(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
13 August 2015 (13.08.2015)

WIPO | PCT

(10) International Publication Number
WO 2015/117892 A1

(51) International Patent Classification:
B65D 85/804 (2006.01)

(21) International Application Number:
PCT/EP2015/051852

(22) International Filing Date:
29 January 2015 (29.01.2015)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
14154083.1 6 February 2014 (06.02.2014) EP

(71) Applicant: **NESTEC S.A.** [CH/CH]; CT-IAM, Av. Nestlé 55, CH-1800 Vevey (CH).

(72) Inventors: **HEYDEL, Christophe Sébastien Paul**; Rue Foulaz 26, CH-2025 Chez Le Bart (CH). **YOAKIM, Alfred**; Ch. de la Routiaz 2, CH-1806 St-legier-la Chiesaz (CH). **TALON, Christian**; Chemin des Vignes 22C, CH-1134 Vufflens-le-Château (CH).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

(54) Title: A CAPSULE FOR IMPROVED BEVERAGE QUALITY

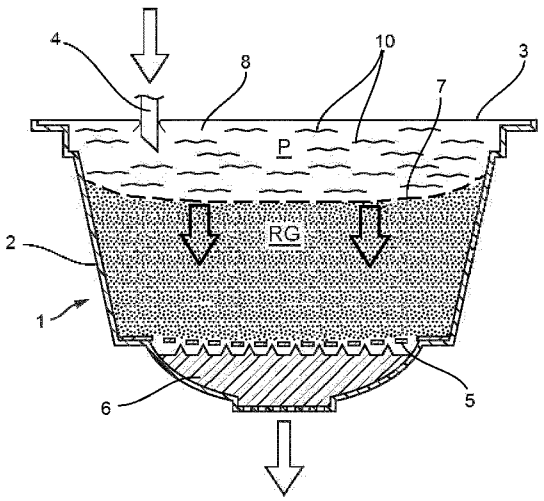

FIG. 5

(57) Abstract: The present invention is directed to a capsule (1) for use in a beverage preparation machine, said capsule comprising : (i) lateral walls (2), a pierceable injection wall (3) adapted to be pierced by fluid injection means (4) of the machine, and a dispensing wall (5) adapted to dispense said beverage, that delimit a closed internal volume, (ii) a flexible fluid distributor wall (7), that is located inside the closed volume of the capsule, at a distance below the pierceable wall (3) so as to separate: - a headspace compartment (8) between the pierceable wall (3) and said fluid distributor wall (7) which is able to accommodate the injection means during injection of the fluid, and - an ingredient compartment (9) located between said fluid distributor wall (7) and said dispensing wall (5), containing a bed of non-soluble beverage ingredient particles, characterized in that the headspace compartment (8) contains a superabsorbent polymer (10) able to absorb a quantity of the injected fluid, and swell so as to fill the headspace compartment (8) and exert a pressure force onto the surface of the fluid distributor wall (7) to prevent substantial movement of ingredient particles while said fluid traverses said ingredient.

WO 2015/117892 A1

A CAPSULE FOR IMPROVED BEVERAGE QUALITY

Field of the invention

The present invention concerns a capsule for use in a beverage preparation machine, that is adapted for being pierced by a water injector of said machine, said water being mixed under pressure with a non-soluble particle ingredient contained in said capsule.

Background of the invention

Beverage preparation machines are well known in the food science and consumer goods area. Such machines allow a consumer to prepare at home a given type of beverage, for instance a coffee-based beverage, e.g. an espresso or a brew-like coffee cup.

Today, most beverage preparation machines for in-home beverage preparation comprise a system made of a machine which can accommodate portioned ingredients for the preparation of the beverage. Such portions can be soft pods or pads, or sachets, but more and more systems use semi-rigid or rigid portions such as rigid pods or capsules. In the following, it will be considered that the beverage machine of the invention is a beverage preparation machine working with a rigid capsule.

The machine comprises a receptacle for accommodating said capsule and a fluid injection system for injecting a fluid, preferably water, under pressure into said capsule. Water injected under pressure in the capsule, for the preparation of a coffee beverage according to the present invention, is preferably hot, that is to say at a temperature above 70°C. However, in some particular instances, it might also be at ambient temperature. The pressure inside the capsule chamber during extraction and/or dissolution of the capsule contents is typically about 1 to 8 bar for dissolution products, 2 to 12 bar for extraction of roast and ground coffee. Such a preparation process differs a lot from the so-called "brewing" process of beverage preparation – particularly for tea and coffee, in that brewing involves a long time of infusion of the ingredient by a fluid (e.g. hot water), whereas the beverage preparation process allows a consumer to prepare a beverage, for instance coffee within a few seconds.

The principle of extracting and/or dissolving the contents of a closed capsule under pressure is known and consists typically of confining the capsule in a receptacle of a machine, injecting a quantity of pressurized water into the capsule, generally after piercing a face of the capsule with a piercing injection element such as a fluid injection needle mounted on the machine, so as to create a

pressurized environment inside the capsule either to extract the substance or dissolve it, and then release the extracted substance or the dissolved substance through the capsule. Capsules allowing the application of this principle have already been described for example in applicant's European patent **EP 1472156 B1**, and in **EP 1784344 B1**.

Machines allowing the application of this principle have already been described for example in patents **CH 605 293** and **EP 242 556**. According to these documents, the machine comprises a receptacle for the capsule and a perforation and injection element made in the form of a hollow needle comprising in its distal region one or more liquid injection orifices. The needle has a dual function in that it opens the top portion of the capsule on the one hand, and that it forms the water inlet channel into the capsule on the other hand.

The machine further comprises a fluid tank – in most cases this fluid is water – for storing the fluid that is used to dissolve and/or infuse and/or extract under pressure the ingredient(s) contained in the capsule. The machine comprises a heating element such as a boiler or a heat exchanger, which is able to warm up the water used therein to working temperatures (classically temperatures up to 80-90°C). Finally, the machine comprises a pump element for circulating the water from the tank to the capsule, optionally though the heating element. The way the water circulates within the machine is selected via a selecting valve means, such as for instance a peristaltic valve of the type described in applicant's European patent publication **EP 2162653**.

When the beverage to be prepared is coffee, one interesting way to prepare the said coffee is to provide the consumer with a capsule containing roast and ground coffee powder, which is to be extracted with hot water injected therein. Hot water circulates through the bed of coffee powder and extracts coffee substances to prepare a coffee beverage.

Capsules have been developed for such an application, which are described and claimed in applicant's European patent **EP 1784344 B1**, or in European patent publication **EP 2062831**.

In short, such capsules comprise:

- a hollow body and an injection wall which is impermeable to liquids and to air and which is attached to the body and adapted to be punctured by e.g. an injection needle of the machine,

- a chamber containing a bed of roast and ground coffee to be extracted,

- an membrane (e.g. aluminium) disposed at the bottom end of the capsule, closing the said capsule, for retaining the internal pressure in the chamber, the said membrane being associated with piercing means for piercing dispensing holes in the said aluminum membrane when said internal pressure inside the chamber reaches a certain pre-determined value, the opening principle being described in Applicant's patent **EP 1472156 B1**,

- a perforated wall configured to break the jet of fluid entering the capsule so as to reduce its speed, and distribute the fluid across the bed of substance at a reduced velocity ; such a distributing and jet-breaking wall separates the fluid injection space of the capsule from the ingredient-containing chamber ; such a distributing wall is described in applicant's European patent **EP 1784344 B1**.

An example of such capsules of the prior art are more precisely illustrated in **figure 1**, which feature a pierceable injection membrane wall "PM" which is sealed on top edges of a substantially cylindrical body. The injection membrane (which is generally on the top of the capsule when the latter is in a functional position) is pierceable by the fluid injection needle of a beverage preparation machine. The tip of the injection needle is represented in **Figure 1**, with an arrow directed upside-down to illustrate the piercing movement of said needle through the pierceable wall "PM" of the capsule.

When liquid – it will be considered in the following that it is hot water – is injected in the capsule compartment as illustrated in **figure 2**, a pressure "P" is built up, which serves as an extraction means for extracting ingredients contained inside the capsule, as described above.

The capsule internal volume is divided into two compartments, as illustrated in **figure 1**. Both compartments are separated by a perforated water distributor wall, which serves to distribute the flow of water in an even manner across the bed of coffee powder and also to break the speed of the powerful jet of water which comes out of the injection needle. The distributor wall is preferably a plastic film sealed onto the internal surface of the capsule lateral walls, which is pierced with a plurality of small holes evenly distributed across its surface, as shown in **figures 1** and **2**.

Under the distributor film is the roast and ground coffee ingredient, referenced "RG" in **figure 1**, which rests onto a bottom pierceable delivery membrane "DM". The bottom membrane of the capsule is also sealed onto the internal surface of the capsule walls, and is pierceable by piercing means located below and arranged such that said bottom membrane will be pierced when fluid pressure increases, as illustrated in **figure 2** (pierced bottom membrane in dotted lines). The bottom membrane and the bottom piercing means form the beverage delivery wall of the capsule.

Above the distributor film is an empty space which serves as a headspace to arrange the tip of the injection needle during the preparation of a beverage, as illustrated in **figure 2**.

After a capsule is functionally inserted inside the machine, i.e. the capsule is in place within the machine brewing cavity, and the latter is closed so that the injection needle has pierced the pierceable membrane "PM" of the capsule and protrudes therein as shown in **figure 1**, the consumer can start a beverage preparation.

When a brewing cycle starts, water – or an equivalent mixing fluid – is injected under pressure inside the capsule through the injection needle, for extracting the coffee ingredient.

At this point of the beverage system functioning, a technical problem was found with prior art capsules, as described hereafter.

Although the bed of roast and ground coffee powder is held between the bottom membrane "BM" and the distributor film "DF", as shown in **figure 2**, it was found that water circulating through the capsule moves the particles of the powdered ingredient (in the following it will be considered as a preferred example that the ingredient comprises particles of roast and ground coffee powder), which creates channels "CH" where hot water flows preferentially, hence bypassing the normal homogeneous flowpath that should take place evenly through the bed of coffee. Due to the movement of roast and ground coffee particles, zones of higher density "HD" of coffee particles delimit the channels, as shown also in **figure 2**.

This results in poorer coffee strength and organoleptic properties, because for a given volume of hot water that is circulated through the coffee ingredient, only a fraction of the coffee substances is extracted. Therefore, it is necessary to increase the volume of coffee ingredient inside the capsule in order to obtain a given volume of good coffee in the cup. Furthermore, channelling limits greatly the quality and quantity of crema (in the case the prepared beverage is coffee), i.e. the creamy foam that is supposed to form at the top of the beverage in the cup, especially on short cups of quality coffee like espressos.

The undesirable phenomenon of "channelling" created through a roast and ground coffee bed, was also found in all capsules through which high pressure of water circulates (typically between 1 and 40 bar relative pressure of water inside the capsule), and where water in injected through a beverage preparation ingredient , as represented in the example of **figures 1** and **2**.

It is therefore an objective of the present invention to provide a capsule for preparing beverages by circulation of a pressurized fluid through a non-soluble powder ingredient contained therein, and adapted to be pierced by a water injection needle as described above, which resolves the problem of channelling.

Summary of the invention

According to the invention, the objective set out above is met with a capsule for use in a beverage preparation machine, said capsule comprising :

(i) lateral walls, a pierceable injection wall adapted to be pierced by fluid injection means of the machine, and a dispensing wall adapted to dispense said beverage, that delimit a closed internal volume,

(ii) a flexible fluid distributor wall, that is located inside the closed volume of the capsule, at a distance below the pierceable wall so as to separate:

- a headspace compartment between the pierceable wall and said fluid distributor wall which is able to accommodate the injection means during injection of the fluid, and
- an ingredient compartment located between said fluid distributor wall and said dispensing wall, containing a bed of non-soluble beverage ingredient particles,

characterized in that the headspace compartment contains a superabsorbent polymer able to absorb a quantity of the injected fluid, and swell so as to fill the headspace compartment and exert a pressure force onto the surface of the fluid distributor wall to prevent substantial movement of ingredient particles while said fluid traverses said ingredient.

The fluid injection means is preferably a hollow needle having one outlet for producing a jet of fluid. The needle is preferably made of stainless steel.

In a highly preferred embodiment of the invention, the fluid that is injected by the machine within the capsule, for extracting ingredient substances is water, preferably hot water having a temperature comprised between 65°C and 90°C.

Advantageously, a suitable superabsorbent polymer (SAP) suitable for application in the invention is a food-grade sodium polyacrylate or a potassium polyacrylate.

Furthermore, the superabsorbent polymer preferably comprises particles made of:

- a low cross-linked superabsorbent particle core, which provides fast absorption, and
- a high cross-linked superabsorbent coating, which provides good fluid retention properties.

In a preferred embodiment of the invention, the mass of dry superabsorbent polymer in the capsule is comprised between 0.01g and 50g, preferably between 0.01g and 20g, more preferably between 0.1g and 10g. Such a quantity of superabsorbent polymer within the capsule is sufficient to absorb fluid and expand to a volume superior to the volume of the headspace compartment, given that a suitable superabsorbent for working the invention should swell by absorption of 5 to 1000 times, preferably between 10 and 200 times, its dry volume of water.

In a highly preferred embodiment of the invention, the beverage ingredient contained in the capsule comprises roast and ground coffee powder. However, other types of beverage precursor ingredients could be contained therein, as long as they take the form of non-soluble powder particles from which beverage-forming substances are extracted by circulation of fluid under pressure.

Preferably, the working fluid pressure that circulates within the capsule for beverage preparation is comprised between 1 and 20 bar, preferably between 2 and 15 bar (relative pressure vs. atmospheric pressure).

Brief description of the drawings

Additional features and advantages of the present invention are described in, and will be apparent from, the description of the presently preferred embodiments which are set out below with reference to the drawings in which:

Figure 1 is a schematic profile cut view of a capsule according to the prior art that is functionally inserted within the beverage preparation machine, before injection of fluid therein;

Figure 2 is a view similar to figure 1, during circulation of fluid under pressure within the capsule;

Figure 3 is a schematic profile cut view of a capsule according to the invention, before use;

Figure 4 is a view similar to figure 3, when the capsule is functionally inserted within the beverage preparation machine, and injection fluid inside the capsule starts;

Figure 5 is a view similar to figure 4, during beverage preparation when fluid circulates through the capsule;

Figure 6 is a view similar to figure 4, after beverage preparation is complete, when the machine injection needle is withdrawn from the capsule.

Detailed description of the invention

A capsule 1 according to the invention is illustrated in **figure 3**. This capsule is designed for use in a beverage preparation machine (not illustrated in the drawing) that comprises a machine reservoir for water, a heating element

for heating the water to a temperature suitable for beverage preparation within the capsule (i.e. about 85°C for coffee prepared by extraction under pressure through roast and ground coffee), a fluid circulation system including water pipes and a water pump, and an electronic circuitry with control panel to allow a consumer to select and command a beverage preparation properly. The machine further comprises a so-called "brewing head" which is adapted to functionally insert a beverage ingredient capsule according to the invention.

As already described, beverage preparation takes place within the capsule by circulating hot water through the ingredient particles, under pressure, as already known in the art of preparing beverages under pressure within a closed capsule.

Preferably, and as will be considered in the rest of the description, the ingredient is a roast and ground coffee powder.

The capsule 1 comprises lateral walls 2, a top pierceable injection wall 3 adapted to be pierced by fluid injection needle 4 of the machine as illustrated in **figure 4**, said top wall being sealed on the top edges of the lateral wall, and a dispensing wall 5 adapted to dispense said beverage. The bottom dispensing wall is a membrane adapted in thickness and material type for being pierced by an opening plate 6 covered by sharp protrusions, as illustrated in **figure 3**. The opening principle is of the type described in Applicant's patent **EP 1472156 B1** and relies on a downward flexing movement of the bottom wall 5 when internal fluid pressure increases in the capsule, such that said bottom wall 5 is pierced or otherwise torn onto the sharp protrusions of the opening plate 6, as illustrated in **figure 5**. All the walls delimit a closed internal volume of the capsule.

The capsule 1 further comprises a flexible fluid distributor wall 7, that is located inside the closed volume of the capsule as illustrated in **figure 3**. The water distributor wall 7 is located at a distance below the top pierceable wall 3 that is sufficient to separate:

- a headspace compartment 8 between the top pierceable wall 3 and said fluid distributor wall 7 ; the headspace compartment 8 being able to accommodate the injection needle 4 when the capsule 1 is functionally inserted within the brewing cavity of the machine during injection of the fluid, and

- an ingredient compartment 9 located between said fluid distributor wall 7 and said dispensing wall 5 ; the ingredient compartment 9 containing a bed of non-soluble roast and ground coffee ingredient particles RG.

According to the principle of the invention and as illustrated in **figure 3**, the headspace compartment 8 contains a quantity of superabsorbent polymer powder 10 able to absorb a quantity of the injected fluid, and swell so as to fill the headspace compartment 8 and exert a pressure force onto the surface of the fluid distributor wall to prevent substantial movement of coffee particles RG while said fluid flows through said coffee particles. Preferably, the mass of dry superabsorbent polymer in the capsule is comprised between 0.01g and 50g, preferably between 0.01g and 20g, more preferably between 0.1g and 10g.

The superabsorbent polymer (SAP) powder 10 is a food-grade sodium polyacrylate or potassium polyacrylate SAP. More precisely, the superabsorbent polymer comprises particles made of:

- a low cross-linked superabsorbent particle core, which provides fast absorption, and

- a high cross-linked superabsorbent coating, which provides good fluid retention properties.

Superabsorbents (also known as superabsorbent polymers or SAP) consist of a material which can absorb many times its own dry weight in aqueous fluids (without dissolving). They can absorb 20 to 1000 times their weight in water in few seconds, and once absorbed, do not subsequently release it.

The difference between SAPs and other absorbents like cellulose fibre or sponge is that the latter absorb water by capillary action and readily

release the water when pressure is applied, whereas SAPs hold water within molecular chains and retain the water even under pressure.

SAPs as such are known. In particular, superabsorbent material was first produced in the early 1970s in Japan and the US. It was introduced into baby diapers in the early 1980s and later that decade into adult incontinence pads. By the early 1990s superabsorbent material had become widely used in disposable baby diapers/nappies and incontinence products.

The most widely used is sodium polyacrylate. But other SAPs are known and used, for instance potassium polyacrylate. It contains chains of macromolecules that have many oxygen atoms with a particular affinity for water molecules. This super absorbent is also negatively charged with sodium ions. Water has a tendency to migrate to the polymer to balance the osmotic pressure. Once negatively charged, the macromolecular chains repel each other: the polymer unfolds and the SAP material swells. The sodium polyacrylate is cross-linked : groups of molecules are attached between them. Once an entry in the network, the water is trapped, even under pressure. The absorption capacity of the SAP is determined by: osmotic pressure, the polymer affinity and the polymer's rubber elasticity. The osmotic pressure has the most impact on the absorption capacity.

The difference between the ion concentration inside the polymer and that of the surrounding solution water solution determine the osmotic pressure. The lower the ion concentration of the water solution, the greater the resultant difference in ion concentration, and accordingly the osmotic pressure goes up. This osmotic pressure enables the polymer to absorb a large quantity of water. Absorption capacity is therefore very variable depending on the liquid.

The affinity of the SAP with its surrounding solution also affects the absorption capacity, but is less significant than osmotic pressure.

As a result of these two factors, the polymer should continue to absorb water to the extent that the ion concentration between inside the polymer and the surrounding solution equalizes. To control the water absorption to an intended level, the polymer must be provided with specific rubber elasticity.

The rubber elasticity of the polymer increases as the crosslinking density of that polymer increases. The absorption capacity of the polymer reaches its maximum when its rubber elasticity and the water absorbing power generated from osmotic pressure and affinity of the polymer are balanced. Therefore, absorption capacity is dependent of the crosslinking density.

SAPs having a non-cross-linked structure resemble a gel in the swollen state. They have a high specific surface, and they provide a very quick absorption, with the gel structure resulting in a bad retention of water.

On the contrary, SAPs having a highly cross-linked structure are stiff in the swollen state. They have a low specific surface and a slow absorption. However, they provide a good retention of water.

It is therefore crucial to achieve a good comprise of the best properties attached to each of the two types of SAP structures mentioned above.

In the case of the present application, the invention will be better put into practice if the absorption is quite fast (full absorption within a few seconds, typically between 1 and 10 seconds), and that retention of water is optimum.

Such a good compromise can be achieved for instance with an SAP comprising particles which comprise:

- a low cross-linked superabsorbent particle core, which provides in particular fast absorption, and
- a high cross-linked superabsorbent coating, which provides good retention properties.

Manipulation of the surface coating on SAP particles is therefore one of the key steps in tailoring the properties of the product. With a good quality

base polymer (i.e. low extractable, low residual and desired capacity) different types of coating solution and cross-linker can be applied to give the polymer many different performance characteristics, which will best meet the invention requirements mentioned above.

Also, in order to improve the speed of absorption, it is preferably that the SAP particles be as small and regular in diameter as possible.

Of course, in the application of the present invention, the selected SAP must be food safe, and meet the international and national food safety standards. Such food-safe SAP exist which are used in food applications, such as in meat or poultry trays for instance, in order to absorb biological liquids released during storage. It is not the purpose of the present specification to give a list of food safe SAP for application in the present invention, they will be chosen by the skilled person appropriately from SAP manufacturers.

When the capsule 1 is inserted in the capsule-receiving brewing head of a beverage preparation machine, and the machine brewing head is closed, the water injection needle 4 pierces through the top pierceable wall 3 as illustrated in **figure 4**.

In that configuration, the tip of the needle 4 protrudes into the headspace compartment 8 as shown in **figure 4**, without touching nor piercing the water distributor wall 7.

When the user starts a beverage preparation by actuating the machine, injection of water into the capsule starts inside the capsule. The water sprayed from the needle 4 flows into the headspace compartment 8 and starts mixing with the superabsorbent polymer (SAP) powder 10 which starts to swell as illustrated by swollen SAP fibers 11 in **figure 4**, and presses onto the flexible water distributor film 7 that starts to bend downwards and compress the mass of coffee as indicated by two arrows in **figure 4**. Due to the compression effect, the coffee particles are gathered and prevented from substantial movements. By

"substantial" movements, it is meant that of course, a few particles may move a few microns, or rotate under the effect of water flowing there between under pressure, however formation of hollow channels through the coffee mass ("channelling") is prevented, and water is forced through the coffee particles so that molecules necessary to build a quality coffee beverage are extracted from the roast and ground coffee particles and mixed with the water to form a final beverage.

The interface between the capsule and the injection needle comprises leak-tight means to prevent backflow of water from inside the capsule towards the outside, so that the capsule vicinity is a closed volume at the beginning of the water injection cycle. Consequently to the injection of water in this closed volume, a pressure "P" starts to build up inside the capsule. Water flows through the water distributor film 7 and is distributed homogeneously through the mass of roast and ground coffee RG in the ingredient compartment 9.

As explained above, when the pressure inside the capsule is sufficiently high, the bottom dispensing wall 5 flexes downwards as illustrated in **figure 5**, and is pierced on the sharp protrusions of the piercing plate 6, allowing beverage to flow out of the capsule into the consumer cup placed below the capsule (not shown). At that moment, because the machine continue to inject water inside the capsule under pressure, the fluid pressure inside the capsule, and in particular into the headspace compartment is maintained. Furthermore, the superabsorbent polymer is almost fully swollen and reaches a high expansion volume which presses the distributor wall 7 downwards. As a consequence, the holding/compaction effect of the mass of coffee RG within the ingredient compartment is maximal as illustrated in **figure 5**, such that channelling is prevented in spite of the water flow and fluid pressure there through.

With the holding and compaction effect, the invention allows to obtain a very good quality of beverage in the cup, with less quantity of roast and

ground powder in the capsule, because there is no need to compensate for the water than would bypass the coffee particles flowpath by flowing through channels, as it is the case in prior art capsules. Similar or even higher organoleptic properties are achieved with less ingredient, which is very beneficial for the consumer because quality is maintained with beverage capsules which are less expensive.

Finally, when the desired quantity of beverage has been produced and the machine stops injecting water inside the capsule, the needle can be withdrawn from the capsule, as illustrated in **figure 6**. Interestingly, a beneficial side effect of the invention that was surprisingly found, is that the swollen superabsorbent polymer inside the headspace compartment of the capsule clogs the hole pierced through the top pierceable wall, as shown in **figure 6**, which prevents any product or liquid flowing back to the top of the capsule, especially in case there would be any residual pressure inside the capsule headspace compartment. Clogging of the pierced hole in the top wall 3 is due to the superabsorbent polymer which resembles a gel in the swollen state.

It should be understood that various changes and modifications to the presently preferred embodiments described herein will be apparent to those skilled in the art. Such changes and modifications can be made without departing from the spirit and scope of the present invention and without diminishing its attendant advantages. It is therefore intended that such changes and modifications be covered by the appended claims.

Claims

1. A capsule (1) for use in a beverage preparation machine, said capsule comprising :

(i) lateral walls (2), a pierceable injection wall (3) adapted to be pierced by fluid injection means (4) of the machine, and a dispensing wall (5) adapted to dispense said beverage, that delimit a closed internal volume,

(ii) a flexible fluid distributor wall (7), that is located inside the closed volume of the capsule, at a distance below the pierceable wall (3) so as to separate:

- a headspace compartment (8) between the pierceable wall (3) and said fluid distributor wall (7) which is able to accommodate the injection means during injection of the fluid, and
- an ingredient compartment (9) located between said fluid distributor wall (7) and said dispensing wall (5), containing a bed of non-soluble beverage ingredient particles,

characterized in that the headspace compartment (8) contains a superabsorbent polymer (10) able to absorb a quantity of the injected fluid, and swell so as to fill the headspace compartment (8) and exert a pressure force onto the surface of the fluid distributor wall (7) to prevent substantial movement of ingredient particles while said fluid traverses said ingredient.

2. A capsule (1) according to claim 1, wherein the fluid injection means is a hollow needle (4) having one outlet for producing a jet of fluid.

3. A capsule (1) according to any of the preceding claims, wherein said fluid is water, preferably hot water having a temperature comprised between 65°C and 90°C.

4. A capsule (1) according to any of the preceding claims, wherein the superabsorbent polymer (SAP) is a food-grade sodium polyacrylate or potassium polyacrylate SAP.

5. A capsule (1) according to claim 4, wherein the superabsorbent polymer comprises particles made of:

- a low cross-linked superabsorbent particle core, which provides fast absorption, and
- a high cross-linked superabsorbent coating, which provides good fluid retention properties.

6. A capsule (1) according to any of the preceding claims, wherein the mass of dry superabsorbent polymer in the capsule is comprised between 0.01g and 50g, preferably between 0.01g and 20g, more preferably between 0.1g and 10g.

7. A capsule (1) according to any of the preceding claims, wherein the beverage ingredient contained therein comprises roast and ground coffee powder.

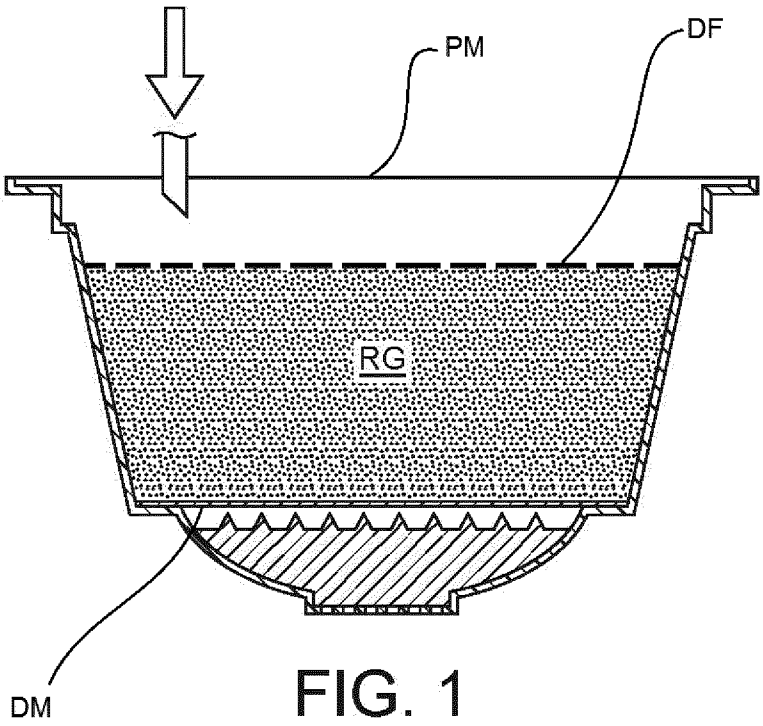

FIG. 1
PRIOR ART

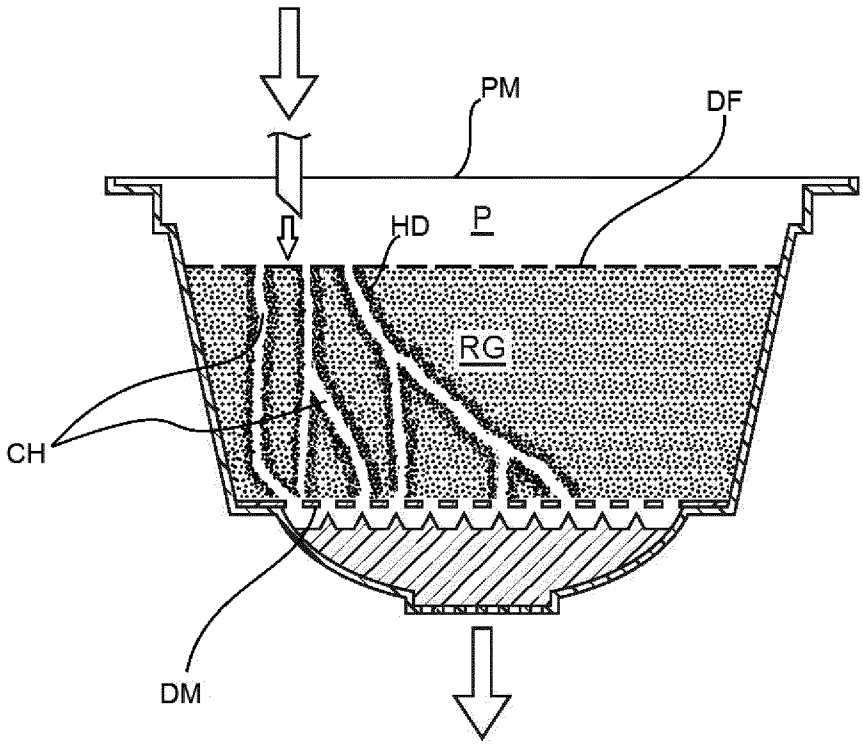

FIG. 2
PRIOR ART

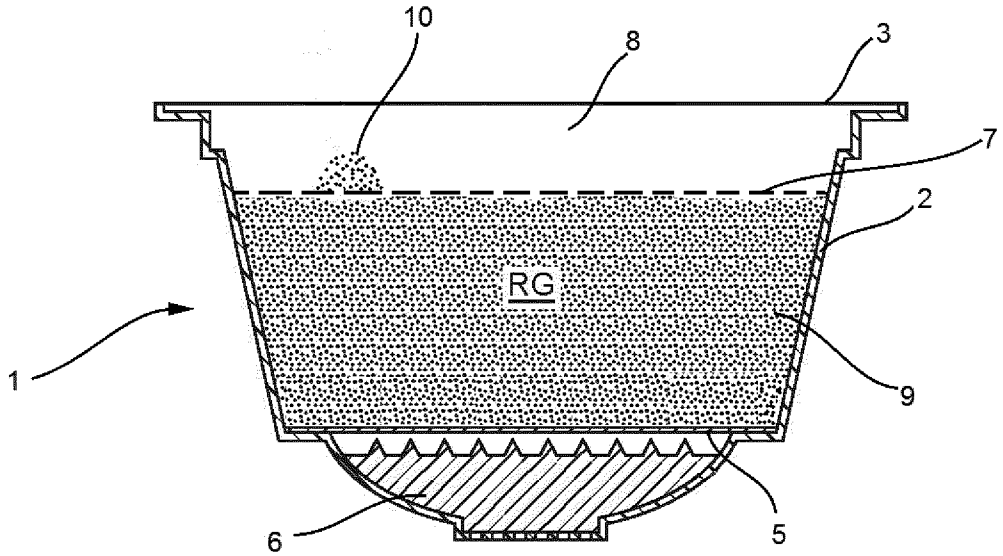

FIG. 3

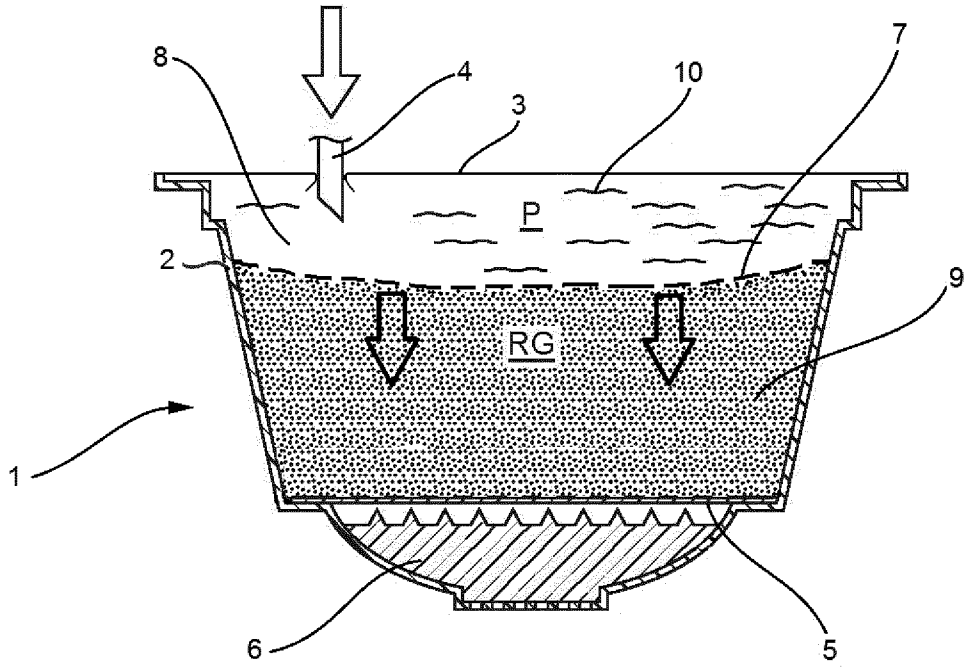

FIG. 4

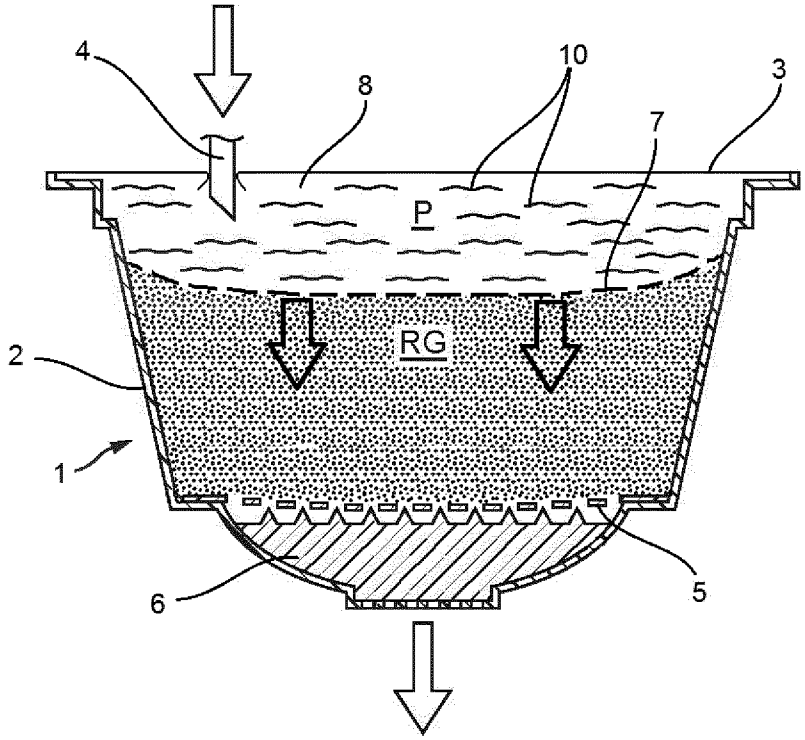

FIG. 5

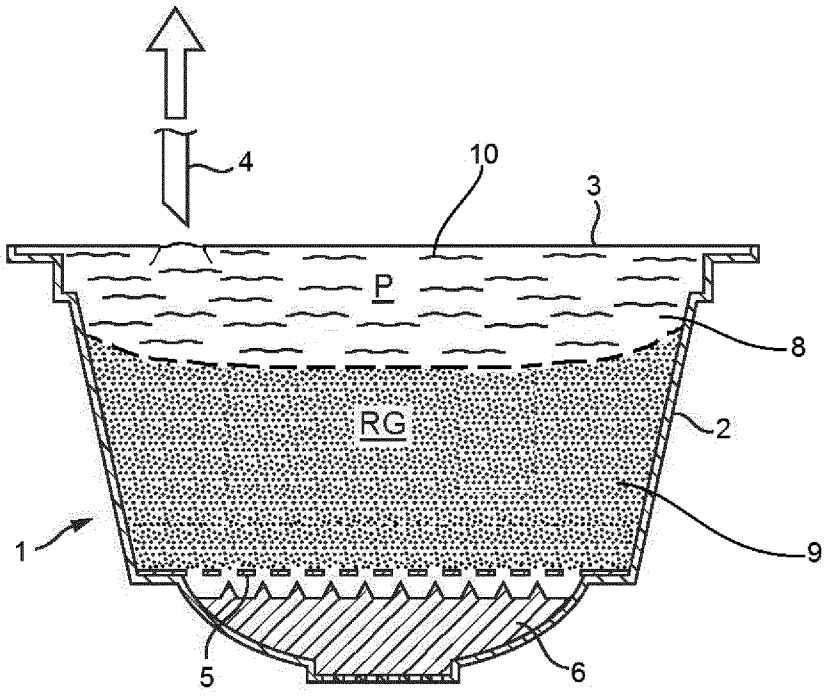

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/051852

A. CLASSIFICATION OF SUBJECT MATTER
INV. 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)
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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 2 062 831 A2 (NESTEC SA [CH]) 27 May 2009 (2009-05-27) cited in the application page 29 - page 30; figure 15	1-3,7
A	EP 1 864 917 A1 (NESTEC SA [CH]) 12 December 2007 (2007-12-12) paragraph [0061] - paragraph [0063]; figures 6a-c	1-4,7

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"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
17 April 2015	06/05/2015

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	Czerny, M

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2015/051852

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2062831 A2	27-05-2009	AR 052640 A1	28-03-2007
		AT 427900 T	15-04-2009
		AT 500164 T	15-03-2011
		AU 2005276627 A1	02-03-2006
		CA 2579475 A1	02-03-2006
		CN 101014513 A	08-08-2007
		DK 1784344 T3	02-06-2009
		DK 2062831 T3	02-05-2011
		EP 1784344 A2	16-05-2007
		EP 2062831 A2	27-05-2009
		EP 2298667 A1	23-03-2011
		ES 2323379 T3	14-07-2009
		ES 2360920 T3	10-06-2011
		JP 4879898 B2	22-02-2012
		JP 2008510540 A	10-04-2008
		MY 139660 A	30-10-2009
		NZ 553063 A	26-11-2010
		PT 1784344 E	21-04-2009
		PT 2062831 E	11-03-2011
		RU 2379225 C2	20-01-2010
		SI 2062831 T1	29-04-2011
		US 2009211458 A1	27-08-2009
		WO 2006021405 A2	02-03-2006
EP 1864917 A1	12-12-2007	AR 062819 A1	10-12-2008
		AT 404465 T	15-08-2008
		AT 452839 T	15-01-2010
		AT 501064 T	15-03-2011
		AU 2007255494 A1	13-12-2007
		BR PI0712900 A2	08-01-2013
		CA 2652575 A1	13-12-2007
		CL 2007001633 A1	25-01-2008
		CN 101466618 A	24-06-2009
		CY 1108406 T1	12-02-2014
		DK 1908706 T3	06-04-2010
		DK 2029458 T3	02-05-2011
		EP 1864917 A1	12-12-2007
		EP 1908706 A2	09-04-2008
		EP 2029458 A1	04-03-2009
		ES 2313501 T3	01-03-2009
		ES 2337959 T3	30-04-2010
		ES 2360891 T3	10-06-2011
		HK 1111959 A1	20-02-2009
		HK 1118777 A1	27-08-2010
		HR P20080487 T3	30-11-2008
		HR P20100136 T1	30-04-2010
		JP 5080571 B2	21-11-2012
		JP 2009539443 A	19-11-2009
		KR 20090020587 A	26-02-2009
		MA 31721 B1	01-10-2010
		MY 148005 A	28-02-2013
		NZ 572938 A	22-12-2011
		PE 06182008 A1	07-07-2008
		PT 1864917 E	08-10-2008
		PT 2029458 E	18-03-2011
		RU 2008151701 A	20-07-2010
		SI 1864917 T1	31-10-2008
		SI 2029458 T1	31-05-2011

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2015/051852

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		TW 200817253 A	16-04-2008
		UA 97955 C2	10-04-2012
		US 2010282091 A1	11-11-2010
		UY 30390 A1	02-01-2008
		WO 2007141202 A1	13-12-2007
		ZA 200900064 A	31-03-2010