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(54) Microwave cooking appliance and method of operating it

(57) A microwave cooking appliance includes:
an interior chamber including a cooking space (2;30);
an apparatus (17,18;38,39) for providing microwaves of
at least one wavelength λ to the interior chamber; and
a fan, including a rotor (10;47;48) with at least one fan

blade (28a-i;49a-h;52a-d,53a-d) for exchanging work
with a fluid in the interior chamber, configured such that
a pressure difference is present across the fan blade(s)
(28a-i;49a-h;52a-d,53a-d) when the rotor (10) rotates.
The rotor (10) is provided with at least one electromag-
netically resonant structure (19-25).

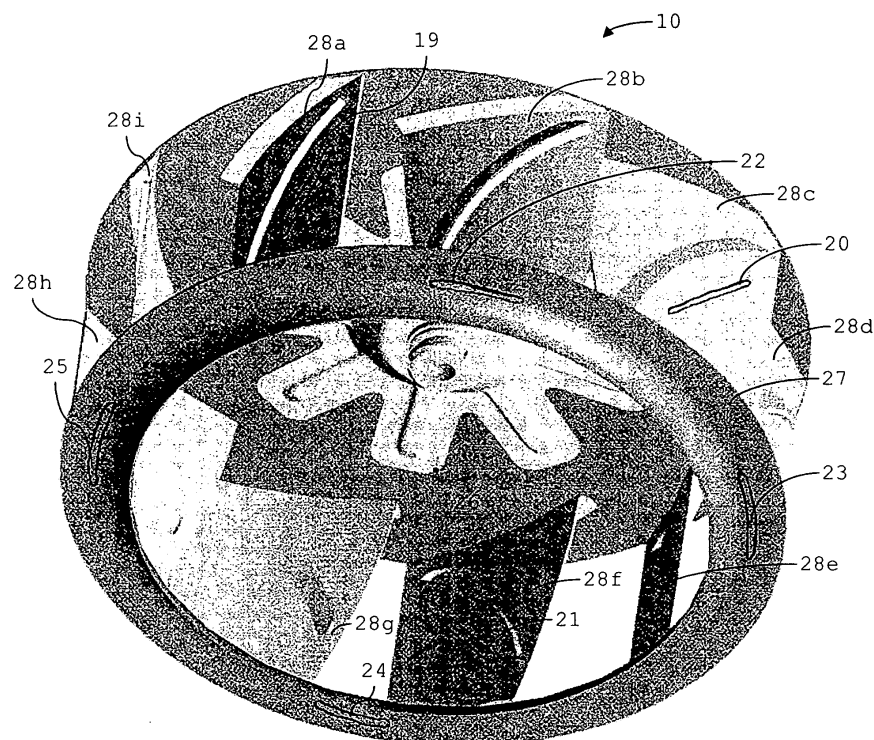


Fig. 2

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Description

[0001] The invention relates to a microwave cooking appliance, including:

an interior chamber including a cooking space;
an apparatus for providing microwaves of at least one wavelength λ to the interior chamber; and
a fan, including a rotor with at least one fan blade for exchanging work with a fluid in the interior chamber, configured such that a pressure difference is present across the fan blade(s) when the rotor rotates.

[0002] The invention also relates to a method of operating a microwave cooking appliance, in particular a microwave cooking appliance according to any one of the preceding claims, including an interior chamber including a cooking space, the method including:

providing microwaves of at least one wavelength λ to the interior chamber; and
causing a fan including a rotor with at least one fan blade to rotate such that a pressure difference is present across the blade(s).

[0003] The invention also relates to a microwave cooking appliance including:

an interior chamber including a cooking space;
an apparatus for providing microwaves of at least one wavelength λ to the interior chamber; and
a rotatable device for homogenising an energy distribution in the cooking space, the device being driven by fluid flow past at least one fan blade and provided with at least one of reflective and resonant structures arranged in the interior chamber.

[0004] US 2008/0121635 A1 discloses a cooking apparatus including a convector which circulates inner air of the cooking chamber and is provided at a side of the cooking chamber. A convection fan includes a centrifugal blowing fan provided in the convection chamber oppositely facing an air intake. The centrifugal fan may include a conductor and is positioned about halfway between a microwave guide and a convection panel. The centrifugal blowing fan improves the uniformity of the microwave field formed in the cooking chamber by stirring the microwaves transmitted through the convection panel from the microwave guide.

[0005] GB 1 463 826 B discloses a mode stirrer for a microwave oven. The stirrer is a thin circular sheet-metal disc having a plurality of slots arranged at regular intervals around the periphery of the disc and extending radially inwards to form a plurality of sectors. The radially outer ends of the sectors are each inclined to the plane of the radially inner portion of the disc about a line which extends in said plane perpendicular to a radial line symmetrically disposed within the respective sector. The out-

er ends are preferably bent at different angles. It is also possible to bend some of the fins up and others down.

[0006] GB 2 193 618 A relates to a fan for a microwave oven cavity which both disperses microwaves and circulates air, the fan comprising a central hub portion, a plurality of blades extending radially outward from the hub portion and a plurality of fin attachment members mounted on respective ones of the blades, the fin attachment members being operable to modify the air circulation within the cavity. A plurality of pin connectors is operable to pass through aligned holes to secure a supplementary fin member to its associated fin. A problem of the appliance known from GB 2 193 618 A, is that the fan blades fulfil the dual function of exchanging work with the surrounding fluid and reflecting the microwaves. The requirements of the blade design that follow from these different functions can conflict.

[0007] US 3,471,671 discloses a microwave heating apparatus comprising a heating chamber in which the foodstuff to be heated is placed. A coaxial inlet coupling is provided centrally in the cover of the heating chamber, through which microwave energy is coupled into the heating chamber acting as a cavity resonator. In order to achieve a uniform field distribution, an oscillation type converter which as a field stirring or whirling device is provided. It consists of a circular plate, which provided with vanes at its periphery for driving, which are impelled by an air stream. This air stream is obtained from a fan. The air stream simultaneously serves for ventilating the heating chamber and causes a satisfactory vapour removal though a perforated plate of a door to the heating chamber. A problem of this known appliance is that the ventilation requirements affect the stirring function. There can thus be too large or too small an air flow in terms of the ventilation requirements. In other circumstances, the air flow needed to achieve a uniform field distribution can have an undesirable effect on the cooking process, e.g. the food can become too dry.

[0008] According to one aspect, it is an object of the invention to provide a microwave cooking appliance and method of operating such an appliance of the types defined above in the opening two paragraphs, wherein at least the blade form can be optimised for the function of the fan as a fluid machine, whereas the fan can also continue to contribute effectively to the homogenisation of the microwave energy distribution.

[0009] According to another aspect, it is an object of the invention to provide a microwave cooking appliance of the type mentioned above in the third paragraph of the introduction, in which the air flow can be set to a level appropriate for the ventilation requirements without substantial effects on the function the rotatable device fulfils in homogenising the microwave energy distribution in the interior chamber.

[0010] The object according to the first aspect is achieved by the microwave cooking appliance according to the invention, which is **characterised in that** the rotor is provided with at least one electromagnetically resonant

structure.

[0011] Alternatively or additionally, the rotor maybe provided with a plurality of fan blades for exchanging work with a fluid in the interior chamber, arranged around an axis of rotation of the rotor and configured such that a pressure difference is present across the fan blade(s) when the rotor rotates, wherein at least one aspect of the composition and/or the mutual spacing of the fan blades varies in a rotationally asymmetric manner with angular position about the axis of rotation of the rotor.

[0012] In an embodiment, at least one resonant structure is supported by one of the fan blades, in particular, all resonant structures may be supported by fan blades.

[0013] At least one resonant structure may comprise an aperture in a conductive surface, in particular an aperture in a conductive surface of one of the fan blades.

[0014] In a further embodiment, at least one aspect of the manner in which resonant structures are provided on the rotor varies, in particular in a rotationally asymmetric manner, with angular position about an axis of rotation of the rotor, in particular wherein the aspects include at least one of:

- shape of the resonant structure;
- position of the resonant structure relative to a fan blade on which it is provided;
- orientation of the resonant structure relative to the rotor; and
- material composition of the resonant structure and/or of the fan blade on which it is provided.

[0015] In a further embodiment, the rotor is provided with a plurality of fan blades having at least one surface that is at least partially reflective to microwaves, and at least one of:

an angle of the fan blades about an axis through the fan blade and fixed relative to the rotor and a shape of the fan blades varies in a rotationally asymmetric manner with angular position about the axis of rotation of the rotor.

[0016] According to another aspect, the method of operating a microwave cooking appliance according to the invention is characterised by influencing a microwave energy distribution in the interior chamber by means of at least one electromagnetically resonant structure provided on the rotor.

[0017] The problem according to the second aspect of the invention is solved by a microwave cooking appliance that is **characterised in that** the rotatable device further includes at least one device for adjusting at least one of the fan blades in dependence on at least one of a speed of rotation, centrifugal forces and forces exerted by the fluid flow on the blade.

[0018] The device for adjusting at least one of the fan blades may include at least one resilient element connected to at least part of a fan blade, with the rotatable

device arranged to cause at least one of a centrifugal force and a force exerted onto the blade to be transferred to the resilient element.

[0019] In a variant of this embodiment, at least one of the fan blades comprises a deformable aerofoil including an elastic material, arranged to deform under a load exerted by the fluid flow to a shape providing a different amount of lift.

[0020] In a further variant, the resilient element forms a connection between at least one fan blade part and a part in fixed relation to a hub of the rotatable device.

[0021] Furthermore, at least one of the fan blades may be configured to provide a different level of resistance to fluid flow in each of two opposite directions of rotation of the rotatable device.

[0022] The invention according to the first aspect is based on the surprising insight that, because the rotor is provided with at least one electromagnetically resonant structure, microwave energy is absorbed and re-emitted by a rotating structure. At least one moving source of microwave energy is thereby provided, which is located in the interior chamber. The apparatus for providing microwaves to the interior chamber can be stationary, e.g. in the form of a waveguide terminating in an aperture and/or antenna, which makes it relatively easy to seal the interior chamber to gases and microwaves at the point of introduction of the microwaves into the interior chamber. Because the rotor has at least one fan blade for exchanging work with a fluid in the interior chamber, configured such that a pressure difference is present across the fan blade(s) when the rotor rotates, the fan also functions as a fluid machine, either causing a fluid flow or being driven by one, depending on the embodiment. The fan blade shape can be chosen to ensure that this function is fulfilled properly, since the homogenisation of the microwave energy distribution is not solely reliant on reflection of microwaves off the blades of the rotor.

[0023] The same insight leads to the provision of the rotor with a plurality of fan blades for exchanging work with a fluid in the interior chamber, arranged around an axis of rotation of the rotor and configured such that a pressure difference is present across the fan blade(s) when the rotor rotates, wherein at least one aspect of the composition and/or the mutual spacing of the fan blades varies in a rotationally asymmetric manner with angular position about the axis of rotation of the rotor.

[0024] As used herein, a variation in a rotationally asymmetric manner means that a parameter is varied such that no angle of rotation other than a multiple of 360° yields a rotor with the same parameter variation with angular co-ordinate about the axis of rotation of the rotor.

[0025] Variations in the composition and/or the mutual spacing of the fan blades allow the fan blades to have the shape and pitch required for them to exchange work with the surrounding fluid in the interior chamber effectively. However, these variations mean that the influence on the electromagnetic field distribution varies with angular position of the rotor.

[0026] If at least one resonant structure is supported by one of the fan blades, in particular if all resonant structures are supported by fan blades, the rotor can be made relatively compact. It is, for example, more compact than would be the case if a separate stirrer and fan wheel were to be provided on a common axis.

[0027] If at least one resonant structure comprises a slot in a conductive surface, in particular a slot in a conductive surface of one of the fan blades, then an effective resonant structure is provided with limited constructional effort.

[0028] In an embodiment, at least one aspect of the manner in which resonant structures are provided on the rotor varies, in particular in a rotationally asymmetric manner, with angular position about an axis of rotation of the rotor, such as to influence the electromagnetic field distribution in the interior chamber in a generally chaotic manner. The aspects may in particular include at least one of:

- shape of the resonant structure;
- position of the resonant structure relative to a fan blade on which it is provided;
- orientation of the resonant structure relative to the rotor; and
- material composition of the resonant structure and/or of the fan blade on which it is provided.

[0029] If the rotor is provided with a plurality of fan blades having at least one surface that is at least partially reflective to microwaves, and an angle of the fan blades about an axis extending radially from the axis of rotation of the rotor and/or a shape of the fan blades varies in a rotationally asymmetric manner with angular position about the axis of rotation of the rotor, the uniformity of the microwave field distribution in the interior chamber is further improved.

[0030] The invention according to the second aspect is based on the surprising insight that, by configuring the rotatable device to include at least one device for adjusting at least one of the fan blades in dependence on at least one of a speed of rotation, centrifugal forces and forces exerted by the fluid flow on the blade, the speed of rotation can be regulated. In particular, an increase in the speed of rotation with an increase in the velocity of the fluid flow can be prevented automatically. Thus, if during a particular cooking process, a higher fluid flow is required, this can be achieved without increasing the speed of rotation of the rotatable device. Because the rotatable device is provided with at least one of reflective and resonant structures arranged in the interior chamber its rotation causes the microwave energy distribution to become more uniform. The reflective or resonant structures form additional (moving) sources of microwave energy. In larger cooking appliances, multiple rotatable devices driven by fluid flow can be provided, since they do not require a motor and drive mechanism. Furthermore, in a microwave cooking appliance, the absence of drive

axles which have to pass through a wall of the interior chamber makes it easier to seal the interior chamber against leakage of microwaves, gases and heat.

[0031] If the device for adjusting at least one of the fan blades includes at least one resilient element connected to at least part of a fan blade, and the rotatable device is arranged to cause at least one of a centrifugal force and a force exerted onto the blade to be transferred to the resilient element, then a self-actuating adjustment mechanism is provided, which does not require externally powered actuators to bring about the adjustment.

[0032] If at least one of the fan blades comprises a deformable aerofoil including an elastic material, arranged to deform under a load exerted by the fluid flow to a shape providing a different amount of lift, then the rotatable device can be of a relatively simple construction. There are fewer component parts to the adjustment mechanism, making it both easier to manufacture and less susceptible to accumulating dirt in the interior chamber of the cooking appliance.

[0033] In another embodiment, the resilient element forms a connection between at least one fan blade part and a part in fixed relation to a hub of the rotatable device. This embodiment is relatively inexpensive to construct. A change in the pitch of the blade part or the angle of the blade part to the hub alters the lift and/or drag resistance provided by the fan blade part

[0034] In an embodiment, at least one of the fan blades is configured to provide a different level of resistance to fluid flow in each of two opposite directions of rotation of the rotatable device. This embodiment provides a rotatable device that is driven by an air flow in any particular direction, the direction of rotation being determined by the different resistance levels. Thus, nozzles and ducts to direct an air flow onto the rotatable device can be largely dispensed with.

[0035] The invention will be displayed in further detail with reference to the accompanying drawings, in which:

- Fig. 1 is a top cross-sectional view of a microwave cooking appliance provided with a centrifugal fan with slot antennas;
- Fig. 2 is a perspective view of a fan wheel of the centrifugal fan;
- Fig. 3 is a top cross-sectional view of a microwave cooking appliance with a centrifugal fan and two examples of mode stirrers driven by respective air flows;
- Fig. 4A is a side view of a first of the mode stirrers of Fig. 3;
- Fig. 4B is a front plan view of the first mode stirrer of Fig. 4A; and
- Fig. 5 is a schematic diagram illustrating a second

one of the mode stirrers of Fig. 3.

[0036] Fig. 1 shows a first cooking appliance 1 comprising an interior chamber substantially partitioned into a cooking space 2 and a pressure space 3 by means of a fluid guide member 4. The interior chamber is defined by a back wall 5, left and right side walls 6,7 and a door 8, as well as by a ceiling and floor (not visible in Fig. 1). The walls 5-7, ceiling, floor and door 8 are reflective to microwaves, being either made of metal or provided with a metal coating. In the case of the door 8, a metal mesh (not shown) can be provided on the inside of an otherwise transparent window, for example.

[0037] Foodstuffs to be heated are accommodated in the cooking space 2, which, in the illustrated embodiment, comprises a rack 9 for supporting trays (not shown) or other carriers for foodstuffs at various levels in the cooking space 2. The rack 9 is just an example of an accessory for supporting foodstuff carriers. In other embodiments, plate racks or the like can be provided, or the cooking space 2 can be arranged to accommodate a trolley or a rotisserie assembly, for example.

[0038] The cooking appliance 1 illustrated in the drawings comprises a fan wheel 10 driven by a motor 11. The motor 11 is located in an electrical equipment chamber 12, and connected to the fan wheel 10 by means of an axle 13 extending through the side wall 6 in such a manner as substantially to prevent microwave leakage. The fan wheel 10 is part of a centrifugal fan, sucking in the cooking space atmosphere through a central opening 14 in the plane of the fluid guide member 4 and expelling it radially. The gases, fumes and vapour return to the cooking space by way of slits 15,16 left free at edges of the fluid guide member 4, by virtue of the fact that the centrifugal fan establishes a pressure difference between the pressure space 3 and the cooking space 2.

[0039] Although not shown, conventional electrical resistance heater elements can be placed in the flow generated by the central fan to provide electrical heating of the cooking space 2. Additionally, injectors of vapour, aromas and the like can be present in the cooking appliance 1.

[0040] In the illustrated embodiments, the cooking appliance 1 further includes a microwave generator 17, e.g. a magnetron, and a waveguide 18 for providing microwaves generated by the microwave generator to the interior chamber. The microwave generator 17 generates electromagnetic waves with a frequency of about 2.45 GHz, which translates to a wavelength λ of about 12 cm in free space. In other embodiments, other frequencies are used. In the illustrated embodiment, the waveguide 18 is provided with an aperture or antenna (not shown) for emitting microwave radiation into the pressure space 3 adjacent the cooking space. Both the pressure space 3 and cooking space 2 are dimensioned such that they can form resonant cavities, being typically several wavelengths (in free space) deep and high and, in the case of the cooking space, wide.

[0041] Normally, an electromagnetic field distribution would form in an oven cavity of the dimensions indicated above, the field distribution having fixed minima and maxima. This could lead to an uneven cooking result. The position of the minima and maxima depends on several factors, including the resonant frequency, the dimensions and geometry of the oven cavity, the dimensions and configuration of antennas or waveguide apertures for feeding the microwaves into the oven cavity, the presence and configuration of foodstuffs and accessories in the oven cavity, etc.

[0042] To help prevent the establishment of standing wave patterns in the interior chamber, the fan wheel 10, which is made of metal and is therefore reflective to microwaves, is additionally provided with microwave resonant structures in the form of slots 19-25. The slots 19-25 function as antennas. They are isolated from the microwave generator 17 or any other source of microwave energy, instead capturing and re-radiating microwave energy provided to the interior chamber. Each of the slots 19-25 has a length slightly below $\lambda/2$, with reference to the microwave wavelength in free space. The width is of the order of 3-6 cm

[0043] The fan wheel 10 illustrated in Fig. 2 further comprises a back plate 26 and a front ring 27, which interconnect and support fan blades 28a-i. The front ring 27 functions as a duct to guide the fluid drawn in from the cooking space 2. Some of the slots 19-21 are provided in blades 28a,c,f. Other slots 22-25 are provided in the front ring 27. It would be possible to provide slots in the back plate 26. However, these would be less effective, because they would be shielded by the blades 28.

[0044] Several aspects of the placement of the resonant slots 19-25 vary with angular position about the axis of rotation of the fan wheel 10 in a rotationally asymmetric manner. These include the distance of the centroids of the slots to the axis of rotation, their orientation (e.g. expressed as the angle of their longitudinal axis to the axis of rotation of the fan wheel 10), as well as their mutual spacing. In other embodiments, further aspects can be varied, including the composition of a dielectric occupying the slot (air, glass, etc.) and the shape of the slots. In yet other embodiments, other types of resonant structures can be provided, such as antennas formed out of conductors. The slots 19-25, however, have relatively little effect on the function fulfilled by the blades 28a-i in re-circulating the gases from the cooking space 2.

[0045] The illustrated fan wheel 10 disturbs the microwave field in two ways, namely due to the influence of the slots 19-25 that re-radiate microwave energy and due to the configuration of the blades 28a-i, at least some of which are provided with at least one electrically conducting surface that is also reflective to microwaves.

[0046] In an embodiment, at least one aspect of the composition and/or the mutual spacing of the fan blades varies in a rotationally asymmetric manner with angular position about the axis of rotation of the fan wheel 10. That is to say that the distance between consecutive fan

blades 28a-i going round the fan wheel 10 is not the same everywhere. Furthermore, some of the fan blades 28a-i can be made of, or coated with a dielectric material or a material with a different reflection coefficient. Thus, the manner in which the microwaves are reflected by the blades 28a-i varies in a rotationally asymmetric manner with angular position about the axis of rotation of the fan wheel 10.

[0047] In yet a further embodiment, the chaotic nature in which the microwave field is perturbed by the fan wheel 10 is enhanced by varying an angle of the fan blades 28a-i about an axis through the respective fan blade 28a-i and fixed relative to the fan wheel 10, in particular the back plate 26, and/or by varying the shape of the fan blades 28 in a rotationally asymmetric manner with angular position about the axis of rotation of the fan wheel 10. However, these variations may involve deviations from the optimum configuration of the fan wheel 10 for circulating fluids. The blades 28a-i may carry out less work on the fluid because they are not of the optimum shape or at the optimum angle to their direction of movement.

[0048] A second microwave cooking appliance 29 is shown in Fig. 3. It also comprises an interior chamber substantially partitioned into a cooking space 30 and a pressure space 31 by means of a fluid guide member 32. The interior chamber is defined by a back wall 33, left and right side walls 34,35 and a door 36, as well as by a ceiling and floor (not visible in Fig. 3), all reflective to microwaves. A rack 37 for supporting trays (not shown) or other carriers for foodstuffs at various levels in the cooking space 30 is shown as an example of an accessory.

[0049] Microwaves are generated by a microwave generator 38 and conducted to the interior chamber by a microwave waveguide 39. Both are positioned in an equipment chamber 40 situated adjacent the interior chamber. The equipment chamber 40 also houses an electric motor 41 and axle 42 for driving a conventional centrifugal fan wheel 43. The centrifugal fan wheel 43 is of substantially similar configuration to the fan wheel 10 shown in Fig. 2, except that it has no slits. Fumes, gases, vapours and the like are sucked in through a central opening 44 in the fluid guide member 32 and expelled radially, returning to the cooking space 30 through slits 45,46 left free at the edges of the fluid guide member 32.

[0050] The microwave cooking appliance 29 illustrated schematically in Fig. 3 is provided with two further fans 47,48. These fans 47,48 are rotatably mounted in the cooking space 30 and are driven by fluid currents, rather than motors. Thus, instead of the fans 47,48 exerting work on the surrounding fluid, the fluid flow exerts work on the fans 47,48. The fluid flow in question is established by means of the centrifugal fan 43.

[0051] The two fans 47,48 are illustrated schematically in Figs. 4 and 5, respectively. In the illustrated embodiment, the fans 47,48 are provided with reflective structures for reflecting microwaves. In other embodiments,

they are additionally or alternatively provided with resonant structures, e.g. in the form of apertures in conductive surfaces or other forms of antennas. Due to the rotational motion, the reflective and/or resonant structures move continually, contributing to the homogenisation of the microwave energy distribution in the cooking space 30.

[0052] The first fan 47 is rotated by an axial fluid flow through the central opening 44. It comprises eight fan blades 49a-h mounted to a hub 50. The fan blades 49a-h are in the form of aerofoils, shaped such that a pressure difference across the blades 49a-h is established when fluid flows across them. Although not clearly visible in the drawings, the fan blades 49a-h are shaped such that their flow resistance is different for different directions of rotation. This ensures that the fan 47 always rotates in the same direction.

[0053] The second fan 48 is caused to be rotated by a cross-flow. It is illustrated in very schematic fashion in Fig. 5. Shown in that drawing are a hub 51, first blade parts 52a-d, fixed rigidly to the hub 51, and second blade parts 53a-d, attached to distal ends of the first blade parts 52a-d relative to the hub 51. The attachment is by means of resilient elements 54a-d. The second blade parts 53a-d are shaped to provide a different level of resistance to fluid flow in each of two opposite directions of rotation of the second fan 48. This ensures that the second fan 48 will rotate even where no special ducts are provided to direct a jet of gases onto the second fan 48.

[0054] Because the amount of circulation in the cooking space 30 that is required can vary according to cooking process, the load in the cooking space 30, humidity and other variables, the fluid flow velocity can also vary. It is desirable to limit the speed of rotation of the fans 47,48 to enable a separation of the recirculation function and the energy distribution function. To this end, the fans 47,48 are provided with at least one device for adjusting at least one of the fan blades in dependence on at least one of a speed of rotation, centrifugal forces and forces exerted by the fluid flow on the blade.

[0055] In particular, in the case of the fan blades 49a-h, they are made of an elastic material, and are arranged to deform under a load exerted by the fluid flow past the blades 49a-h to a shape providing a different amount of lift. Different types of deformation are illustrated in Fig. 4A and 4B. As illustrated in Fig. 4A, the pitch f of the blades 49 can change due to torsion of the blades 49a-h caused by a load exerted by the fluid flow past the blades 49a-h. As illustrated in Fig. 4B, the fan blades 49 can bend in the direction opposite to the direction of rotation, so that a central axis of the fan blade 49a-h moves from a first position 55 to a second position 56 with associated different shapes.

[0056] In the case of the second fan 48, the forces exerted by the fluid onto the second blade parts 53a-d are transferred to the resilient elements 54a-d. These deform until the forces balance, allowing the second blade parts 53a-d to assume a different angle to the radially directed first blade parts 52a-d. At this angle, the

driving forces are lower, so that the second fan 48 slows down as the forces increase.

[0057] To increase the randomness of the manner in which the first and second fans 47,48 influence the microwave energy distribution, at least one aspect of the composition and/or the mutual spacing d of the fan blades 49a-h,52,53 can vary in a rotationally asymmetric manner with angular position about the axis of rotation of the fan 47,48. In particular, the fan blades 49ah,52,53 can vary in material composition and/or in the type of coating provided on them, such that they are more or less reflective to microwaves. Some can be made of or coated with, a predominantly dielectric material. Similarly, at least one of an angle of the fan blades 49,52,53 about an axis through the fan blade 49,52,53, and fixed relative to the hub 50,51, and a shape of the fan blades 49,52,53 can be made to vary in a rotationally asymmetric manner with angular position about the axis of rotation of the fan 47,48.

[0058] Thus, the fans 47,48 contribute to a more even heating of foodstuffs in the cooking space 30 whereas the recirculating fluid flow through the cooking space 30 can be varied without adverse effects on this function of the fans 47,48.

[0059] The invention is not limited to the embodiments described above, which may be varied within the scope of the accompanying claims. The features of the embodiments described above may be essential to the implementation of the invention individually or in any desired combination.

[0060] For example, the centrifugal fan wheel 43 can be provided with reflective and/or electromagnetically resonant structures in addition to those provided on the first and second fans 47,48.

LIST OF REFERENCE NUMERALS

[0061]

1	Cooking appliance
2	Cooking space
3	Pressure space
4	Fluid guide member
5	Back wall
6	Left side wall
7	Right side wall
8	Door
9	Rack
10	Fan wheel
11	Motor
12	Equipment chamber
13	Axle
14	Opening
15	Slit
16	Slit
17	Microwave generator
18	Waveguide
19	Slot in fan wheel
20	Slot in fan wheel

21	Slot in fan wheel
22	Slot in fan wheel
23	Slot in fan wheel
24	Slot in fan wheel
5 25	Slot in fan wheel
26	Back plate
27	Front ring
28a-i	Fan blade
29	Cooking appliance
10 30	Cooking space
31	Pressure space
32	Fluid guide member
33	Back wall
34	Left side wall
15 35	Right side wall
36	Door
37	Rack
38	Microwave generator
39	Waveguide
20 40	Equipment chamber
41	Motor
42	Axle
43	Fan wheel
44	Opening
25 45	Slit
46	Slit
47	1 st Fan
48	2 nd Fan
49a-h	Fan blades
30 50	Hub
51	Hub
52a-d	1 st Blade parts
53a-d	2 nd Blade parts
54a-d	Resilient elements
35 55	First blade position
56	Second blade position

Claims

1. Microwave cooking appliance, including:

an interior chamber including a cooking space (2;30);

an apparatus (17,18;38,39) for providing microwaves of at least one wavelength λ to the interior chamber; and

a fan, including a rotor (10;47;48) with at least one fan blade (28a-i;49a-h;52a-d,53a-d) for exchanging work with a fluid in the interior chamber, configured such that a pressure difference is present across the fan blade(s) (28a-i;49a-h;52a-d,53a-d) when the rotor (10) rotates, **characterised in that** the rotor (10) is provided with at least one electromagnetically resonant structure (19-25).

2. Microwave cooking appliance according to claim 1 or the pre-amble of claim 1, wherein the rotor (10) is provided with a plurality of fan blades (28a-i;49a-h;52a-d,53a-d) for exchanging work with a fluid in the interior chamber, arranged around an axis of rotation of the rotor (10) and configured such that a pressure difference is present across the fan blade(s) (28a-i;49a-h;52a-d,53a-d) when the rotor (10) rotates, and wherein at least one aspect of the composition and/or the mutual spacing of the fan blades (28a-i;49a-h;52a-d,53a-d) varies in a rotationally asymmetric manner with angular position about the axis of rotation of the rotor (10). 5
3. Microwave cooking appliance according to claim 1 or 2, wherein at least one resonant structure (19-21) is supported by one of the fan blades (28a,c,f), in particular wherein all resonant structures are supported by fan blades. 10 20
4. Microwave cooking appliance according to claim 3, wherein at least one resonant structure (19-25) comprises an aperture in a conductive surface, in particular an aperture in a conductive surface of one of the fan blades (28a,c,f). 25
5. Microwave cooking appliance according to any one of the preceding claims, wherein at least one aspect of the manner in which resonant structures (19-25) are provided on the rotor (10) varies, in particular in a rotationally asymmetric manner, with angular position about an axis of rotation of the rotor (10), in particular wherein the aspects include at least one of: 30 35
 - shape of the resonant structure (19-25);
 - position of the resonant structure (19-21) relative to a fan blade (28a,c,f) on which it is provided;
 - orientation of the resonant structure (19-25) relative to the rotor (10); and
 - material composition of the resonant structure (19-25) and/or of the fan blade (28a,c,f) on which it is provided. 40 45
6. Microwave cooking appliance according to any one of the preceding claims, wherein the rotor (10) is provided with a plurality of fan blades (28a-i;49a-h;52a-d,53a-d) having at least one surface that is at least partially reflective to microwaves, and wherein at least one of: 50
 - an angle of the fan blades (28a-i;49a-h;52a-d,53a-d) about an axis through the fan blade (28a-i;49a-h;52a-d,53a-d) and fixed relative to the rotor (10) and
- a shape of the fan blades (28a-i;49a-h;52a-d,53a-d) varies in a rotationally asymmetric manner with angular position about the axis of rotation of the rotor (10).
7. Method of operating a microwave cooking appliance (1), in particular a microwave cooking appliance according to any one of the preceding claims, including an interior chamber including a cooking space (2), the method including:
 - providing microwaves of at least one wavelength λ to the interior chamber; and
 - causing a fan including a rotor (10) with at least one fan blade (28a-i) to rotate such that a pressure difference is present across the blade(s) (28a-i), **characterised by** influencing a microwave energy distribution in the interior chamber by means of at least one electromagnetically resonant structure provided on the rotor (10).
8. Microwave cooking appliance, in particular a microwave cooking appliance according to any one of claims 1-6, including:
 - an interior chamber including a cooking space (30);
 - an apparatus (38,39) for providing microwaves of at least one wavelength λ to the interior chamber; and
 - a rotatable device (47,48) for homogenising an energy distribution in the cooking space, the device (47,48) being driven by fluid flow past at least one fan blade (49a-h,52a-d,53a-d) and provided with at least one of reflective and resonant structures arranged in the interior chamber, **characterised in that** the rotatable device (47,48) further includes at least one device for adjusting at least one of the fan blades (49a-h,52a-d,53a-d) in dependence on at least one of a speed of rotation, centrifugal forces and forces exerted by the fluid flow on the blade (49a-h,52a-d,53a-d).
9. Microwave cooking appliance according to claim 8, wherein the device for adjusting at least one of the fan blades (49a-h,52a-d,53a-d) includes at least one resilient element (54a-d) connected to at least part of a fan blade (52a-d,53a-d), and wherein the rotatable device (48) is arranged to cause at least one of a centrifugal force and a force exerted onto the blade (52a-d,53a-d) to be transferred to the resilient element (54a-d).
10. Microwave cooking appliance according to claim 9,

wherein

at least one of the fan blades (49a-h) comprises a deformable aerofoil including an elastic material, arranged to deform under a load exerted by the fluid flow to a shape providing a different amount of lift.

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- 11.** Microwave cooking appliance according to claim 9 or 10, wherein

the resilient element (54a-d) forms a connection between at least one fan blade part (53a-d) and a part (52a-d) in fixed relation to a hub (51) of the rotatable device (48).

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- 12.** Microwave cooking appliance according to any one of claims 8-11, wherein

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at least one of the fan blades (49a-h,52a-d,53a-d) is configured to provide a different level of resistance to fluid flow in each of two opposite directions of rotation of the rotatable device (47,48).

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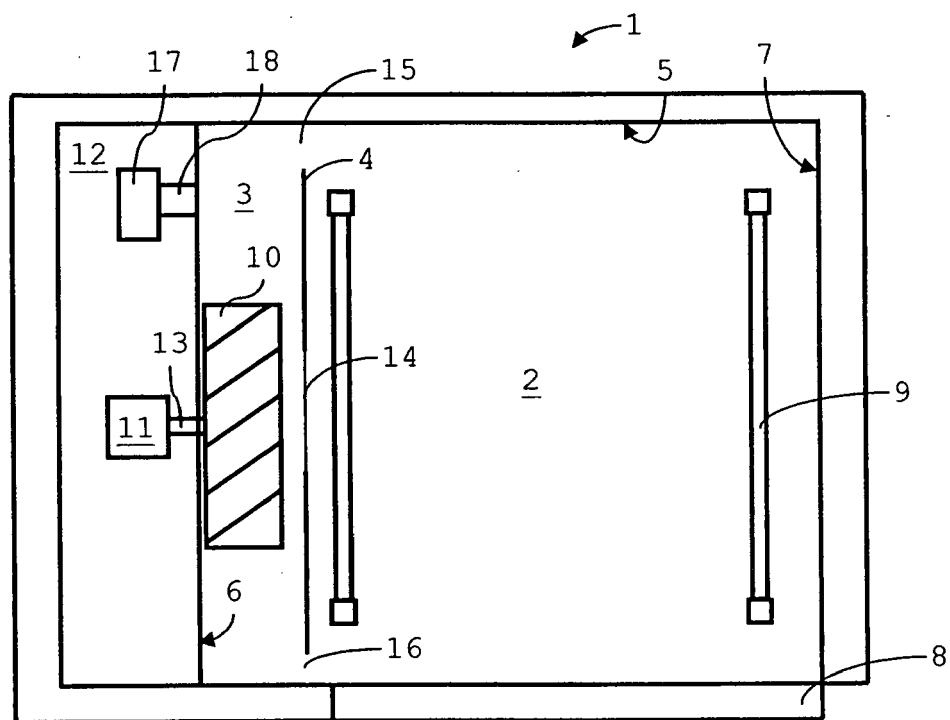


Fig. 1

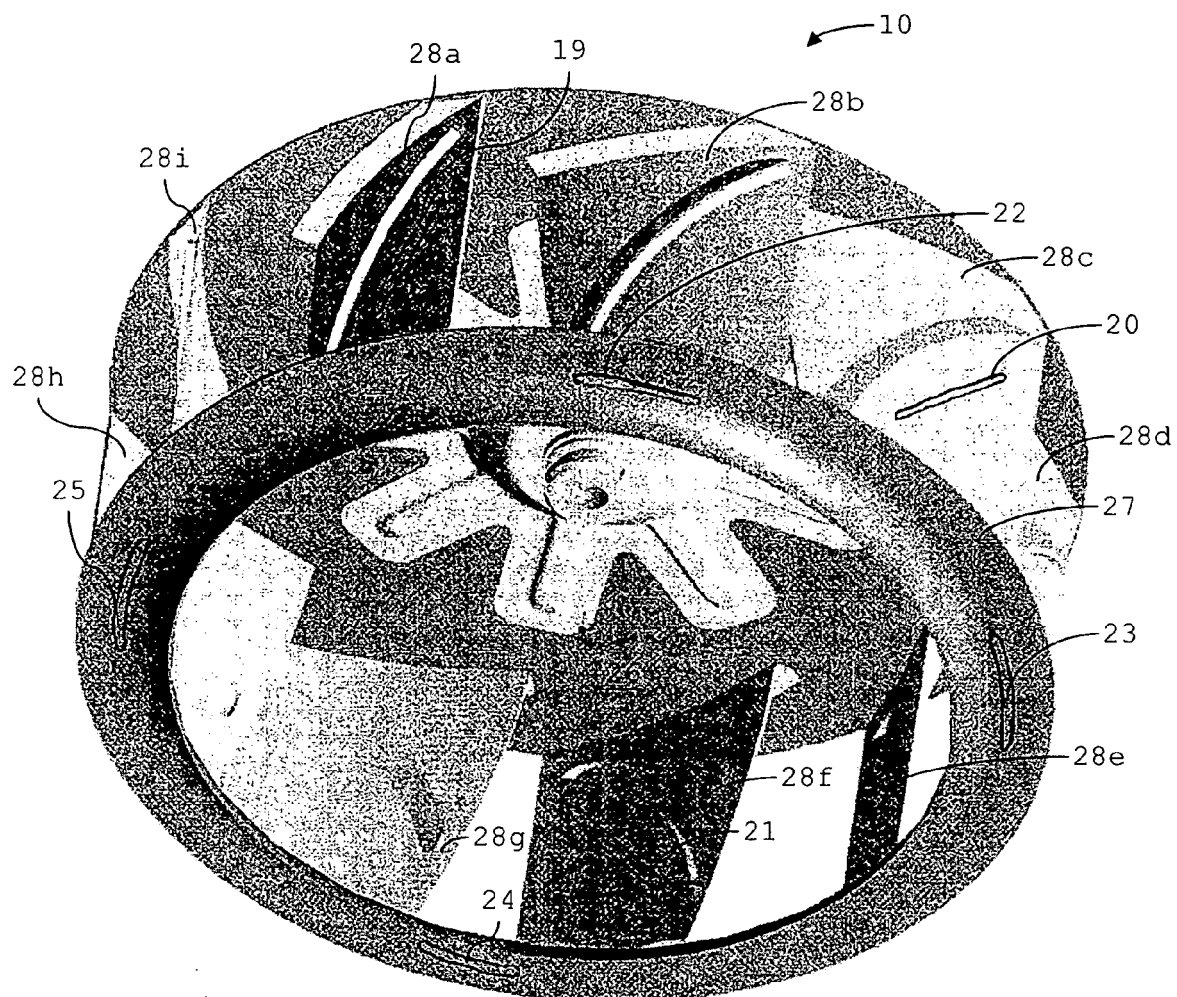


Fig. 2

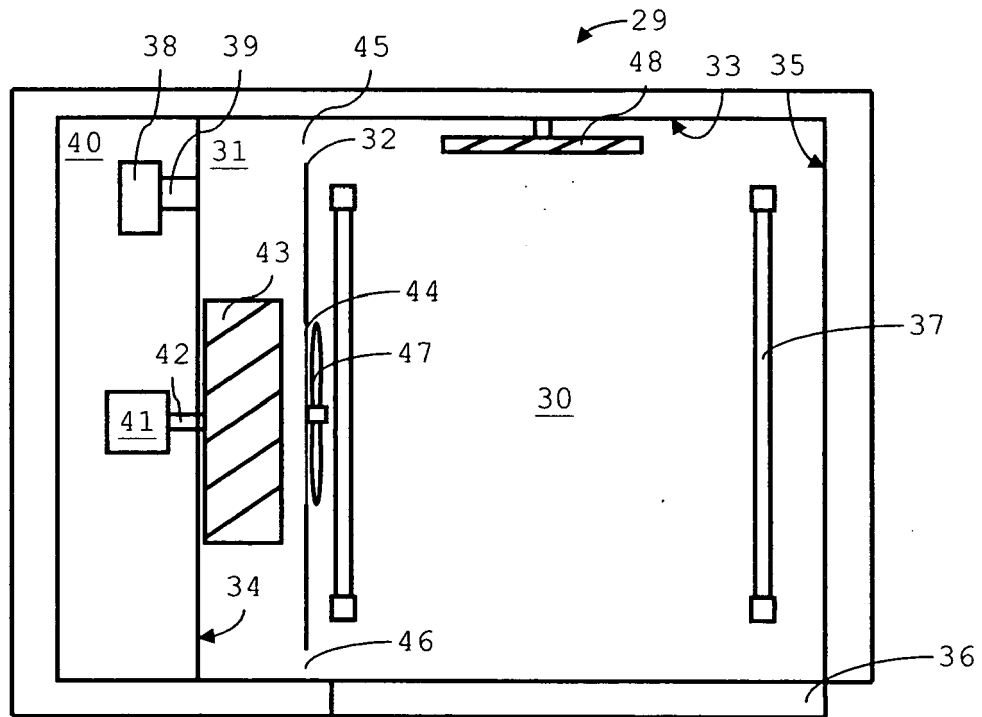


Fig. 3

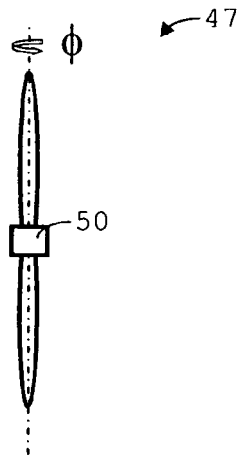


Fig. 4A

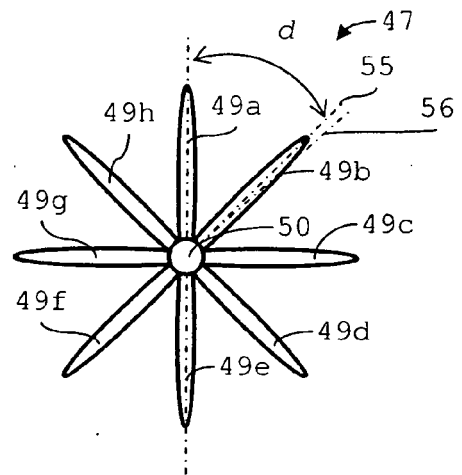


Fig. 4B

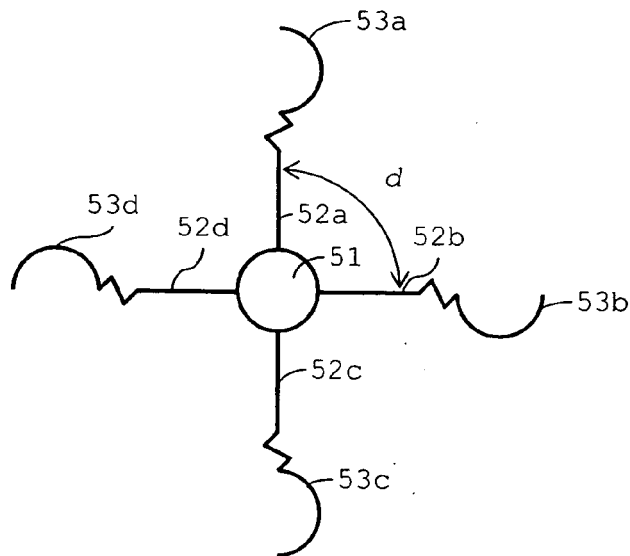


Fig. 5



EUROPEAN SEARCH REPORT

Application Number
EP 09 29 0204

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X	US 4 477 706 A (MITTELSTEADT ROBERT A [US]) 16 October 1984 (1984-10-16) * abstract; claim 8 *	1	
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 17 June 2009	Examiner Garcia, Jesus
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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