United States Patent

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[72] Inventors **Tetsuo Togashi;**
Morio Kumakura, both of Kawasaki, Japan

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[73] Assignee **Tokyo Shibaura Denki Kabushiki Kaisha**
also known as Tokyo Shibaura Electric Co., Ltd.
Kamagawa-ken, Japan

[54] **HIGH-FREQUENCY SEALING DEVICE**
4 Claims, 7 Drawing Figs.

[52] **U.S. Cl.** **126/190,** 219/10.55
[51] **Int. Cl.** **F23m 7/00**
[50] **Field of Search** 126/190, 200; 219/10.55

[56] **References Cited**

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Primary Examiner—Carroll B. Dority, Jr.
Attorneys—Robert E. Burns and Emmanuel J. Lobato

ABSTRACT: For the prevention of wave leakage from within a chamber of a high-frequency sealing device such as a heating device (especially one for food-processing applications), there is provided a hollow metal door having a resilient inner surface for leakageproof contact with the inner edges of the open end of the chamber. A leaking wave, if any, from between the inner surface of the door and the inner edges of the heating chamber is guided into the hollow interior of the door through an elongated window provided on the inner surface thereof. The door may contain a dielectric for absorption of the leaking wave, and its window may be permanently closed with a dielectric thereby to prevent the entrance of any extraneous matter (e.g., water and dust) into the door interior without rendering the window itself impervious to the leaking wave.

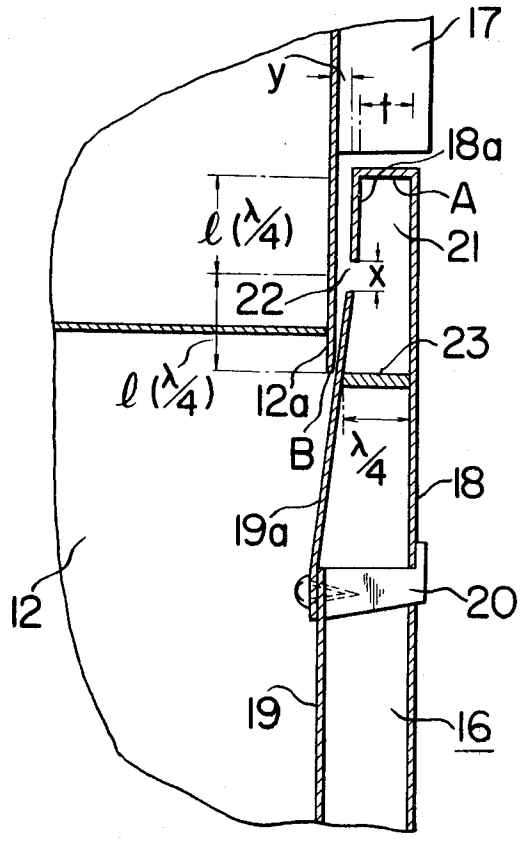


FIG. 1

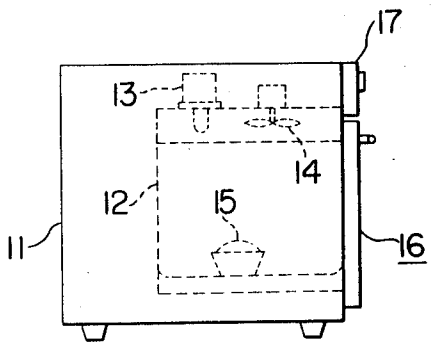


FIG. 2

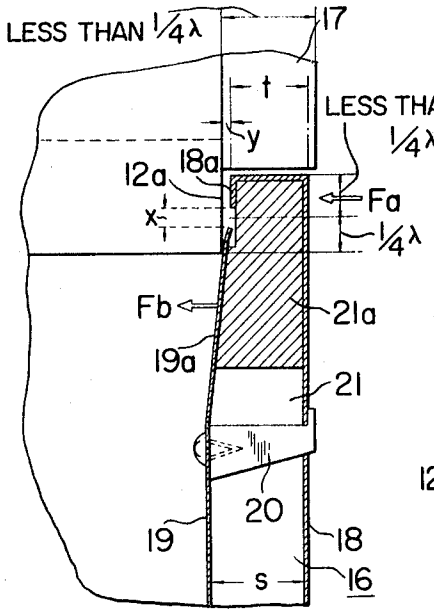


FIG. 3

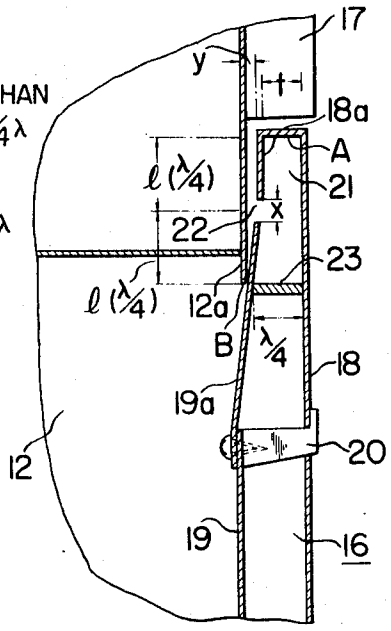


FIG. 4

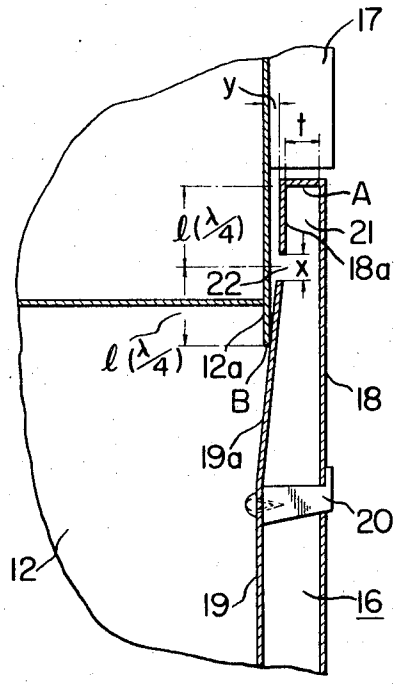


FIG. 5

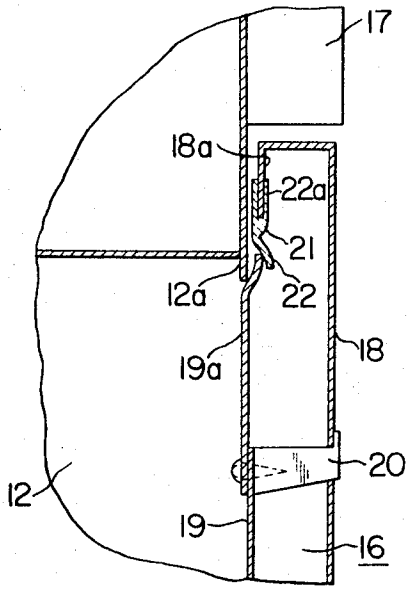


FIG. 6

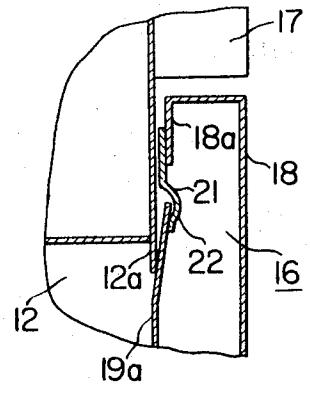
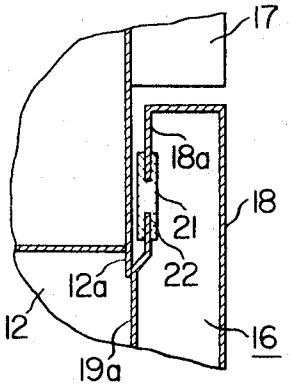


FIG. 7



HIGH-FREQUENCY SEALING DEVICE

BACKGROUND OF THE INVENTION

This invention relates generally to high-frequency sealing devices, and in particular to some improvements made between a door and a high-freqeuency enclosure for the prevention of wave leakage therefrom.

A high-frequency sealing device, for example, a high-frequency heater for the processing of food, among many other applications thereof, is generally known as a "microwave oven" in the consumer market. Although the microwave oven can rapidly and hygienically heat food by using an ultrahigh frequency wave of 2,450 MHz. or thereabouts, the microwave oven has an intrinsic drawback in that said wave may leak from between the enclosure and the door thereof.

Varieties of contrivances have been introduced in prior microwave ovens for the prevention of wave leakage. One is the provision of a resilient gasket at the contacting surface of an oven itself and its door in order to insure close contact therebetween. However, since no perfect contact is possible due to inevitable errors in the manufacturing stage, complete prevention of wave leakage cannot be expected by this means.

Second another expedient is metal-to-metal contact between the enclosure and the door of an oven, in which sparking is caused between the contacting metals, thus greatly deteriorating contacting state of contact metals in the course of time. Moreover, considerable wave leakage is almost unavoidable.

Thirdly, there is the so-called "choke-door" system, in which a cavity is formed in the door toward the enclosure of an oven. According to this system, the cavity must have a depth equal to $\lambda/4$ (λ: fundamental wavelength of the ultrahigh frequency wave in use), so that the door itself has to be of greater thickness than that constructed for the above-described metal-to-metal contact with the enclosure. This, of course, leads to higher manufacturing costs and other undesirable results.

SUMMARY OF THE INVENTION

It is a primary object of the present invention to provide a high-frequency sealing device in which the inner surface of a door itself is made of resilient material for leakage-free contact with an enclosure.

Another object of the invention is to provide a high-frequency sealing device whose door has a hollow interior into which the wave is guided, if any, leaking from between the door and the enclosure.

Still another object of the invention is to provide a high-frequency sealing device whose door contains a dielectric for the dissipation or the absorption of leaking wave.

Yet another object of the invention is to provide a high-frequency sealing device in which no sparking occurs between the contacting portions of its main enclosure and door, whereby it is made possible to prevent the device from wave leakage for an extremely long period of time.

A further object of the invention is to provide an extremely hygienic high-frequency heating apparatus in which its door is so constructed as to prevent the entrance of any extraneous matter (e.g., food crumbs, water and dust) into the interior thereof but not to suffer in its capabilities of leakage prevention.

All these and the other objects of the invention as well as the characteristic features thereof will become more apparent from the following description of several preferred examples as embodied in microwave oven, taken in connection with the accompanying drawings in which like reference characters designate like parts.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. **1** schematically illustrates a microwave oven for the explanation of the present invention; and

FIGS. **2** through **7** are enlarged, fragmentary, vertical sectional views of part of the microwave oven, each representing a different embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. **1**, the reference numeral **11** indicates a main body of an example of microwave oven in which may be incorporated the improvements of the present invention. A metal-made heating chamber **12** having its front side opened is provided within the main body **11**. A magnetron **13** and a stirrer fan **14** are disposed on the top surface of the heating chamber **12**. Hence, a ultrahigh frequency wave of approximately 2,450 MHz., for example, generated by the magnetron **13** is turbulently diffused by means of the stirrer fan **14**, with the result that a constant electric field is produced in the heating chamber **12** for the uniform heating of food **15** placed therein.

The aforesaid open side of the heating chamber **12** is ordinarily kept closed by means of an openable metal-made door **16** the lower edge of which is pivoted to the main body **11**. Above this door **16** there is provided a decorative front plate **17** that is secured to the main body **11**.

As shown in FIG. **2**, the door **16** is formed by an outer sheet metal frame **18** and an inner thin metal plate **19** attached to that inner side of the door **16** which is opposed to the main body **11**. This metal plate **19** is formed slightly larger than the opening **21** of the heating chamber **12**, and is secured to the outer frame **18** by means of a support member **20** disposed at a position spaced over a certain desired distance toward the center from the edges. A contact portion **19***a* of the metal plate **19** is equipped with a resiliency, and is slightly inclined at its edges toward the outer frame **18** so that it abuts on the lower edge of front-end wall **12***a* of the heating chamber **12** at its portion near the edge. And a dielectric material **21***a* having the desired resiliency is contained in the inside cavity **21** of the door **16**.

The edge of the outer frame **18** is bent inwardly, i.e., toward the metal plate **19**, in the shape of an upside-down "U" over a door end with t, and a spacing x adapted to form an elongated window is provided between the bent end **18***a* of the outer frame **18** and the edge of the metal plate **19**. The bent end **18***a* is at such a position that when the door **16** is closed, a spacing y exists between itself and the front-end wall **12***a* of the heating chamber **12**.

The width s of the door **16** at its middle portion, of course, is greater than the width t. Further, in order to insure the relation $x>y$ between the aforesaid spacings x and y, x is set at a value in the range of from one-tenth to one-fortieth of a fundamental wavelength λ of a ultrahigh frequency wave in use, while y is set at a value in the range of $0<y<\lambda/40$.

In this first embodiment of the present invention, constructed as in the foregoing and illustrated in FIGS. **1** and **2**, a force F*a* exerted toward the heating chamber **12** by the door **16** when this door is closed is counterbalanced by a force F*b* working in the opposite direction of the force F*a* as the contact portion **19***a* of the metal plate **19** is pressed against the lower edge of the front-end wall **12***a* of the heating chamber **12**. Hence, the door **16** is closed stably, with the forces F*a* and F*b* at equilibrium as in FIG. **2**.

The contact portion **19***a* of the metal plate **19** thus pressed stably against the lower edge of the front-end wall **12***a* insures the tight closure of the heating chamber **12** and, accordingly, prevents the leakage of a ultrahigh frequency wave therefrom. Moreover, even though there was some wave leakage from between the contact portion **19***a* and the front-end wall **12***a* of the heating chamber **12**, this leaking wave is unfailingly absorbed by the dielectric material **21***a* charged inside the door **16** through the spacing x between the bent end **18***a* and the upper end of the contact portion **19***a*, because the spacing y between the bent end **18***a* and the front-end wall **12***a* is smaller than the mentioned spacing x. Practically no wave is thus permitted to leak outside of the heating chamber **12**.

Another embodiment of the invention is shown in FIG. 3. As illustrated, a door **16** is constructed essentially in the same way as that of FIG. 2 except for a few differences. The part of the dielectric material **21***a* of FIG. 2 is replaced by a cavity **21**. Further, a window **22** is so disposed that a distance *l* between its center and a bottom A of the cavity **21** is less than λ/4 and a distance *l* between its center and a position B at which a contact portion **19***a* contacts the front-end wall **12***a* of the heating chamber **12** is equal to λ/4 of a ultrahigh frequency wave in use, while a door end width *t* is set at a value less than λ/4. A distance between the position inside of the contact portion **19***a* corresponding to the aforesaid position B and a sheet metal outer frame **18** is also set at λ/4, and an electric conductor **23** having the desired resiliency is provided therebetween.

In this second embodiment of the above construction, the bottom A of the cavity **21** is in a condition electrically short-circuited, as it were, and the electric field is most weakened there. Accordingly, the electric field is also weakest at a position spaced over a distance of λ/2 from the bottom A of the cavity **21**, i.e., the point B at which the contact portion **19***a* contacts the front-end wall **12***a* of the heating chamber **12**, so that any sparking at this point B is prevented. The contact portion **19***a* thus protected from damage due to sparking is capable of maintaining a leakage-free contact over an extremely long period of time. Moreover, wave leakage, if any, from between the contact portion **19***a* and the front-end wall **12***a* of the heating chamber **12** does not cause any trouble because this leaking wave is absorbed in the cavity **21**. With provision of the conductor **23** having λ/4 width inside the door **16** at a position spaced λ/4 from the window **22**, the total of the width of this conductor **23** and the length between the window **22** and one of the ends of the conductor **23** is λ/2, so that a "choking" effect is obtainable for the surer prevention of wave leakage.

FIG. **4** shows still another embodiment of the invention, the construction of which is identical with the foregoing embodiment illustrated in FIG. **2**. The only pronounced difference is that the conductor **23** of FIG. **3** is not provided in this particular embodiment.

According to this construction, too, the bottom A of the cavity **21** is in an electrically short-circuited condition, and the electric field is weakest there, and further the point B of contact between the contact portion **19***a* and the front-end wall **12***a* of the heating chamber **12**, is at a position spaced λ/2 from the bottom A of the cavity **21**, so that the electric field at said point B is also weakest and no sparking occurs at said point B. The contact portion **19***a* thus prevented from damage due to sparking is capable maintaining a favorable, leakage-free state of door closure over an extremely long period of time. Moreover, there is virtually no possibility of wave leakage outside of the door **16** because all the leaking wave, if any, from between the contact portion **19***a* and the front-end wall **12***a* of the heating chamber **12** is absorbed in the cavity **21**. As an added convenience, the door **16** may be made to be adequately thin because the cavity **21** is provided lengthwise therein.

FIG. **5** illustrates a further embodiment of the invention, in which the edge of the contact portion **19***a* is slightly bent toward the outer frame **18** of the door **16**, contacting the lower edge of the front-end wall **12***a* of the heating chamber **12** approximately at the bending point. And a resilient dielectric member **22** is provided at the window **21** formed by the bent end **18***a* of the frame **18** and the bent end of the contact portion **19***a*. One of the ends of this dielectric member **22** may be bifurcated to hold the bent end **18***a* of the outer frame **18** between its two branches, while the other end thereof is bent toward the interior of the door **16** so as to abut on the edge of the contact portion **19***a* from within the door **16**.

By this construction, in which the window **21** formed between the edge of the contact portion **19***a* and the bent end **18***a* of the frame **18** is kept completely closed by means of the dielectric member **22**, food crumbs, water, dust and the like are prevented from intruding into the interior of the door **16** via the window **21**. Because of its very nature, the dielectric member **22** does not render the window **21** impervious to the wave, if any, leaking from between the contact portion **19***a* and the front-end wall **12***a* of the heating chamber **12**. Moreover, since the contact portion **19***a* is not deprived of its resiliency by the dielectric member **22**, it is capable of making close contact with the front-end wall **12***a* for prevention of wave leakage.

While one of the ends of the dielectric member **22** is bifurcated in the last described embodiment of the invention, it may be either simply bonded, as in FIG. **6**, or screwed to the bent end **18***a* of the frame **18**. As a further modification, as illustrated in FIG. **7**, the bent end **18***a* and the contact portion **19***a* may be buried in a solid piece **22** made of a dielectric material.

Although the invention has been shown and described in the foregoing with reference to several currently preferred embodiments thereof, it will be obvious that many modifications thereof can be made without departing from the spirit of the invention.

We claim:

1. A high-frequency sealing device comprising a main body in which is provided a heating chamber having a front opening and a door for closing said opening, said door comprising an inner metal plate resiliently contacting the periphery of said opening and another metal plate spaced apart from said inner plate, the peripheral edge of said other plate being bent inwardly into the shape of a letter U, thus forming an annular cavity in said U-shaped peripheral edge, characterized in that said contact between the periphery of said front opening and said inner metal plate is direct metal-to-metal contact, that at least one opening is formed between said contact and the peripheral sidewall of said other plate at a distance of λ/4 from said contact, and that the distance between the center of said opening and said other plate is up to λ/4.

2. A high-frequency sealing device according to claim 1 wherein a dielectric material is contained in the space between said inner and other plate, said space including at least said cavity.

3. A high-frequency sealing device according to claim 2 wherein said dielectric material is resilient.

4. A high-frequency sealing device according to claim 1 wherein a conductive plate is inserted between said inner and outer plate at a point λ/2 apart from the bottom wall of the outer plate.

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