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(54) Title: METHOD AND APPARATUS FOR FABRICATING A BEVERAGE CAPSULE

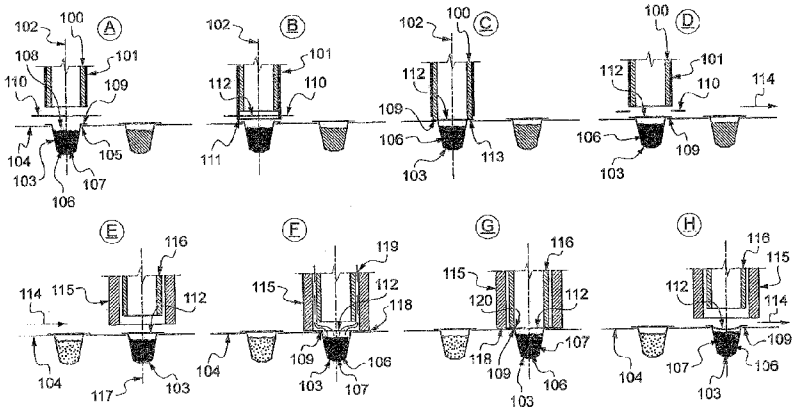

Fig.1

(57) Abstract: A method for fabricating a beverage capsule comprises the steps of providing a first wall member (103) delimiting a cavity (106) and having a flange (109) disposed about an open end (108) communicating with said cavity (106), providing a quantity of edible granules (107) within said cavity (106), positioning a second wall member (112) upon said flange (109)and said open end (108) of said first wall member (103), attaching said second wall member (112) to said flange (109) at at least two regions of said flange (109) thereby dividing the flange (109) circumferentially into at least two attached regions and at least two unattached regions, applying a vacuum (119) between said first and second wall members (103, 112) creating a vacuum (119) within said cavity (106), and sealing said first and second wall members (103, 112) along said flange (109), thereby maintaining said vacuum (119) within said cavity (106).

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Method and apparatus for fabricating a beverage capsule

Field of the Invention

This invention relates generally to a method for the fabrication of a beverage capsule for use in a beverage machine. It also relates to an apparatus for performing said method, as well as the beverage capsules so produced. In particular, this invention relates to such capsules as adapted for coffee beverages.

Background

It is known in the art to package perishable food products in sealed packages or containers. This excludes air and moisture from the unopened container, improving the shelf life and flavor of the products within. This method is especially advantageous for packaging roasted coffee.

The roasting process is what produces the characteristic flavor of coffee by causing the green coffee beans to expand and to change in color, aroma, and density. The oils and aromatic volatiles contained and/or developed during roasting confer the aroma and flavor of the coffee beverage produced therefrom, but are also prone to degradation when exposed to the oxygen in the surrounding air. Packaging coffee in sealed containers will protect it from the surrounding air, resulting in greater shelf life and optimal flavor and aroma during consumption.

Recently, it has been common to package coffee and other such beverage ingredients in single-serving capsules, adapted for use in a beverage system which prepares a beverage on demand from such capsules. These capsules contain a pre-portioned amount of a beverage ingredient or ingredients in the form of finely-textured edible granules. Such beverage capsules may be hermetically-sealed, preventing degradation of the beverage ingredient(s) within prior to consumption.

While this document is primarily concerned with beverage capsules containing roasted coffee, it is understood that other alimentary substances may be

used in such capsules. By way of non-limiting example, such edible granules may comprise ground roasted coffee, soluble coffee, powdered milk, powdered cocoa, loose tea leaves and/or other herbs, broth, or any combination thereof.

To prepare the beverage, the beverage capsule is placed into the beverage production machine, which introduces hot water into the beverage capsule and dispenses the resulting beverage into a container for consumption. While this document refers to a "capsule," it is understood that other terms, such as "pod," "cartridge," or "packet," may be employed instead.

To offer further protection of the edible granules from degradation prior to consumption, it is also known to seal beverage capsules under modified atmosphere (e.g. an atmosphere saturated with nitrogen or carbon dioxide) or under vacuum. In particular, a vacuum may be applied to the capsule when the capsule is filled with a beverage ingredient to remove the air from within. The beverage capsule is formed of gas-tight packaging materials and hermetically sealed to preserve the vacuum therein. In this way, any oxygen present in the capsule is removed prior to sealing and the edible granules are thus protected from degradation prior to consumption.

However, sealing a beverage capsule by vacuum-sealing introduces additional complications. Since the edible granules are generally of small size and light weight, the application of a vacuum may suck them from the capsule. Such edible granules may be aspirated into the vacuum-application means, causing damage to and increasing maintenance costs of the vacuum-sealing apparatus.

The edible granules may also become entrained between the sealing walls of the capsule, e.g. between the body and the capsule sealing means, preventing the latter from being properly bonded to the former. This compromises the strength and aesthetic quality of the beverage capsule seal, and by extension the protection of the edible granules within the seal of the beverage capsule.

The entrainment of edible granules may also result in tearing of the seal of the beverage capsule due to the pressure increase within the capsule during the

beverage preparation process. This can result in the rupture of the capsule and the liberation of wet coffee powder through the broken seal, soiling the beverage machine and producing a foul-tasting beverage.

The sealing of a beverage capsule under vacuum containing ground coffee is known in the art, for example in the US patent 5,472,719 and also in European patent EP 1 866 942. The latter document discloses a beverage capsule containing a quantity of coffee, which has been compressed into a tablet, reducing the size of the capsule and obviating the need for a filter therein. A vacuum is created within the capsule and the capsule is sealed by a flexible lid, thereby preventing degradation of the coffee tablet within.

WO2008129350 refers to a machine for packaging capsules also in a vacuum and/or in a controlled atmosphere. After filling with coffee, the capsules are partially closed by hermetic film. Then, a vacuum is formed inside the capsules and sealed by a thermo-sealing vacuum device.

US3775932 refers to a packaging apparatus for making vacuum packages of a product by sealing of two superimposed films together with the product contained therebetween. A vacuum is drawn by a vacuum tube connection in the partially sealed package whereby the edge of the packaging film is captured between the sealing head and a resilient strip with the edge of the superimposed film being free.

WO2010007633 refers to a machine for packaging products, in particular capsules for machines for delivering infusion beverages. A vacuum bell provides vacuum around each capsule to be welded. At the same time, vacuum compensating means take care of inserting gas, in particular nitrogen, inside each capsule in such a way to compensate the presence of vacuum. Afterwards, the welding means take care of welding the aluminium sheet onto the edge of the respective capsule.

US4069349 refers to a process for vacuum packaging of roasted ground coffee in pouches. The pouches are partially sealed, with a tortuous unsealed

passage, and then stored for a predetermined period of time to permit the gases to evolve from the pouches and then sealing the pouches to prevent further gaseous passage to and from the product.

The prior art references do not, however, resolve the problem of aspiration and entrainment of the edible granules.

It is accordingly an object of the invention to provide a method for the fabrication of beverage capsules in which edible granules may be sealed under vacuum within a beverage capsule, while reducing or eliminating the aspiration of such edible granules and thereby producing a seal of high integrity.

According, therefore, to a first aspect of the invention, the invention is directed to a method for fabricating a beverage capsule, comprising the steps of providing a first wall member, said first wall member at least partially delimiting a cavity and having a flange disposed circumferentially about an open end communicating with said cavity; providing a quantity of edible granules within said cavity of said first wall member; positioning a second wall member upon said flange and said open end of said first wall member; attaching said second wall member to said flange at at least two regions of said flange, thereby dividing the flange circumferentially into at least two attached regions and at least two unattached regions; applying a vacuum between said first and second wall members, thereby evacuating the gas from within said cavity and said edible granules through said at least two unattached regions of the flange and creating a vacuum within said cavity; and sealing said first and second wall members along said flange, thereby maintaining said vacuum within said cavity.

The attachment of the second wall member to the flange of the first wall member along at least two regions prevents the second wall member from moving in any direction along the flange when a vacuum is applied. This is advantageous because the attachment of the second wall member to at least two regions of the flange of the first wall member will reduce or eliminate the aspiration of edible granules during the application of the vacuum. This also prevents the second wall

member from being displaced (e.g. moved off-center), deformed, or folded prior to the sealing step, preventing the formation of wrinkles, creases, plies, or other undesirable forms in the second wall member. As a result, it is possible to produce capsules at a faster pace on the production line while guaranteeing the quality with a high vacuum level.

According to a feature, the second wall member is attached to said flange at a plurality of regions of said flange, thereby dividing the flange circumferentially into a plurality of attached regions and a plurality of unattached regions; and the vacuum is applied between said first and second wall members, thereby evacuating the gas from within said cavity and said edible granules through said plurality of unattached regions of the flange, thereby creating a vacuum in said cavity.

The term “plurality” in the present context means more than two.

This is advantageous because the attachment of the second wall member to a plurality of regions of the flange of the first wall member will reduce or eliminate the aspiration of edible granules during the application of the vacuum. Particularly, the attached regions prevent the edible granules from leaving the capsule. However, the gas within the cavity and edible granules may still be removed, as it may still flow through the spaces between the flange and the second wall member at the unattached regions.

Thus, since the edible granules may be confined to the first wall member during the application of the vacuum, the quantity of such edible granules which are aspirated into the vacuum-sealing apparatus is greatly reduced. The amount of damage the edible granules cause to the sealing and vacuum means of the apparatus, and the consequent maintenance and repair costs, are reduced or eliminated. The performance of this method is thereby rendered more cost-effective and reliable, while the quality of the beverage capsules so produced is simultaneously improved.

The entrainment of edible granules between the second wall member and the flange of the first wall member is similarly reduced or eliminated. Since the edible granules no longer interfere with the interface between the wall members, the strength and aesthetic quality of the seal between the two are improved. The physical properties of the beverage capsule are thus optimized, providing more effective protection to the edible granules and better preserving the flavor and aroma of the beverage produced from them.

Finally, the method permits the above-mentioned advantages to be realized while providing vacuum and sealing the beverage capsules individually. The attachment of the second wall member to the flange of the first wall member prior to the application of a vacuum and the sealing of the beverage capsule permits a vacuum to be rapidly applied while still maintaining a high level of strength and aesthetic quality in the sealed beverage capsules. Since the vacuum is applied only to one beverage capsule at a time, the sealing of each beverage capsule may be individually monitored and controlled. The sealing process may thus be made adaptable so that each capsule is given a seal of the highest possible quality. In this way, the efficiency of the method is maximized while simultaneously ensuring that the beverage capsules so fabricated are of the highest possible quality.

According to another feature, the method is characterized in that said first wall member is a self-supporting capsule body and said second wall member is a flexible membrane.

This is advantageous in that first and second wall members in the form of a self-supporting capsule body and a flexible membrane facilitate the provision of coffee within the capsule body and the sealing of the membrane upon the flange. Also, a self-supporting capsule body will give structural strength to the unsealed beverage capsule, facilitating handling during the manufacturing process. The advantages of the invention may be realized with a minimum of effort and expense.

According to another feature, the steps for attaching and sealing said second wall member onto said flange are performed by heat sealing.

This is advantageous in that heat sealing processes can rapidly produce seals which are generally airtight, durable, flexible, and sanitary. Heat-sealing means may also be integrated into an apparatus embodying this method, such as by the incorporation of hot air jets, electric resistance heaters, or the like. Heat sealing processes may also be adapted to work with a variety of materials, improving the compatibility of this method.

Furthermore, the bonds created between the second wall member and the flange of the first wall member during the attachment step will be substantially identical to the seal created during the sealing step. This results in a seal which is uniform across its entire surface, without any areas of diminished strength or other undesirable variations. Moreover, this feature is advantageous in that the first and second wall members need only be suitable for a single type of bonding process rather than two types, increasing the selection of possible materials for the components of the beverage capsule. This feature, therefore, makes the invention simpler and easier to practice while producing improved results.

In a possible alternative, the steps for attaching and sealing of said second wall member onto said flange are performed by ultrasonic welding.

This is advantageous in that, as with heat sealing, ultrasonic welding can rapidly produce seals which are generally airtight, durable, flexible, and sanitary. Ultrasonic welding is also advantageous in that it does not require the first and second wall members to be heated in order to create the seal, permitting these components to be fabricated from materials which may not be suitable for heat sealing. The versatility of the invention is thereby improved.

According to still another feature, the second wall member is attached to said flange over an area comprising between 25% and 90%, preferentially between 30% and 75% of the total sealed surface of said flange of said first wall member.

This is advantageous in that attaching the second wall member to the flange over the ranges given above will permit the vacuum to be applied with maximum speed and minimal aspiration of the edible granules within the beverage capsule. As a result, the efficiency and cost-effectiveness of the method are improved.

According to still another feature, the edible granules are provided within the cavity in loose form.

This is advantageous in that providing the edible granules in this way eliminates the need for compacting the edible granules within the beverage capsule. Instead, the edible granules are simply inserted into the cavity and sealed therein, without requiring any time for compacting them or additional apparatus for doing so. In this way, the process is rendered faster, more efficient, and more economical

According to still another feature, the application of vacuum and sealing while maintaining the vacuum within the cavity are carried out immediately after the attaching of the second wall member to the flange and dividing the flange into the at least two or a plurality of attached and unattached regions. By “immediately”, it is meant that there is no pause higher than a few seconds allowing the edible granule to significantly loose gas and consequently aroma.

According to a second aspect, the invention is directed to a beverage capsule fabricated as described above.

This is advantageous in that a beverage capsule so fabricated will embody the advantages of the invention as detailed above.

According to a third aspect, the invention is directed to an apparatus for the fabrication of a beverage capsule, comprising an attachment means, said attachment means being configured to attach a first wall member to a second wall member at a flange disposed circumferentially about an open end of said first wall member, said attachment being situated over at least two regions of said flange and thereby dividing the flange into at least two attached regions and at least two

unattached regions, said first wall member at least partially delimiting a cavity in communication with said open end and being provided with a quantity of edible granules within said cavity; a vacuum application means, said vacuum application means being provided with a receptacle adapted for airtight communication with said first and second wall members, and being further configured to evacuate the gas from said first wall member and edible granules through the at least two unattached regions of the flange, thereby creating a vacuum within said cavity; and a sealing means, said sealing means being configured so as to create a seal between said first and second wall members along said flange, thereby maintaining said vacuum within said cavity.

This is advantageous in that such an apparatus embodies the method for fabricating a beverage capsule described above. The advantages of the invention are thereby embodied in beverage capsules whose production is rendered more efficient, adaptive, consistent, and economical.

In a preferred mode, the first wall member is a self-supporting capsule body defining said cavity and said flange and the second wall member is a flexible membrane. The membrane may have a thickness comprised between 10 and 250 microns, preferably between 30 and 100 microns. The membrane contains at least one layer fabricated from a material having gas barrier properties, such as aluminum. The membrane also preferably comprises a sealant layer comprised of a material such as polypropylene.

According to a feature, the apparatus is characterized in that the attachment means attaches said second wall member to said flange over a plurality of regions of the flange, thereby dividing the flange into a plurality of attached regions and a plurality of unattached regions and the vacuum application means is configured to evacuate the gas from said first wall member and edible granules through the at least one unattached region of the flange.

The term “plurality” in the present context means more than two.

This is advantageous in that it permits one to optimize the attachment and vacuum-application means, as described above.

According to another feature, the attachment means comprises a plurality of faces disposed perpendicular to and in radial symmetry about an axis of said attachment means, and which are configured to attach said second wall member to said flange of said first wall member over a plurality of regions corresponding to said plurality of faces.

This is advantageous in that such an attachment means will attach the second wall member to the flange of the first wall member over a uniform, symmetric pattern, thereby providing a plurality of equally symmetric and uniform unattached regions. The resulting attachment will be thus rendered more uniform and reliable. This further reduces the aspiration and entrainment of the edible granules during the application of the vacuum, and produces beverage capsules having further improved seal quality. The efficiency and cost-effectiveness of the apparatus are thereby improved.

According to another feature, said vacuum-application means and said sealing means are disposed coaxially about a longitudinal axis, said vacuum-generating means being adapted to translate along said longitudinal axis relative to said sealing means.

This is advantageous in that the sealing means may be disposed within the vacuum application means. This conserves space in the apparatus, effectively placing the two means in the space of one. This is also advantageous in that the steps for vacuum application and sealing may be performed simultaneously as described above. This feature will thereby improve the output and efficiency of the apparatus, while simultaneously making it more compact and space-efficient.

According to still another feature, the apparatus further comprises a means for cutting said second wall member to substantially match the outline of said flange and open end of said first wall member.

This is advantageous in that it permits the material from which the second wall member is fabricated to be provided in bulk form, such as a sheet or ribbon, thereby facilitating the handling of said second wall member and reducing the overall complexity of the apparatus. Furthermore, cutting said second wall member to substantially match the outline of said flange and open end of said first wall member will result in a second wall member which does not have to be trimmed after the fabrication of the beverage capsule. This eliminates the need for additional means for trimming. In this way, the efficiency and speed of the invention may be improved.

According to still another feature, said means for cutting said second wall member is disposed about said attachment means, said attachment means and means for cutting said second wall member being coaxial about a longitudinal axis, and said cutting means being adapted to translate along said longitudinal axis relative to said sealing means.

This is advantageous in that the two means may be disposed so that the attachment means is within the means for cutting the second wall member. This conserves space in the apparatus, effectively placing the two components in the space of one. The vacuum application and sealing means may be adapted to act upon the first and second wall members simultaneously, thereby reducing the time required to carry out the attachment and cutting steps. This feature will thereby improve the output and efficiency of the apparatus, while simultaneously making it more compact and space-efficient.

Brief Description of the Drawings

Other particularities and advantages of the invention will also emerge from the following description.

In the accompanying drawings, given by way of non-limiting examples:

- Figure 1 is a series of orthogonal section views depicting an attachment means, a cutting means, a vacuum-application means, and a sealing means;

- Figure 2 is a series of views of attachment apparatuses in four different configurations; and

- Figure 3 is a flowchart depicting the method of the invention as integrated into a process for the fabrication of beverage capsules, said process comprising a series of steps.

Description of the Invention

The following description will be given with reference to the above-mentioned figures.

Figure 1 is a sequence of section views depicting the sealing of a beverage capsule according to the invention. Figure 1 depicts the attachment and cutting steps in views A through D, and the vacuum application and sealing steps in views E through H. Portions of the apparatus are omitted from each of these views for purposes of clarity.

View A depicts an attachment means 100 and a cutting means 101 disposed in a first position, prior to the start of an attachment step. The attachment means 100 and the cutting means 101 are generally tubular and coaxial about the first longitudinal axis 102. Preferably, the cutting means 101 will be disposed around and capable of translation relative to the attachment means 100, as depicted here.

A capsule body 103 is positioned within the base plate 104, which is provided with a capsule seat 105 in which the capsule body 103 is positioned. The base plate 104 is preferably configured to be mobile, facilitating a high rate of production of beverage capsules. This mobile configuration may comprise such means as a conveyor belt system or rotating turret, for example. In the preferred embodiment, the capsule body 103 is positioned beneath the attachment means

100 and cutting means 101 so as to be coaxial with them about the first longitudinal axis 102.

The capsule body 103 defines a cavity 106, in which a predetermined quantity of ground coffee powder 107 is provided. The capsule body 103 is substantially cup-shaped, and is provided with an open end 108 communicating with said cavity 106. The capsule body 103 is further provided with a flange 109, disposed about the circumference of the capsule body 103 at the open end 108.

The capsule body 103 is preferably fabricated from a formable material such as aluminum, plastic, starch, cardboard, or combination thereof. Where the capsule body itself is not gas-impermeable, a gas barrier layer may be incorporated therein to prevent the entry of oxygen. The gas barrier may comprise a coating, film, or layer of aluminum, ethylene vinyl alcohol, polyamide, oxides of aluminum or silicon, or combinations thereof.

For example, in one embodiment, the capsule body 103 is formed of deep-drawn aluminum. In another embodiment, the capsule body 103 is formed of deep-drawn polypropylene and aluminum. In a third embodiment, the capsule body 103 is thermoformed from a combination of polypropylene, ethylene vinyl alcohol, and polyethylene terephthalate.

In a preferred embodiment, the flange 109 and the capsule seat 105 are configured so that the capsule body 103 protrudes through the base plate 104, with the flange 109 resting directly on the base plate 104 and substantially the entire beverage capsule 103 being disposed beneath the base plate 104. In an alternate configuration, the capsule seat may be configured as a cup, in which the capsule body is seated.

A portion of membrane material 110 is disposed between the cutting means 101 and the base plate 104. Said membrane material 110 is preferably provided in the form of a continuous sheet or web, which may be fed into the apparatus by techniques adapted from those known in the art of materials handling. The membrane material 110 is preferably flexible, permitting moderate

elastic deformation. The membrane material 110 may have a thickness between 10 and 250 microns, preferably between 30 and 100 microns.

In a preferred embodiment, the membrane material 110 comprises at least a base layer fabricated of aluminum, polyester (e.g. PET or PLA), polyolefin(s), polyamide, starch, paper, or any combination thereof. The base layer is preferentially formed of a laminate comprising two or more sub-layers of these materials. The base layer may comprise a sub-layer which acts as a gas barrier, if none of the other sub-layers are of a material which is impermeable to gas. The gas barrier sub-layer is fabricated from a gas-impermeable material such as aluminum, ethylene vinyl alcohol, polyamide, oxides of aluminum or silicon, or combinations thereof. The membrane material 110 preferably also comprises a sealant layer, e.g. polypropylene, disposed to create a seal with the capsule body 103.

For example, in one embodiment the membrane material 110 is an aluminum layer between 25 and 40 microns. In another embodiment, the membrane material 110 comprises a base layer with two sub-layers: an external sub-layer made of PET and an internal sub-layer made of aluminum. The aluminum sub-layer serves the function of preventing undesirable transmission of light, moisture, and oxygen. In another embodiment, the membrane material 110 comprises three sub-layers: an external sub-layer of PET 5 to 50 microns thick, a middle sub-layer of aluminum 5 to 20 microns thick, and an internal sub-layer of cast polypropylene 5 to 50 microns thick.

View B depicts the apparatus in a second position, during a cutting step. The cutting means 101 is advanced downward along the first longitudinal axis 102 into the membrane material 110. In a preferred embodiment, the cutting means 101 is sharpened along its peripheral edge 111 so as to cut the membrane material 110 when pressed into it. However, alternate configurations, such as a hot-knife apparatus, may be preferable for certain compositions of heat-sensitive membrane

material. The cutting means 101 is advanced through the membrane material 110, cutting a membrane 112 from the membrane material 110.

View C depicts the apparatus in a third position, during an attachment step. At the lower end 113 of the attachment means 100 are disposed a plurality of faces disposed substantially perpendicular to the longitudinal axis 102, which are pressed into the membrane 112. The attachment means 100 is advanced so that the lower end 113 presses the membrane 112 into the flange 109 over a plurality of regions corresponding to the aforementioned faces.

The attachment means 100 is configured to attach the membrane 112 to the flange 109 over the regions where the faces of the lower end 113 press said membrane 112 into the flange 109 of the capsule body 103. In the present embodiment, the attachment of the membrane 112 to the flange 109 of the capsule body 103 is achieved by heat-sealing; though in other embodiments alternate techniques such as ultrasonic welding may be preferred.

The attachment means 100 is therefore preferably furnished with appropriate means for attaching the membrane 112 to the flange 109 during the attachment step. For example, such means may comprise an electrical resistance heater, hot air jet, or ultrasonic welding horn. This will make the apparatus more compact and space-efficient.

Said regions of the flange 109 corresponding to the faces of the lower end 113 of the attachment means 100 will comprise a portion of the total surface of the flange 109. The cavity 106 of the capsule body 103 thereby remains in communication with the surrounding atmosphere, via the spaces between the flange 109 and the membrane 112 where the membrane 112 remains unattached to the flange 109.

View D depicts the apparatus in a fourth position, after the completion of the attachment step. The attachment means 100 and cutting means 101 are withdrawn from the capsule body 103 and membrane 112. The scrap membrane material 110 may be removed, while the base plate 104 is advanced in direction

114 to both place the current beverage capsule in position for vacuum sealing and bring the next beverage capsule into position for the attachment and cutting steps.

Preferably, the step for cutting the membrane 112 as depicted in View B and the step for attaching said membrane 112 to the flange 109 as depicted in View C are performed sequentially but in a continuous movement of descent of the cutting and attachment means 101, 100. A slight vacuum is further applied through the attachment means to maintain the membrane 112 in coaxial position in axis 102 during the cutting and attachment steps. This is advantageous, in that it minimizes the time to fabricate a capsule and thus increases the rate at which capsules are produced.

View E depicts the apparatus in a fifth position, prior to the start of a sealing step. The cutting and attachment means depicted in the previous steps are omitted here for clarity; however, the cutting and attachment means are ideally disposed adjacent or in close proximity to the vacuum-application means 115 and sealing means 116, making the apparatus more compact and space-efficient.

In a preferred embodiment, the vacuum-application means 115 and the sealing means 116 are preferably tubular and disposed coaxially about the second longitudinal axis 117. The sealing means 116 is in the form of a hollow cylinder, of approximately the same width and diameter of the flange 109 of the beverage capsule 103. The vacuum-application means 115 is also in the form of a hollow cylinder, and is provided with a means for creating a vacuum within. Preferably, the vacuum-application means 115 is configured so as to be capable of translation relative to the sealing means 116 along their shared second longitudinal axis 117.

The base plate 104 is advanced in the direction 114 until the capsule body 103 and membrane 112 are also coaxial with the vacuum-application means 115 and the sealing means 116 about the second longitudinal axis 117. The capsule body 103 and membrane 112 are thus positioned in a centered position directly below the vacuum-application means 115 and sealing means 116.

View F depicts the apparatus in a sixth position, during a vacuum-application step. The vacuum-application means 115 have been advanced so as to create an airtight seal between the mouth 118 of the vacuum-application means 115 and the flange 109 of the capsule body 103. A vacuum 119 is applied to the capsule body 103 through the vacuum-application means 115, reducing the pressure in the cavity 106 of the capsule body 103 below atmospheric pressure.

The vacuum 119 causes the gas within the cavity 106 of the capsule body 103 to be drawn out through the plurality of spaces between the flange 109 and the membrane 112, which are defined by the regions where said membrane 112 remains unattached to said flange 109. The gas can be air or any inert gas, such as nitrogen, CO_2, or any combination thereof. In this way, the cavity 106 of the capsule body 107 is voided of gas and a vacuum created within it.

The vacuum-application step is preferentially configured so that the vacuum may be rapidly applied to the capsule body 103 while avoiding sucking the coffee powder 107 from the cavity 106. It is known that the rapid application of a vacuum to a beverage capsule may cause some of the coffee powder within to be sucked out, which may result in damage to the apparatus from aspirated coffee powder. The coffee powder may also become entrained between the sealing surfaces of the beverage capsule, weakening the seal and diminishing its aesthetic properties. The application of vacuum may also cause the sealing means to move, further compromising seal integrity.

Here, the attachment of the membrane 112 to the flange 109 of the capsule body 103 over a plurality of regions will prevents the aspiration and entrainment of the coffee powder 107 between the flange 109 and the membrane 112, as well as prevent the displacement of the membrane relative to the capsule body during the application of the vacuum 119. The integrity of the beverage capsule seal and the reliability of the sealing apparatus are thus preserved even when the vacuum is applied very rapidly, permitting higher-quality beverage capsules to be produced at a faster rate.

The vacuum-application step is also preferentially configured to enable the conditions within the capsule to be monitored as the vacuum 119 is applied. Specifically, the vacuum-application means permits the rapid application of the vacuum 119 to a single capsule body 103, rather than the slower application of a vacuum to a group of capsule bodies in a vacuum chamber. Thus, by use of data collection and/or control-loop methods known in the art, one may continually adapt the parameters of the vacuum-sealing process to optimize the sealing of each capsule while still maintaining an overall high rate of production.

View G depicts the apparatus in a seventh position, during a sealing step. The mouth 118 of the vacuum-application means 115 is kept in contact with the flange 109 of the capsule body 103, such that the vacuum within the cavity 106 of the capsule body 103 is maintained.

The sealing means 116 is preferably provided with a means for creating a seal between the membrane 119 and the flange 109 of the capsule body 103, similar to the attachment means as discussed above. As with the attachment means, this may comprise such means as an electrical resistance heater, hot-air jets, or ultrasonic welding horn.

The sealing means 116 is advanced into contact with the membrane 112, pressing into it along the sealing edge 120 disposed at an end of said sealing means 116. The membrane 112 is pressed into the flange 109 by the sealing means 116, thereby bonding the remaining unattached regions of the membrane 112 to the surface of the flange 109 and sealing the cavity 106 of the capsule body 103. While the remaining unattached regions of the membrane are bonded, the bond of the attached regions created during the attachment step may be renewed. The air-tight hermetic seal created between the flange 109 and the membrane 112 will thereby preserve the vacuum in the cavity 106 of the capsule body 103, protecting the coffee powder 107 from exposure to air and subsequent loss of flavor and aroma.

View H depicts the sealed beverage capsule after the completion of the sealing step. The sealing means 116 is withdrawn to allow the bond to solidify. Then the vacuum is stopped in the vacuum means, exposing the capsule body 103 and membrane 112 to atmospheric pressure and causing the membrane 112 to take a concave form as depicted. Finally, the vacuum-application means 115 is withdrawn. The vacuum which was applied to the capsule body 103 in an earlier step is preserved therein by the seal between the flange 109 and the membrane 112. The base plate 104 is then moved off in direction 114, removing the capsule to be packaged and distributed and bringing the next capsule into position for vacuum sealing.

In addition to the benefits realized by the invention as discussed above, an additional benefit is realized when, as in this embodiment, the edible granules are of a substance that tends to evolve a gas. Such substances notably include roasted coffee, especially ground roasted coffee powder as described here.

As a result of chemical processes triggered by the roasting process, the coffee powder 107 will evolve gas for a period of time after the roasting process is completed, a process known in the art as “degassing.” As the coffee powder 107 within the beverage capsule degasses, the gases which are evolved are kept within the cavity 106 of the beverage capsule by the membrane 112, the capsule body 103, and the hermetic seal between them.

This accumulation of evolved gases will cause the pressure within the beverage capsule to increase until equilibrium pressure is reached. At equilibrium, there will be a positive pressure within the beverage capsule, i.e. a pressure above the atmospheric pressure, causing the membrane 112 to be deflected outwardly.

The vacuum which is sealed into the beverage capsule thus partially offsets the pressure generated by the gases evolved from the coffee powder 107. The degree to which the vacuum offsets the evolved gases may vary from embodiment to embodiment, depending on the volume of the beverage capsule, the mass of coffee provided within, and the type and degree of roast of the coffee

powder itself. In any case, the vacuum within the beverage capsule compensates for the degassing at least to the extent that the evolved gas is prevented from compromising the structural integrity of the beverage capsule and its hermetic properties.

In a preferred embodiment, the initial vacuum pressure of the capsule immediately after the sealing step will be between 300 and 600 mbar, and preferably between 400 and 500 mbar. After the beverage capsule is sealed, the gases evolved by the coffee powder during degassing will continue to accumulate in the cavity 106 of the beverage capsule, causing the internal pressure of the beverage capsule to rise above atmospheric pressure in approximately 5 hours and reach equilibrium at between 1050 and 1600 mbar, and most preferably between 1050 and 1350 mbar in approximately 72 hours.

Additionally, the method is preferably configured so that all, or substantially all, of the degassing occurs within the beverage capsule after it has been sealed. While the pressure within the beverage capsule will be negative at time of sealing, the evolved gases will rapidly increase the pressure within the capsules. In a preferred embodiment, the capsule will rise above atmospheric pressure in less than 5 hours and stabilize in approximately 72 hours.

Figure 2 is a series of views depicting several configurations for the attachment means. As discussed above, the attachment means comprises at its bottom end a plurality of faces, which are pressed into the membrane to attach it to the flange of the capsule body over a plurality of regions corresponding to said faces.

Figure 2A and 2B depict an orthogonal view and a perspective view, respectively, of an attachment means 200. As previously discussed, the attachment means 200 is substantially in the form of a hollow cylinder. Two slots 201 have been provided in the attachment means 200, with the result that the end of the attachment means 200 is divided into two faces 202 and two voids 203.

When pressed into a membrane during the attachment step as described above, the membrane will be attached to a flange of a capsule body over the portion of the surface of the flange corresponding to the faces 202 of a first kind. The membrane will remain unattached and permit fluid communication between the cavity of the capsule body and the surrounding atmosphere through the unattached regions between the membrane and flange defined by the voids 203 of a first kind.

Figure 2C depicts an orthogonal view of an alternate configuration for the attachment means, comprising four faces 204 of a second kind and four voids 205 of a second kind. Such an attachment means will attach a membrane to a flange of a capsule body over a plurality of regions corresponding to each of the four faces 204 of a second kind, while leaving the regions of the membrane corresponding to the four voids 205 of a second kind unattached.

Figure 2D depicts an orthogonal view of another alternate configuration for the attachment means, provided with eight faces 206 of a third kind and separated by eight voids 207 of a third kind. As above, the faces 206 of a third kind will define the region over which a membrane is attached to the flange of a capsule body, and the voids 207 of a third kind defining where it is unattached.

Figure 2E depicts an orthogonal view of another alternate configuration for the attachment means, provided with eight faces 208 of a fourth kind which are separated by eight voids 209 of a fourth kind. Compared to the attachment means depicted in Figure 2D, the faces 208 of a fourth kind are much smaller than the faces 206 of a third kind, while the voids 209 of a fourth kind are much larger than the voids 207 of a third kind. As a result, the proportion of the flange of a capsule body to which a membrane will be attached by the attachment device in Figure 2E is much lower than would be achieved by the attachment device of Figure 2D, with a corresponding increase in the size of the regions of the flange to which the membrane remains unattached.

The attachment devices may in this way be configured to best suit the particular application in which the attachment device is to be employed. In the foregoing embodiments the attachment devices are altered by adjusting their number and size; however, in other embodiments it may be advantageous to modify other elements of their form and geometry such as shape, thickness, or placement about the lower end of the attachment means.

In this way, one may configure the attachment means to reduce the time required to apply the vacuum to the capsule body while still minimizing the aspiration and entrainment of the coffee powder or other edible granules contained within the capsule body. The sealing of the beverage capsules may thus be optimized to achieve a maximum output at a minimum cost.

Figure 3 is a flowchart depicting a process for the fabrication of beverage capsules, said operation comprising a series of elements. The first step of the operation is Capsule Body Destacking 300. The empty capsule bodies are generally stored stacked atop each other when stored before use, and so must be separated before they can be further processed. In the step for Capsule Body Destacking 300, the capsule bodies are separated from each other and placed in the proper orientation to continue in the process.

Simultaneously, the Coffee Preparation Process 301 furnishes a supply of coffee powder for packaging within the beverage capsules. In the Coffee Preparation Process 301, coffee beans are roasted to the desired degree of roasting and then ground to the desired degree of fineness.

As discussed above, the gases generated within the coffee beans during roasting are evolved from the coffee. Some degassing will occur between the roasting of the coffee and the sealing of the beverage capsule. It is preferable, however, to configure the process for fabrication of beverage capsules to minimize degassing outside of the capsule, so that the degassing essentially occurs after the beverage capsule has been sealed. In a preferred embodiment, the duration between the grinding of the coffee and its provision within the beverage capsule is

less than ten minutes; in this way the flavor and aroma of the beverage ultimately produced from the beverage capsule is best preserved.

Furthermore, since the coffee is not degassed before the sealing process, the infrastructure required to degas the coffee beforehand is no longer necessary. This renders the beverage capsule sealing operation more compact, economical, and flexible.

During Product Filling & Densifying 302, a portion of the coffee powder provided by the Coffee Preparation Process 301 is placed within the capsule body and densified, so that the coffee is settled within the capsule body and the amount of gas therein is so minimized. In an alternate embodiment, the beverage powder may be compacted into a tablet during the Coffee Preparation Process 301 step, which is then positioned in the capsule body during the step of Product Filling & Densifying 302.

Ideally, each element of the operation is linked by a step for Transport 303, where the capsule body is transferred between the devices for carrying out each element of the operation. In addition, it is understood that the elements for carrying out each of the elements of the process may be located in proximity to each other, or even integrated into each other, so that the time required for transporting the beverage capsule between elements is minimized. The process is thereby rendered more space-efficient and economical.

After this is Membrane Attachment and Cutting 305, as depicted in Views A-D of Figure 1. In this step, the membrane is attached to the flange of the capsule body at a plurality of regions of the flange, leaving a plurality of unsealed regions on said flange as well. The membrane is also cut to a size which will cover the flange and open end of the capsule body.

Following Membrane Attachment & Cutting 305 is Vacuum Application & Sealing 306, depicted in Figure 1, Views E-H. A vacuum is applied to the capsule body, removing the gasfrom within through the plurality of unsealed regions of the

flange. The membrane is then sealed over the entirety of the surface of the flange, preserving the vacuum within the capsule.

In beverage capsules containing roasted, ground coffee as shown here, it is particularly advantageous that the vacuum within the capsule is a reduction of pressure high enough to offset the pressure generated by the gases evolved by the coffee as it degasses in the capsule. A normally configured beverage capsule will so resist the pressure accumulated within the sealed capsule as a result of the evolved gases.

Finally, the capsule is transferred to Distribution 308, where it may be packaged in a box, sleeve, bag, or the like and distributed for sale.

Of course, the invention is not limited to the embodiments described above and in the accompanying drawings. Modifications remain possible, particularly as to the construction of the various elements or by substitution of technical equivalents, without thereby departing from the scope of protection of the invention.

In particular, it should be understood that the present invention may be adapted to fabricate beverage capsules for the preparation of various kinds of alimentary substances, for example broth, cocoa, coffee, infant formula, milk, tea, tisane or any combination thereof. It should also be understood that the edible granules comprising said alimentary substances may be provided in various forms and sizes, such as flakes, grains, granules, pellets, powders, shreds, or any combination thereof. While the particular embodiment of the preceding description is directed to a beverage capsule containing a quantity of roasted, powdered coffee, it should not be construed as limiting the scope of the invention to beverage capsules so configured.

Furthermore, while the embodiments depicted in the accompanying figures depict an attachment means which is configured to attach a membrane to a flange of a capsule body over a plurality of regions, it should be understood that an

attachment device which does so over only one region of the flange of the capsule body may equally be feasible.

The exact configuration and operation of the invention as practiced may thus vary from the foregoing description without departing from the inventive principle described therein. Accordingly, the scope of this disclosure is intended to be exemplary rather than limiting, and the scope of this invention is defined by any claims that stem at least in part from it.

CLAIMS

1. A method for fabricating a beverage capsule, comprising the steps of:
   - providing a first wall member (103), said first wall member (103) at least partially delimiting a cavity (106) and having a flange (109) disposed circumferentially about an open end (108) communicating with said cavity (106);
   - providing a quantity of edible granules (107) within said cavity (106) of said first wall member (103);
   - positioning a second wall member (112) upon said flange (109) and said open end (108) of said first wall member (103);
   - attaching said second wall member (112) to said flange (109) at at least two regions of said flange (109), thereby dividing the flange (109) circumferentially into at least two attached regions and at least two unattached regions;
   - applying a vacuum (119) between said first and second wall members (103, 112), thereby evacuating the gas from within said cavity (106) and said edible granules (107) through said at least two unattached regions of the flange (109) and creating a vacuum (119) within said cavity (106); and
   - sealing said first and second wall members (103, 112) along said flange (109), thereby maintaining said vacuum (119) within said cavity (106).

2. The method of Claim 1, characterized in that
   - the second wall member (112) is attached to said flange (109) at a plurality of regions of said flange (109), thereby dividing the flange (109) circumferentially into a plurality of attached regions and a plurality of unattached regions, and

– the vacuum (119) is applied between said first and second wall members (103, 112), thereby evacuating the gas from within said cavity (106) and said edible granules (107) through said plurality of unattached regions of the flange (109), thereby creating a vacuum (119) in said cavity (106).

3. The method of Claim 1 or 2, characterized in that said first wall member (103) is a self-supporting capsule body and said second wall member (112) is a flexible membrane.

4. The method of any of Claims 1 to 3, characterized in that the steps for attaching and sealing said second wall member (112) onto said flange (109) are performed by heat sealing.

5. The method of any of Claims 1 to 3, characterized in that the steps for attaching and sealing said second wall member (112) onto said flange (109) are performed by ultrasonic welding.

6. The method of any of Claims 1 to 5, characterized in that the second wall member (112) is attached to said flange (109) over an attachment area comprising between 25% and 90%, preferentially between 30% and 75% of the total sealed surface of said flange (109) of said first wall member (103).

7. The method of any of Claims 1 to 6, characterized in that the edible granules (107) are provided within the cavity (106) in loose form.

8. The method of any of Claims 1 to 7, characterized in that the application of vacuum and sealing while maintaining the vacuum within the cavity are carried out immediately after the attaching of the second wall member to the

flange and dividing the flange into the at least two or a plurality of attached and unattached regions.

9. A beverage capsule fabricated by the method of any of Claims 1 to 8.

10. An apparatus for the fabrication of a beverage capsule, comprising:

- an attachment means (100, 200), said attachment means (100, 200) being configured to attach a first wall member (103) to a second wall member (112) at a flange (109) disposed circumferentially about an open end (108) of said first wall member (103), said attachment being situated over at least two regions of said flange (109) and thereby dividing the flange (109) into at least two attached regions and at least two unattached regions, said first wall member (103) at least partially delimiting a cavity (106) in communication with said open end (108) and being provided with a quantity of edible granules (107) within said cavity (106);
- a vacuum application means (115), said vacuum application means (115) being provided with a receptacle (118) adapted for airtight communication with said first and second wall members (103, 112), and being further configured to evacuate the gas from said first wall member (103) and edible granules (107) through the at least two unattached regions of the flange (109), thereby creating a vacuum (119) within said cavity (106); and
- a sealing means (116), said sealing means (116) being configured so as to create a seal between said first and second wall members (103, 112) along said flange (109), thereby maintaining said vacuum (119) within said cavity 106).

11. The apparatus of Claim 10, characterized in that

a. the attachment means (200) attaches said second wall member (112) to said flange (109) over a plurality of regions of the flange (109), thereby dividing the flange (109)into a plurality of attached regions and a plurality of unattached regions; and

b. the vacuum application means (115) is configured to evacuate the gas from said first wall member (103) and edible granules (107) through the plurality of unattached regions of the flange (109).

12. The apparatus of Claim 11, characterized in that said attachment means (200) comprises a plurality of faces (202, 204, 206, 208) disposed perpendicular to and in radial symmetry about an axis (102) of said attachment means (100, 200), and which are configured to attach said second wall member (112) to said flange (109) of said first wall member (103) over a plurality of regions corresponding to said plurality of faces (202, 204, 206, 208).

13. The apparatus of any of Claims 10 to 12, characterized in that said vacuum-application means (115) and said sealing means (116) are disposed coaxially about a longitudinal axis (117), said vacuum-application means (115)being adapted to translate along said longitudinal axis (117) relative to said sealing means (116).

14. The apparatus of any of Claims 10 to 13, further comprising a means (101) for cutting said second wall member (112) to substantially match the outline of said flange (109) and open end (108) of said first wall member (103).

15. The apparatus of Claim 14, wherein said means (101) for cutting said second wall member (112) is disposed about said attachment means (100), said attachment means (100) and means (101) for cutting said second wall

member (112) being coaxial about a longitudinal axis (102), and said means (101) for cutting said second wall member (112) being adapted to translate along said longitudinal axis (102) relative to said attachment means (100).

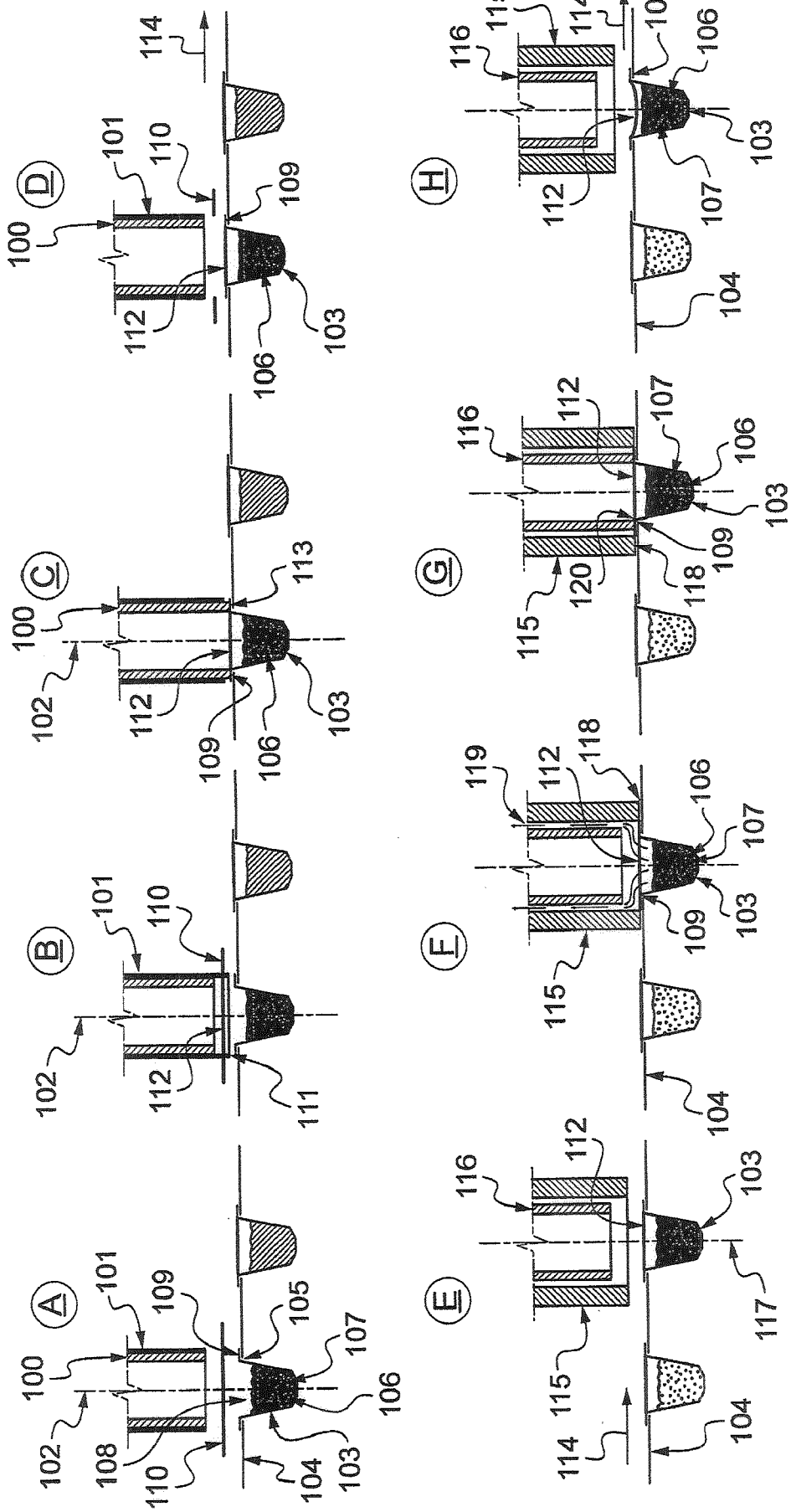
A
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Fig.1

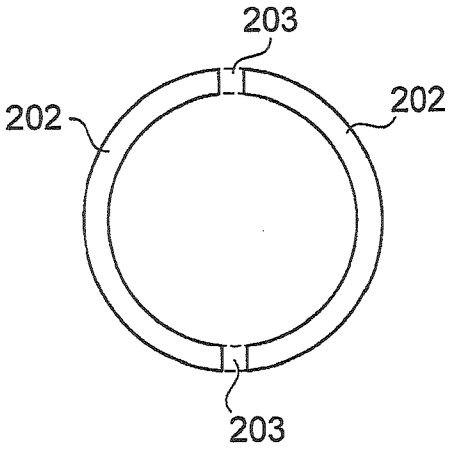

Fig.2A

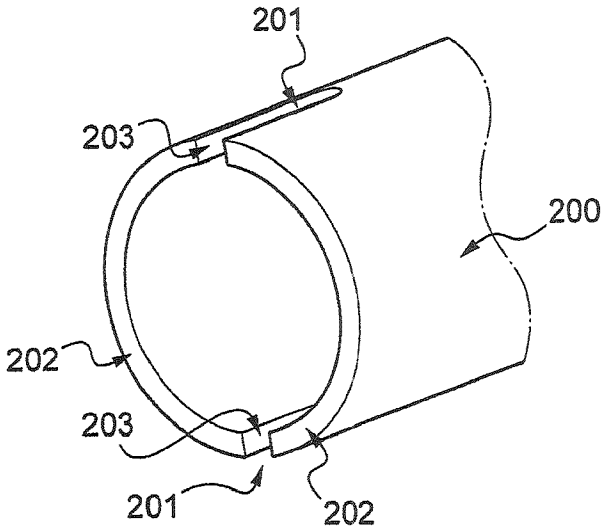

Fig.2B

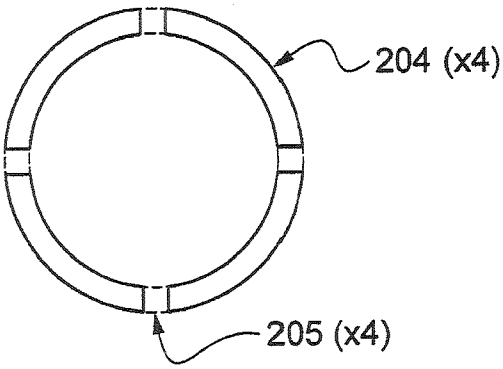

Fig.2C

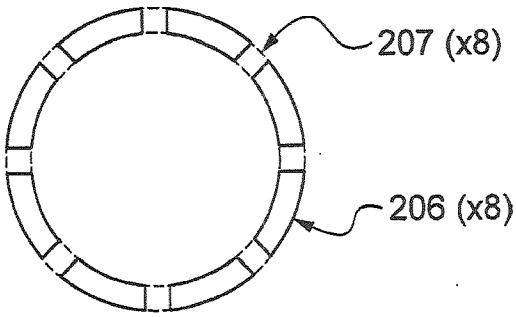

Fig.2D

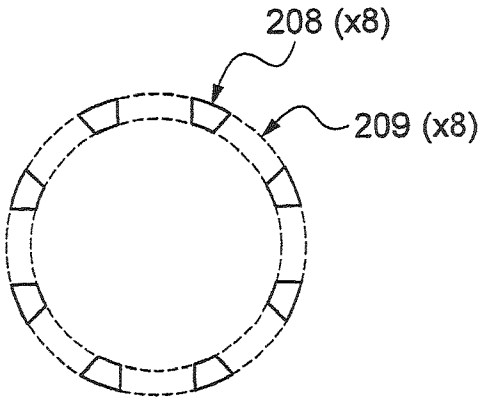

Fig.2E

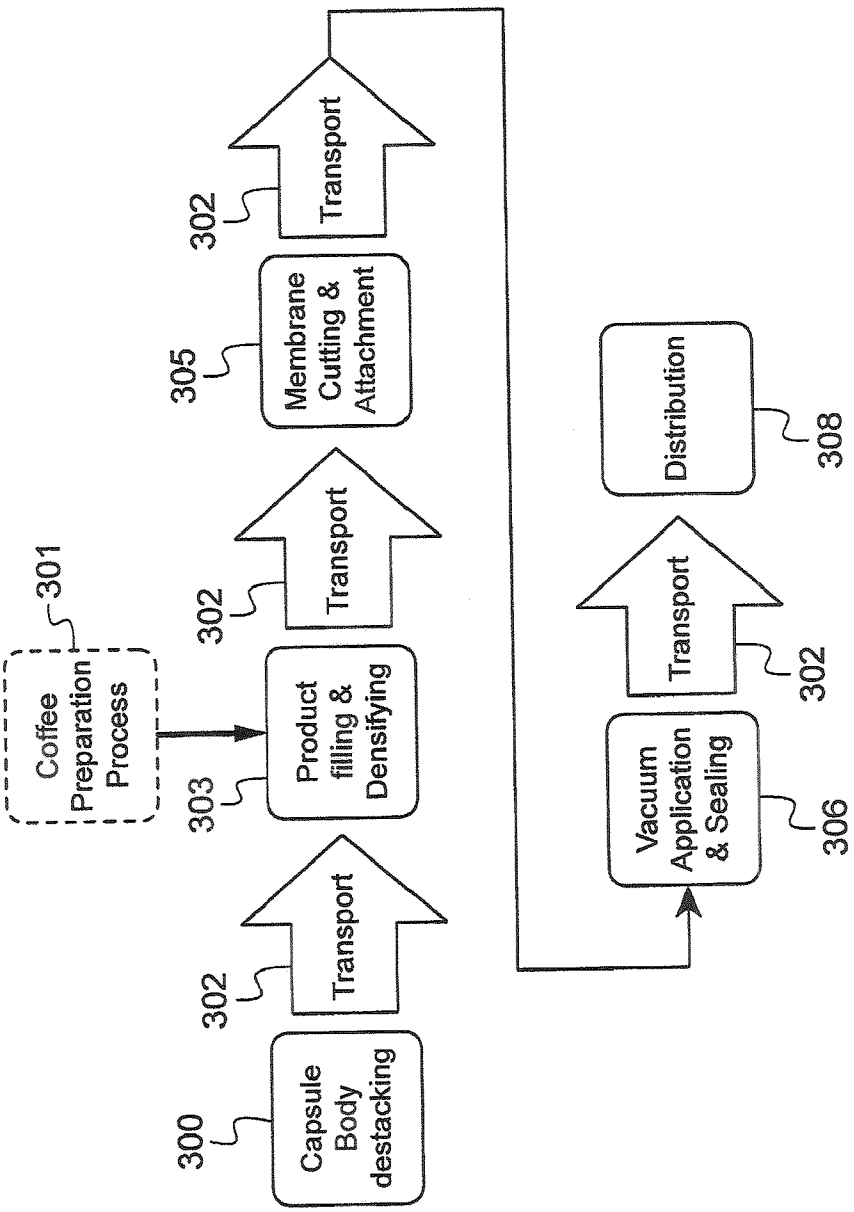
Capsule Body destacking
300
302
Transport
Coffee Preparation Process
301
303
Product filling & Densifying
302
Transport
Membrane Cutting & Attachment
305
302
Transport
Vacuum Application & Sealing
306
302
Transport
Distribution
308

Fig.3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/063174

A. CLASSIFICATION OF SUBJECT MATTER
INV. B65B7/16 B65B29/02 B65B31/02 B65D85/804
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B65B B65D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A		12

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 September 2013	19/09/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Rodriguez Gombau, F

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Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/063174

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	WO 2011/039711 A1 (IMA FLAVOUR S R L [IT]; CONTI ROBERTO [IT]) 7 April 2011 (2011-04-07) page 1, line 12 - line 14 page 3, line 31 - page 14, line 33 figures 1-12	1-15
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1

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