for limited range of cooking as mentioned above. The combination microwave and gas oven has already been proposed, for example, by U.S. Pat. No. 3,789,178, wherein the combination microwave and gas oven is provided with a divider shelf preferably horizontally disposed, thereby dividing the oven cavity into a cooking section and a section containing the gas heating apparatus. The outer boundary of the shelf forms a low impedance choke directly coupled to the cooking section with a perimetrical shelf holder, thereby terminating microwave energy fed to the cooking section and preventing degradation of the gas heating apparatus provided therebelow.

The known combination microwave and gas oven as described above has such a disadvantage that energy supplying source for the oven portion such as a gas burner or the like must be still provided with relatively large capacity for quick heat-treatment of an object to be heated.

However, if the heat is excessively added to the combination of microwave and gas oven mentioned above, there appears a tendency to overheat the source of the microwave supplies such as a magnetron. Furthermore, even the combination of microwave and gas oven which can transmit heat under the forced convection condition therein, has not been applicable for browning surfaces of foodstuffs within relatively short period of cooking time due to its lack of the desired radiant heat.

Furthermore, when a fan is provided for circulating the heat generated by a heater such as the electric heater in the heating cavity of the oven mentioned above, there is a problem of leakage of microwave resulting from the construction of a shaft of the fan for circulation, wherein since the shaft connected with the fan located inside the heating cavity will pass through the boundary of the heating cavity and come out to be connected with the driving motor, a leakage of microwave cannot be avoided and naturally occurs in the vicinity of a through hole for setting said shaft.

Accordingly, an essential object of the present invention is to provide a combination microwave and gas oven which will combine both characteristics of a microwave oven and that of a gas oven, whereby disadvantages in each of the cooking method is compensated for each other, and which can treat foodstuffs in many ways as far as the range of browning, defreezing and reheating.

Another important object of the present invention is to provide a combination microwave and gas oven of the above described type, which is provided with a fan for effectively circulating the heat in a heating cavity, and also with a proper protectional member against over-heating of a source of microwave energy.

A further object of the present invention is to provide a combination microwave and gas oven of the above described type, wherein a choking system is provided for terminating leakage of microwave energy especially with respect to a shaft of a circulation fan and its connectors.

A still further object of the present invention is to provide a combination microwave and gas oven of the above described type, which is simple in construction and efficient in operation, and can be manufactured at low cost.

SUMMARY OF THE INVENTION

In accomplishing these and other objects according to one preferred embodiment of the present invention, there is provided a combination microwave and gas oven which comprises an outer casing, a heating cavity defined by walls within the outer casing, a high frequency oscillator for supplying microwave energy into the heating cavity, a combustion chamber independently positioned from said heating cavity, a door means adapted to selectively open and close an access opening defined at one side of the heating cavity, a gas burner positioned inside the combustion chamber and supplying heated air to the heating cavity, a circulation fan accommodated inside an independent room connected with the heating cavity and circulating the heated air inside the heating cavity, a microwave terminating member for terminating leakage of microwave from the heating cavity through the fan accommodating room, a microwave insulated exhaust passage for the heated air positioned between the heating cavity and the outer casing and an insulating member of leakage of microwave and heated air interposed between the door and the heating cavity in order to avoid leakage of microwave from an inside of the heating cavity to an outside of the heating cavity.

The microwave terminating member, which is interposed between the fan accommodating room and the motor for driving the circulation fan, comprises a fan having a back board for cooling the motor positioned at the backward end of the shaft of the circulation fan, said fan for cooling having a diameter which is more than a half length of a basic wavelength generated by the high frequency oscillator, an outer box having an open side on a facing side to the fan for cooling being securely fixed to a rear side of the heating cavity on the same shaft, a diameter of said outer box being approximately same to the diameter of the fan for cooling, and a silk-hat shaped member fixed to an inner surface of the outer box at its top surface, said silk-hat shaped member having a slight less diameter of the diameter of the outer

box and interposed between the fan for cooling and the outer box, whereby a choke cavity for terminating leaked microwave from the heating cavity is being assembled. The substantial vertical length of the central portion of the entrance portion of the choke cavity mentioned above is equivalent to the one-fourth of the basic wavelength of the microwave generated. Furthermore, the choke cavity provided in a combination microwave and gas oven of the present invention is characterized in that the choke cavity is interposed between the fan for cooling mounted outside of the heating cavity and the heating cavity, and thereby, the choke cavity is independently located outside of the heating cavity. By the arrangement of the choke cavity mentioned above, not only the utilization of the fan for cooling to the portion of the choke cavity will lead the low cost of manufacturing the oven, but also the contamination of the choke cavity is prevented due to its location separated from the heating cavity.

Furthermore, bounding member between the heating cavity and the microwave introducing port is provided with a layer made of silicone, and this layer freely mounted and demounted in position by means of rails laid thereunder. The one side of silicone layer, which is facing to the heating cavity is coated by a film made of magnesium oxide or barium sulfide, the nature of which can transmit the microwave energy, however can reflect the radiant energy such as heat due to an infrared ray. The both sides of silicone layer may be coated by said films. Furthermore, the coating dimension of the film may be a partial surface or a whole surface. A partial coating of the film can be utilized for the modification of the temperature distribution inside the heating cavity. The radiant heat of the heated air introduced into the heating cavity may heat and brown the object inside the heating cavity through the radiation reflecting film positioned on the boundary mentioned above. In these situation, the radiant heat is avoided to transmit to the above wave guide and be enclosed inside the heating cavity. Therefore, by the radiant energy reflecting construction of the present invention, not only the overheating of the high frequency oscillator is prevented, but also the effective utilization of the energy generated can be affected.

Still furthermore, especially for preventing the leakage of the microwave from the heating cavity, the microwave insulating member such as the punched board is provided at a connecting boundary between the heating cavity and the combustion chamber as well as a connecting boundary between the exhaust passage and the heating cavity, and a connecting boundary between the exhaust passage and the microwave introduction port respectively.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and features of the present invention will become apparent from the following description taken in conjunction with the preferred embodiment thereof with reference to the accompanying drawings in which;

FIG. **1** is a perspective view of a combination microwave and gas oven of the present invention,

FIG. **2** is a cross section taken along the line II—II of FIG. **1**,

FIG. **3** is a cross section taken along the line III—III of FIG. **1**,

FIG. **4** is a top plan view of the combination microwave and gas oven of the present invention with upper portion of an outer casing removed for clarity,

FIG. **5** is a cross sectional view of a modified embodiment of the present invention,

FIG. **6** is a partial cross sectional view of a modified embodiment of the present invention,

FIG. **7** is a cross sectional view of a modified embodiment of the present invention, and

FIG. **8** is a partial view of the embodiment shown in FIG. **7** on an enlarged scale.

Before the description of the present invention proceeds, it is to be noted that like parts are designated by like reference numerals throughout several views of the accompanying drawings.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to FIGS. **1** through **4**, there is shown a combination microwave and gas oven according to the present invention which heat-treats objects or food material to be heated based on the principle of high frequency heating and combustion heating by utilizing a microwave oven and a gas burner therein. The oven of FIG. **1** includes an outer casing **2** of cubical box-like shape open at the front side thereof, to which a door **19** is provided. The door **19** is provided with a handle **40** adjacent to one edge thereof remote from a hinge **21** through which the door **19** is supported, at the lower edge thereof, to the lower front edge of the casing **2** in a position corresponding to the access opening **20** for pivotal upward and downward movements about the hinge **21** so as to selectively open and close the opening. The door **19** has a rectangular observation window **22** formed therein to allow the object placed in a heated cavity **1** to be observed therethrough and also for preventing the high frequency energy from leaking out of the heating cavity **1** during operation of the said oven of the present invention.

The outer casing **2** forms a double wall structure together with inner walls which are defining the heating cavity **1**.

The outer casing **2** further includes an outside front wall portion immediately above the opening. On the front wall portion as shown in FIG. **1**, there is mounted a control panel **34** for controlling functioning of a high frequency oscillator and the like mentioned above, which panel carries thereon from right to left a gas operation knob **34**a which includes the operational function of the ignition, a start button **34**b for initiating the high frequency oscillator, a temperature controlling knob **34**c for controlling the inside temperature of the heating cavity **1** during gas combustion operation, a timer operating knob **34**d for heating by a high frequency oscillator, and a timer operating knob **34**e for heating by a gas combustion burner **5**. On the upper side surface of the oven, there is provided an exhaust opening **27** of rectangular configuration for exhausting heated air in the heating cavity **1** due to combustion out of the outer casing **2**, while a combustion chamber **4** is independently provided as an understructure of the heating cavity **1** inside the casing **2** as shown in FIGS. **2** and **3**.

Referring to FIGS. **2** and **3**, the heating cavity **1** is lined in its inner surfaces, with thin enamel layer, while its outer surface is provided with a layer **3** of heating insulating material, such as glass-wool or the like. The understructure of the heating cavity **1** is the combustion

chamber **4** for this embodiment as mentioned above, in which a gas burner **5** is located. The gas burner **5** is ignited by a gas ignition plug **5**. The air heated by gas combustion with a gas burner **5** is introduced into the heating cavity **1** through a connecting opening **6** between the combustion chamber **4** and the heating cavity **1**, while in the understructure partial wall of the heating cavity **1** is inevitably heated in this construction.

An antenna **7'** of a high frequency oscillator **7** such as a magnetron for generating microwave energy is protruded into a wave guide **8**, through which microwave is transmitted into a microwave introducing port **9** via a microwave supplying port **51** and into the heating cavity **1**.

A cover **10** made of heat insulating and microwave transmitting material, which protects a source of microwave oscillator **7** from overheating by the heat transferred from the port **9** through the wave guide **8** is provided. A microwave mode averaging device or a stirrer fan **11** for making the microwave distribution uniform within the heating cavity **1** is rotatably mounted on the upper portion of the heating cavity **1** for rotation by the air flow caused by a blower **12** which has already been utilized for cooling the high frequency oscillator **7** and guided through the microwave guide **8** as shown in FIG. **2**.

The outer casing is provided with a sucking portion **100** thereon to draw air into the blower **12**. The air drawn through the sucking portion **100** flows towards the cooling blower **12**. On its way to the blower **12**, the air contacts the heat insulating layers **3**, which surround the heating cvity **1**, to cool the heat insulating layers **3**. Afterwards, the air is arranged to pass through an insulating member **30** to cool the motor therewith.

A circulation fan **13** for circulating the heated air is positioned in the rear portion of the heating cavity **1** and rotatably housed in a fan accommodating room or a housing **14**, which is communicated with the heating cavity **1**, for drawing in the air through a central opening **15**a of a flow rectifying board or a baffle plate **15** interposed between the fan accommodating room **14** and the heating cavity **1**, and discharging it along the both substantially vertical sides and the underside of the flow rectifying board **15** in order to effectively circulate the heated air inside the heating cavity **1** and thereby to prevent uneven heat distribution as well as to rapidly raise the temperature in the heating cavity **1**.

A shaft **16** of the circulation fan **13** mentioned above is connected to the shaft of a motor **17** disposed at the rear of the accommodating room **14**, and thus said fan **13** is driven by the motor **17** at high speed.

To cover the communicating portion between the fan accommodating room **14** and the heating cavity **1**, there is provided a plate **18** with fine pores which allows the heated air due to combustion to pass therethrough, but prevents the high frequency energy from entering the fan accommodating room or the housing **14** for shielding.

As mentioned earlier, the door **19** has the rectangular observation window **22** formed at the central portion thereof to allow the object placed in the heating cavity **1** to be observed therethrough and also for preventing the high frequency energy from leakage out of the heating cavity **1** during operation of the combination microwave and gas oven of the present invention.

The observation window **22** includes a pair of glass plates **22**a and **22**b of double wall structure for observing inside of the heating cavity **1**, at least one of which

has its corresponding inner surface lined with a light transmitting electrically conductive layer **23** for shielding against high frequency energy.

In place of the layer **23** mentioned above, a punched board may be employed. Choking cavities **24** formed in the rear portion of the door **19** and adjacent to the rear glass **22**a of said observation window **22**, are arranged for absorbing the microwave energy leaking through a clearance between the front bounding portion of the heating cavity **1** and the door **19** in order to prevent the transmission of the microwave out of the oven from the safe point of view.

Furthermore, as shown in FIG. **3**, a medium or seal **25** formed by metallic fiber, which is attached to the door **19** at the further remote peripheral position from the choking cavity **24** mentioned above is arranged to contact a projection **26** which is provided on the inward corner of the cavity opening so that the microwave energy which has not been perfectly prevented by the choking cavity **24** mentioned above can be prevented thereby, with simultaneous iterception of leakage of air heated, when the door **19** is closed for operation.

As shown in FIGS. **2** through **4**, there is provided an exhaust passage **27** for discharging the hot air within the heating cavity **1** which comprises a pair of exhaust ports **28** located at upper portion of the heating cavity **1**, a pair of exhaust pipes **27**a and **27**b communicated with the exhaust ports **28** mentioned above, and a space **27**d to collect the exhaust air from the pair of said exhaust pipes for communicating the upper openings of the pipes **27**a and **27**b with outside atmosphere as is most clearly seen in FIG. **2**. The heated air to be exhausted within the space **27**d is driven out of the apparatus through an opening **27**c located at the upper side face of the casing **2**. A duct **29** for exhausting the air flow, which has already been utilized both for cooling the high frequency oscillator and for rotating the microwave mode averaging device **11**, is communicated with the exhaust space **27**d shown in FIG. **4**. An insulating member **30** is provided to cover the backward periphery of the motor **17** as shown in FIG. **3**, whereby the microwave happened to enter the following accommodating room **14** can be prevented from further leaking through the shaft **16** of the motor **17**, which will function as an antenna in such a case. The insulating member **30** is composed of a punched board **30**a and a metallic board **30**b.

There is further provided a cooling fan **31** in front of the motor **17** as shown in FIG. **3** for cooling through forced convection, the motor **17**, which fan **31** suctions the air through the punched board **30**a of the insulating member **30** and exhaust it through a small opening **33** passing through a supporting member **32** which supports the motor **17**.

A thermosensor **35** is provided at the central position of the heating cavity **1** for detecting changes of temperatures in the heating cavity **1** for maintaining a predetermined temperatures during operation through the operation of the knob **34**c shown in FIG. **1**.

The punched boards **36**a, **36**b and **36**c for terminating the leakage of microwave energy from the heating cavity **1** are provided at the communicating portion between the heating cavity **1** and the combustion chamber **4** as well as the communicating portion between the exhaust passages **27**a and **27**b and the heating cavity **1** which is specifically shown in FIG. **2**, and a communicating portion between the another exhaust passage **10** and the microwave introducing port **51** respectively.

An electric port **37** of the high frequency oscillator **7** is located at the lowest portion of the apparatus as shown in FIG. **2**.

By the arrangement as described in the foregoing, the combination microwave and gas oven of the present invention makes it possible to heat and form browning on the surfaces of cooking objects simultaneously through combination of advantages in microwave heating and gas combustion heating, which has not been otherwise possible by single heating apparatus such as the gas oven, microwave oven or a microwave oven with browning arrangement or the like.

Although simultaneous heating and browning of cooking objects in a quick way may be thought of through combination of the microwave oven and electric heater based upon the microwave heating and the electric heating, such combination has not been proper for domestic use even if devised, due to limitation of domestic electric supplies.

Furthermore, in the oven of the present invention, since the gas burner is independently accommodated in its specific burning chamber separated from the heating cavity, not only the broad space is available for the heating cavity, but also the microwave leakage through the gas burner portion which functions as an antenna is advantageously prevented. Since the heat insulating cover is provided at the microwave introducing port of the heating cavity, the high frequency oscillator is protected from overheating which might otherwise take place by the heated air transferred through the wave guide and the like.

Moreover, the heat insulating layer provided to line the inner wall of the heating cavity is quite effective for preventing occurrence of overheating of the outer casing as well as the parts of the high frequency oscillator.

Referring to FIG. **5** there is shown a modification of the oven of FIGS. **1** to **4**. In this modification, it is so arranged that part of heated air can be directly bypassed to the exhaust opening **27**, and furthermore, the bounding board **10** disposed between the heating cavity **1** and the microwave introducing port **51** is provided with a heat insulating layer made of silicone, and this layer is mounted for moving back and forth with respect to the heating cavity **1** by means of rail or the like laid thereunder.

The one side of silicone layer, which is facing the heating cavity **1** is coated with a film **55** made of magnesium oxide or barium sulfide, having characteristics to transmit the microwave, but reflect the radiant energy such as the heat due to infrared rays. Both sides of the silicone layer may be coated with said film. Furthermore, the coating of the film **55** may be applied onto a partial surface or a whole surface. A partial coating of the film is effective for correction of uneven temperature distribution within the heating cavity **1**. Air flow for cooling the high frequency oscillator is circulated by a blower **56**, then flows through the wave guide **8** to rotate the microwave mode averaging device or the stirrer fan **11**. The device may be driven by the motor **57** if necessary as shown in FIG. **6**. Thereafter, the cooling air is flown out of the apparatus through the exhaust opening **27**. As mentioned in the foregoing, the air heated by combustion of the gas burner **5** is introduced into the heating cavity **1** from the combustion chamber **4** through entraining motion of the circulating flow resulting from the sucking effects of the fan **13**.

The radiant heat of the heated air introduced into the heating cavity **1** may heat or brown the object inside the

heating cavity **1** when the radiant energy or heat thereof is reflected by the radiant reflecting film **55** positioned at the boundary mentioned above. In the above state, the radiant heat is prevented from being directed to the above wave guide **8** and enclosed inside the heating cavity **1**.

Therefore, by the radiant heat reflecting construction of the present invention, not only the overheating of the high frequency oscillator is prevented, but also the effective utilization of the energy generated is guaranteed.

In another modified embodiment of the present invention shown in FIG. **6**, the heat insulating body **72** provided with the film **56** having the characteristics as described is stuck to the exit side of the microwave transferring port **9** or the entrance side of microwave introducing port **51**, thereby the film **56** reflects the radiant heat conversely introduced to the wave guide **8** through the microwave introducing port **51** in order to protect the high frequency oscillator **7** from overheating. Furthermore, the heat insulating body **72** prevents the further transmission of the heat transferred through convection from the heating cavity **1**.

As shown in FIGS. **7** and **8**, a microwave insulating member or a choke cavity **87** for terminating leaked microwave, which insulates leakage of microwave from the heating cavity **1** through the fan accommodating room or the housing **14**, comprises a basic board **88** of a fan **31** for cooling the motor **17** positioned at the backward end of the shaft **16** of the circulation fan **13**, an outer box **93** having an open side on a side facing the fan **31** securely fixed to the rear end of the heating cavity **1** on the same shaft **16**, and a silk-hat shaped member **96** stuck to the inner surface of the outer box **92** at its literal top surface. The fan **31** for cooling the motor **17** is inserted in the shaft **16**, while closely positioning to one silk-hat shaped member.

The fan **31** with blades **97** has a diameter which is more than a half length of a basic wavelength λ generated by the high frequency oscillator **7**. The diameter of the box **92** is approximately same to the diameter of the fan **31**. The silk-hat shaped member **96** has a diameter slightly smaller than the diameter of the outer box **92** and interposed between the fan **31** and the outer box **92**.

By the arrangement mentioned above, the choke cavity **87** for terminating leaked microwave from the heating cavity **1** is being formed, whereby the substantial vertical length of the central portion of the entrance portion of the cavity **87** mentioned above, which is denoted as 'l' in FIG. **8**, is equivalent to the one-fourth of the basic wavelength of the microwave generated.

Furthermore, the choke cavity **87** provided in the present invention of a combination microwave and gas oven is characterized in that the choke cavity **87** is interposed between the fan **31** mounted outside of the heating cavity **1**, and the heating cavity **1** and thereby, the choke cavity is independently located outside of the heating cavity **1**.

By the arrangement as described above, not only the utilization of the fan **31** as a portion of the choke cavity will lead to the low cost in manufacturing the apparatus, but also the soiling of the choke cavity **1** is prevented owing to its location separated from the heating cavity **1**.

The operational characteristics of the present invention are as follows.

(1) For heating by microwave

After having set the high frequency oscillator for desired time duration for a specific cooking object by the setting timer **34d** and subsequently, putting on the start button **34b**, the generation of microwave is initiated and microwave thus generated is transmitted to the heating cavity **1** through the wave guide **8**.

Simultaneously, the air flow generated by the blower **12** as shown in FIG. **2** cools the source of the high frequency oscillator and then, is introduced into the microwave introducing port **51** to rotate the stirrer fan or the microwave mode averaging device **11**.

Accordingly, the microwave introduced into the heating cavity **1** uniformly heats the heating object with microwave energy evenly distributed by means of the stirrer fan **11**.

The air flow utilized for rotating the stirrer fan **11** is discharged out of the oven through the exhaust duct **29**.

(2) For heating by gas combustion

At the initiation of the operation, the temperature of the heating cavity **1** is adjusted to the optimum level for cooking a specific heating object by the temperature controlling knob **34c** and then, the gas combustion portion is ignited to initiate the combustion by turning around the gas operation knob **34a**.

The flow of the heated air generated by the gas burner **5** mentioned above is introduced into the heating cavity **1** through the opening **6**, and the simultaneous actuation of the circulation fan **13** of air rapidly causes the temperature in the heating cavity **1** to rise to the set level (the preheating process).

When the temperature of the heating cavity **1** is reached the set temperature, the heating objects to be heated are to be accommodated in position inside the heating cavity **1**. The temperature in the heating cavity **1** is automatically kept around the set temperature by the thermosenser **35**, which has been set in advance for the desired time duration by a timer operating knob for heating by the gas combustion burner **34e**. The thermosenser **35** actuates the gas combustion, while repeating the on and off operation of ignition of the gas burner **5** in order to maintain the desired temperature for the desired duration. The exhaust gas after cooking is discharged from the opening **27c**.

(3) For combination of heating by microwave and heating by gas combustion

Simultaneous utilization of the gas combustion and the microwave for cooking will reduce the cooking duration for specific objects, if the operational characteristics of each heating method are properly utilized and combined, whereby the delay in time preheating, which is specific in heating by gas combustion will be compensated by the microwave heating which almost has no time delay for heating.

For example, depending upon the nature of objects for heating and the specifically desired heating degree of the objects, the cooking may be initiated by the microwave heating and then replaced by the gas burner heating.

Furthermore, the cooking may be initiated by either one of the microwave heating operation of the gas combustion heating operation, and the subsequent heating may be effected simultaneously by two heating methods when necessary.

As is clear from the foregoing description, the combination microwave and gas oven of the present invention can serve to provide a variety of cookings, depending upon the nature of the cooking objects and the desired heating degree of the cooking objects, and thus, also serve for promoting the daily life from the point of view of cooking.

Although the present invention has been fully described by way of examples with reference to the attached drawings, it is to be noted that various changes and modifications are apparent to those skilled in the art. Therefore, unless otherwise such changes and modifications depart from the scope of the invention, they should be construed as included therein.

What is claimed is:

1. A combination microwave and gas oven which comprises:

an outer casing, a heating cavity defined by walls within said outer casing, means for supplying microwave energy into said heating cavity, a combustion chamber positioned adjacent to said heating cavity within said outer casing, a door means adapted to selectively open and close an opening defined at one side of said heating cavity, a gas burner positioned within said combustion chamber for supplying heated air to said heating cavity, a circulation fan positioned within a housing and communicating with said heating cavity for circulating said heated air inside said heating cavity, first microwave screen means, positioned within said outer casing on the side thereof opposite said door means for preventing the leakage of microwave energy from said heating cavity through said housing, an exhaust passage positioned between said heating cavity and said outer casing, for allowing said heated air to flow out of said outer casing, and seal means interposed between said door means and a periphery of said opening of said heating cavity for preventing the leakage of microwave energy and heated air from inside of said heating cavity to outside of said heating cavity through the space between said door means and the periphery of said opening.

2. A combination microwave and gas oven as claimed in claim **1**, including a connecting through hole between said heating cavity and said combustion chamber and second microwave screen means positioned on said connecting through hole.

3. A combination microwave and gas oven as claimed in claim **1** and including a microwave introducing port, and a cover means for heat insulating and microwave transmitting, said cover means being positioned at said microwave introducing port to protect said means for supplying microwave energy from overheating.

4. A combination microwave and gas oven as claimed in claim **3**, wherein said cover means comprises a medium for reflecting radiant energy transmitted from the inside of said heating cavity.

5. A combination microwave and gas oven as claimed in claim **4**, wherein said medium is positioned to face an object to be heated.

6. A combination microwave and gas oven as claimed in claim **1**, including exhaust duct means, exhaust tubes extending from said heating cavity and coupled to said duct means, and an air exhaust duct for cooling said means for supplying microwave energy coupled to said duct means.

7. A combination microwave and gas oven as claimed in claim 1, wherein seal means is securely attached to a peripheral corner of said door wherein said seal means is interposed by said door and a corner of the periphery of the opening of said heating cavity when said door is closed cavity when said door is closed.

8. A combination microwave and gas oven as claimed in claim 1, wherein each timer operating knob for operating said means supplying microwave energy and said gas burner independently operate said means supplying microwave energy and said gas burner.

9. A combination microwave and gas oven as claimed in claim 1, wherein said combustion chamber is located under said heating cavity.

10. A combination microwave and gas oven as claimed in claim 1, including exhaust ports at the upper portion of said heating cavity.

11. A combination microwave and gas oven as claimed in claim 1, including a microwave mode averaging means at a microwave introducing port located above said heating cavity.

12. A combination microwave and gas oven as claimed in claim 1, wherein said heating cavity is covered with heat insulating layers.

13. A combination microwave and gas oven as claimed in claim 1, including a flow rectifying member in front of said circulation fan for enhancing the circulated flow of heated air within said heating cavity.

14. A combination microwave and gas oven as claimed in claim 1, wherein said housing is provided by recessing the opposite side portion of said heating cavity, said housing having a microwave screening, porous board in front thereof.

15. A combination microwave and gas oven as claimed in claim 1, wherein said motor positioned outside said housing for driving said circulation fan is covered by a microwave insulating member at the rear end thereof.

16. A combination microwave and gas oven as claimed in claim 1, wherein said outer casing is provided with an inlet portion to draw air into a blower therein, said air introduced contacting with said heat insulating layers for cooling said heat insulating layers.

17. A combination microwave and gas oven as claimed in claim 16, wherein said air introduced is passed through the vicinity of said motor to cool said motor therewith on its way to said blower.

18. A combination microwave and gas oven as claimed in claim 1, wherein said first microwave screen means comprises a fan having a back board for cooling said motor positioned at the rear of the shaft of said circulation fan, said fan having a back board for cooling, said fan having a diameter which is more than a half length of a fundamental wavelength generated by said means for supplying microwave energy, an outer box having an open side on a side facing said fan, said outer box being securely fixed to the rear of said housing surrounding said shaft, the diameter of said box being approximately the same as said diameter of said fan, and a silk-hat shaped member fixed to an inner surface of said outer box at its top surface, said silk-hat shaped member having a smaller diameter than said diameter of said outer box, said silk-hat shaped member being interposed between said fan and said outer box, thereby forming a choke cavity for terminating leaked microwave energy from said heating cavity.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : Re. 31,637

DATED : July 31, 1984

INVENTOR(S) : NAGATOSHI YOSHIDA ET AL

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the cover page, Item [73], change "Sanyo Electric Co., Ltd., Osaka, Japan" to --- Sanyo Electric Co., Ltd., Osaka, Japan and Tottori Sanyo Electric Co., Ltd., Tottori, Japan ---.

Signed and Sealed this

Eleventh Day of *June 1985*

[SEAL]

Attest:

DONALD J. QUIGG

Attesting Officer *Acting Commissioner of Patents and Trademarks*