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Tang

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[54] MICROWAVE OVEN APPARATUS

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[52] **U.S. Cl.** **219/10.55,** 333/7

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

[58] **Field of Search** ..... 219/10.55; 343/783; 333/7, 9, 21 R, 21 A, 98.5

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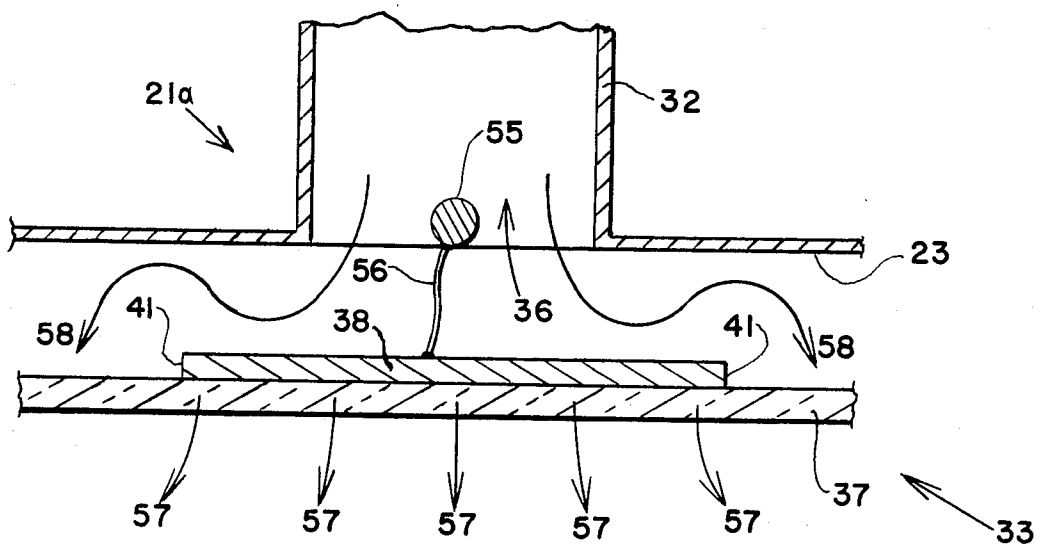
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Assistant Examiner—Hugh D. Jaeger
Attorney—John E. Toupal

[57] **ABSTRACT**

Disclosed is a shield apparatus for a microwave oven. The shield is situated adjacent to a wall of a cooking chamber that defines an opening which is the termination of a waveguide that carries high frequency energy from an energy source to the cooking chamber. A non-electrically conductive shield surface optically shields the opening and an electrically conductive redirector diffuses energy emanating from the waveguide so as to prevent "hot spots" within the cooking chamber. In preferred embodiments that are disclosed herein the shield surface is a sheet of heat resistant glass and the redirector is metallic and of a substantially smaller surface area than the glass and is laminated thereto. The redirector may be a metal plate, metallic material deposited on the glass, metal rings, etc. Another preferred embodiment disclosed herein includes a metallic shorting bar across the opening that protects the high frequency energy source by preventing high frequency energy within the cooking chamber from entering the waveguide. In addition, the shorting bar and the redirector are electrically connected and function as a large surface area antenna and thereby distribute the high frequency energy still more evenly throughout the cooking chamber.

13 Claims, 8 Drawing Figures



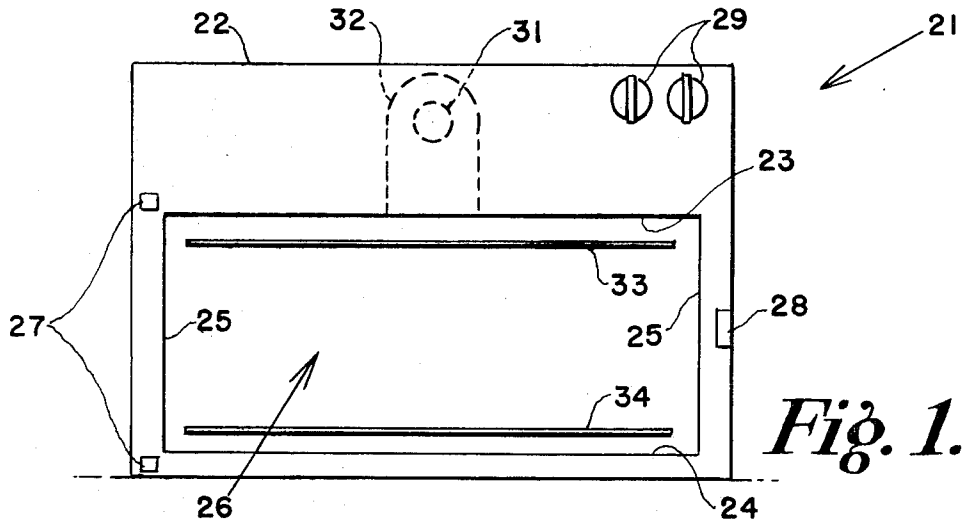


Fig. 1.

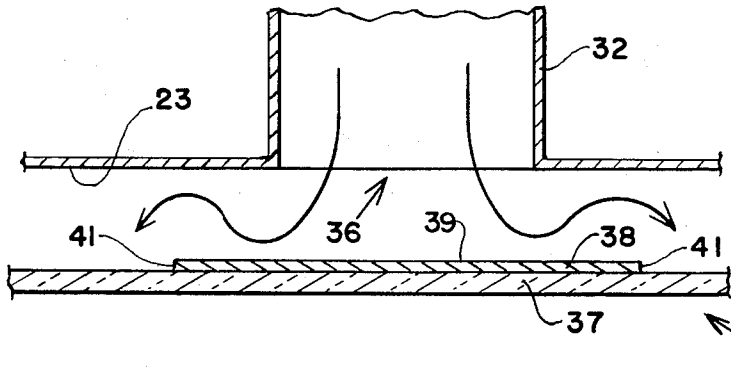


Fig. 2.

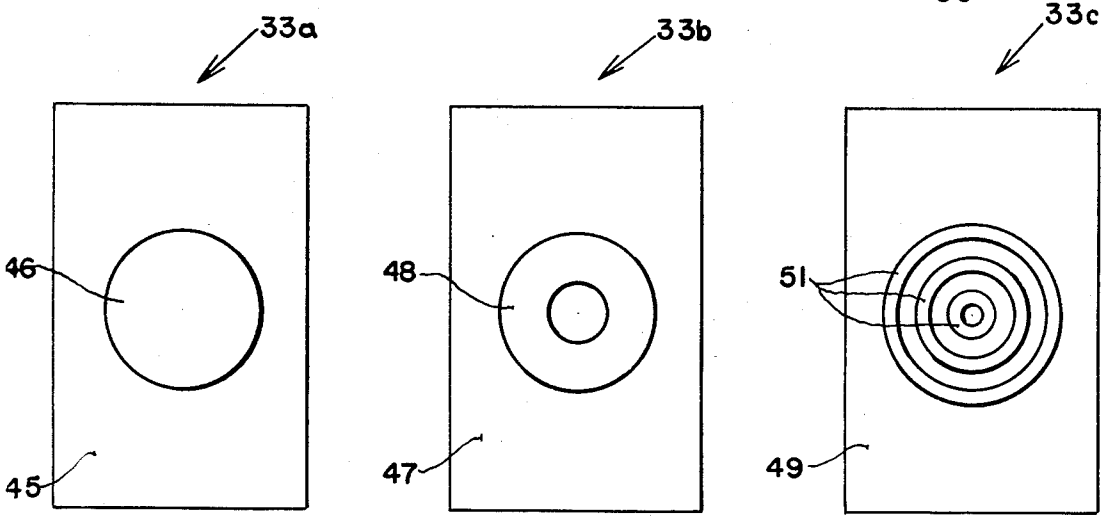


Fig. 3. Fig. 4. Fig. 5.

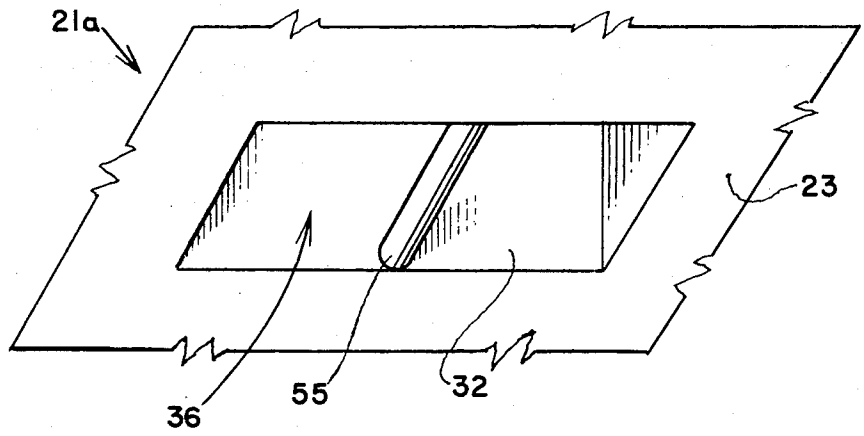


Fig. 6.

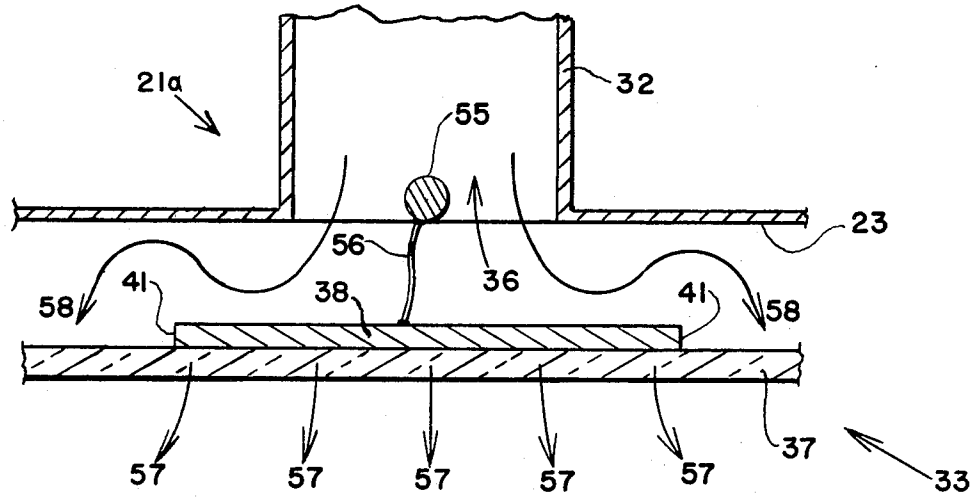


Fig. 7.

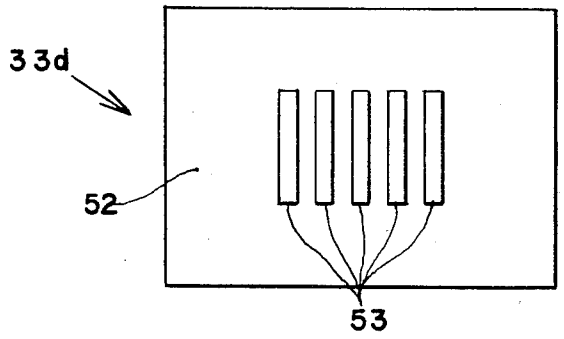


Fig. 5a.

MICROWAVE OVEN APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to microwave ovens, and more particularly to shielding apparatus for use in the cooking chambers thereof that shield the microwave energy source from splattering grease and oil, and shield the cooking chamber from a nondiffused beam of high intensity high frequency energy emanating from the energy source.

Cooking of food by microwave energy is known, and microwave ovens both in household and commerical applications, are becoming more popular. However, one problem associated with microwave cooking is the difficulty in attaining a uniform wave distribution within the oven cooking chamber to provide uniform cooking. Energy is usually supplied to the cooking chamber at only one or two locations and since the oven chamber itself is a metal resonant box, standing waves of the fundamental or other low order mode are often produced therein. For this reason, "hot spots" are created near high energy points within the standing wave pattern and uneven cooking results. Attempts to diffuse the standing wave patterns have previously concentrated on rotating fans or "stirrers" and other types of mode mixers within the oven chamber. While such devices do provide a degree of diffusion, they are expensive and cumbersome, rendering unusable a substantial portion of the cooking chamber. In addition, maintenance has been a problem. For example, plastic stirrers are themselves often destroyed by the concentration of microwave energy at a given point.

Therefore, an object of this invention is to provide an apparatus fo diffusing microwave energy within the cooking chamber that is inexpensive, efficient and small enough in size that only a minimal portion of the cooking chamber is occupied thereby.

SUMMARY OF THE INVENTION

This invention is characterized by a microwave oven including a housing with walls that define a cooking chamber and a conventional source of microwave energy connected to the cooking chamber by a coupling apparatus. A waveguide in the coupling apparatus directs high frequency energy to an opening defined by a wall of the cooking chamber thereby introducing energy into the chamber. Adjacent the wall with the opening is a shield apparatus with a shield surface of heat resistant glass that supports a metallic redirector in the path of energy emanating from the waveguide. The redirector is of a substantially smaller surface area than the glass and can be a metal plate, a metallic deposit on the glass, one or more metallic rings, etc. Energy directed through the opening is reflected by the metallic redirector back to the wall near the opening and from there to the metallic redirector again. The energy emerges from the area between the wall and the metallic redirector only after a plurality of reflections therebetween. Consequently, if the redirector is a metal disc or plate the energy enters the cooking chamber from the space between the wall and the redirector around the entire periphery of the redirector. If the redirector is one or more metallic rings, some energy will enter the oven through and between the ring or rings, and the remainder will emerge around the periphery of the outer rings. In this way, the beam is diffused as if energy were entering the chamber from a

plurality of openings. Thus, no single standing wave pattern is generated within the oven and "hot spots" are eliminated. The subject shield is inexpensive to manufacture and in addition, the larger shield surface prevents splattering grease and oils from entering the wave guide. If the user so desires, the shield apparatus may be removably mounted within the cooking chamber to facilitate cleaning.

Another embodiment includes a metallic shorting bar across the opening to prevent energy within the cooking chamber from entering the waveguide. Thus, energy reflecting from the redirector is prevented from returning to the microwave energy source. When reflected energy is allowed to return, it often causes overheating of the energy source. In addition, the shorting bar can be electrically connected to the metallic redirector. In this embodiment, the space between the metallic redirector and the cooking chamber wall still provides the fanning out effect described above. In addition, the metal redirector also receives energy absorbed by the shorting bar and serves as a large antenna. Thus, high frequency energy is introduced into the cooking chamber from the entire surface area of the redirector. As described previously, if the metallic redirector is a single metal ring or a plurality of rings, energy will enter the oven from through and between the rings, further enhancing the diffusion characteristics of the redirector. Thus, this embodiment provides excellent diffusion characteristics, yet is also inexpensive and requires little maintenance.

DESCRIPTION OF THE DRAWINGS

These and other features and objects of the present invention will become more apparent upon a perusal of the following description taken in conjunction with the accompanying drawings wherein:

FIG. **1** shows an elevation view of a microwave cooking apparatus utilizing the subject shield;

FIG. **2** is a sectional detail view of a portion of the shield apparatus utilized in the cooking apparatus shown in FIG. **1**;

FIG. **3** is a plan view of the shield shown in FIG. **2**;

FIG. **4** is a plan view of an alternate shield embodiment;

FIG. **5** is a plan view of yet another preferred shield embodiment;

FIG. **5***a* is a plan view of still another preferred shield embodiment;

FIG. **6** is a detail view of an opening in the cooking chamber wall defining the end of the waveguide that is utilized in a cooking apparatus similar to the one shown in FIG. **1**; and

FIG. **7** is a sectional detail view of the waveguide shown in FIG. **6** and a shield that is utilized therewith.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIG. **1** there is shown a microwave cooking apparatus **21** including a housing **22** with an upper wall **23**, a lower wall **24** and side walls **25** that partially define a cooking chamber. To insure clarity, a door that is normally mounted on two hinges **27** and operates in conjunction with a latch **28** is not shown. A conventional microwave energy source is controlled by switches **29**. The energy source includes a microwave tube **31** that is coupled to the cooking chamber **26** by a coupling apparatus including a waveguide **32**. Within

the cooking chamber **26** a planar shield apparatus **33** and a lower shelf **34** are removably mounted.

FIG. **2** is a sectional view of a portion of the waveguide **32** and the shield **33**. The upper wall **23** defines an opening **36** at the termination of the waveguide **32**. The planar shield **33** optically shields the opening **36** from the cooking chamber **26** and is comprised of a non-electrically conductive heat resistant glass shield surface **37** and a substantially smaller metallic redirector plate **38** affixed thereto. If the shield **33** were not in place, a high intensity beam of high frequency of energy would emerge from the opening **36** and saturate the portion of the cooking chamber **26** directly below the opening. However, high frequency energy emerging from the opening **36** in the embodiment **21** strikes a reflector surface **39** of the redirector **38** and is reflected thereby toward the upper wall **23**. Consequently, the high frequency energy is released into the cooking chamber **26** only after a plurality of reflections between the reflector surface **39** and the upper wall **23**. Typical energy paths are shown by the arrows in FIG. **2**. Therefore, the energy is dispersed and enters the cooking chamber from the area around a periphery **41** of the redirector plate **38**. Diffusing the high frequency energy prevents the formation of standing wave patterns inasmuch as energy entering the chamber **26** from different locations in different directions cannot form a single dominant standing wave pattern. Thus, even energy distribution within the cooking chamber **26** is provided. The glass shield surface **37** supports the redirector **38** and prevents splattering greases and oils from entering the waveguide **32**. As mentioned previously, the shield **33** is removably mounted to facilitate cleaning.

Referring next to FIG. **3** there is shown an alternate shield **33***a* that includes a shield surface of electrically nonconductive heat resistant glass **45** and a substantially smaller redirector **46** of metallic material deposited thereon. The shield **33***a* functions precisely as does the shield **33**.

Referring next to FIGS. **4, 5** and **5***a* there are shown alternate shields **33***b*, **33***c* and **33***d* respectively. The shield **33***b* includes a shield surface of electrically nonconductive heat resistant glass **47** and a metallic redirector ring **48**. The shield **33***c* includes a shield surface **49** of heat resistant glass and a plurality of metallic redirector rings **51**. A plurality of metal bars or rods **53** are affixed to a sheet of heat resistant glass **52** in the shield **33***d*. Operation of the cooking apparatus **21** with the shield **33***b*, **33***c* or **33***d* is similar to the operation with the shield **33** except that in addition to energy entering the cooking chamber **26** around the periphery **41** of the redirector **38**, a portion of the energy passes through the center of the ring **48** or between the rings **51** or the bars **52**. Therefore, the energy is more dispersed inasmuch as energy enters the cooking chamber **26** from additional locations as compared with operation of the shield **33**. The shields **33***b*, **33***c* and **33***d* may be substituted directly for the shield **33** in the cooking apparatus **21**.

Referring next to FIGS. **6** and **7** there is shown part of another preferred cooking apparatus **21***a* that is similar to the oven **21**. A metallic shorting bar **55** spans the opening **36**. In addition, as shown in FIG. **7**, an antenna wire **56** electrically connects the shorting bar **55** to the metallic redirector **38**.

During operation of the cooking apparatus **21***a* some of the high frequency energy travelling down the waveguide **32** is received by the shorting bar **55** and transferred to the metallic redirector **38** by the antenna wire **56**. Thus, in addition to high frequency energy that emerges around the periphery **41** of the redirector **38** (as shown by the arrows **58** in FIG. **7**), a substantial portion of the energy is radiated directly into the cooking chamber **26** by the redirector **38** as shown by the arrows **57**. Therefore, the cooking apparatus **21**a produces yet a more even energy distribution within the cooking chamber **26** in that energy enters the cooking chamber **26** from the entire lower surface of the metallic redirector **38**. Thus, the embodiment **21***a* also provides an inexpensive method of insuring even distribution of energy within the cooking chamber **26**.

The shields **33***a*, **33***b* and **33***c* can be directly substituted for the shield **33** in the embodiment **21***a*. When such a substitution is made, the shields **33***a*, **33***b* and **33***c* function as described above with respect to FIGS. **3, 4** and **5** with the addition that energy also radiates from them.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is to be understood, therefore, that the invention can be practiced otherwise than as specifically described.

What is claimed is:

1. Microwave oven apparatus comprising:
- housing means including walls defining a cooking chamber;
- energy source means for producing high frequency cooking energy;
- coupling means for introducing said high frequency energy into said cooking chamber, said coupling means comprising waveguide means for directing said energy from said energy source means to an opening defined by one of said walls; and
- shielding means disposed adjacent said one wall and comprising a shield surface that is nonconductive of electricity and optically shields said opening from said cooking chamber; and electrically conductive redirector means of a substantially smaller surface area than said shield surface and disposed on said shield surface and adapted to redirect high frequency energy emanating from said opening.

2. Microwave oven apparatus according to claim **1** wherein said shield surface comprises heat resistant glass and said redirector means is a metallic material deposited thereon.

3. Microwave oven apparatus according to claim **1** wherein said shield surface comprises heat resistant glass and said redirector means comprises a metal plate.

4. Microwave oven apparatus according to claim **1** wherein said shield means is planar.

5. Microwave oven apparatus according to claim **1** wherein said redirector means comprises reflector means adjacent to said opening that reflects said high frequency energy emanating therefrom.

6. Microwave oven apparatus according to claim **1** wherein said redirector means comprises a shorting bar disposed across said opening to prevent high frequency energy from entering said opening from said cooking chamber.

7. Microwave oven apparatus according to claim **6** wherein said shield surface comprises heat resistant

glass and said redirector means comprises a metal plate.

8. Microwave oven apparatus according to claim **7** wherein said redirector means further comprises antenna wire means electrically connecting said shorting bar and said metal plate.

9. Microwave oven apparatus according to claim **8** wherein said redirector means is of substantially smaller surface area than said shield surface.

10. Microwave oven apparatus according to claim **6** wherein said shield surface comprises heat resistant glass and said redirector means comprises metal ring means.

11. Microwave oven apparatus according to claim **10** wherein said redirector means further comprises antenna wire means electrically connecting said shorting bar and said metal ring means.

12. Microwave oven apparatus according to claim **11** wherein metal ring means comprises a plurality of metal rings.

13. Microwave oven apparatus according to claim **11** wherein said metal ring means comprises a single metal ring.

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