March 4, 1969 C. L. ANDERSON 3,431,381

DUAL STIRRER ASSEMBLY

Filed March 29, 1966 Sheet 1 of 2

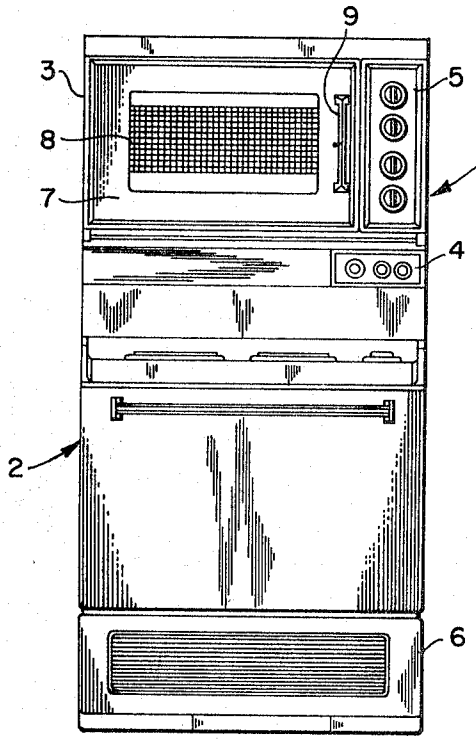


Fig. 1

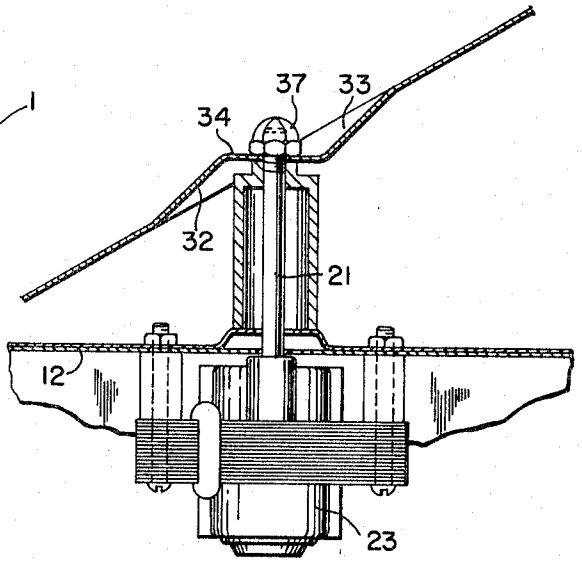


Fig. 3

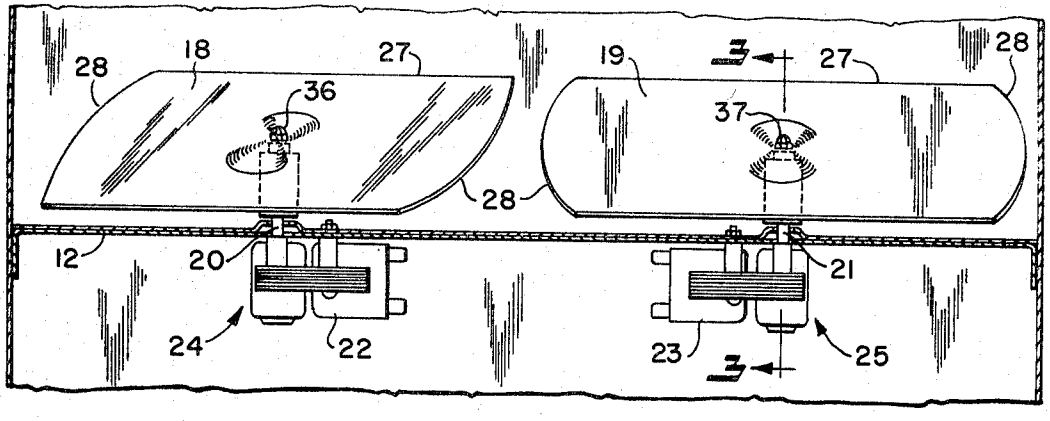


Fig. 2

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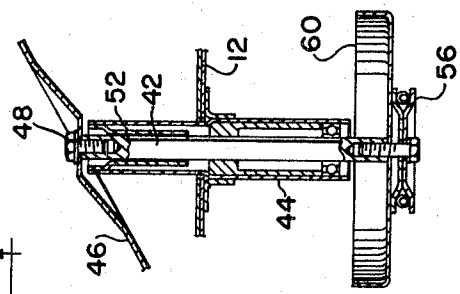


FIG. 5

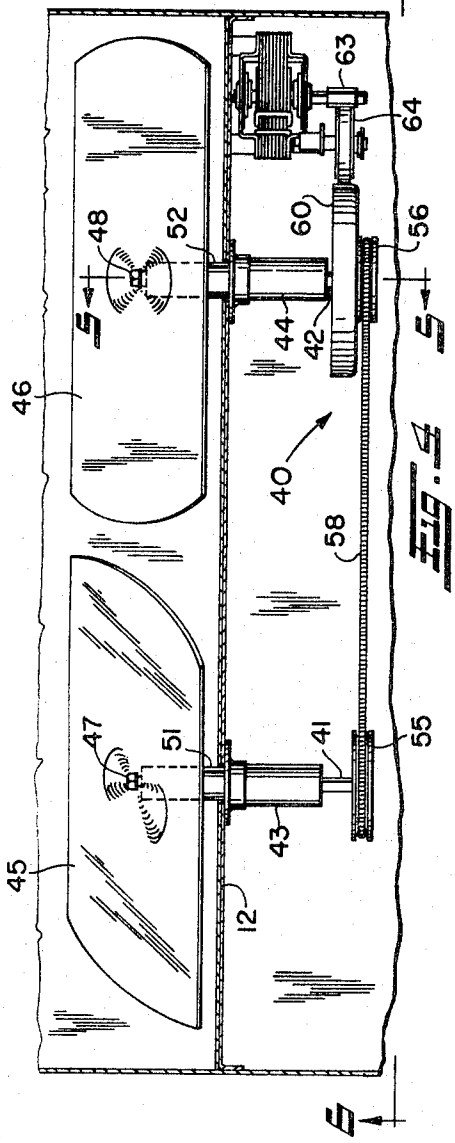


FIG. 4

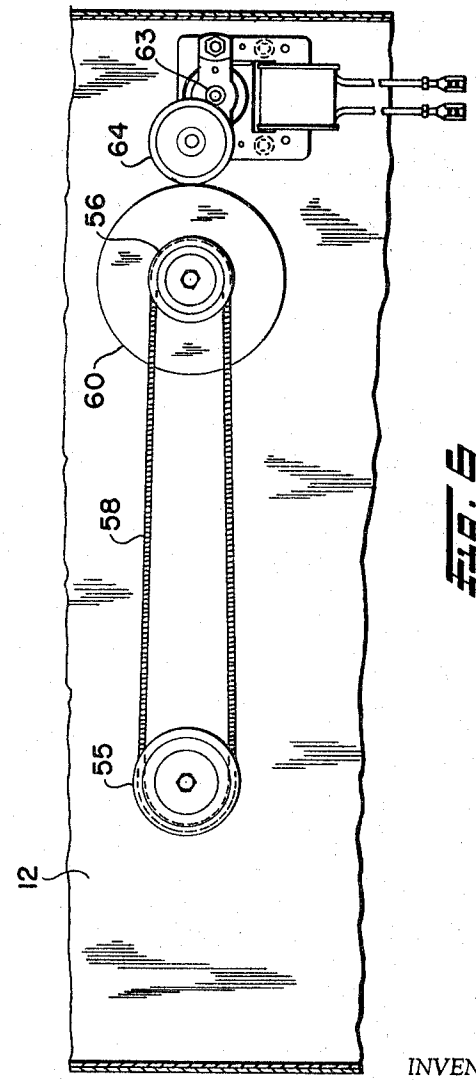


FIG. 6

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DUAL STIRRER ASSEMBLY

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U.S. Cl. 219—10.55 6 Claims
Int. Cl. H05b 9/06

ABSTRACT OF THE DISCLOSURE

A dual stirrer arrangement for use in a microwave cooking oven consisting of a pair of blades mounted for rotation and located in the bottom liner of the oven cavity. The stirrers are spaced apart and the blades are of sufficient length and angularly mounted so as to intercept substantially all of the energy directed toward the bottom of the cavity and to variably redirect same to prevent a static condition of standing waves. The blades are rotated at different speeds either by independent direct-coupled motors or by a single motor, belt and pulley drive arrangement.

This invention relates to high energy microwave cooking ovens and more particularly to improved apparatus for modifying the distribution of energy within the oven.

One of the problems encountered in the microwave oven is that the high frequency energy provided by the magnetron tube distributes itself within the cavity of the oven in a definite pattern dependent upon the configuration of the cavity. The energy reflecting from the interior walls of the cavity interferes with the directly introduced energy and sets up standing waves or a condition of reinforcement of the waves in certain patterns. This produces localized areas of high intensity energy and consequently hot spots which are undesirable and produce an unevenly heated product. Various methods have been used in the past to continually change the pattern of the standing waves, one of which has been to electronically vary the frequency of oscillation of the magnetron tube, since energy emitted at different frequencies will set up different standing wave patterns.

Another method has been to vary the dimensions or positions of interior surfaces of the cavity in an oscillatory manner, for example, by a rotary reflective blade within the cavity, to change the reflective configuration and thus the distribution of the standing waves within the cavity. This invention relates to the latter method and is an improved apparatus for providing such variation. It is significant in this method of variation that an appreciable area of the cavity be oscillated, since it has been determined that the greater the area of variation, the more even the distribution of the high frequency energy will be.

Thus it is an object of this invention to provide improved apparatus for varying the reflective surfaces of the working cavity of a microwave cooking oven.

It is a further object of this invention to provide apparatus for distributing the high frequency energy wherein the period of repetition of distribution of the energy is rendered substantially longer than has been possible in the past.

It is another object of this invention to provide a simplified apparatus for producing a more random distribution of energy for better efficiency, especially in an oven having unequal depth and width.

Other objects and advantages of the present invention will become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the

claims, the following description and the annexed drawing setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but several of the various ways in which the principles of the invention may be employed.

In said annexed drawings:

FIG. 1 is an elevational view of an electric range with a microwave oven;

FIG. 2 is a cross-sectional view of a portion of the interior of the microwave oven showing the preferred form of the invention;

FIG. 3 is an enlarged cross-sectional view taken along the lines 3—3 of FIG. 2;

FIG. 4 is a cross-sectional view similar to FIG. 2 showing a second embodiment of the invention;

FIG. 5 is an enlarged cross-sectional view taken along the lines 5—5 of FIG. 4; and

FIG. 6 is a bottom view of the second embodiment of the invention taken along the lines 6—6 of FIG. 4.

Referring now to FIG. 1, there is shown a front view of a range **1** having a conventional lower electric oven and surface element section **2** and an electronic microwave upper oven **3**. The range has conventional control sections **4** and **5** and power control section **6** located at the bottom of the range. The oven **3** is provided with a door **7** in which there is the usual reticulated screen **8** for viewing therethrough, a handle **9** being attached to the door. The relative locations of the oven control and power sections are not of any significance to the present invention, but, it should be appreciated that the dimensions of the microwave oven **3** are such that the width is appreciably greater than the depth, that is, the front-to-back dimension. Thus this microwave oven is a cavity of a rectangular-parallelepiped configuration, not of the generally cubicle cavity most commonly used.

Located on the liner portion **12** which forms the bottom of the microwave oven cavity are two microwave energy reflective blades **18**, **19**, which are mounted for rotation within the cavity on the shafts **20**, **21** of two low torque motors **22**, **23**. The stirrers designated generally by reference numerals **24**, **25**, consist of the blades **18**, **19** and motors **22**, **23** and are in a side by side relationship along the width of the microwave oven **3** and approximately on the longitudinal centerline. The blades **18**, **19** are flat sheets of microwave energy reflecting material, such as aluminum, of an approximate rectangular configuration having straight sides **27** and rounded ends **28**. These blades have indentations **32**, **33** in their center sections on the opposite surfaces to form horizontal mounting surfaces **34**, while the blades are at a substantial angle to the plane of the bottom oven liner **12** and each blade is affixed to the associated motor shaft by an acorn nut **36**.

As can best be seen in FIG. 2, the dimensions of the stirrers **24**, **25** in relation to the oven cavity are such that when the blades **18**, **19** are aligned parallel with the front, they extend substantially the full width of the cavity, and when they are rotated to positions approximately 90°, they extend substantially the full depth of the oven. The curved ends of the blades are provided for clearance purposes to enable the blades to come as close as is practical to each other and to the liner walls of the oven during their rotation. Since the blades are angularly disposed in relation to the bottom oven liner **12** they also intercept and have an effect upon a portion of the energy reflecting from the side walls of the cavity, although this is limited to only a relatively small height of the side wall dependent upon the blade width and angle of mounting, neither of which is critical. It should be understood that a shelf for supporting the food article to be heated is disposed just above the stirrer blades **18**, **19** to form the effective bottom of the article-receiving portion of the oven, and such shelf is of a glass or plastic compo-

sition which is transparent to the microwave energy and has practically no effect upon the reflective conditions of the cavity. It should also be understood that although the energy stirring apparatus of the invention is shown disposed on the bottom liner **12** of the oven **3**, its use is not restricted to this area and it may be positioned in any other location within the oven cavity where its particular features can be advantageously used. The location shown in the drawings is preferred since the stirrers **24**, **25** may be conveniently positioned without affecting the overall dimensions of the particular range type shown, and the blades and their drive motors **22**, **23** are protected from food splatter and the like by the microwave-transparent support shelf. Thus it can be seen that the two stirrer blades when undergoing rotation, affect substantially all the bottom reflecting surface of the cavity and a portion of the side wall reflecting surface, thereby changing the dimensions of the reflecting working cavity and the high energy field patterns. The energy can of course, be supplied to the cavity in any suitable known manner. In this embodiment energy is supplied from a magnetron oscillator tube located in the power control section **6** along with power transformers and associated electronic components. The energy is directed to the microwave oven **3** by wave guides which are not shown but which are quite standard in the art.

The motors **22**, **23** used to drive the stirrer blades **18**, **19** are special low-torque motors which do not have a critical speed of rotation. These motors are designed for the same nominal speed but due to variances inherently resulting in their manufacture, actually operate at slightly different speeds, which is a desirable criteria, as will be more fully explained hereinafter.

When the motors **22**, **23** rotate the stirrer blades **18**, **19** at close but yet different rotational speeds, it will be appreciated that the blades present a changing relationship to each other and to the cavity walls and thus continually alter the reflecting surfaces and the distribution of energy. If the stirrer blades **18**, **19** were rotating at the same speed, it can be seen that they would repeat an identical reflective condition once each revolution. Since the time required for a standing wave pattern to be set up is practically instantaneous, identical hot spots would occur within the oven cavity for each revolution of the blades. This is an undesirable condition in that, even though the hot spots are continually moving, they will recur often enough in the same position to cause an uneven heating effect. Although this condition may not appear to be of great importance, it should be noted that the heating times of a microwave oven may be relatively short, often measured in terms of seconds, depending upon the size of the object to be heated, its heat acceptance factor and the intensity of the energy within the oven. Because the stirrer blades **18**, **19** of the invention are rotated at different speeds, the recurrence of identical reflective conditions will take place at periods indirectly related to the difference in their speeds of rotation. If the speeds are sufficiently close, this period may be so extended that it becomes appreciable in relation to the heating time of the object.

FIGS. 4, 5 and 6 show a second embodiment of the invention wherein a pulley type motor drive **40** is used to provide the control of the repetition period. Here two pulley shafts **41**, **42** are rotatably mounted in bearing assemblies **43**, **44** in the lower liner **12** of the oven in a manner similar to that shown in the first embodiment. Stirrer blades **45**, **46** are similarly affixed to the top ends of the pulley shafts **41**, **42** by clamping bolts **47**, **48** and choke sleeves **51**, **52** are similarly mounted to attenuate the high frequency radiation. Pulleys **55**, **56** of slightly different diameters are affixed to the bottom of the pulley shafts **41**, **42** and are interconnected by a belt **58**. A drive wheel **60** is affixed to pulley **56** to rotate with pulley shaft **42**. A motor **62** is also mounted beneath the lower liner **12** of the oven with its drive shaft **63** extending in a downward direction for coupling to the drive wheel **60** through a rotatable and spring-biased idler **64** to provide rotation to the pulley shafts **41**, **42** and thus the stirrer blades **45**, **46**. Because the diameters of the pulleys **55**, **56** are slightly different, the differential in speed of rotation is provided and the long period for identical reflective conditions is again achieved.

The only restriction of the speed of rotation of the stirrer blades of either embodiment is that the speed should be sufficiently fast so that undesirable reflective conditions are not maintained excessively long. The source of high frequency energy, which is usually a magnetron oscillator tube (not shown) is most efficient when a particular configuration of oven cavity and thus the load is matched to the energy source. Changing the reflective conditions of the cavity changes the loading upon the source and also introduces a higher level of reflected energy back to the source which could be detrimental to the oscillator tube. By rotating the stirrer blades at a sufficient speed in accordance with the thermal lag time of the energy source, these variations in loading can be envened out to a great extent. For the types of oscillator tubes used with the apparatus of the invention it has been determined that a minimal speed of about 150 r.p.m. is sufficient. The high end of the speed range is determined primarily by vibrational and life-time considerations, but it is desirable to operate the stirrers at a relatively slow speed since this has the additional effect of extending the period of repetition of reflective conditions which is dependent not only upon the difference in speeds of the two stirrer blades but also upon the rates at which they rotate.

Other modes of applying the principles of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

I, therefore, particularly point out and distinctly claim as my invention:

1. Apparatus for distributing energy in a high frequency electronic oven having walls forming a cooking cavity, comprising a pair of energy reflective blades independently mounted for rotation within said oven cavity, said blades being spaced apart along one wall of said cavity and being angularly disposed in relation to the walls for intercepting a substantial part of the energy directed toward one wall and for redirecting the energy throughout said cavity during rotation, and drive means coupled to said blades for rotating said blades at different speeds so that the respective positions of said blades in relation to each other and to the walls of said cavity are continuously varied to prevent static wave patterns of energy within the cavity.

2. Apparatus as set forth in claim **1** wherein the drive means for rotating said blades comprises a motor, a pair of pulleys of different diameters mounted for rotation respectively with said blades and a flexible belt interconnecting said pulleys and said motor for imparting different speeds of rotation to said blades.

3. Apparatus as set forth in claim **1** wherein the drive means for rotating said blades comprises a pair of motors having shafts affixed respectively to said blades, said motors being of the non-synchronous type for operating at different speeds of rotation.

4. A microwave oven comprising walls forming an oven enclosure into which high frequency energy is supplied for cooking purposes, stirrer means mounted in at least one of said walls for variably distributing the energy therein, said stirrer means comprising first and second blades of high frequency energy reflective material, said blades being independently mounted for rotation, and means coupled to each of said blades for rotating said blades to randomly distribute the energy within said enclosure.

5. A microwave oven as set forth in claim 4 wherein said walls form an enclosure of rectangular configuration having width greater than depth and wherein said blades are mounted in spaced relation along the width of one of said walls, said blades being of individual length sufficient to extend substantially the full depth of said oven cavity and in an in-line relationship being of sufficient combined length to extend substantially the full width of said cavity, whereby substantially all of the high frequency energy directed toward said one wall is reflected.

6. A microwave oven as set forth in claim 4 wherein said drive means comprises differential drive means

coupled to both said blades for imparting different rates of rotation to each of said blades.

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