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Nakano

[11] **3,803,377**

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[54] **FAIL SAFE DOOR SEAL MICROWAVE OVEN**

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[52] **U.S. Cl.** **219/10.55**

[51] **Int. Cl.** **H05b 9/06**

[58] **Field of Search** 219/10.55

[56] **References Cited**

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3,678,238 7/1972 Vasuoka et al. 219/10.55

3,525,841 7/1970 Haagensen et al. 219/10.55

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[57] **ABSTRACT**

A microwave oven in which a choke seal and capacitive seal are improved and at the same time are combined in an effective manner to limit the amount of escaping microwave energy to a value lower than the predetermined permissible level and thus to provide a fail-safe door seal structure.

6 Claims, 4 Drawing Figures

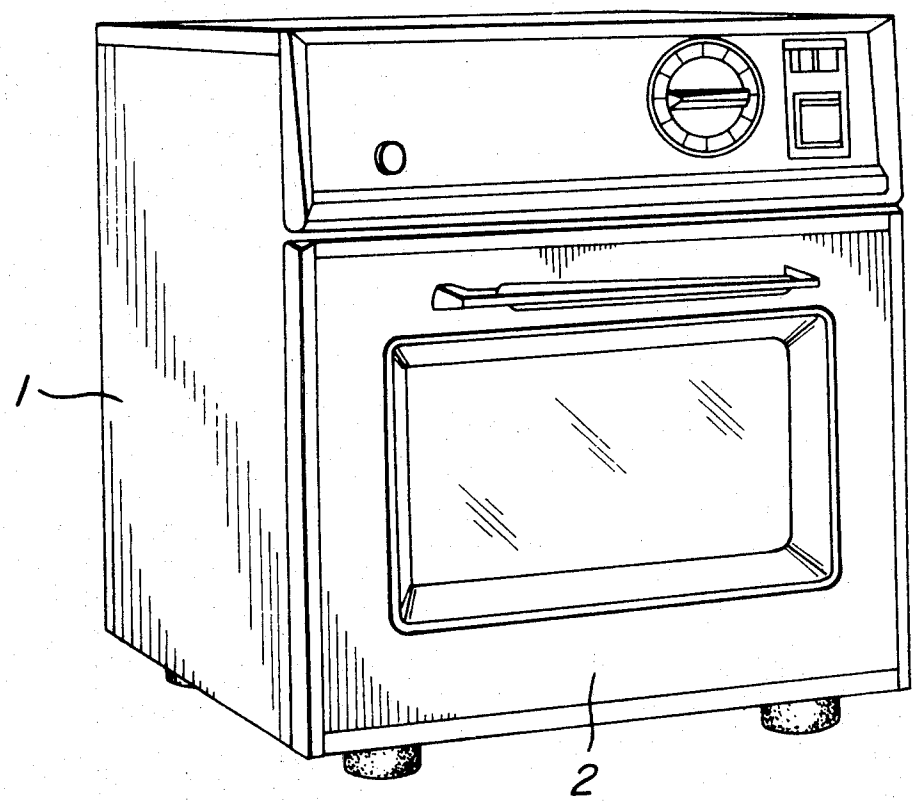


FIG. 1

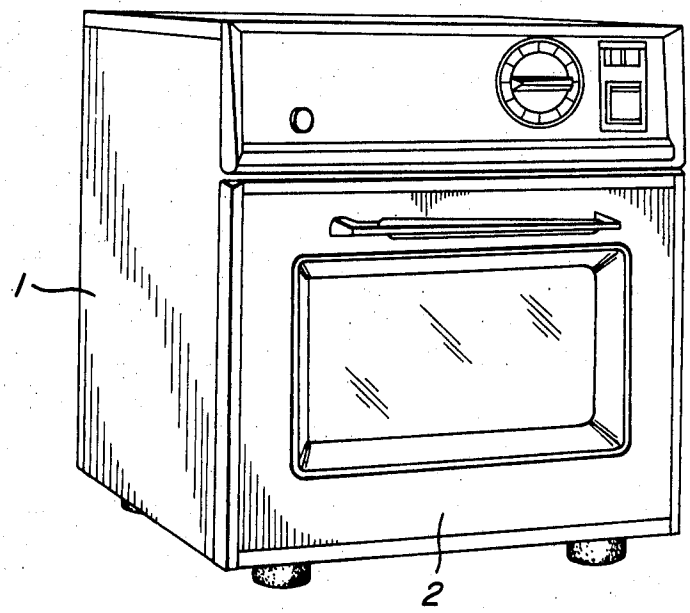


FIG. 2

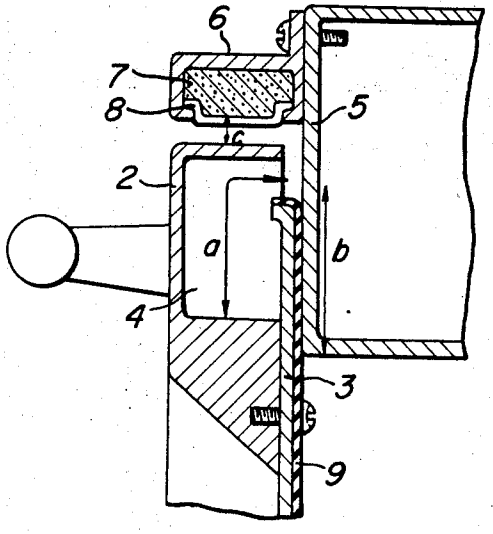


FIG. 3

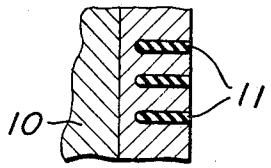
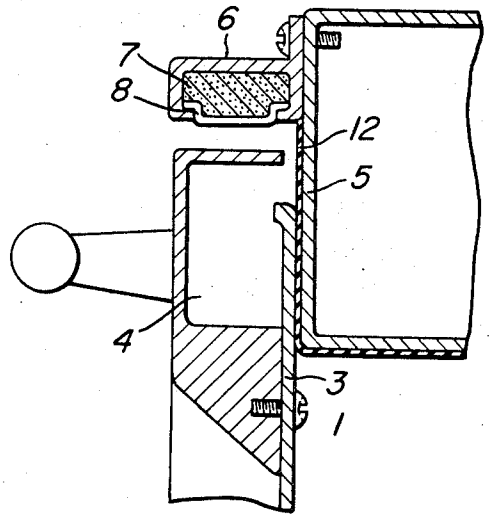


FIG. 4



FAIL SAFE DOOR SEAL MICROWAVE OVEN

The present invention relates to door seals for microwave ovens and is characterized in that a capacitive seal and choke seal are improved and used in combination to limit the amount of leakage microwave energy below the predetermined permissible level.

In a prior art choke seal such as, for example, disclosed in U.S. Pat. No. 3,182,164, there is the danger of the escape of microwave energy when the wavelength of a wave varies with a change in the load or the like.

On the other hand, a type of capacitive seal known in the art is disclosed, for example, in U.S. Pat. No. 2,888,543. A disadvantage of this type of capacitive seal is that if any article such as, for example, a spoon is caught between the door and the oven housing or if the contact surface between the door and the oven housing has been damaged, there is the danger of microwave energy leakage. Thus, if these two types of seals are used separately, there is the danger of allowing the escape of microwave energy. The present invention eliminates these drawbacks, but makes use of the advantages of these two types to provide a very efficient door seal structure.

It is therefore a principal object of the present invention to provide a novel microwave oven in which a capacitive seal and choke seal are combined in a simple construction to prevent the escape of microwave energy in an economical and positive manner.

It is another object of the present invention to provide a novel microwave oven in which an anodically formed oxide coating is deposited on either of the contacting surfaces of the door and oven housing to prevent the occurrence of spark therebetween and thus to prevent the burning of the marginal edges of the oven opening.

It is a further object of the present invention to provide a novel microwave oven in which a microwave absorbing substance is provided at least on either the marginal side edge of the door or the side of the oven housing opposing the marginal side edge in parallel to the direction in which the door is opened, whereby even if the operation of the door switch is delayed, leakage of microwave energy upon the opening of the door can be absorbed.

It is a further object of the present invention to provide a novel microwave oven in which the surface of a microwave absorbing substance is coated with a protective cover of a low dielectric constant material, so that food oil or seasoning is prevented from sticking to the microwave absorbing substance to prevent any deterioration in the sealing effect and at the same time to improve the external appearance of the microwave absorbing substance.

It is a still further object of the present invention to provide an inexpensive microwave oven in which the microwave absorbing substance consists of a conductive rubber admixed with a manganese ferrite material.

The above and other objects and advantages of the present invention will be more readily apparent from the following description of the preferred embodiments of the invention taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a general perspective view of a microwave oven according to the present invention;

FIG. 2 is a sectional view of the door seal structure constituting the principal part of the microwave oven of FIG. 1;

FIG. 3 is a sectional view of the insulating coating constituting the principal part of FIG. 2; and

FIG. 4 is a sectional view showing another embodiment of the door seal structure shown in FIG. 2.

Referring now to the drawings, numeral 1 designates an oven housing having a heating cavity formed therein and the microwave energy is radiated into the heating cavity from a high frequency source. Numeral 2 designates a frame-type door pivotally mounted opposite to the opening of the heating cavity. The door 2 is provided with an aluminum plate 3 covering its inner surface and forming with the door 2 a choke cavity 4 which is opened at one end. The dimensions *a* and *b* of the choke cavity 4, as shown in FIG. 2, are selected at a quarter wavelength. Numeral 5 designates a stainless steel flange mounted around the opening of the heating cavity so that the flange is pressed against the outer surface of the aluminum plate 3 when the door 2 is closed. Numeral 6 designates an aluminum sash attached to the stainless steel flange 5 with a microwave absorbing substance such as a rubber 7 mixed with manganese or nickel ferrite material filled in the inner part thereof. The microwave absorbing substance 7 is mechanically brittle and tends to be easily broken and for this reason its surface is protected by a cover 8 composed of a low dielectric constant material such as polypropylene so as to prevent food from sticking to the microwave absorbing substance 7 and reducing its absorbing effect in the long periods of use. In this case, it is more economical to use a ferrite rubber mixed with a manganese ferrite material. When metals are brought closer to each other in a high frequency field, a spark discharge may be caused by the field. Numeral 9 designates an insulating coating formed on the surface of the aluminum plate 3 to prevent the occurrence of a spark discharge between the plate 3 and the flange 5.

With the construction described above, the aluminum plate 3 and the stainless steel flange 5 held together closely prevent the escape of microwave energy to the outside, while a choke attenuator is formed by the chokes *a* and *b* so that even if there is an opening left between the plate 3 and the flange 5, the wave is attenuated by the choke attenuator. The thus attenuated wave is then absorbed by the succeeding microwave absorbing substance 7 preventing the escape of microwave energy and thus ensuring a complete seal. In this case, since the microwave absorbing substance 7 is disposed substantially parallel to the direction in which the door 2 is opened, even if the door 2 is opened slightly, the distance *c* remains unchanged thus ensuring a satisfactory absorbing effect. Moreover, since the surface of the microwave substance 7 is protected by the cover 8, the substance 7 is not contaminated by food and the like keeping it clean and at the same time providing an excellent external appearance. The provision of the insulating coating 9 between the aluminum plate 3 and the flange 5 prevents the danger of burning by spark discharge. Moreover, since the seals for the door 2 do not require any mechanical contact between the plate 3 and the flange 5, there is no need to forcibly close the door, but only a little strength is required and thus it is easy to handle.

Referring to FIG. 3, there is shown a modified form of the insulating coating consisting of an anodically

formed oxide coating whose insulating property is satisfactory for its thickness. In other words, an anodic oxidation coating is deposited on the surface of a metal substrate **10** and then an insulating material **11** is filled into a large number of small holes in the anodized surface. This ensures a satisfactory insulating property meeting the requirements with a thin film of oxide, with the resultant improvement in the efficiency of surface treatment and a reduction in the manufacturing cost.

FIG. **4** illustrates another embodiment of the invention in which an insulating coating **12** is deposited on the heating cavity side with the equivalent effect as that of the FIG. **1** embodiment in which the insulating coating is formed on the door side.

It is now evident from the foregoing that according to the present invention the escape of microwave energy is prevented by the provision of close contact between the door and the front opening portion of the heating cavity, while a choke attenuator is provided by the chokes to take care of the wave escaping through a gap left between the door and the heating cavity opening by a spoon, for example, which is inadvertently caught therebetween. The wave thus attenuated is then absorbed by the succeeding microwave absorbing substance. Thus, the present invention provides an improved structure which effectively prevents the escape of microwave energy and which also serves as a fail safe.

What is claimed is:

1. A microwave oven comprising:

a. a housing formed with a heating cavity having a first opening at the front part of said housing;

b. means for generating microwave energy;

c. means for supplying said microwave energy to said heating cavity;

d. a door mounted on said housing opposite to said first opening of said heating cavity and being movable between open and closed positions so as to close said first opening in the closed position thereof, said closed position forming a capacitive seal for preventing the microwave energy applied to said heating cavity from escaping therethrough, said capacitive seal being formed between the surfaces of said door and said housing which are placed in contact with each other when said door is closed in a portion adjacent to the periphery of said first opening of said heating cavity, said door being formed with a choke cavity having a second opening for attenuating escaped microwave energy traveling from said heating cavity through said capacitive seal when said door is slightly open, said second opening facing the surface of said housing at the outside portion of the periphery of said capacitive seal when said door is closed;

e. an insulating coating provided on at least one of the surfaces of said door and housing which are placed in contact with each other when said door is closed, and

f. a microwave absorbing material on at least one of the marginal side edge of said door and a portion of said housing opposing said marginal side edge of said door, said microwave absorbing material being disposed substantially parallel to the direction in which said door is opened, said capacitive seal, said choke cavity and said absorption material being in a series relationship in the direction of escaped microwave energy.

2. A microwave oven according to claim **1,** wherein said microwave absorbing material is composed of a ferrite rubber mixed with manganese ferrite material.

3. A microwave oven according to claim **1,** wherein the surface of said microwave absorbing material is coated with a cover composed of a low dielectric constant material.

4. A microwave oven according to claim **1,** wherein said insulating coating comprises an anodically formed oxide coating.

5. A microwave oven according to claim **3,** wherein said low dielectric constant material is composed of polypropylene.

6. A microwave oven according to claim **4,** wherein said oxide coating is composed of anodized aluminum.

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