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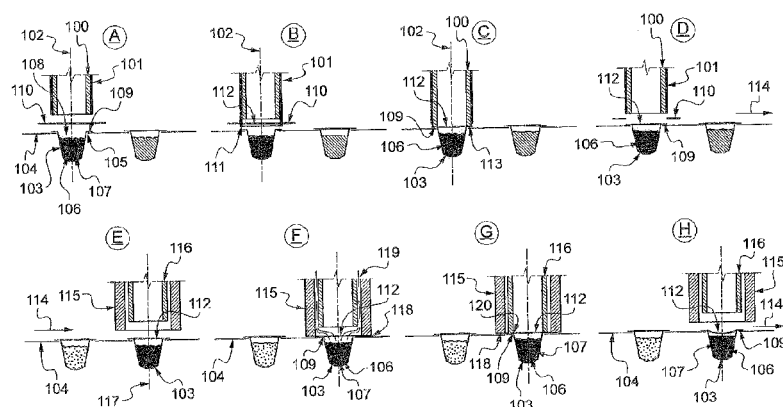


Fig.1

(57) Abstract: A method for packaging in a capsule a beverage powder tending to evolve a gas, said capsule comprising a capsule body (103) defining a cavity (106) containing a quantity of beverage powder, said cavity being hermetically sealed up comprises the following steps: - providing a quantity of said beverage powder evolving a gas within said cavity (106) of said capsule body (103); - applying a vacuum into said cavity (106) of the capsule body (103), so that the internal pressure in the cavity (106) is below atmospheric pressure; - sealing the capsule to hermetically close said cavity (106), while maintaining the internal pressure in the cavity (106), below atmospheric pressure; and - keeping said gas emanating into the cavity (106) of the capsule so that the internal pressure in the sealed-up capsule is above atmospheric pressure. Use for packaging in a capsule a ground coffee.

Method for packaging a beverage powder in a beverage capsule

Field of the Invention

This invention relates generally to a method for packaging a beverage
5 powder tending to evolve a gas in a beverage capsule. It also relates to a beverage capsule so produced. In particular, this invention relates to such capsules as adapted for coffee beverages.

Background

10 Coffee beans, before being used to prepare a coffee beverage, must generally be roasted. This process induces numerous chemical reactions and physical changes within the coffee beans, which must be accounted for when packaging the roasted coffee.

The roasting process is what produces the characteristic flavor of coffee
15 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. It is thus important to protect the roasted coffee from the surrounding air, to maintain
20 optimal freshness and shelf life. The roasting process also causes the production of gases within the coffee beans, primarily carbon dioxide and carbon monoxide. These gases are slowly evolved by the coffee subsequent to roasting in a process called "degassing." Grinding the roasted coffee beans will accelerate this process.

Recently, it has been common to base beverage production systems on
25 the principle of portioned beverages; that is, providing a pre-determined volume of a beverage upon demand. This has been typically accomplished by providing a capsule, which contains a pre-portioned amount of a beverage powder, most commonly ground coffee. Hot water is then introduced into the capsule to prepare the beverage, which is then dispensed into a container for consumption. Before
30 use, the capsule can be hermetically sealed under vacuum or controlled

atmosphere such as mentioned in WO8602537 to reduce oxidation by the contact of coffee with air. While this specification refers to a "capsule," it is understood those other terms, such as "pod," "cartridge," or "packet" may be employed instead.

Such capsules may be configured so as to be hermetically sealed up
5 until use. It is evident that by such hermetical sealing, it is meant that a gas transfer is not made possible in any direction between the inside of the capsule and the external atmosphere at least for many months. This is desirable, as the capsule will prevent the essential oils present in the coffee from degradation caused by contact with oxygen in the air. This improves the flavor and shelf life of the coffee
10 within such a capsule. It is also evident that due to its hermetical closure, the capsule is configured for a single use.

However, as described above, coffee will evolve gas after roasting. When the ground coffee is packaged in a sealed container, the container will trap any gases evolved by the coffee contained within, which in some cases may cause
15 the container to rupture under the pressure generated by the evolved gas. The container must be constructed more robustly, requiring more materials for its construction and increasing the cost of its fabrication.

To avoid this, the coffee is held aside for a period of time, allowing substantially all of the gases to be released from the coffee before it is packaged in
20 containers. This process is known in the art as "degassing." By degassing the coffee beforehand, one may avoid the evolution of gas within the sealed container and the accompanying accumulation of pressure.

However, the step of degassing beforehand coffee causes a loss of aromatic compounds. This aroma loss reduces the aroma intensity and modifies
25 the aromatic profile of the final beverage obtained from the extraction of the beverage capsule.

The degassing process is generally accomplished by the use of degassing silos or buffers, within which the coffee is stored while it degasses. The silos are generally provided with means for removing the evolved gases, and may
30 optionally be provided with means for introducing an inert gas. This inert gas,

generally nitrogen, excludes oxygen from the silos and prevents degradation of the coffee.

One must store the degassing coffee within these silos for as long as is necessary to evacuate a sufficient amount of gas. For ground coffee, the
5 degassing time is usually between 30 and 60 minutes for a partial degassing to 24 hours or more for a full degassing. However during degassing, a large part of volatiles aromas of the coffee are lost, diminishing the flavor and the aroma of the coffee beverage.

Of course, degassing of the coffee cannot be totally eliminated between
10 the grinding and the sealing of the capsule since the coffee must be transported from the grinding area to the filling and sealing areas. This "transport degassing" is dependent on the production line capacity.

WO2008129350 refers to a machine for packaging capsules in a vacuum and/or in a controlled atmosphere. After filling with coffee, the capsules
15 are partially closed by an hermetic film. Then, a vacuum is formed inside the capsules and sealed by a thermo-sealing vacuum device. Optionally, an inert gas can be inserted in the capsule after drawing a vacuum to fill the headspace of the capsule with a controlled atmosphere. This invention does not deal with a better preservation of the aroma of the packaged product. In particular, there is no
20 indication that the degassing of the product is minimized before the capsule is hermetically sealed and gas is kept emanating into the cavity.

In US3077409, the invention seeks to eliminate the holding (degassing) period for coffee before packing it. It so relates to a coffee package with a self-venting reclosure can. The coffee is immediately filled into the can, thus omitting
25 the conventional holding cycle. The filled can is then closed under vacuum. The can comprises a valve means permitting a portion of the gas within the container to pass. However, the problem of preserving aroma is not tackled since the evolving gas is allowed to escape out of the capsule.

US4069349 refers to a process for vacuum packaging of roasted ground
30 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 degassing of the product outside the pouch causes the loss of aromatic compounds.

5 WO2011039711 relates to a method and machine for packing infusion product into capsules; the machine comprising a series of station for manipulating, filling, sealing and overwrapping the capsules and all enclosed within a zone in controlled atmosphere (using nitrogen, for example) so as to preserve the chemical and physical qualities of the product, for example, aroma
10 in the coffee. However, there is no reduction of degassing of the product before sealing and overwrapping the capsule; no vacuum is drawn in the package before sealing and no degassing of the product is contemplated in the package to an extent above the atmospheric pressure. WO2010007633 refers to a machine for packaging products, in particular capsules for machines for
15 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.
20 Typically, the product must be degassed before closure of the capsule to prevent over-pressure due to the presence of the compensating gas. Such degassing causes the loss of volatile aromatic compounds.

Any discussion of the prior art throughout the specification should in no way be considered as an admission that such prior art is widely known or
25 forms part of common general knowledge in the field.

It is an object of the present invention to overcome or ameliorate at least one of the disadvantages of the prior art, or to provide a useful alternative.

It is an object of the preferred embodiments of the invention to provide a method for the packaging of a beverage powder tending to evolve a
30 gas in a capsule, in which the flavor and aroma of the beverage powder are better preserved.

According to a first aspect of the invention there is provided a method for packaging in a beverage capsule a beverage powder tending to evolve a gas, said capsule comprising a capsule body defining a cavity containing a quantity of beverage powder being a predetermined quantity of roast and ground coffee, said cavity being hermetically sealed up or respectively, the capsule being hermetically sealed up by an over-packaging, wherein said method comprises the following steps:

- grinding coffee beans to provide said beverage powder evolving a gas;

- providing a quantity of said beverage powder evolving a gas within said cavity of said capsule body;

- applying a vacuum into said cavity of the capsule body, or respectively, into said over-packaging containing the capsule, so that the internal pressure in the cavity, or respectively, in said over-packaging is below atmospheric pressure;

- sealing the capsule to hermetically close said cavity, or respectively, sealing the over-packaging to hermetically close the over-packaging surrounding the capsule while maintaining the internal pressure in the cavity, or respectively, in said over-packaging below atmospheric pressure;

and

- keeping said gas emanating into the hermetically closed cavity of the capsule so that the internal pressure in the sealed-up capsule, or respectively, in said over-packaging, is above atmospheric pressure,

wherein the duration of the degassing between grinding the coffee beans and sealing the cavity, or respectively, sealing the over-packaging is less than 20 minutes, and

wherein the pressure reduction below atmospheric pressure applied into the cavity, or respectively, into the over-packaging, in the step of applying a vacuum, is comprised between 100 and 800 mbar.

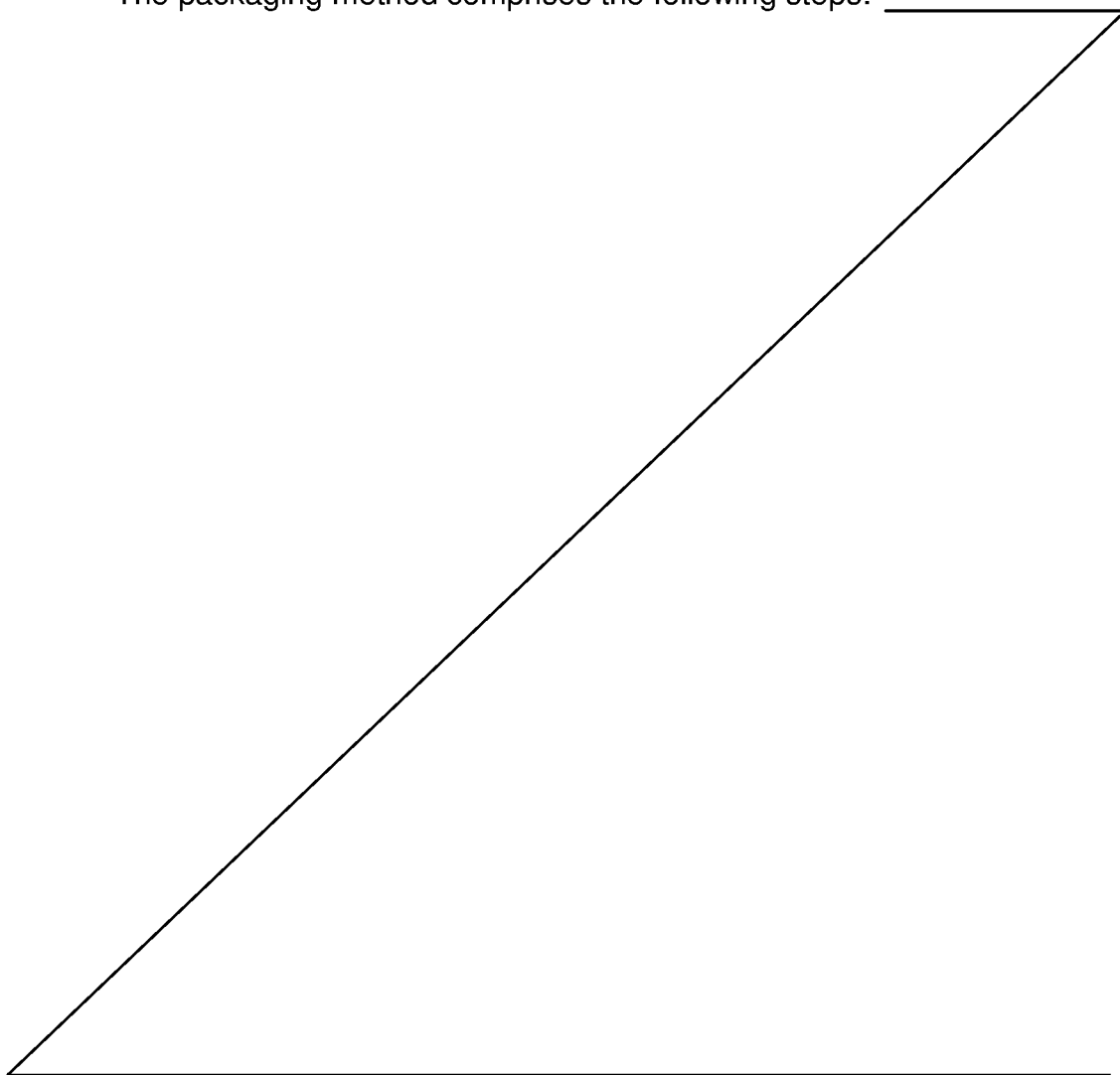
According to a second aspect of the invention there is provided a beverage capsule comprising a capsule body defining a cavity and being adapted to be hermetically sealed up with a quantity of beverage powder

provided within said cavity, fabricated by the method of packaging according to the invention.

5 Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise", "comprising", and the like are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense; that is to say, in the sense of "including, but not limited to".

10 According to an aspect, the invention is directed to a method for packaging in a capsule a beverage powder tending to evolve a gas, said capsule comprising a capsule body defining a cavity containing a quantity of beverage powder, said cavity being hermetically sealed up or respectively, the capsule being hermetically sealed up by an over-packaging.

The packaging method comprises the following steps:



- providing a quantity of said beverage powder evolving a gas within said cavity of said capsule body;

- applying a vacuum into said cavity of the capsule body or respectively, into said over-packaging containing the capsule, so that the internal pressure in the cavity, or respectively, in said over-packaging is below atmospheric pressure;

- sealing the capsule to hermetically close said cavity, or respectively, sealing the over-packaging to hermetically close the over-packaging surrounding the capsule while maintaining the internal pressure in the cavity, or respectively, in said over-packaging below atmospheric pressure; and

- keeping said gas emanating into the hermetically sealed cavity of the capsule so that the internal pressure in the sealed-up capsule, or respectively, in said over-packaging, is above atmospheric pressure.

This is advantageous in that it permits the packaging of a quantity of beverage powder in a capsule after a limited degassing, a further degassing of the coffee instead occurring within the sealed beverage capsule itself or respectively within the over-packaging sealing-up the capsule.

According to a principle of the invention, the vacuum created within the beverage capsule, or respectively within the over-packaging, before the capsule or respectively the over-packaging is sealed, compensates for the pressure generated by the gases evolved from the coffee. The accumulation of evolved gas is thus prevented from building to a pressure that might compromise the integrity of the capsule or respectively of the over-packaging.

Since the coffee is not significantly degassed before sealed into the beverage capsule, the volatile aroma and flavor compounds of the beverage produced therefrom are preserved and maintained in the capsule or respectively, in the over-packaging.

In a practical way, when the beverage powder is a ground coffee, the method comprises a step of grinding coffee beans before the step of sealing, the duration of a degassing step between grinding the coffee beans and sealing the cavity, or respectively, sealing the over-packaging is less than 25 minutes,

preferably less than 20 minutes, and most preferably comprised between 5 and 15 minutes.

Thus the degassing time is reduced, and in any event, is shorter than the duration requested in prior packaging method used to encapsulate ground
5 coffee in a hermetically close capsule.

According to a feature, the pressure reduction below atmospheric pressure applied into the cavity, or respectively, into the over-packaging, in the step of applying a vacuum, is comprised between 100 and 800 mbar, and preferably between 250 and 700 mbar, most preferably between 300 and 600
10 mbar.

These values are well adapted to compensate the increase of pressure in the capsule body due to the gas evolved by the beverage powder after sealing of the capsule body.

The atmospheric pressure is the value of the pressure at the location
15 where the step of applying a vacuum occurs.

After the keeping step, the internal pressure is comprised between 1050 mbar and 1800 mbar, preferably between 1050 and 1600 mbar, most preferably between 1050 and 1350 mbar.

The internal pressure is stabilized to a value comprised between 1050
20 mbar and 1800 mbar, preferably between 1050 and 1600 mbar, most preferably between 1050 and 1350 mbar, about 72 hours after said sealing step.

This internal pressure is acceptable in term of manufacturing a sealed-up capsule and is compatible with a 12 month shelf-life for the beverage capsules.

According to a second aspect, the invention concerns a beverage
25 capsule comprising a capsule body defining a cavity and being adapted to be hermetically sealed up with a quantity of beverage powder provided within said cavity, fabricated by the method of packaging as described above.

The beverage capsule so fabricated will embody the advantages of the method as detailed above.

According to an advantageous embodiment of the invention, the cavity is provided with a predetermined quantity of roast and ground coffee.

Preferably, the cavity is provided with a quantity of roast and ground coffee comprised between 4 and 16 grams, preferably between 5 and 13 grams. At the equilibrium (after full degassing), the cavity of the capsule has also preferably a volume between 8 to 30 ml, preferably 10 to 20 ml, most preferably 12-16 ml.

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 adapted to perform a method of packaging according to an embodiment of the invention;
- Figure 2 is a series of orthogonal views of attachment apparatuses in four different configurations;
- Figure 3 is a flowchart depicting an embodiment of the method of packaging as integrated into a process for the fabrication of beverage capsules; and
- Figure 4 is a schematic view of a method for packaging a capsule in a sealing over-packaging according to an alternative embodiment of the invention.

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
5 means 100 and the cutting means 101 are generally tubular and coaxial about the first longitudinal axis 102.

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
10 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.

15 The capsule body 103 defines a cavity 106, in which a predetermined quantity of roast and 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.

20 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 a gas-impermeable material such as aluminum, ethylene
25 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
30 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 one
5 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
10 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
15 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
20 gas barrier sub-layer is fabricated from 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
25 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
30 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 of the desired size and shape 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.

5 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
10 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
15 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
20 sealing step. The vacuum-application means 115 and the sealing means 116 are preferably tubular and disposed coaxially about the second longitudinal axis 117. 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
25 means 116, making the apparatus more compact and space-efficient.

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
30 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 gas within the cavity 106 of the capsule body 103 is 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, CO₂ or a combination thereof. In this way, the cavity 106 of the capsule body 107 is voided of gas without also sucking any of the coffee powder 107 from the cavity 106. In this way, the aspiration of the coffee powder into the apparatus or its entrainment between the flange 109 and membrane 112 is avoided.

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 prevent 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.

5 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
10 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 advanced into
15 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 hermetically sealing the membrane 112 to the capsule body 103. While the
20 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.

25 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
30 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.

5 Immediately after the completion of the vacuum-sealing step, the membrane 112 will be deflected inwardly into the capsule body 103, a result of the vacuum within the beverage capsule and exposure to the atmospheric pressure.

 As a result of chemical processes triggered by the roasting process, the coffee powder 107 within the beverage capsule degasses, the gases which are
10 evolved are kept within the cavity 106 of the beverage capsule by the membrane 112, the capsule body 103, and the hermetic seal between the two. 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
15 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,
20 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.

25 In a preferred embodiment, the pressure reduction below atmospheric pressure is comprised between 100 and 800 mbar, preferably 250 to 700 mbar and more preferably between 300 and 600 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
30 pressure of the beverage capsule to rise above atmospheric pressure in

approximately 5 hours. The internal pressure of the beverage capsule will preferably reach equilibrium between 1050 and 1800 mbar, preferably between 1050 and 1600 mbar, and most preferably between 1050 and 1350 mbar, in approximately 72 hours after the sealing of the capsule.

5 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
10 pressure in less than 5 hours and stabilize in approximately 72 hours.

 Figure 2 is a series of orthogonal views depicting a series of 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
15 corresponding to said faces.

 Figure 2A depicts an attachment means provided with two faces 200 of a first kind. The faces 200 of a first kind are separated by two channels 201 of a first kind. 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
20 the portion of the surface of the flange corresponding to the faces 200 of a first kind, while remaining unattached and permitting fluid communication between the cavity of the capsule body and the surrounding atmosphere. Upon the application of a vacuum, the air in the capsule body will flow out through the unattached regions between the membrane and flange defined by the channels 201 of a first
25 kind.

 Figure 2B depicts an attachment means provided with four faces 202 of a second kind, separated by four channels 203 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 202 of a second kind,

while leaving the regions of the membrane corresponding to the four channels 203 of a second kind unattached.

Figure 2C depicts an attachment means provided with eight faces 204 of a third kind, separated by eight channels 205 of a third kind. As above, the faces 204 of a third kind will define the region over which a membrane is attached to the flange of a capsule body, and the channels 205 of a third kind defining where it is unattached.

Figure 2D depicts an attachment means provided with eight faces 206 of a fourth kind, separated by eight channels 207 of a fourth kind. Compared to the attachment means depicted in Figure 2C, the faces 206 of a fourth kind are much smaller than the faces 204 of a third kind, while the channels 207 of a fourth kind are much larger than the channels 205 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 2D is much lower than would be achieved by the attachment device of Figure 2C, 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 the method of packaging as integrated into 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 an embodiment, the duration between the grinding of the coffee and the sealing of the capsule is less than ten minutes.

By limiting degassing before sealing, the aroma and flavor in the capsule are best preserved. After several days, equilibrium is reached between the emanated gases and the retained gases in the coffee. This equilibrium depends on the ratio of the coffee weight to the total volume in the capsule, the pressure reduction applied during the vacuum step and the resistance of the capsule to the equilibrium pressure.

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.

5 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
10 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
15 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 air from within through the plurality of unsealed regions of the flange. The membrane is then sealed over the entirety of the surface of the flange,
20 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
25 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.

Figure 4 depicts a method for packaging a capsule 400 containing
30 beverage powder tending to evolve a gas, in an over-packaging. The method

comprises providing a quantity of beverage powder capable of evolving a gas within a cavity 406 of a capsule body 403. The capsule body 403 is substantially cup-shaped and is provided with an open end 408 communicating with said cavity and a bottom end 401. The bottom end may be apertured. For example, a plurality
5 of small apertures can be present in the wall of the bottom end 401 to facilitate (without need for a puncturing member) the feeding of water and/or discharge of beverage during extraction. The apertures are small enough to allow liquid transfer but maintain powder in the cavity.

The capsule 400 may further comprise a flange 409 onto which is
10 sealed a lid such as a flexible membrane 412 (Step II). The membrane material is preferably provided in the form of a continuous sheet or web. In an alternative, the lid can be a rigid or semi-rigid wall member connected to the flange by welding, e.g., heat or ultrasonic welding, and/or press-fitting in the cavity. The lid may be formed of a material hermetical to gas and sealed hermetically on the flange.
15 However, it may also be non-hermetic to gas and liquid. For example, the lid may be apertured. A plurality of small apertures can be present in the lid to facilitate (without need for a puncturing member) the feeding of water and/or discharge of beverage during extraction. The apertures are small enough to allow liquid transfer but maintain powder in the cavity.

20 In this embodiment, the capsule 400 is sealed in an over-packaging 500 (Step III). The over-packaging may be a flexible or rigid package. For example, it can be a flow wrap package sealed onto a seam 501. A vacuum is drawn before and during sealing of the over-packaging in the interior of the over-packaging. Since the capsule 400 is permeable to gas, a vacuum is formed in the cavity as
25 well. A pressure equilibrium is rapidly obtained so that the pressure in the cavity is the same as the pressure between the capsule 400 and the over-packaging 500.

As in the previous embodiment, the gases generated within the coffee beans during roasting are evolved from the coffee. Some degassing will occur between the roasting and the sealing of the over-packaging. It is preferably,
30 however, to configure the process for fabrication of the packed beverage capsule

to minimize degassing before sealing, so that the degassing essentially occurs after the beverage capsule has been sealed in the over-packaging (Step IV). As a result of the gas emanating in the capsule and traversing the capsule, the pressure in the over-packaging becomes above the atmospheric pressure. In this way the flavor of the coffee is most effectively preserved. The over-packaging is essentially impermeable to gas so that the evolved gases after sealing is maintained in the over-packaging. After several days, equilibrium is reached between the emanated gases and the retained gases in the coffee. This equilibrium depends on the ratio of the coffee weight to the total volume in the over-packaging, the pressure reduction applied during the vacuum step and the resistance of the over-packaging to the equilibrium pressure.

In the context as described in the above description, the hermetical closure to the gases refers to the ability of the package, that is the capsule itself or the over-packaging, to maintain an internal pressure above 1050 mbar for a period of at least one week.

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, or shreds and any combinations 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.

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
5 claims that stem at least in part from it.

CLAIMS

1. A method for packaging in a beverage capsule a beverage powder tending to evolve a gas, said capsule comprising a capsule body
5 defining a cavity containing a quantity of beverage powder being a predetermined quantity of roast and ground coffee, said cavity being hermetically sealed up or respectively, the capsule being hermetically sealed up by an over-packaging, wherein said method comprises the following steps:
- 10 - grinding coffee beans to provide said beverage powder evolving a gas;
 - providing a quantity of said beverage powder evolving a gas within said cavity of said capsule body;
 - applying a vacuum into said cavity of the capsule body, or respectively, into said over-packaging containing the capsule, so that the
15 internal pressure in the cavity, or respectively, in said over-packaging is below atmospheric pressure;
 - sealing the capsule to hermetically close said cavity, or respectively, sealing the over-packaging to hermetically close the over-packaging surrounding the capsule while maintaining the internal pressure in
20 the cavity, or respectively, in said over-packaging below atmospheric pressure; and
 - keeping said gas emanating into the hermetically closed cavity of the capsule so that the internal pressure in the sealed-up capsule, or respectively, in said over-packaging, is above atmospheric pressure,
 - 25 wherein the duration of the degassing between grinding the coffee beans and sealing the cavity, or respectively, sealing the over-packaging is less than 20 minutes, and
 - wherein the pressure reduction below atmospheric pressure applied into the cavity, or respectively, into the over-packaging, in the step of applying a
30 vacuum, is comprised between 100 and 800 mbar.

2. A method according to claim 1, wherein the duration of the degassing between grinding the coffee beans and sealing the cavity, or respectively, sealing the over-packaging is between 5 and 15 minutes.

5 3. A method according to claim 1 or claim 2, wherein the pressure reduction below atmospheric pressure applied into the cavity, or respectively, into the over-packaging, in the step of applying a vacuum, is comprised between 250 and 700 mbar.

10 4. A method according to any one of claims 1 to 3, wherein the pressure reduction below atmospheric pressure applied into the cavity, or respectively, into the over-packaging, in the step of applying a vacuum, is comprised between 300 and 600 mbar.

15 5. A method according to any one of claims 1 to 4, wherein after said keeping step, the internal pressure is comprised between 1050 mbar and 1800 mbar.

20 6. A method according to claim 5, wherein after said keeping step, the internal pressure is comprised between 1050 and 1600 mbar.

 7. A method according to claim 5 or claim 6, wherein after said keeping step, the internal pressure is comprised between 1050 and 1350 mbar.

25 8. A method according to any one of claims 5-7, wherein said internal pressure is stabilized to a value comprised between 1050 mbar and 1800 mbar about 72 hours after said sealing step.

30 9. A method according to claim 8, wherein said internal pressure is stabilized to a value comprised between 1050 and 1600 mbar about 72 hours after said sealing step.

10. A method according to claim 8 or claim 9, wherein said internal pressure is stabilized to a value comprised between 1050 and 1350 mbar about 72 hours after said sealing step.

5

11. A method according to any one of claims 1 to 10, wherein the capsule is sealed hermetically by sealing a membrane onto the capsule body.

10

12. A method according to claim 11, wherein the membrane is sealed onto a flange of the capsule body by heat welding or ultrasonic sealing.

15

13. A method according to any one of claims 1 to 10, wherein the capsule is gas permeable and is contained within said hermetically sealed over-packaging.

20

14. A beverage capsule comprising a capsule body defining a cavity and being adapted to be hermetically sealed up with a quantity of beverage powder provided within said cavity, fabricated by the method of packaging according to any one of claims 1 to 12.

15. A beverage capsule according to Claim 14, wherein said cavity is provided with a predetermined quantity of roast and ground coffee.

25

16. A beverage capsule according to Claim 15, wherein said cavity is provided with a quantity of roast and ground coffee comprised between 4 and 16 grams.

17. A beverage capsule according to Claim 16, wherein said cavity is provided with a quantity of roast and ground coffee comprised between 5 and 13 grams.

5 18. A beverage capsule according to any one of claims 15-17, wherein at the equilibrium after full degassing, said cavity has a volume between 8 to 30 ml.

10 19. A beverage capsule according to claim 18, wherein at the equilibrium after full degassing, said cavity has a volume between 10 to 20 ml.

20. A beverage capsule according to claim 18, wherein at the equilibrium after full degassing, said cavity has a volume between 12-16 ml.

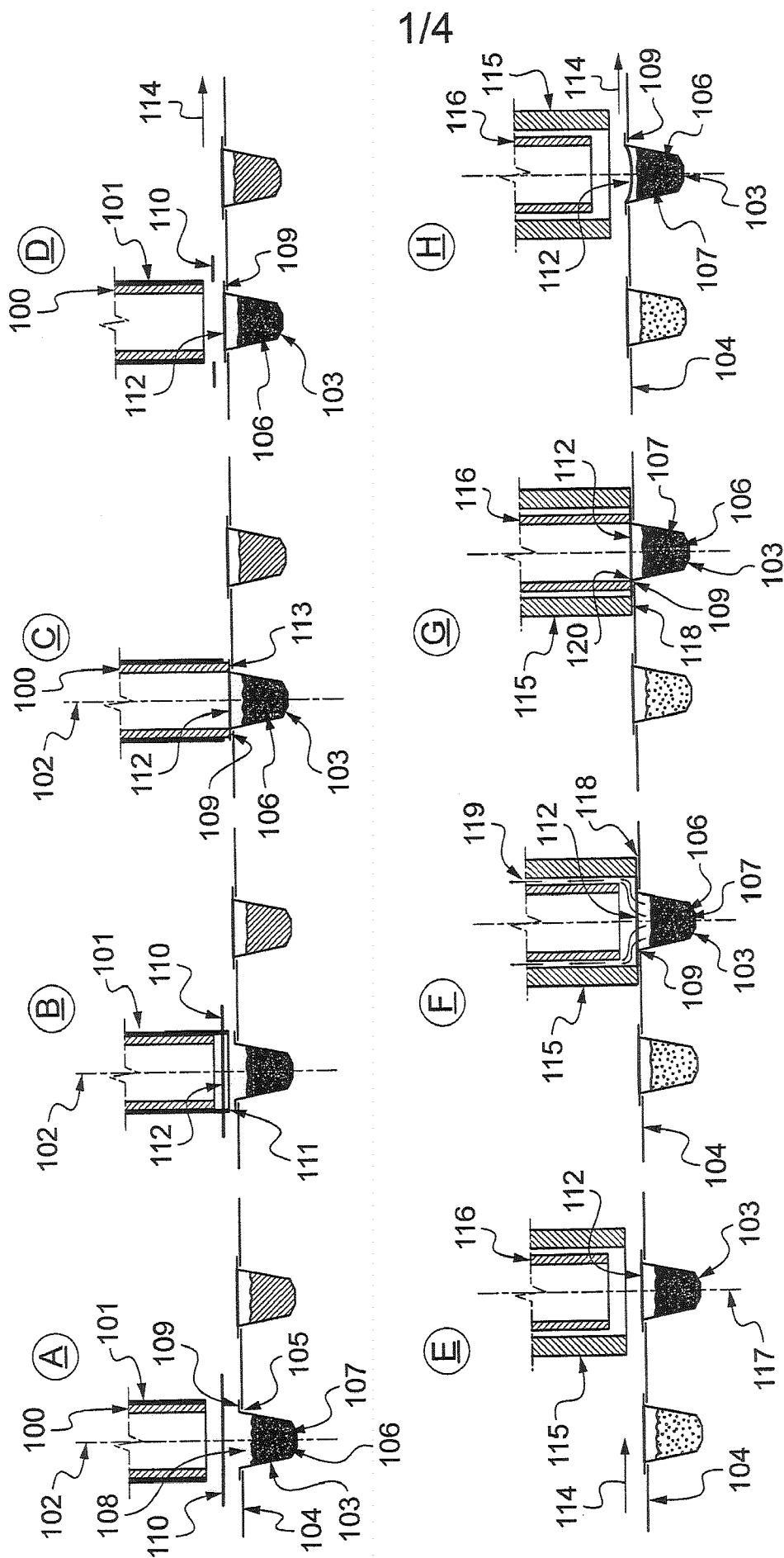


Fig.1

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Fig.2A

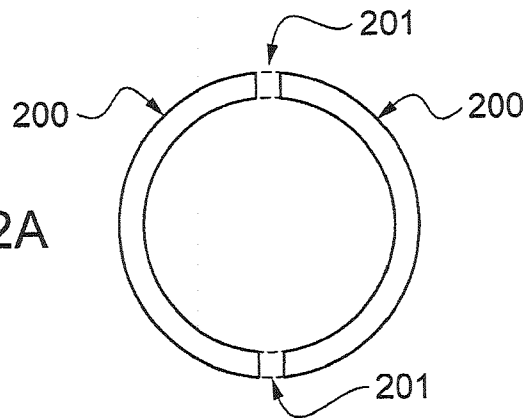


Fig.2B

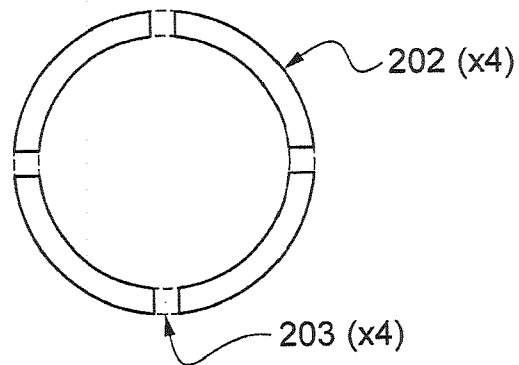


Fig.2C

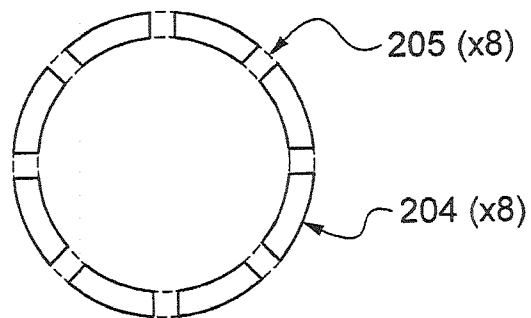
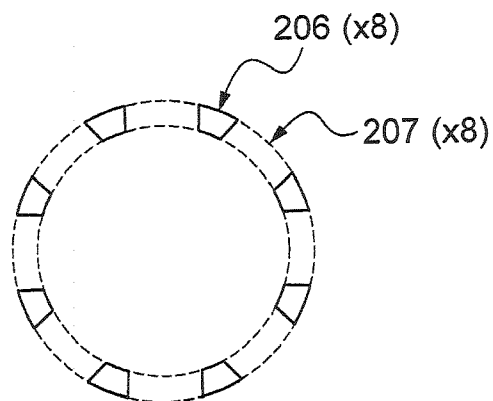


Fig.2D



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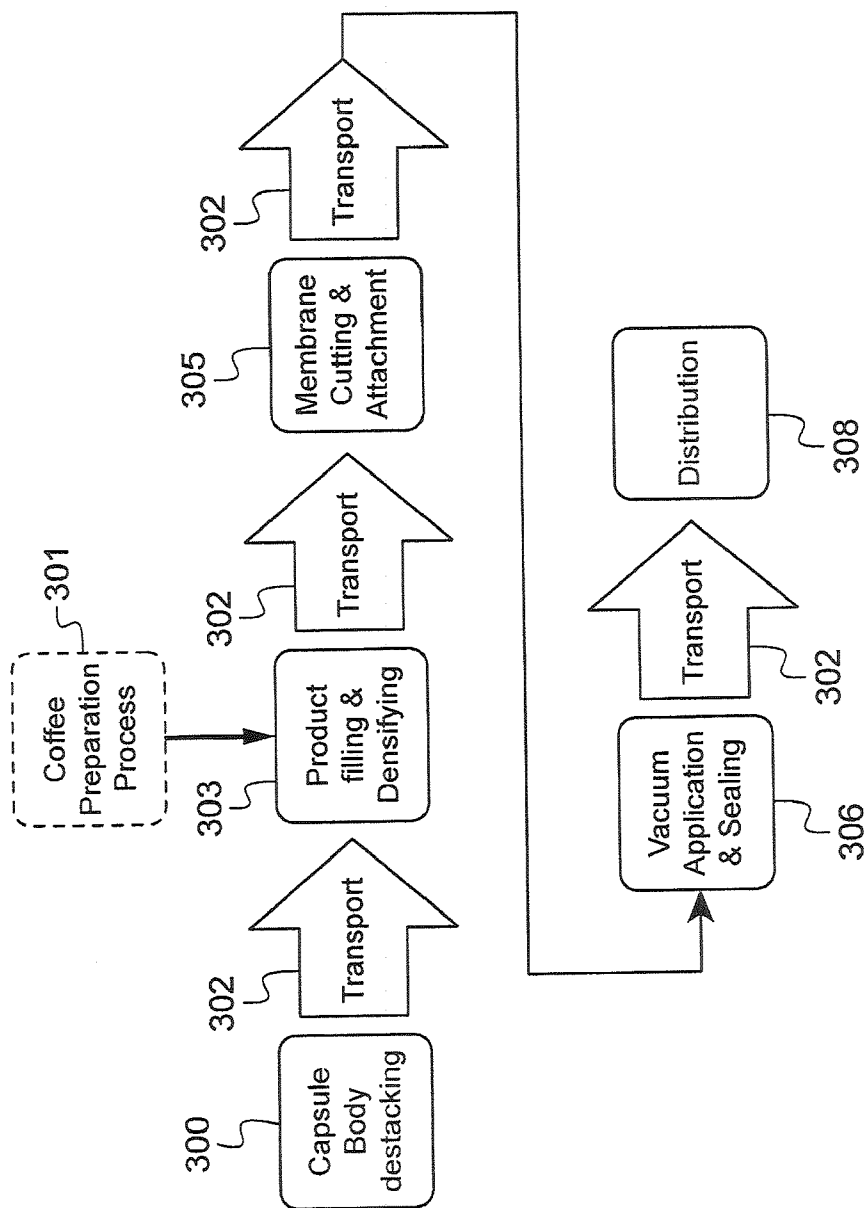


Fig.3

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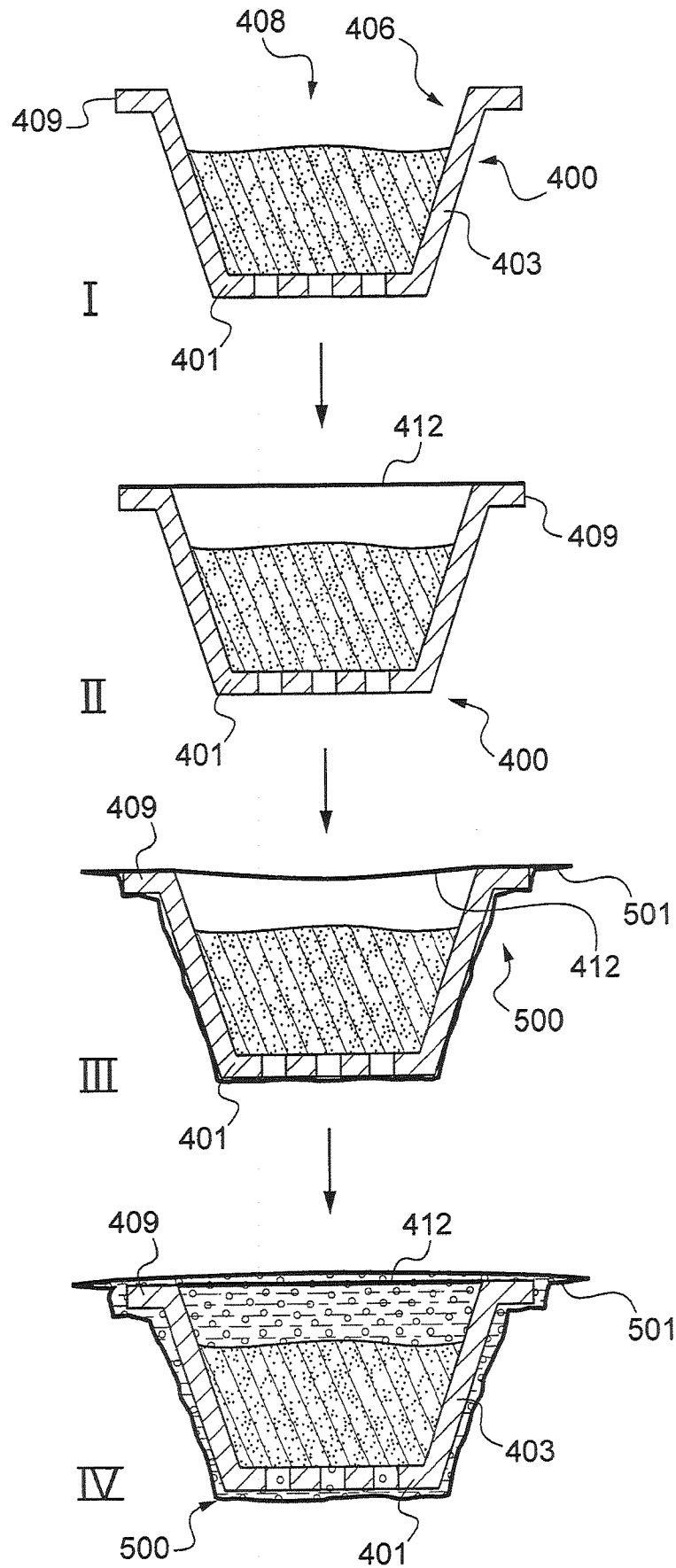


Fig. 4