

(19)



Europäisches Patentamt

European Patent Office

Office européen des brevets



(11)

EP 1 384 683 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:

28.01.2004 Bulletin 2004/05

(51) Int Cl.7: **B65D 81/34**

(21) Application number: **02405641.8**

(22) Date of filing: **23.07.2002**

(84) Designated Contracting States:

**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
IE IT LI LU MC NL PT SE SK TR**

Designated Extension States:

AL LT LV MK RO SI

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(54) **Food package and method for heating a food package using microwave**

(57) The present invention relates to a food package and a method of controlling heating of a foodstuff using microwave energy by permitting entry of both decaying microwave energy and propagating microwave energy into the interior of the package in a manner that achieves

even heating of the foodstuff, effective control over moisture content, effective control over the resulting crispness and texture of the foodstuff, and effective control over the colouration and browning of the foodstuff.

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Description**FIELD OF THE INVENTION**

[0001] The present invention relates to a food package for controlling heating of a foodstuff with microwave energy as well as to a method for the controlled heating of a foodstuff with microwave energy.

BACKGROUND OF THE INVENTION

[0002] With respect to microwave foods, it is often desirable that the microwave heating be controlled in order to prevent a number of potential problems. The three main problems involve overheating of the food, inability to adequately control the browning or colouring of the food, and inability to adequately control the texture of the food.

[0003] One example is microwave heating and popping of starch based foodstuffs such as French fries. If such foodstuffs are subjected to prolonged microwave heating, scorching occurs. Additionally, if moisture content is not adequately controlled, the texture of the foodstuff can be adversely affected, and the inability to achieve consistent and even browning of foodstuffs, especially French fries where there is both intimate and non contact and largely uncontrolled interaction between adjacent fries. Currently, microwave French fries are packaged in cardboard boxes. There have been several attempts in the prior art to address these problem areas. The more notable of these attempts include:

[0004] With respect to control of moisture content:

- The overwhelming focus in a large portion of the patents is a pressure or heat sensitive seal that opens in order to release moisture from the product.
- Use of vented containers (for example US 6,257,401 and US 3,335,846)
- One relevant document is JP 2001-240148, features means of transporting vapour generated from the surface of the food to a position still within the same vicinity but out of immediate contact with the food.
- A major focus is that of actual 'packaging materials'- for example patent applications JP 2001-322683, JP 2001-301845, JP 2001-097436 etc. All more or less propose some forms of resins in a stacking formation (normally 3-4 layers, some have 5). An interesting example of surface segmentation in this area is JP 2001-180765, which uses an air impervious and water proof sheet layer as an outer layer, a water absorptive fibre sheet layer as an intermediate layer, and a moisture-permeable, breathable as an inner layer. This layer uses 'raising like protrusions' so that moisture will not be reintroduced

onto the surface of the food stuff.

- Other solutions to the problem of moisture use simple geometric features such as ribs or protrusions on the container in order to trap moisture and other by products and keep them away from the food product.
- Incorporation of moisture absorbing features such as starch (US 5,423,477) or absorbent pads (US 4,873,101)

[0005] With respect to prevention of over cooking or to aid selective cooking:

- The majority of packages utilise aluminium foil in shielding- this a method that has been used for years to prevent over cooking or to aid selective cooking.
- Food delivery containers that have heat conductive pouches (for example US 4,777,930 and US 5,880,435)
- Use of microwave sensitive adhesive that can be used as a food ready signal (US 6,230,474; US 6,224,918; US 5,482,158).
- Use of features that 'pop-up' when a certain amount of heating has taken place.

[0006] With respect to control of browning:

- Browning in the microwave usually needs help. Tin oxide coatings are excellent for this with almost complete energy to heat conversion (so called susceptors). Ferrites (Ferro- or ferro-magnetic compounds) such as barium and strontium titanate readily absorb microwave energy and convert it to heat.
- Also other susceptors- calcium and lithium bromides, calcium and lithium chlorides, magnesium chloride- can be used singly or in combination with polar solvents such as water
- Metallised film for microwave browning of food products- uses a grid like structure to improve heating (Andreas and Cox, 1990) - use stand up parts in a susceptor device for microwaveable French fried potato products.

SUMMARY OF THE INVENTION

[0007] It is therefore an aim of the present invention to provide an improved food package which allows the controlled heating of a foodstuff with microwave energy.

[0008] This aim is achieved by a food package com-

prising: a food package having a microwave shielding layer with a plurality of apertures sized to permit entry of both evanescent and propagating microwave energy into the interior of the package; a foodstuff contained in the food package with a substantial proportion of the foodstuff initially located in close proximity to the microwave shielding layer; means for moving the microwave shielding layer away from close proximity to the foodstuff after the package and the foodstuff are irradiated with at least a predetermined amount of microwave energy, such that the decaying microwave energy entering the package is insufficient to over heat the foodstuff when the microwave shielding layer is moved out of close proximity to the foodstuff, while the propagating microwave energy continues to heat the foodstuff.

[0009] The combination of evanescent microwave energy and propagating microwave energy is balanced to achieve a desired heating of the foodstuff.

[0010] Microwaves are electromagnetic waves of radiate energy. For food applications the approved and most commonly used microwave frequencies are 2450MHz and 915MHz. Microwaves are reflected by metals, pass through air, pass through many but not all types of glass, pass through paper, pass through plastic materials, are absorbed by several food constituents including water. When microwaves are reflected or pass through a material without absorption they do not impart heat to the object. Penetration depths in microwaves are generally small, approximately a half inch.

[0011] The conversion of microwave energy to heat is expressed by the following equation:

$$P = 2\pi E^2 f \epsilon_0 \epsilon''$$

P= Power in Watts/m

E= The electric field strength in volts/m

f= The frequency in Hertz

ϵ_0 = The permittivity of free space in farad per metre

ϵ'' = The dielectric loss

[0012] Microwave energy comes in two principle states - decaying and propagating. In the state of the art it is believed desirable to use propagating energy throughout the heating cycle when the load is characterized by a substantial mass or bulk that is not agitated or dispersed. An example is to use propagating energy to heat the center of food such as a pie. Decaying microwave energy on the other hand is more suited to surface heating effects and as such, with a pie, for example, it may be desirable to utilize evanescent energy to heat or brown the crust of the pie.

[0013] In the heating of a range of foodstuffs, it has been found desirable to admit both decaying, or non-

propagating, microwave energy and propagating microwave energy into the interior of the food package, with both forms of energy controlled by the package. By allowing controlled entry of the propagating and non-propagating (decaying) microwave energy inside the food package, the total performance of the food package can be balanced.

[0014] The principle means of controlling the two forms of energy is through use of apertures, with each aperture sized to permit a controlled amount of both conventional propagating microwave energy and decaying or non-propagating microwave energy to enter the package. This is achieved primarily by maintaining the maximum dimension of each aperture to be sufficiently small to limit the transmission of propagating modes of microwave energy to desired levels.

[0015] The key of the present invention therefore resides in the fact that a microwave shielding layer is provided which permits entry of both evanescent and propagating microwaves into the interior of the package, whereby the ratio between evanescent and propagating microwave is chosen such that in the first phase of the heating process, this microwave shielding layer is close to the foodstuff thus allowing intense irradiation of the foodstuff with evanescent and propagating microwave, while in the second phase of the heating process the microwave shielding layer is moved away from the foodstuff such that the evanescent part of the microwave reaching the foodstuff is reduced. Thus there is a balance between evanescent microwave (primarily affecting the heating of the surface of the foodstuff) and propagating microwave (also reaching the interior parts of the foodstuff which is determined by the particular design of the microwave shielding layer. The balance changes in the course of the heating process, as moving the microwave shielding layer away from close proximity to the foodstuff also reduces the amount of evanescent microwave reaching the foodstuff while the propagating microwave remains hardly unaffected. This particular design of the food package therefore allows a very controlled heating of the foodstuff permitting to adjust a fine balance of browning and texture, at the same time preventing overheating of the foodstuff.

[0016] Entry of both decaying microwave energy and propagating microwave energy is permitted into the interior of the package in a manner that achieves even heating of the foodstuff, effective control over moisture content, effective control over the resulting crispness and texture of the foodstuff, and effective control over the colouration and browning of the foodstuff.

[0017] The shielding layer is preferably made of aluminium. Examples of such layers are given in US 4351997 (Mattison), 4268738 (Flaut) et al, 3408164 (Goltsoos). The major problem with shielding layers is their relatively high cost vs benefits that they accrue. Possible is the use of a shielding layer that allows different amounts of two types of microwave energy. Also possible is the use of a heat sensitive strip. After heating

initially the strip is moved by the heat and the evanescent part of the microwave is reduced. The preferable shape of the layer is oval (see e.g. US 5593610). Such an oval shape is very efficient in utilising microwave heating more efficiently. The positioning of shielding elements is also important. A wave shape/ crested shape is optimal for the shielding layer although this may be uneconomical.

[0018] According to a preferred embodiment of the present invention water vapor is generated by the microwave energy and the means for moving the microwave shielding layer away from close proximity to at least a portion of the foodstuff is a water vapor barrier layer sufficiently impermeable to water vapor and operative to inflate the package in response to the generation of water vapor. Usually water vapour is automatically created during the heating process thus providing a natural means for moving the microwave shielding layer away from the foodstuff. The foodstuff can be French Fry potatoes or any other foodstuff which may be heated by a microwave.

[0019] According to a further preferred embodiment, the food package is provided with a plurality of apertures extending substantially across the entire food package. Alternatively, the plurality of apertures may be provided across a predetermined, limited region of the food package, wherein preferentially such predetermined, limited region includes non-contiguous sub-regions. It is also possible to provide such predetermined, limited regions extending over more than one surface of the food package, and/or to provide such predetermined, limited regions generally at least congruent to the foodstuff as it exists prior to heating.

[0020] According to another preferred embodiment of the present invention, susceptors are provided in the food package. These susceptor materials can be located interior and/or exterior of the microwave shielding layer in a non-planar, protruding sense, thus giving rise to a controlled browning of the foodstuff. The internal geometry may contain a number of local protrusions and dips in conjunction with the susceptor material. The areas of the protrusions furthest from contact with the foodstuff may contain drain vents to assist the removal of excess moisture from the package. The internal protrusions may have an asymmetrical cross-section profile and may be made up of curved surfaces. The internal protrusions may be made up of curved or ribbed surfaces which in turn contain 'mini-ribs' or 'mini-curves' ('ribs on ribs'). The overall arrangement of protrusions may be made up of straight lines, spirals, concentric circles, hexagons and other tessellating shapes. Preferentially, the local protrusions are positioned in a manner that encourages the motion of moisture away from the foodstuffs. The protrusions may contain slots and other vent arrangements to facilitate the control of moisture within the packaging.

[0021] According to another preferred embodiment (which may be useful also independent of the concept

of the particular microwave shielding layer) of the present invention, the food package comprises at least one variable geometry feature provided on and/or in the packaging, which serves to agitate the contents of the package and/or to agitate the package such that the package is caused to physically move within the microwave. Preferentially, the heat and/or the moisture generated within the device is used to move said variable geometry feature. A multitude of variable geometry features with different actuation characteristics can be provided that act in a sequence which serves to agitate the contents and/or the package a multiple number of times such that several agitation motions are achieved during the heating process. The packaging may contain bi-stable geometries comprised of two or more materials with different thermal expansion coefficients such that after a certain amount of heating, the geometry abruptly shifts from one stable state to the other, and thus serves to agitate the packaging and/or the contents of the package. The food package may be designed in an octagonal external shape to facilitate motion within the microwave oven. The motion of the contents may also be induced by providing an unstable internal platform which moves due to the rotation of the microwave oven platen, and thus serves to agitate the foodstuff. It is also possible to provide internal protrusions which are able to change their shape during the heating process in order to facilitate internal agitation of the foodstuff.

[0022] According to another preferred embodiment of the present invention, the food package further comprises a septic layer located adjacent the microwave shielding layer. This is to maintain a sanitary environment for the interior of the food package.

[0023] Another preferred embodiment is characterised by the ability of the food package to contract during heating and thus to assist the removal of excess moisture from the foodstuff.

[0024] Another preferred embodiment of the food package is characterised by a foam surface susceptor material provided to minimize contact with the foodstuff, to act as moisture traps and to improve heating profile, wherein preferentially the foam structure contains active elements that evaporate during heating and serve to flavour or season the foodstuff.

[0025] The food package may also contain variable geometry features that serve to inform the user when the product is sufficiently heated, whereby the heat generated within the device is used to move these features. The heat generated within the device may also be used to move a pop-up eating implement such that it informs the user that heating has been sufficient, and to enable the consumer to have an integral system that does not require external eating implements. The heat generated within the device may alternatively be used to move change the colour of a thermochromic dye in order to inform the user that satisfactory heating has occurred. The heat generated within the device may also be used to change the colour of a multitude of thermochromic

dyes with different colour change temperatures in order to inform the user that different levels of heating have occurred.

[0026] The user may be able to add to the contents of the package a choice of different flavourings and seasonings. The food package may also contain food which is coated with a browning agent. The food package may additionally comprise a moisture absorbing pad included in the structure of the packaging. Additionally, a thermochromic window portion may be included, and the packaging may be designed to be re-fillable by the user and re-usable.

[0027] According to another preferred embodiment of the invention, the packaging includes popcorn to facilitate agitation of the package whereby the popcorn is isolated from and/or mixed with the foodstuff and additionally may contain a seasoning or flavouring element.

[0028] To allow the heating of specific portions gaps can be provided between adjacent food products such that precisely the right amount of food can be selected for heating by cutting the packaging at said gaps.

[0029] Additional preferred embodiments of this invention are described in the dependent claims.

[0030] The present invention also relates to a method of controlling heating of a foodstuff with microwave energy comprising the steps of: a. providing a food package, preferentially in the form of a semi-rigid concertina/accordion geometry, made of construction materials capable of allowing controlled entry of both decaying and propagating microwave energy and preferentially containing susceptor materials on the walls to improve heating; b. initially locating a foodstuff within the food package in close proximity to the microwave shielding layer; c. irradiating the package and foodstuff with microwave energy; and d. extending the walls from close proximity to at least a portion of the foodstuff after the package and the foodstuff is irradiated with at least a predetermined amount of microwave energy.

[0031] Water vapor can thereby be generated by the microwave irradiation expanding the concertina to move the microwave shielding layer away from close proximity to at least a portion of the foodstuff after the package and the foodstuff is irradiated with at least a predetermined amount of microwave energy. The package may further comprise a water vapor barrier layer substantially impermeable to water vapor. Additionally, the food package may be provided with a septic layer sufficient to maintain a sanitary environment for the interior of the food package.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032]

Fig. 1 shows possible protrusions for the foodstuff;

Fig. 2 a) shows a view on to a protrusion ; b) various cross-sections through protrusions; c) a con-

certina type package; d) a package comprising gaps;

Fig. 3 shows heat sensitive tabs;

Fig. 4 shows a package with a movable disc;

Fig. 5 shows a package with popcorn inserts; and

Fig. 6 shows a package with a section with modified air.

DETAILED DESCRIPTION OF THE INVENTION

[0033] The invention combines a series of unique features which may be combined in various ways in order to adjust the operation of the packaging to suit a variety of different foodstuffs to be heated. The first section examines the novel features on an individual basis. This is then followed by a second section which details some of the possible combinations of features and their combined benefits.

Microwave shielding layer:

[0034] The shielding layer is made of aluminium. Examples of such layers are, as mentioned above, given in US 4351997 (Mattison), 4268738 (Flaut) et al, 3408164 (Goltsos).

Geometric Features:

[0035] In one variant, the microwave packaging will take the form of a semi-rigid box. The materials used in the construction of this box will be similar to the multi-layer materials found in the literature in this field (these will include cardboard plus aluminium susceptor materials, possible moisture trapping and release layers and various microwave compatible plastics - Polysulfone, filled thermo-set-polyester, modified poly phenylene oxide, Poly butylenes terephthalate, Polycarbonate, Polypropylene, Polymethylpentene). The box shape may take on several forms including conventional rectangular prism and other shapes common in the state of the art. Other novel shapes - including regular shapes manufacturable from a folded flat sheet such as tetrahedral, octahedral, hexahedral, decahedra and dodecahedra may also be utilised. In the case of the decahedra and dodecahedra, the shape is intended to facilitate motion of the packaging and contents within the microwave. This motion is desirable from the perspective of agitating the foodstuff in order to improve evenness of heating and colouring.

[0036] With regard to the internal shape of the packaging, the use of three-dimensional surfaces is recommended. In order to improve the evenness of heating within the packaging, it is important that the various three-dimensional surfaces include some form of sus-

ceptor materials. Various geometry features like protrusions 2 are possible. Favoured geometries include triangular ridges (these help to trap moisture and other by products and keep them away from the food product, see figure 1).

[0037] These ridges may be arranged in straight lines (like a ploughed field) or may be arranged in an expanding spiral arrangement (see figure 2a).

[0038] Other possible configurations will include, but not be limited to concentric circles, egg-box-shape protrusions, honeycomb hexagonal shapes, etc.

[0039] For the purposes of ease of manufacture, it is recommended that the desired shape be pressed into the surface in a single operation. Other shapes of protrusion that may be included are circular arc profiles, and asymmetrical features as given in figure 2b).

[0040] All of these offer additional benefits in terms of the heating profile to the foodstuffs contained adjacent to the local shapes.

[0041] At the base of the protrusions, where we expect moisture to migrate to, it may also be helpful to include further features to assist in the complete removal of this moisture from the foodstuff-containing space within the package. A possible means of including such a capability will be the inclusion of a multitude of small openings at the base of the protrusions. Such openings will appear during the heating cycle due to the action of a shape change feature like that described earlier.

[0042] Other means of separating liquid moisture from the foodstuff will include geometric features in the protrusion features. Such features may comprise slots or holes. In a passive form, the packaging will include these features as a separate component within the package in order to ensure airtight packaging during transport and storage.

[0043] An alternative packing configuration, still using the same packing materials, but incorporating the protrusion concept in a more beneficial manner, is the 'accordion' packaging concept illustrated in figure 2c).

[0044] In addition to providing the required heat profile, the accordion package offers the additional advantage of being able to change its shape such that it expands as it heats. This means that the initial packaging can be quite small - an advantage from a storage and transportation perspective - but then expansion during heating offers the additional benefits of moisture and atmosphere control and space for the foodstuffs to be agitated. Expansion of the packaging will also facilitate the agitation process. Especially if the structure of the accordion is configured in such a way that certain accordion folds will open before other ones.

[0045] A final configuration for the packaging involves use of a non-structural bag. The basic idea here is to feature a bag that comprises the necessary multi-layer structure in order to provide the correct combination of susceptor, moisture control and packaging integrity properties. The bag may be of an expanding nature in order to facilitate transition from a small to a large inter-

nal space. This may be achieved by having the package split into two zones - the first zone containing the foodstuff, and the second part initially empty (possibly folded over onto the first part of the packaging), with a heat-released seal between the two. As heating progresses, the seal is broken such that the space around the foodstuff within the package is increased. By continuing to trap air within the package, the package will thus expand during heating and will thus also serve to agitate the foodstuffs somewhat.

[0046] In an extension to this concept, we propose the additional idea of a flexible bag package in which each individual component of the foodstuff to be heated is encapsulated. It is proposed, that the packaging be formed from a continuous sheet in order to facilitate economic manufacture. The product can be sold as 'strips' of product. It is then possible to enable the customer to place into the microwave precisely the amount of product they require by enabling them to cut the packaging at any convenient point (see figure 2d). It is further envisaged that the seals around each individual food product will be of the heat release type. The advantage of this type of configuration is that the susceptor elements in the packaging material will facilitate even browning all around the food product during the initial heating stage, and then open up to improve moisture control and avoid overheating. The bag-packaging concept also offers a number of unique branding opportunities. The 'expanding bag' feature can also offer an elegant and unique sales feature.

[0047] The bag concept may also be extended to incorporate a number of opening seal features. These may include concepts in which heat generation is used to open at least one venting hole - which may be used to assist in the management of moisture around the foodstuffs.

Variable Geometry and Motion Providing Features:

[0048] In order to facilitate agitation of the foodstuffs within the packaging for the purposes of even heating and colouring, a number of novel variable geometry features are envisaged.

[0049] The packaging may feature external tabs and pop-up features that will also assist in the task of providing motion of the packaging and contents within the box. These features will comprise shape-change features triggered by heating of the packaging. By way of example of this effect in action, one can take a cardboard and metal composite tab that curls or lifts from the surface of the packaging upon absorption of a certain amount of heat. The use of multiple composite, movable tabs with different heat input/shape-change characteristics (see figure 3, of which a shows a composite shape-change heat tab in unheated state 7 and b such a heat tab in a heated state 8) will also be included in order that different tabs will act at different times such that the box will move more than once during a given heating cycle.

[0050] These tabs may or may not return to their pre-heated state upon termination of the microwave heating cycle. An additional, but related concept relating to this idea of variable geometry is to include in the packaging a 'pop-up' eating implement. This offers the opportunity of a useful sales gimmick, but also enables the customer to be offered a completely integral package. In certain combinations, the pop-up eating implement can also be used in conjunction with other desirable functions - such as package agitation (for example if the fork is positioned on the underside of the package) and/or moisture control (if the pop-up feature simultaneously serves to un-seal the package and thus allow moisture to escape).

[0051] These features may be combined with the external shape of the box such that the lifting tabs or other features may cause the packaging to shift its orientation during the heating process. One possible configuration is to employ an octagonal (or similar) shaped box with tabs on each side of the box in order to facilitate rotation of the box inside the microwave. The octagonal shape can also serve to provide a unique sales feature.

[0052] Another concept first given in figure 4 would involve placing inside the box a circular layer 10 on a pin 9 (type/cardboard 'head'). This will act such that as the microwave plate rotates within the oven, the circular layer moves the chips around meaning that chips are cooked but not burned by an aluminium susceptor.

[0053] Other possible means of delivering the agitation function include the concept of popcorn inserts 11 (see figure 5) into various points within the package. These could either be integral with the packaging, and thus separated from the foodstuff, or they can be included in the same space as the foodstuffs - especially in instances where the popcorn can also add a complimentary function - like for example distributing salt or other flavourings to the foodstuff.

Stand-up features:

[0054] The invention also features the use of variable stand up susceptor devices. These may initially be laying flat and, like the composite tabs described above for the outside of the box, may feature different properties such that different features stand-up at different times during the heating cycles. The stand-up features may comprise a variety of different shapes and profiles. They may be positioned on any of the internal faces of the packaging, but most likely on the base where the foodstuff will be resting.

[0055] In a variation on this theme, the invention includes a structure which uses an air impervious and water proof sheet layer as an outer layer, a water absorptive fibre sheet layer as an intermediate layer, and a moisture-permeable, breathable as an inner layer. This layer uses 'raising like protrusions' so that moisture will not be reintroduced onto the surface of the food stuff.

[0056] These geometric features may also comprise shape change properties in order to combine the bene-

ficial effects of agitation within the packaging and moisture control.

[0057] In an extreme form, the susceptor/protrusion structure may take the form of a 'foam' like insert. The idea here is that the foam would come as an insert on the base of the package (but also possibly on other internal surfaces). The foam can optimally be configured as a semi-rigid, relatively open structure somewhat like a loose web. It can be formed from a microwave compatible plastic dipped in an appropriate susceptor material. The foam serves to minimize contact between foodstuff and surface, acts as a moisture trap, and also acts as an effective heat distributor - ensuring even heating of the foodstuff products.

[0058] Another benefit of variable geometry features is that, through use of microwave sensitive adhesive, various pop-up features can be introduced to act as a food ready signal. In other forms, this kind of feature can be used to prevent overheating or scorching.

[0059] Simpler examples of feedback systems utilise the concept of 'weak openings'- when pressure within a package reaches a certain point heat and moisture is vented. Again one can utilise this trend to provide a crispiness indicator that uses a multitude of colours as a means to show varying levels of French fry crunchiness.

Other Variable Features:

[0060] It may be highly advantageous to include some form of thermo-chromic dye into the packaging. Ideally this dye would be used to communicate the branding and other consumer printed information on the package in the unheated state. The thermo-chromic dye would then change colour during the heating process. This colour change may be used as a sales feature, or it may have other functional uses - such as communicating when the foodstuff is adequately heated.

Other Functions:

[0061] Another function is to improve browning functions whilst decreasing chances of burning. Additives can be added to the chips in order to improve browning. These may be sprayed on prior to packaging, or may be contained on the walls of the packaging such that as the foodstuff is agitated around the inside of the packaging either during transport or cooking, it comes into contact with the browning agent on the walls.

[0062] The invention also includes the possibility of hybrid heating mechanisms within the microwave. One possible application in this area would employ heat sensitive release of either some form of oil, flavoured coating or air. Figure 6 shows a box 12 with a heat sensitive seal 13 and a section 14 which might contain some form of modified air that retains heat. Once the weakly heat sensitive seal is broken we create an impingement type introduction of hot air. One can have the box vent itself.

Combinations of Features:

[0063] The invention basically covers two families of design; one featuring semi-rigid construction, the other featuring a completely flexible package.

[0064] In terms of the semi-rigid packaging, any combination of geometry, variable geometry, actuation means, venting means or moisture control means may be configured. In the ideal state, these combinations take advantage of synergistic integration benefits.

[0065] In terms of the completely flexible package, a smaller set of geometry features are possible. The inclusion of inserts can again be used in any combination.

LIST OF REFERENCE NUMERALS

[0066]

- | | | |
|----|--|----|
| 1 | foodstuff | |
| 2 | protrusion | 20 |
| 3 | packaging | |
| 4 | flexible packaging | |
| 5 | foodstuff (end on view) | |
| 6 | material/wall of the package | |
| 7 | composite shape-change heat tab in unheated state | 25 |
| 8 | composite shape-change heat tab in heated state | |
| 9 | pin | |
| 10 | circular layer | |
| 11 | popcorn inserts or other heat sensitive rigid body capable of moving chips | 30 |
| 12 | chip box | |
| 13 | heat sensitive seal | |
| 14 | section containing modified air | 35 |

Claims

- | | | |
|----|--|----|
| 1. | Food package for controlling heating of a foodstuff with microwave energy comprising: | 40 |
| | a. a food package having a microwave shielding layer with a plurality of apertures sized to permit entry of both evanescent and propagating microwave energy into the interior of the package; | 45 |
| | b. a foodstuff contained in the food package with a substantial proportion of the foodstuff initially located in close proximity to the microwave shielding layer; | 50 |
| | c. means for moving the microwave shielding layer away from close proximity to the foodstuff after the package and the foodstuff are irradiated with at least a predetermined amount of microwave energy | 55 |

such that the decaying microwave energy entering the package is insufficient to over heat the foodstuff when the microwave shielding layer is moved out of close proximity to the foodstuff, while the propagating microwave energy continues to heat the foodstuff.

- | | |
|----|---|
| 2. | The food package of claim 1 wherein water vapor is generated by the microwave energy and the means for moving the microwave shielding layer away from close proximity to at least a portion of the foodstuff is a water vapor barrier layer sufficiently impermeable to water vapor and operative to inflate the package in response to the generation of water vapor. |
| 3. | The food package according to one of the preceding claims, wherein the plurality of apertures extend substantially across the entire food package or across a predetermined, limited region of the food package, wherein preferentially such predetermined, limited region includes non-contiguous sub-regions, and/or wherein preferentially such predetermined, limited region extends over more than one surface of the food package, and/or wherein preferentially such predetermined, limited region is generally at least congruent to the foodstuff as it exists prior to heating. |
| 4. | The food package according to one of the preceding claims, wherein the food package further comprises susceptor materials located interior and/or exterior of the microwave shielding layer in a non-planar, protruding sense. |
| 5. | The food package according to one of the preceding claims, wherein at least one variable geometry feature is provided on and/or in the packaging, which serves to agitate the contents of the package and/or to agitate the package such that the package is caused to physically move within the microwave, wherein preferentially the heat and/or the moisture generated within the device is used to move said variable geometry feature. |
| 6. | The food package according to claim 5, wherein a multitude of variable geometry features with different actuation characteristics is provided that act in a sequence which serves to agitate the contents and/or the package a multiple number of times such that several agitation motions are achieved during the heating process. |
| 7. | The food package according to one of the claims 5 or 6, in which the packaging contains bi-stable geometries comprised of two or more materials with different thermal expansion coefficients such that after a certain amount of heating, the geometry |

abruptly shifts from one stable state to the other, and thus serves to agitate the packaging and/or the contents of the package.

8. The food package according to one of the preceding claims, wherein a foam surface susceptor material is provided to minimize contact with the foodstuff, to act as moisture traps and to improve heating profile, wherein preferentially the foam structure contains active elements that evaporate during heating and serve to flavour or season the foodstuff. 5
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9. The food package according to one of the preceding claims in which the packaging includes popcorn to facilitate agitation of the package whereby the popcorn is isolated from and/or mixed with the foodstuff and additionally may contain a seasoning or flavouring element. 15
10. The food package according to one of the preceding claims, wherein gaps are provided between adjacent food products such that precisely the right amount of food can be selected for heating by cutting the packaging at said gaps. 20
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11. A method of controlling heating of a foodstuff with microwave energy comprising the steps of:
 - a. providing a food package, preferentially in the form of a semi-rigid concertina/accordion geometry, made of construction materials capable of allowing controlled entry of both decaying and propagating microwave energy and containing susceptor materials on the walls to improve heating; 30
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 - b. initially locating a foodstuff within the food package in close proximity to the microwave shielding layer; 40
 - c. irradiating the package and foodstuff with microwave energy; and
 - d. extending the walls from close proximity to at least a portion of the foodstuff after the package and the foodstuff is irradiated with at least a predetermined amount of microwave energy. 45
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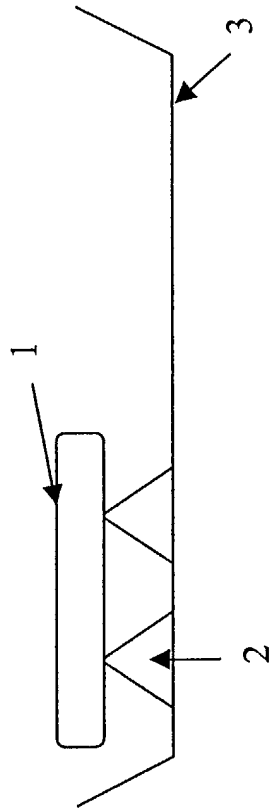


Fig. 1

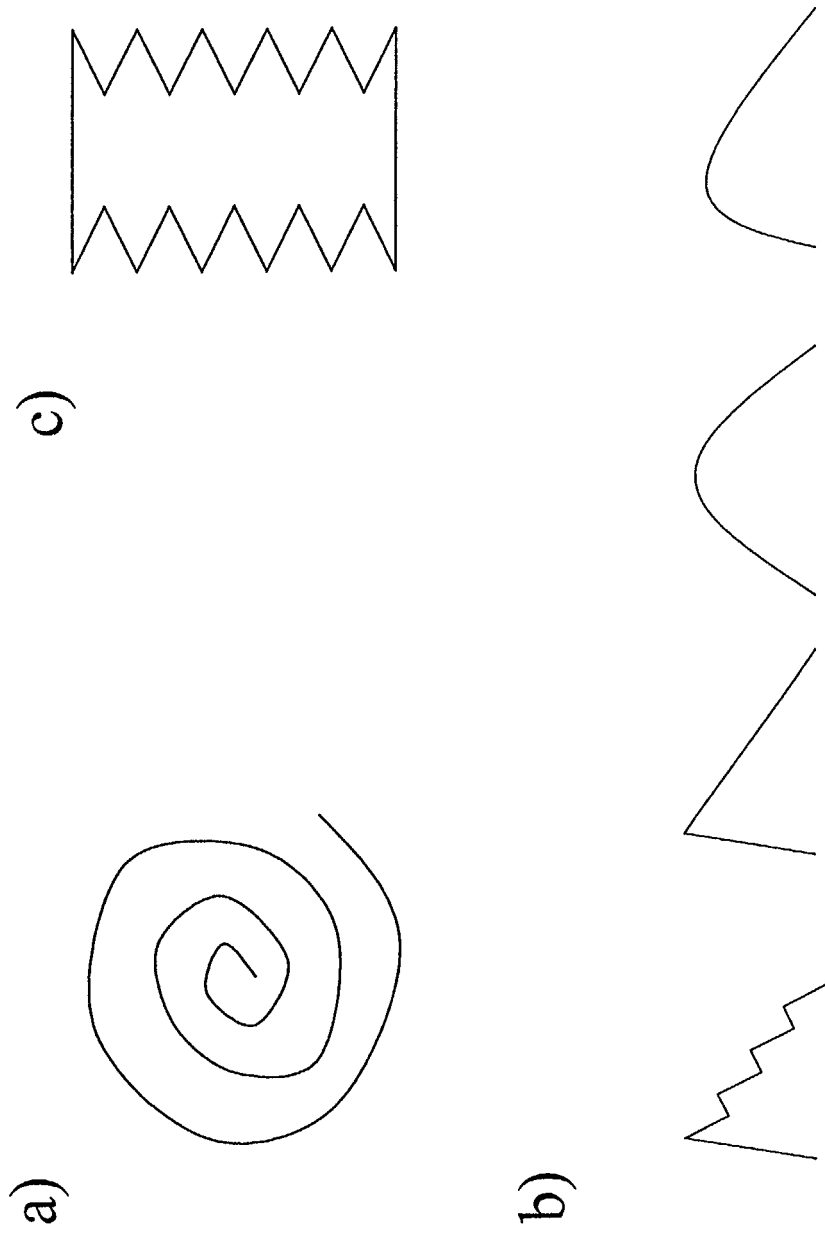


Fig. 2

d)

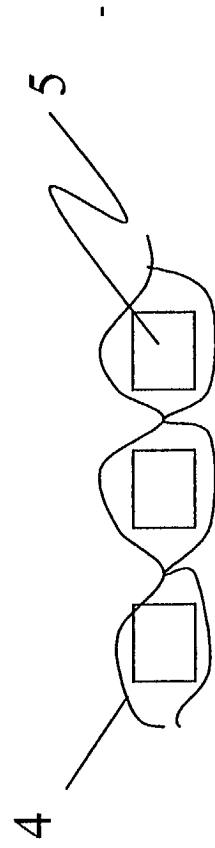


Fig. 2

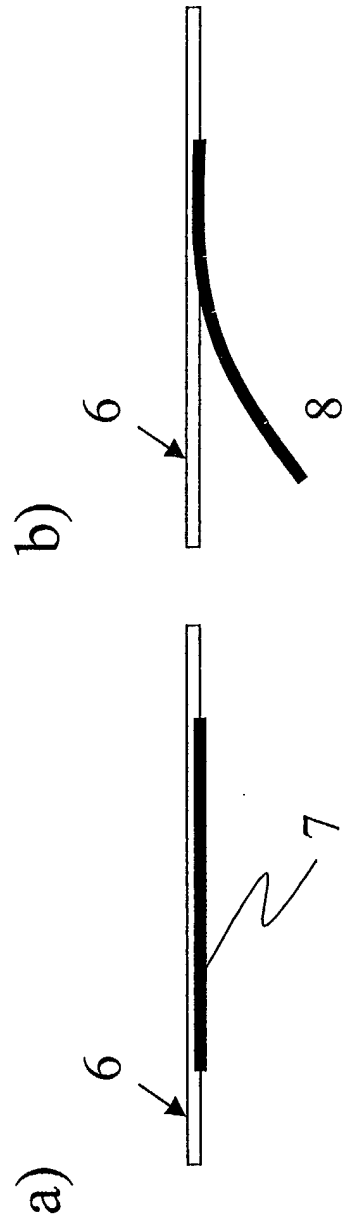


Fig. 3

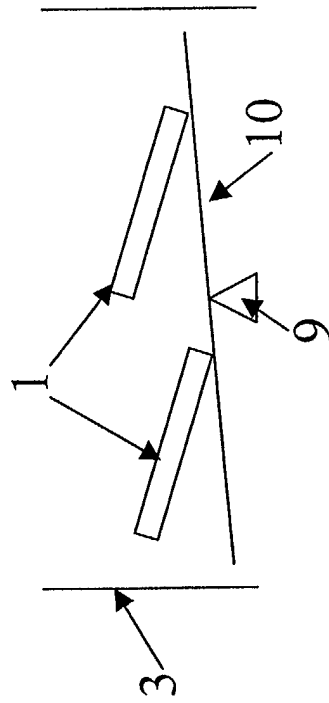


Fig. 4

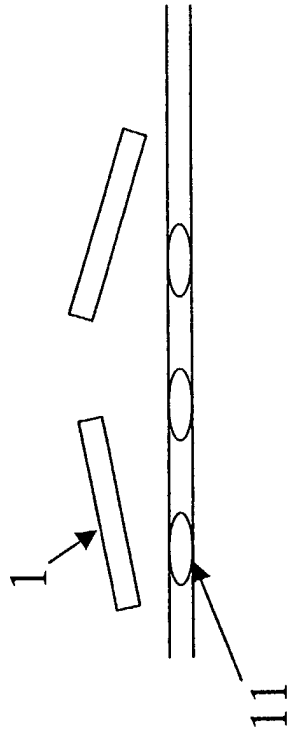


Fig. 5

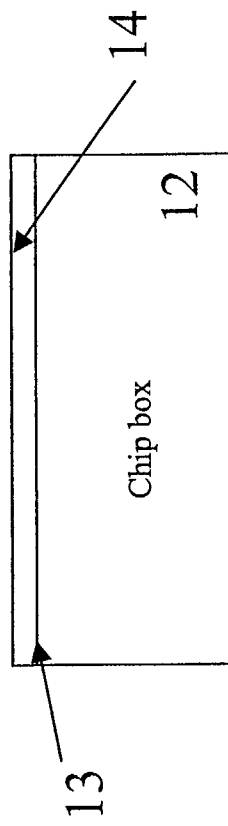


Fig. 6



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 02 40 5641

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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Y	---	4	
Y	WO 01 30657 A (M S O LTD ;WALSH DOMINIC (GB); MAST ROY LEE (US)) 3 May 2001 (2001-05-03) * claims 1-4; figures 3,4 *	4	
X	EP 0 839 737 A (MAST ROY LEE) 6 May 1998 (1998-05-06) * the whole document *	1-3,9,11	
<p>The present search report has been drawn up for all claims</p>			<p>TECHNICAL FIELDS SEARCHED (Int.Cl.7)</p> <p>B65D</p>
Place of search		Date of completion of the search	Examiner
THE HAGUE		17 December 2002	PERNICE, C
<p>CATEGORY OF CITED DOCUMENTS</p> <p>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</p> <p>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</p> <p>& : member of the same patent family, corresponding document</p>			

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EP 02 40 5641

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

- ☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):
- ☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

- ☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
- ☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.
- ☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:
- ☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-4,9,11



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LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 02 40 5641

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. Claims: 1-4, 9, 11

A food package for controlling heating of a foodstuff with microwave energy comprising:

- a) a food package having a microwave shielding layer with a plurality of apertures;
- b) a foodstuff contained in the package and initially located in close proximity to the microwave shielding layer;
- c) means for moving said microwave shielding layer away from close proximity to the foodstuff after the package and foodstuff are irradiated with microwave energy

2. Claims: 5-7

A food package for controlling heating of a foodstuff with microwave energy wherein a variable geometry feature is provided.

3. Claim : 8

A food package for controlling heating of a foodstuff with microwave energy having a foam surface susceptor material which minimizes contact with the foodstuff and acts as a moisture trap.

4. Claim : 10

A food package for controlling heating of a foodstuff with microwave energy where gaps are provided between adjacent food products such that the right amount of food can be selected for heating by cutting the packaging at said gaps.

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 02 40 5641

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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17-12-2002

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