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(71) Applicant: **SAMSUNG ELECTRONICS CO., LTD.**
**Suwon-City, Kyungki-do (KR)**

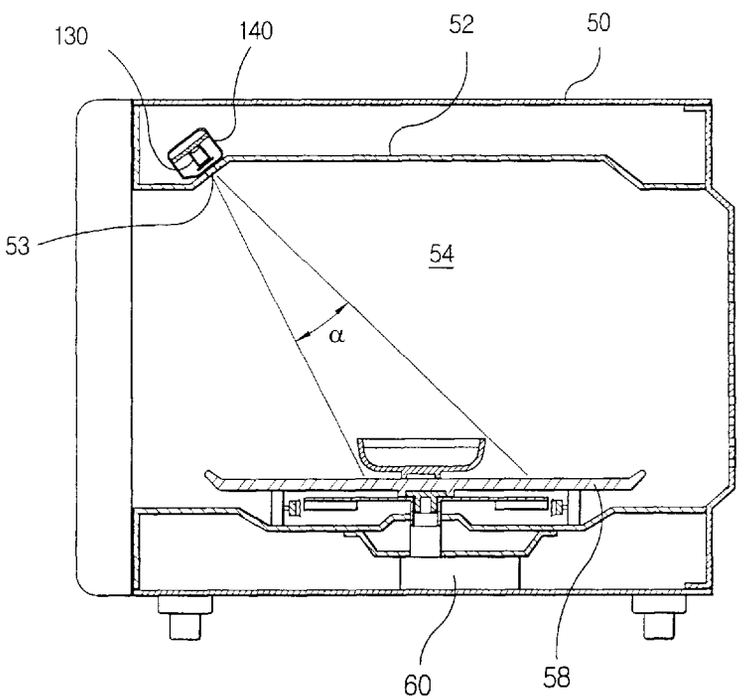
(72) Inventor: **Oh, Sea-lea**
**Suwon-City, Kyungki-do (KR)**

(74) Representative: **Geary, Stuart Lloyd et al**
**Venner, Shipley & Co.,**
**20 Little Britain**
**London EC1A 7DH (GB)**

## (54) Microwave oven with infrared sensor

(57) A microwave oven has an infrared sensor (110) for sensing the temperature of food during cooking. The sensor (110) is directed obliquely downwards and rearwards from the upper front edge of the cooking chamber (54). A shutter (150) protects the sensor (110) when it is not required for sensing food temperature.

FIG. 4B

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## Description

**[0001]** The present invention relates to a microwave oven including a cooking chamber and an infrared sensor for sensing the temperature of food during cooking.

**[0002]** Generally, a microwave oven cooks food by irradiating it with microwaves. A known microwave oven is shown in Figures 1 and 2.

**[0003]** Referring to Figures 1 and 2, a microwave oven comprises a case 1 which is internally divided into a cooking chamber 3 and an electrical component chamber 4 by walls 2. A rotatable tray 5 for supporting food during cooking is located at the bottom of the cooking chamber 3. The rotatable tray 5 is rotated by a driving motor 6 installed at the lower side of the cabinet 2.

**[0004]** The electrical component chamber 4 houses a plurality of electric devices including a magnetron 7 and a high voltage transformer 8.

**[0005]** Microwaves generated by the magnetron 7 are guided by a waveguide 9 into the cooking chamber 3. The waveguide 9 opens into the cooking chamber 3. A door (not shown) is provided for providing access to the cooking chamber 3 and a controlling section for controlling the microwave oven are installed at the front of the case 1. An infrared sensor assembly 10 is installed centrally at the top of the cooking chamber 3 and is used to detect the temperature of food during cooking.

**[0006]** Referring to Figure 3, the infrared sensor assembly 10 includes an infrared sensor 11, a printed circuit board 12, on which are mounted a plurality of electronic components (not shown) for producing an electrical signal in dependence on the food temperature sensed by the sensor 11, a cylindrical sensor cover 13, and a casing 14 housing the foregoing elements. The sensor cover 13 encases the infrared sensor 11 and has a hole 13a in its lower end. The sensor cover 13 projects toward the middle of the cooking chamber 3 through a hole defined in the upper wall 2 of the cooking chamber 3.

**[0007]** In use, food is loaded onto the rotatable tray 5 and the rotatable tray 5 starts to rotate. Simultaneously, microwaves generated by the magnetron 7 are guided into the cooking chamber 3 by the waveguide 9 to heat the food. At this point, when the temperature of the food, detected by the infrared sensor assembly 10, reaches a predetermined level, the control section stops the magnetron 7 and driving motor 5 so as to finish the cooking operation.

**[0008]** However, the above-described microwave oven has the following drawbacks.

**[0009]** As shown in Figure 2, the infrared sensor assembly 10 is positioned centrally at the top of the cooking chamber 3. This means that the field of view of the infrared sensor 11 is limited to the central portion of the rotatable tray 5. Accordingly, if the food to be cooked is placed outside of this limited field of view, the temperature of the food can not be precisely sensed. Also, although the infrared sensor 11 is covered by the sensor cover 13, the infrared sensor 11 is exposed to the humid atmosphere in the cooking chamber 13a through the hole 13a. Accordingly, the operation of the infrared sensor 11 becomes unstable and its temperature measurements unreliable.

**[0010]** Such inaccurate detecting of temperature often causes the food to be under- or overcooked.

**[0011]** A microwave oven according to a first aspect of the present invention is characterised in that the sensor is directed obliquely towards a food receiving region of the cooking chamber from a position substantially at the top of the cooking chamber.

**[0012]** Conveniently, the sensor is located substantially at the front of the cooking chamber and is directed downward and rearwards. Preferably, the sensor is centrally located substantially at the from the cooking chamber.

**[0013]** Preferably, the sensor is located outside the cooking chamber and senses food temperature via a hole in a wall of the cooking chamber.

**[0014]** Preferably, the hole is dimensioned such that the sensor has a field of view in the range 4° to 6°. More preferably, the hole is circular and has a diameter in the range 14mm to 25mm.

**[0015]** A microwave oven according to a second aspect of the present invention is characterised by a shutter for protecting the sensor.

**[0016]** Preferably, the shutter comprises a substantially planar base having an aperture aligned with the sensor, first and second slidable plates lying plane parallel to the base and having respective apertures therein and drive means for sliding the first and second slidable plates in opposite directions between a closed configuration in which the slidable plates block each others apertures and the aperture of the base, and an open configuration in which all of the apertures are aligned with the sensor.

**[0017]** Preferably, the two aspects of the present invention will be combined in a single microwave oven.

**[0018]** An embodiment of the present invention will now be described, by way of example, with reference to Figures 4A to 7B of the accompanying drawings, in which:-

Figure 1 is a schematic cross-sectional view of a known microwave oven;

Figure 2 is a cross-sectional side view of the oven of Figure 1;

Figure 3 is an enlarged cross-sectional view of the infrared sensor assembly of Figure 1;

Figure 4A is a cross-sectional view of a microwave oven according to the present invention;

Figure 4B is a cross-sectional side view of the oven of Figure 4A;

Figure 5 is an enlarged cross-sectional view of the infrared sensor assembly of Figures 4A and 4B;

Figure 6 is an exploded perspective view showing a sensor-protecting shutter for the infrared sensor

assembly;

Figure 7A is a plan view showing the base of the shutter of Figure 6 with a third hole in its close state; and

Figure 7B the base of the shutter of Figure 6 with a third hole in its open state.

**[0019]** Referring to Figures 4A and 4B, a microwave oven comprises a case 50 which is internally divided into a cooking chamber 54 and an electrical component chamber 56 by internal walls 52.

**[0020]** A rotatable tray 58 is installed at bottom of the cooking chamber 54. The rotatable tray 58 is rotated by a driving motor 60 installed below the rotatable tray 58. The electrical component chamber 56 houses a plurality of electrical devices induding a magnetron 62, a waveguide 64 and a high voltage transformer.

**[0021]** Referring to Figure 5, an infrared sensor assembly 100 for detecting the temperature of food during cooking comprises an infrared sensor 110, a printed circuit board 120, a sensor cover 130, a sensor protecting shutter 150 and a casing 140. The printed circuit board 120 supports a plurality of electronic components (not shown) for converting the sensed temperature of the food into an electrical signal and transmitting the signal to a control section. The sensor cover 130 is mounted to the printed circuit board 120 so as to encase the infrared sensor 110 and has a first hole 131 at its lower end. The sensor-protecting shutter 150 selectively opens and closes the first hole in the sensor cover 130. The casing 140 has a second hole 141 aligned with the first hole 131 of the sensor cover 130.

**[0022]** Referring to Figure 6, the sensor-protecting shutter 150 comprises a base 151, first and second shutter plates 154, 155, an lever 153, a driving motor 152 and a shutter cover 156. The base 151 has a third hole 151a aligned with the first hole 131. The first and second shutter plates 154, 155 overlap each other in front of the base 151. The lever 153 reciprocally moves the first and the second shutter plates 154, 155 in opposite directions. The driving motor 152 drives the lever 153.

**[0023]** The driving motor 152 is installed behind the upper part of the base 151 and has a rotary shaft 152a which passes through the base 151 and projects from the front surface of the base 151. The lever 153 is mounted to the rotary shaft 152a. The lever 153 is elastically supported by a torsion spring 153b which tends to rotate it clockwise as viewed in Figure 6.

**[0024]** The first and second shutter plates 154, 155 have slits 154a, 155a and guide holes 154b, 155b. Support shafts 153a projecting from respective ends of the lever 153 are inserted into the slits 154a, 155a, and guide protrusions 151b formed on either side of the base 151 are inserted into the guide holes 154b, 155b. The first and second shutter plates 154, 155 are attached with to shutter cover 156 at the front of the assembly.

**[0025]** The shutter cover 156 has arc-shape holes into which the free ends of the support shafts 153a are inserted.

**[0026]** The infrared sensor assembly 100 is installed centrally in a front, upper portion of the cabinet 52. An observation hole 53 is formed in a wall 52 of the cooking chamber 54 in alignment with the second hole 141 of the casing 140. The infrared sensor assembly 100 is obliquely installed such that an extension of the centerline of the infrared sensor 110 and the observation hole 53 will pass through the middle of the rotatable tray 58.

**[0027]** The observation hole 53 has such a diameter that the infrared sensor 110 has a field of view (a) of 4° ~ 6°, and more preferably 5°. The diameter of the observation hole 53 ranges from 14mm to 25mm.

**[0028]** Thus, the infrared sensor 110 detects the temperature of the food positioned within the above field of view through the observation hole 53 during cooking. Even when the food is not centrally on the rotatable tray 58, its temperature can be accurately determined.

**[0029]** The sensor-protecting shutter 150 opens the first hole 131 of the sensor cover 130 only when it is required to detect the temperature of the food. The sensor-protecting shutter 150 does not operate without power from the driving motor 152. Accordingly, the first and second shutter plates 154, 155 co-operate with each other so as to close the third hole 151a of the base 151. When electric power is applied to the driving motor 152, the rotary shaft 152a of the driving motor 152 rotates, rotating the lever 153 anticlockwise. Consequently, the first and second shutter plates 154 and 155 are moved by the support shafts 153a of the lever 153 in opposite directions. In this situation, the first and second shutter plates 154, 155 move longitudinally along the base 151, guided by the guide protrusions 151b. Thus, as the first and second shutter plates 154, 155 move in opposite directions, the third hole 151a is opened and, accordingly, the first hole 131 of the sensor cover 130 is opened. Consequently, the infrared sensor 110 detects the temperature of the food in the cooking chamber 54 through the third hole 151a of the base 151 and the observation hole 53. Figure 7B shows the third hole 151a in its open state.

**[0030]** When the electric power is cut-off, the lever 153 is rotated clockwise by the restoring force of the torsion spring 153b which was tensioned by the rotation of the lever 153. By the rotation of the lever 153, the first and second shutter plates 154, 155 move in opposite directions so as to close the third hole 151a of the base 151, as shown in Figure 7A. Accordingly, the first hole 131 of the sensor cover 130 is closed.

**[0031]** As described, since the sensor-protecting shutter 150 opens the first hole 131 of the sensor cover 130 only when the infrared sensor 110 needs to detect the temperature of food, the negative factors of the cooking chamber such as humidity, microwaves etc. affect the infrared sensor 110 less.

**[0032]** Thus, a microwave oven embodying all aspects of the present invention has the advantages of ac-

curate temperature detection even when food not centrally placed on the rotating tray and protection of the sensor by means of the shutter. It should be noted that the aspects of the present invention need not both be embodied in a microwave oven.

## Claims

1. A microwave oven including a cooking chamber (54) and an infrared sensor (110) for sensing the temperature of food during cooking, characterised in that the sensor (110) is directed obliquely towards a food receiving region of the cooking chamber (54) from a position substantially at the top of the cooking chamber (54).

2. A microwave oven according to claim 1, wherein the sensor (110) is located substantially at the front of the cooking chamber (54) and is directed downward and rearwards.

3. A microwave oven according to claim 2, whereing the sensor (110) is centrally located substantially at the from the cooking chamber (54).

4. A microwave oven according to claim 1, 2 or 3, wherein the sensor (110) is located outside the cooking chamber (54) and senses food temperature via a hole (53) in a wall (52) of the cooking chamber (54).

5. A microwave oven according to to claim 4, wherein the hole (53) is dimensioned such that the sensor has a field of view (a) in the range 4° to 6°.

6. A microwave oven according to claim 5, wherein the hole (53) is circular and has a diameter in the range 14mm to 25mm.

7. A microwave oven induding a cooking chamber (54) and an infrared sensor (110) for sensing the temperature of food during cooking, **characterised by** a shutter (150)for protecting the sensor (110).

8. A microwave oven according to claim 7, wherein the shutter (150) comprises a substantially planar base (151) having an aperture (151a) aligned with the sensor (110), first and second slidable plates (154, 155) lying plane parallel to the base (151) and having respective apertures therein and drive means (152, 152a, 153) for sliding the first and second slidable plates (154, 155) in opposite directions between a dosed configuration in which the slidable plates (154, 155) block each others apertures and the aperture (151a) of the base, and an open configuration in which all of the apertures are aligned with the sensor (110).

9. A microwave oven according to any one of claims 1 to 6 and any one of claims 7 to 8.

10. A microwave oven comprising:

    a case whose interior space is divided by a cabinet into a cooking chamber for receiving a food to be cooked and a device chamber for generating and supplying a microwave to the cooking chamber; and
    an infrared sensor assembly for detecting temperature of the food cooked by the microwave in the cooking chamber; the infrared sensor assembly being installed at a upper portion of the cabinet so as to face toward a central portion of a rotating dish from a front and upper middle portion of the cooking chamber;
    wherein the cabinet is defined with an observation hole corresponding to the infrared sensor assembly so as to interconnect the infrared sensor assembly with the cooking chamber.

11. The microwave oven as claimed in claim 10, wherein the observation hole has a diameter that an infrared ray radiated from the food is detected by the infrared sensor assembly within a range from four to six degrees.

12. The microwave oven as claimed in claim 11, wherein the diameter of the observation hole is in a range from fourteen millimeter to twenty five millimeter.

13. The microwave oven as claimed in claim 11, wherein the infrared sensor assembly comprises:

    an infrared sensor for detecting the temperature of the food;
    a printed circuit board installed with a plurality of electric elements for converting the temperature of the food into an electric signal;
    a sensor cover encasing the infrared sensor, and having a first hole through which the infrared sensor detects the infrared ray of the food in the cooking chamber; a sensor protecting shutter for opening/closing the first hole of the sensor cover; and
    a casing for receiving the printed circuit board, the sensor cover, and the sensor protecting shutter, and having a second hole corresponding to the observation hole of the cabinet.

14. The microwave oven as claimed in claim 13, wherein the sensor protecting shutter for infrared sensor comprises:

    a base having a third hole corresponding to the first hole of the sensor cover;
    an arm lever rotatably installed at a front and

upper side of the base;
a driving motor for rotating the arm lever;
a first shutter plate moved in a longitudinal direction of the base by the arm lever;
a second shutter plate, moved by the arm lever toward an opposite direction of the first shutter plate, for dosing/opening the third hole by incorporated with the first shutter plate; and
a shutter cover, fixed to the base and formed with an opening corresponding to the third hole, for covering the arm lever, the first shutter plate, and the second shutter.

FIG. 1

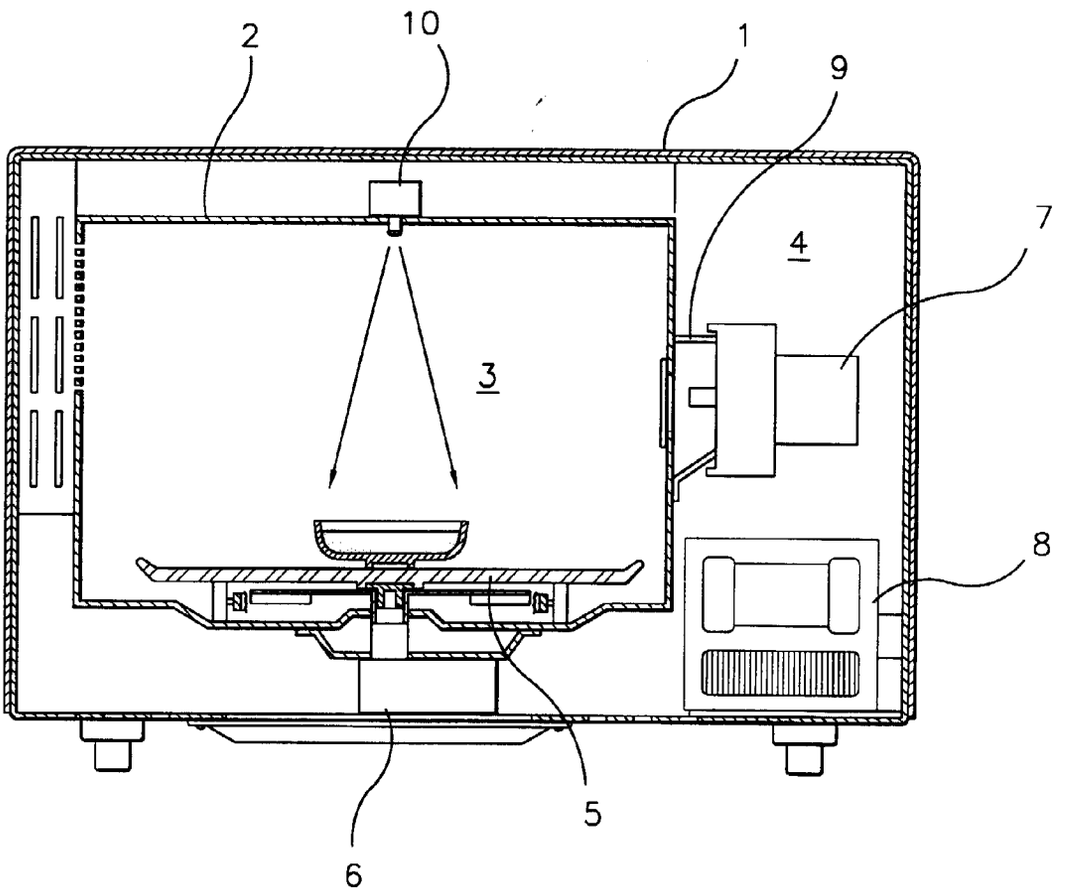


FIG. 2

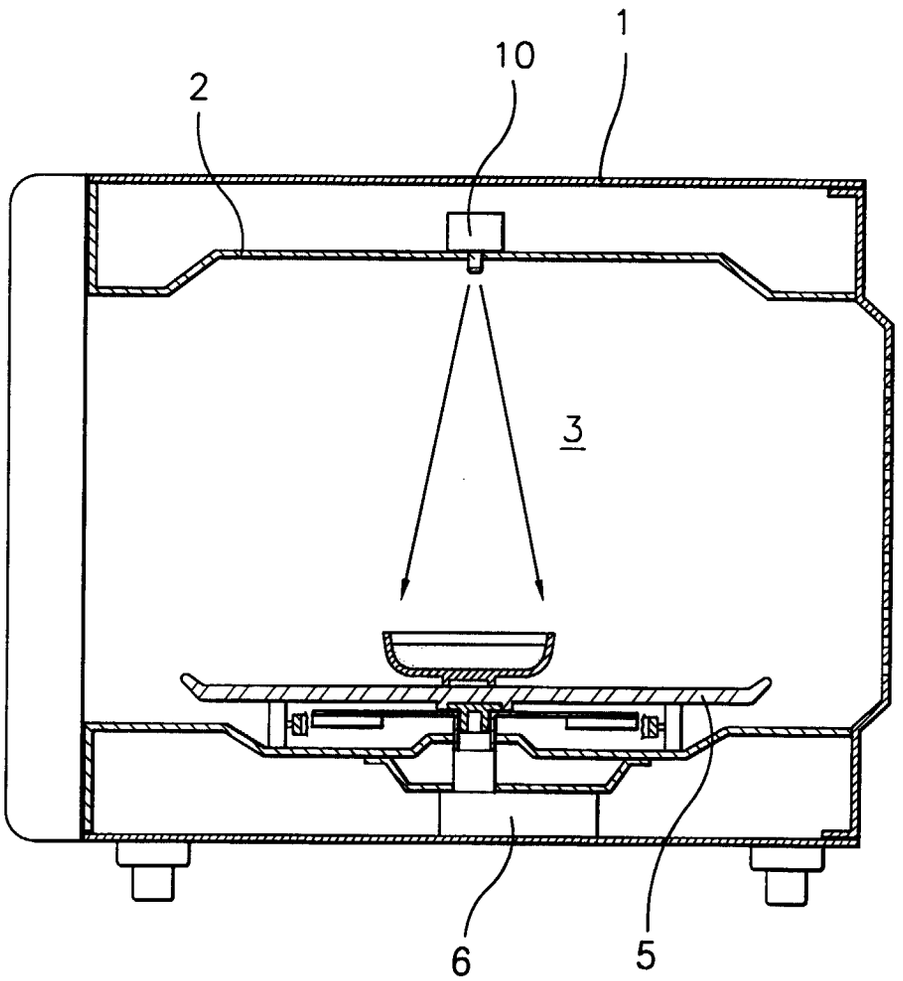


FIG. 3

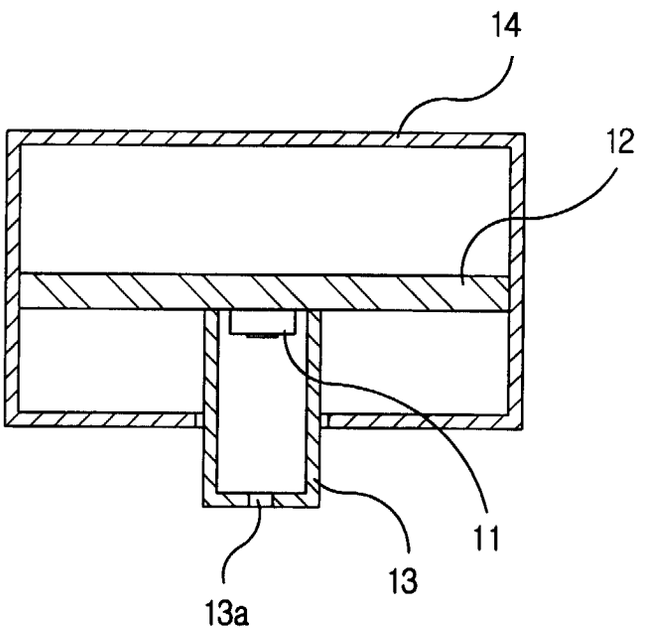


FIG. 4A

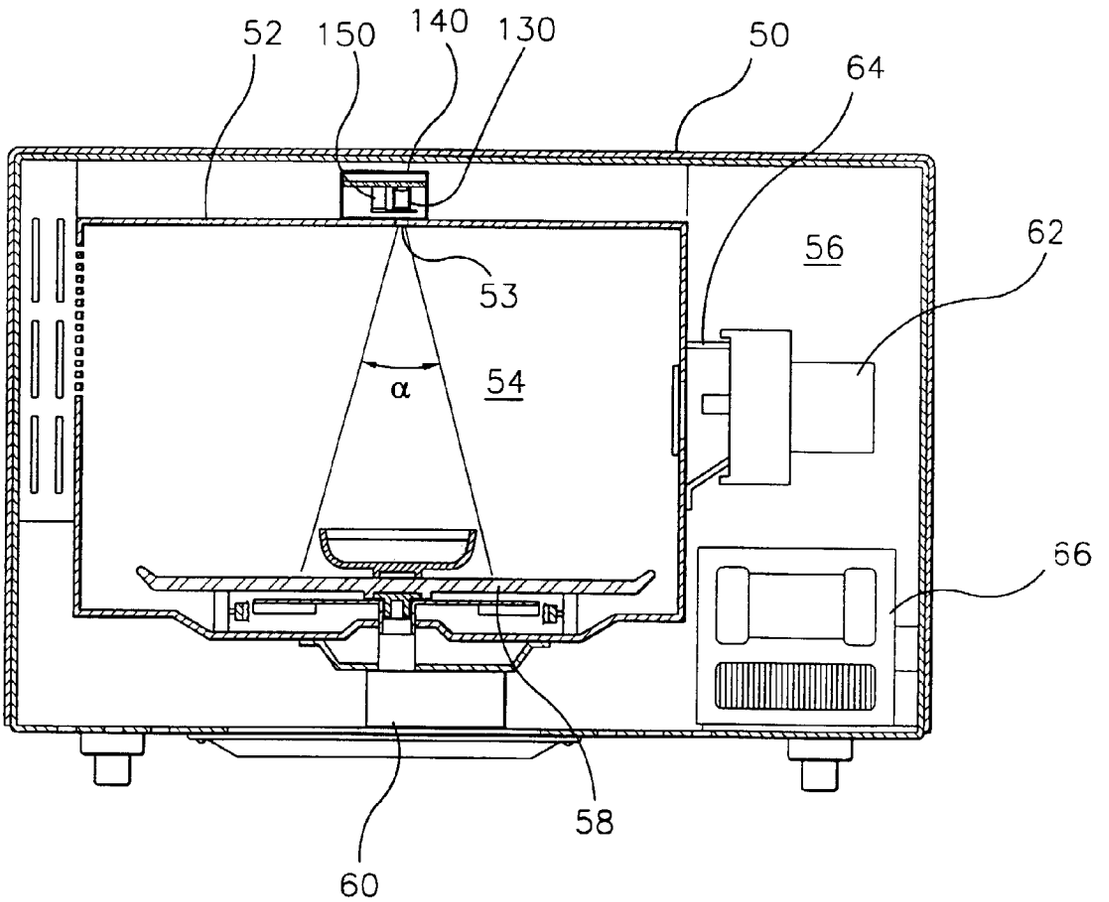


FIG. 4B

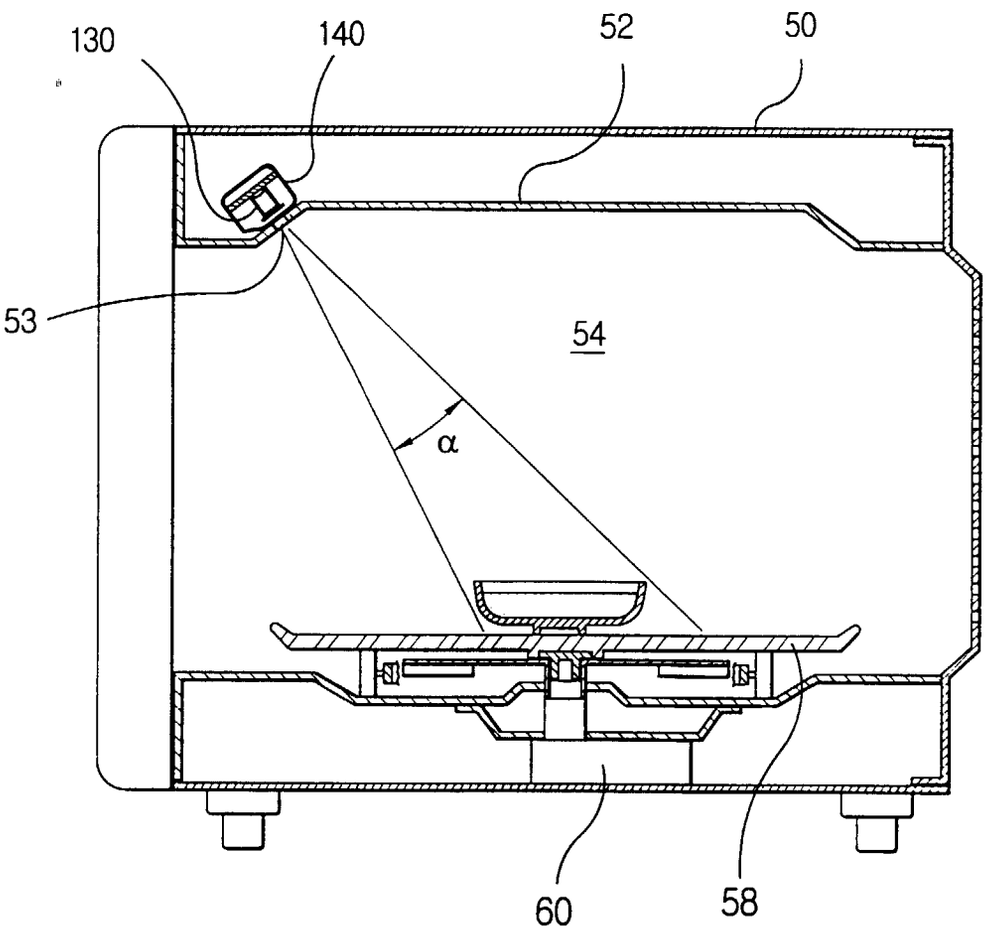


FIG. 5

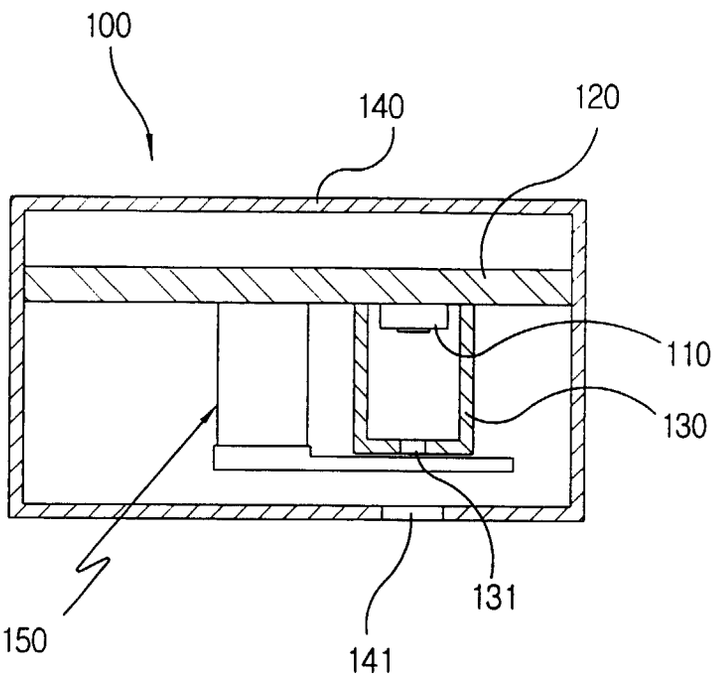


FIG. 6

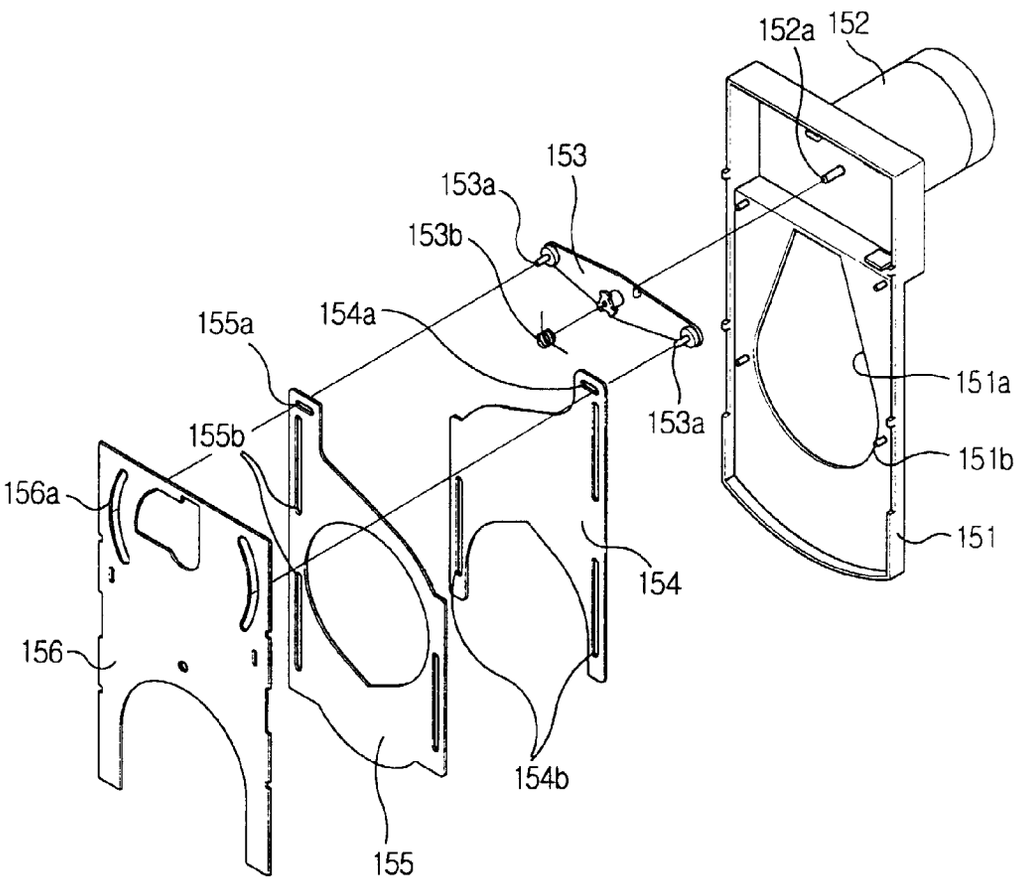
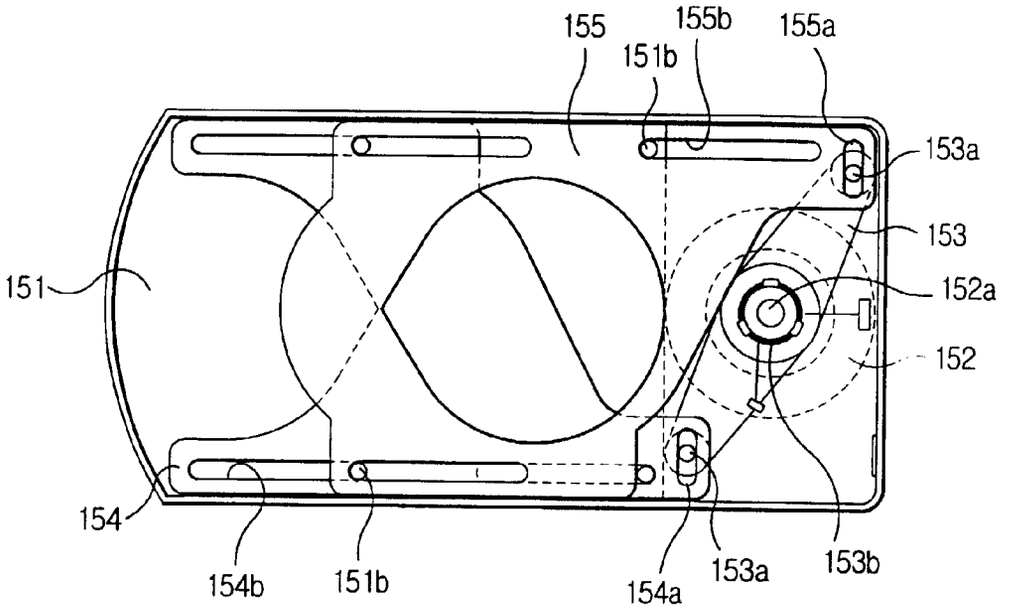

152a
152
153
153a
153b
155a
154a
151a
153a
155b
151b
156a
151
154
156
154b
155

FIG. 7A


155
155b
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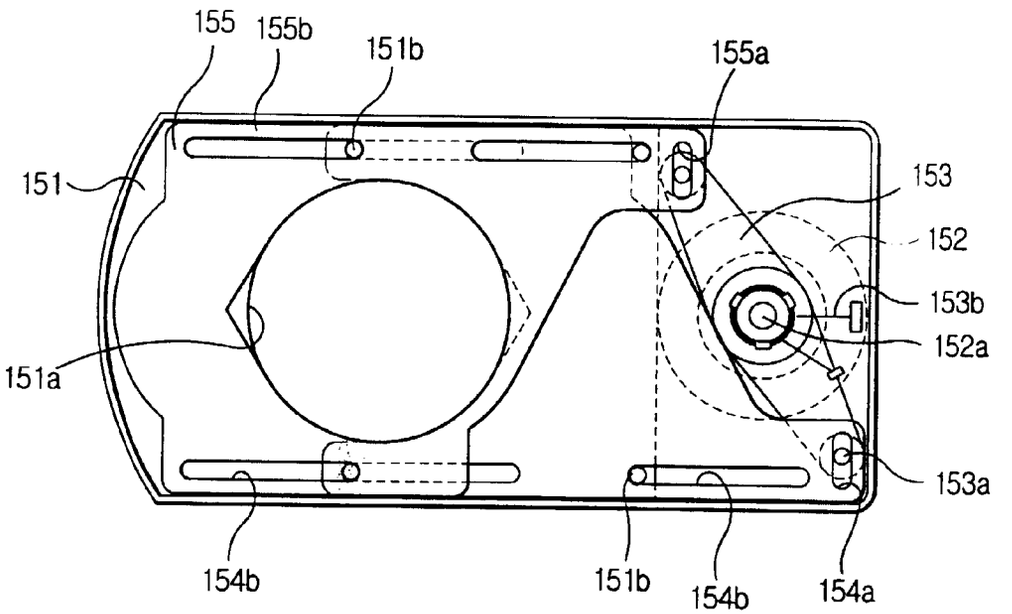
151b
153a
153
151
152a
152
154
154b
151b
154a
153a
153b

FIG. 7B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