



CARTRIDGE FOR THE PREPARATION OF BEVERAGES AND METHOD OF
MANUFACTURING A CARTRIDGE

The present invention relates to a cartridge for the
5 preparation of beverages and, in particular, to sealed
cartridges which are formed from substantially air- and
water-impermeable materials and which contain one or more
ingredients for the preparation of beverages.

It has previously been proposed to seal beverage
10 preparation ingredients in individual air-impermeable
packages. For example, cartridges or capsules containing
compacted ground coffee are known for use in certain coffee
preparation machines which are generally termed "espresso"
machines. In the production of coffee using these
15 preparation machines the coffee cartridge is placed in a
brewing chamber and hot water is passed through the cartridge
at relatively high pressures, thereby extracting the
aromatic coffee constituents from the ground coffee to
produce the coffee beverage. Typically, such machines
20 operate at a pressure of greater than 6×10^5 Pa. The
preparation machines of the type described have to date been
relatively expensive since components of the machine, such
as the water pumps and seals, must be able to withstand the
high pressures.

25 In WO01/58786 there is described a cartridge for the
preparation of beverages which operates at a pressure
generally in the range 0.7 to 2.0×10^5 Pa. However, the
cartridge is designed for use in a beverage preparation
machine for the commercial or industrial market and is
30 relatively expensive. Hence, there remains a requirement
for a cartridge for the preparation of beverages wherein the



cartridges and beverage preparation machine are suitable, in particular, for the domestic market in terms of cost, performance and reliability.

It has also proven difficult to sterilise beverage
5 cartridges of the types described above due to the narrow and tortuous pathways which are formed in the cartridge bodies. Sterilisation, for example by exposure of the cartridges to steam vapour, may not be fully effective for tortuous pathways due to the surface tension properties of
10 the cartridge which prevent ingress of the steam vapour into the tortuous pathways and hence prevent exposure of the entire component surfaces to the steam vapour.

Beverage cartridges can be prone to spluttering and splashing problems wherein during the dispensation of the
15 beverage from the cartridge beverage is sprayed or splashed outside the confines of the receptacle. This is particularly the case with beverages dispensed at relatively high pressure. It has been attempted to alleviate this problem by providing a discharge probe on the beverage preparation
20 machine which guides the beverage into the receptacle. However, the discharge probe tends to become contaminated over time with beverage residue and is difficult to clean. Further, there is a risk of cross-contamination between beverage types.

25 In addition, in the cartridge of WO01/58786 a jet of the beverage is formed by passing the beverage through an aperture. It has proven difficult to accurately size and position apertures of this type. The accurate sizing and positioning of the aperture is very important as it is
30 critical to the correct entrainment of air bubbles in the final beverage. Forming small apertures is especially

difficult in injection moulded components where the aperture location is internal and surrounded by other portions of the component. The traditional method of forming an aperture is to use a mould pin sized to the required diameter of the aperture. However apertures formed by mould pins can normally only be directed towards an opening of the component (which opening allows the mould pin access to the component during moulding). In a beverage cartridge this results in the beverage being dispensed very quickly out of the opening at speeds up to 12-16 m/s since it is directed directly towards the outlet.

One factor in the reliability of cartridges is their ability to withstand internal pressurisation. Hence it is an object of the present invention to provide a beverage cartridge with an improved ability to withstand internal pressurisation.

In order to reduce the cost of such cartridges it is desirable for them to be manufactured in a simple, reliable manner. In particular it is desirable to reduce the degree of manual handling of components of the cartridge during manufacture and to reduce the overall number of components.

Accordingly, the present invention provides a cartridge containing one or more beverage ingredients and being formed from substantially air- and water-impermeable materials, the cartridge comprising an inlet for the introduction of an aqueous medium into the cartridge and an outlet for discharge of a beverage produced from the one or more beverage ingredients, wherein the cartridge comprises an outer member and an inner member conjoined on assembly with the outer member, characterised by the inner member

comprising a discharge spout defining the outlet of the cartridge.

The cartridge of the present invention is easily assembled with the main components being the inner member and the outer member. By using separate components for the inner and outer members which are then conjoined on assembly the manufacture of each component can be optimised. This is particularly advantageous in the cartridge of the present invention where very small tolerances are desirable since the beverage flow path through the cartridge is defined by the interface between the outer member and the inner member. In addition the components of the inner member and the outer member may more easily be sterilised prior to assembly when they are separated. Once the components are conjoined a number of small-apertured, tortuous pathways are created which cannot effectively be sterilised using known methods. The ability to sterilise the components is a particularly advantageous feature where the cartridges are used for dispensing dairy-based beverages. In addition, by using separate components which are conjoined, the cartridge is not required to be inverted during assembly since the joining of the inner member and optionally a filter, the filling of the beverage ingredients and the joining of a lid, such as a laminate, can all be carried out with the outer member in one orientation.

Advantageously, the inner member comprises the discharge spout. The discharge spout serves to direct the discharged beverage into a receptacle such as a cup. The discharge spout avoids excessive splashing or spraying of the beverage and is also useful in adjusting the flow characteristics of the beverage as it is transferred from

the cartridge into the receptacle. For example, the discharge spout can be shaped to reduce the degree of turbulence imparted to the beverage to avoid unnecessary reduction in the quantity of bubbles contained in the beverage. Also advantageously, the cartridge itself comprises the discharge spout rather than providing a separate discharge spout or probe in a beverage preparation machine. Thus, there is no danger of cross-contamination of beverage types between dispense cycles since each discharge spout is used only once and then disposed of with the remainder of the cartridge. Also, preferably, the beverage discharged through the discharge spout will not contact the outlet mechanism of the beverage preparation machine thus avoiding soiling of the beverage preparation machine with beverage residue. Preferably, the discharge spout is integral with the inner member. Advantageously, the discharge spout and inner member are moulded or otherwise formed as an integral, single unit which reduces the manufacturing cost of the cartridge and reduces the number of components which require assembly.

In one embodiment the discharge spout comprises a tapered portion. In an alternative embodiment, the discharge spout comprises a cylindrical portion. In a further optional variation, the discharge spout comprises a partition extending at least part way along the length of the discharge spout. The partition reduces the amount of spraying and splashing of beverage on discharge.

Preferably, a snap-fit arrangement is provided to conjoin the outer member and the inner member. Typically, the snap-fit arrangement comprises co-operating formations on the inner member and the outer member. A snap-fit

arrangement provides a quick to assemble but secure method of conjoining the inner member and outer member.

Advantageously, the snap-fit arrangement avoids the need for glues or other such adhesives in the interior of the
5 cartridge which will be exposed to the beverage ingredients.

Preferably, the outer member comprises a closed first end and an open second end, wherein with the inner member conjoined to the outer member the outlet of the discharge spout is directed towards the open second end. Also
10 preferably, the inlet is directed towards the open second end of the outer member. Thus the inlet and outlet are directed to the same side of the cartridge. This allows the cartridge to be used in a low-profile machine where piercing means for forming the inlet and the outlet, in use, project
15 from a single plane of the beverage preparation machine.

Preferably, the outer member and inner member are conjoined at or near the closed first end of the outer member. Thus, the conjoining of the inner and outer members is achieved at a point remote from the open end, or mouth,
20 of the outer member. Advantageously, the conjoining step can be done before beverage ingredients are filled into the cartridge and before sealing of the open end or mouth of the cartridge. This simplifies the assembly process since the inner and outer members may first be conjoined to form a
25 cartridge sub-assembly which may then be transferred to a filling station on the packing line where the one or more beverage ingredients are inserted. The filled cartridge is then sealed, for example, by a laminated sheet which is heat welded to the open end of the outer member. This assembly
30 process avoids the difficult task of aligning and keeping in

alignment an outer member, inner member and laminate during the heat-welding step.

Preferably, the outer member comprises an inwardly directed extension which is received in a proximal end of the discharge spout on conjoining of the outer member and the inner member.

In one embodiment, the inner member comprises a frame having a filter disposed thereupon. Preferably, one or more passages are defined between the frame and a closed first end of the outer member when the inner member and outer member are conjoined. Further, the one or more passages are preferably delimited by webs extending upwardly from the frame to the closed first end of the outer member. Preferably, the one or more passages slope downwardly towards the discharge spout.

In another embodiment the inner member further comprises a skirt surrounding the discharge spout. Preferably, the skirt comprises an upper extension which, on assembly of the cartridge, contacts the closed first end of the cartridge. An upper rim of the upper extension preferably, engages a co-operating formation of the outer member to form a snap-fit arrangement for conjoining the inner member to the outer member. Typically, the co-operating formation of the outer member is an inwardly directed extension.

Preferably, the cartridge is disc-shaped. Optionally, the cartridge further comprises means for producing a jet of the beverage, which means comprises an aperture in a beverage flow path between the inlet and the outlet. The inlet and/or outlet is preferably covered by a substantially air- and water-impermeable material prior to the formation,

in use, of the inlet and/or outlet in the cartridge. For example, the inlet and/or outlet is covered by a substantially air- and water-impermeable laminate. The laminate may be polypropylene. The outer member and/or inner member are formed, for example, from polypropylene. Alternatively, the outer member and/or inner member may be formed from a biodegradable polymer.

Preferably, the inner member forms a load-bearing member.

10 Preferably, there is also provided a plurality of cartridges, each cartridge as described above, wherein the percentage yield of the beverage produced from the one or more beverage ingredients contained in the cartridges is consistent to within 1.0 standard deviations.

15 The present invention also provides a cartridge containing one or more beverage ingredients and being formed from substantially air- and water-impermeable materials, said cartridge comprising an inlet for the introduction of an aqueous medium into the cartridge, and an outlet for a beverage produced from said one or more beverage ingredients, wherein said cartridge comprises an outer member, an inner member inserted in the outer member and means for producing a jet of the beverage, wherein said means for producing the jet of the beverage comprises an aperture in a beverage flow path linking the inlet to the outlet, characterised in that the aperture is delimited by an interface between the inner member and the outer member.

25 The cartridge of the present invention produces a jet of the beverage which can be used to alter the appearance and characteristics of the dispensed beverage, by for example entraining air into the jet of beverage to produce a

multitude of small air bubbles in the dispensed beverage. The cartridge of the present invention is easily assembled with the main components being the inner member and the outer member. By using separate components for the inner and
5 outer members which are then preferably conjoined on assembly the manufacture of each component and the assembly of the cartridge can be optimised. This is particularly advantageous in the cartridge of the present invention where very small tolerances are required for the size and location
10 of the aperture that produces the jet of beverage and also for the remainder of the beverage flow path through the cartridge. In addition, the aperture can be directed perpendicular to the overall flow path direction such that the beverage impacts on a wall or surface of the cartridge
15 and thereby slows down before being dispensed. As described above such precision and orientation of the aperture is difficult in injection moulded components. According to the present invention, this difficulty is overcome by delimiting the aperture by using the interface between the inner member
20 and the outer member rather than by forming the entire aperture in a single component by, for example, a mould pin. Preferably, one of the inner member or outer member comprises an opening and the other of the inner member or outer member comprises an obstruction, wherein on insertion
25 of the inner member in the outer member, the obstruction partially obstructs the opening to so delimit the aperture.

Advantageously, it is easier to produce a separate opening and obstruction which can be brought together to delimit the aperture. Preferably, the opening comprises an
30 elongated slot, which may be provided in the inner member. In this case, the outer member comprises the obstruction.

Preferably, the obstruction comprises an extension of the outer member at least a part of which projects into the inner member. The elongated slot may be formed in a cylindrical wall of the inner member. Preferably, the elongated slot extends to the upper edge of the cylindrical wall. In one embodiment, the extension of the outer member is a cylindrical extension which is received as a sliding fit within the cylindrical wall of the inner member. Typically, the aperture has a cross-sectional area of 0.4 to 0.7 mm².

Preferably, the cartridge further comprises at least one inlet for air and means for generating a pressure reduction of the jet of beverage, whereby, in use, air from the at least one air inlet is incorporated into the beverage as a plurality of small bubbles. Preferably, the at least one air inlet is provided in the inner member downstream of the aperture. The inner member may comprise a discharge spout defining the outlet. Preferably, the jet of beverage issuing from the aperture is directed into the discharge spout where it may impinge a surface of the discharge spout between issuing from the aperture and exiting the outlet. Preferably, the surface is a concave wall of the discharge spout. The concave wall is preferably positioned on an opposite side of the discharge spout from the aperture. Preferably, the aperture directs the beverage to flow at an angle substantially perpendicular to a flow of beverage out of the outlet. The beverage thus has to be deflected before it can exit the cartridge which results in a slowing of the beverage, which is desired to prevent splashing in the receptacle.

The components of the inner member and the outer member may more easily be sterilised prior to assembly when they are separated. Once the components are conjoined a number of small-apertured, tortuous pathways are created which cannot effectively be sterilised using known methods. The ability to sterilise the components is a particularly advantageous feature where the cartridges are used for dispensing dairy-based beverages.

Advantageously, the discharge spout is integral with the inner member. The discharge spout serves to direct the discharged beverage into a receptacle such as a cup. The discharge spout avoids excessive splashing or spraying of the beverage and is also useful in adjusting the flow characteristics of the beverage as it is transferred from the cartridge into the receptacle. For example, the discharge spout can be shaped to reduce the degree of turbulence imparted to the beverage to avoid unnecessary reduction in the quantity of bubbles contained in the beverage. Also advantageously, the cartridge itself comprises the discharge spout rather than providing a separate discharge spout in a beverage preparation machine. Thus, there is no danger of cross-contamination of beverage types between dispense cycles since each discharge spout is used only once and then disposed of with the remainder of the cartridge. Also, preferably, the beverage discharged through the discharge spout will not contact the outlet mechanism of the beverage preparation machine thus avoiding soiling of the beverage preparation machine. Advantageously, the discharge spout and inner member are moulded or otherwise formed as an integral, single unit which reduces

the manufacturing cost of the cartridge and reduces the number of components which require assembly.

Preferably, the cartridge is disc-shaped. The outer member and/or inner member are formed, for example, from polypropylene. The cartridge may be made of a biodegradable polymer.

The present invention also provides a cartridge containing one or more beverage ingredients and being formed from substantially air- and water-impermeable materials, the cartridge comprising a compartment containing the one or more beverage ingredients, the compartment comprising a plurality of inlet apertures for the introduction of an aqueous medium into the compartment and a plurality of outlet apertures for a beverage produced from the one or more beverage ingredients, wherein at least a proportion of the inlet apertures are out of alignment with the outlet apertures such that at least a proportion of the aqueous medium entering the compartment through the inlet apertures is forced to circulate within the compartment before exiting the compartment through the outlet apertures characterised in that the inlet apertures are arranged around the periphery of the compartment.

Advantageously, the cartridge of the present invention comprises inlet apertures and outlet apertures at least a proportion of which are out of alignment. This ensures that the aqueous medium which enters the compartment containing the beverage ingredients cannot pass directly from the inlet apertures to the outlet apertures. Instead the aqueous medium is constrained to circulate in the compartment before exiting via the outlet apertures. This increases the degree of mixing of the aqueous medium and the beverage ingredients

since substantially all portions of the beverage ingredients in the compartment encounter the aqueous medium flow path.

Preferably the inlet apertures may be equi-spaced around the compartment periphery. Preferably, the outlet apertures are located towards a centre of the compartment relative to the inlet apertures. The outlet apertures may be equi-spaced around the centre of the compartment. Equi-spacing of the inlet and outlet apertures provides more even flow characteristics within the compartment which provides more consistent mixing of the beverage ingredients and aqueous medium.

Preferably, the cartridge comprises 3 to 10 inlet apertures. In one embodiment, 4 inlet apertures are provided.

Preferably, the cartridge comprises 3 to 10 outlet apertures. In one embodiment, 5 outlet apertures are provided.

Preferably, unequal numbers of inlet apertures and outlet apertures are provided.

Preferably, the number of inlet apertures and outlet apertures are given by the formula:

$$X_o = X_i + C$$

where

X_i = the number of inlet apertures

X_o = the number of outlet apertures

C = the set of integers not including 0 or nX_i

n = any integer.

Advantageously, the number of inlet apertures and outlet apertures are chosen according to the above formula. This is particularly advantageous where the cartridge is disc-shaped and the apertures are equi-spaced around the disc since it is not then necessary to consciously align the components of the cartridge containing the inlet apertures and outlet apertures during assembly. Whatever the mutual orientation of the components at least a proportion of the inlet apertures and outlet apertures will be out of alignment. For example, with four inlet apertures and five outlet apertures, all being equi-spaced it is impossible to align more than one inlet aperture with an outlet aperture whatever the alignment of the components containing the inlet and outlet apertures. This results in a much faster and simpler assembly procedure. Alternatively, the cartridge may contain equal numbers of inlet apertures and outlet apertures, but their spacing may be arranged to ensure that at least a proportion of the inlets and outlets are not aligned.

Typically, the inlet apertures are provided in an outer member of the cartridge and the outlet apertures are provided in an inner member of the cartridge. Preferably, the inner member comprises a discharge spout communicating with the outlet apertures.

In a preferred embodiment, the cartridge is disc-shaped. Preferably, the flow of aqueous medium through the inlet apertures into the compartment is directed radially inwards towards a centre of the cartridge.

The cartridge finds particular application with beverage ingredients in the form of viscous liquids or gels. In one application a liquid chocolate ingredient is

contained in the cartridge 1 with a viscosity of between 1700 and 3900mPa at ambient temperature and between 5000 and 10000mPa at 0°C and a refractive solids of 67 Brix $\pm$ 3. In another application liquid coffee is contained in the
5 cartridge 1 with a viscosity of between 70 and 2000mPa at ambient and between 80 and 5000mPa at 0°C where the coffee has a total solids level of between 40 and 70%.

With soluble beverage ingredients, such as a viscous liquid or gel, incomplete mixing of the ingredients with the
10 aqueous medium can be a particular problem. In particular, in cartridges containing such products channels can be quickly created linking the inlet to the outlet of the cartridge due to local dissolution of the ingredient. The channels then form a relatively low resistance flow path for
15 the remaining aqueous medium which will tend to flow along the channels rather than through the remaining, undissolved, viscous ingredient in the compartment. The cartridge of the present invention largely solves this problem by forcing the aqueous medium to recirculate within the compartment which
20 acts to not only dissolve a greater proportion of the ingredients but also to create turbulence within the compartment which improves mixing of the remaining ingredient which in turn prevents the creation or maintenance of low resistance flow paths linking the inlet
25 apertures to the outlet apertures.

The outer member and/or inner member may be formed from polypropylene and may be formed by injection moulding. In one embodiment the outer member and/or inner member are formed from a biodegradable polymer.

30 The present invention also provides a cartridge containing one or more beverage ingredients and being formed

from substantially air- and water-impermeable materials, the cartridge comprising an outer member defining a storage chamber in which is stored the one or more beverage ingredients and an inner member having a discharge spout forming an outlet for outflow of beverage formed from the one or more beverage ingredients, characterised in that the inner member forms a load-bearing member.

The cartridge of the present invention provides a robust mechanism for dispensing beverages. In particular the inner member forms a load-bearing member which allows the cartridge to withstand relatively high compressive loads during use. This allows the cartridge to be used in a beverage preparation machine which subjects the cartridge to a compressive load prior to commencing a dispense cycle. This in turn reduces the likelihood that the cartridge will fail when it is internally pressurised. In addition the application of the compressive load to the cartridge ensures that the components of the cartridge are held firmly and precisely in place.

Preferably, the inner member and outer member are separate components which are conjoined during assembly of the cartridge.

Preferably, the cartridge further comprises a filter conjoined to the inner member.

Preferably, the inner member forms a load-bearing member of sufficient rigidity such that the cartridge can withstand a compressive load of greater than 130N. More preferably, the load-bearing member is of sufficient rigidity such that the cartridge can withstand a compressive force of greater than 200N. Preferably, the load-bearing member is of sufficient rigidity such that the load-bearing

member can withstand a compressive force of greater than 130N.

In one embodiment the inner member is formed from polypropylene. Alternatively, the outer member and/or inner member are formed from a biodegradable polymer.

Advantageously, the inner member comprises the discharge spout. The discharge spout serves to direct the discharged beverage into a receptacle such as a cup. The discharge spout avoids excessive splashing or spraying of the beverage and is also useful in adjusting the flow characteristics of the beverage as it is transferred from the cartridge into the receptacle. For example, the discharge spout can be shaped to reduce the degree of turbulence imparted to the beverage to avoid unnecessary reduction in the quantity of bubbles contained in the beverage.

Preferably, the inner member and discharge spout are formed as one piece.

The present invention also provides a cartridge containing one or more beverage ingredients and being formed from substantially air- and water-impermeable materials, the cartridge comprising a housing having a closed first end and an open second end, the housing defining a storage chamber in which is stored the one or more beverage ingredients, wherein the open second end of the housing is sealed by a lid, characterised by the cartridge further comprising a load-bearing member spanning between the closed first end of the housing and the lid.

Preferably, the load-bearing member comprises a discharge spout forming an outlet for outflow of beverage formed from the one or more beverage ingredients.

Preferably, the load-bearing member is located at or near a centre of the cartridge.

Preferably, the load-bearing member is of sufficient rigidity such that the cartridge can withstand a compressive
5 load of greater than 130N. More preferably, the load-bearing member is of sufficient rigidity such that the cartridge can withstand a compressive force of greater than 200N. Preferably, the load-bearing member is of sufficient rigidity such that the load-bearing member can withstand a
10 compressive force of greater than 130N.

The present invention also provides a cartridge containing one or more beverage ingredients and being formed from substantially air- and water-impermeable materials, the cartridge comprising an outer member defining a storage
15 chamber in which is stored the one or more beverage ingredients, an inner member having a discharge spout forming an outlet for outflow of beverage formed from the one or more beverage ingredients, and a filter disposed between the storage chamber and the discharge spout,
20 characterised in that the inner member and filter are conjoined in one operation to the outer member by means of at least one weld.

Advantageously, the cartridge of the present invention can be assembled in a reliable manner with minimal manual
25 handling of the components. In addition, the outer member, inner member and filter can be assembled first as a sub-assembly and then easily transported without risk of dislodging the filter. This enables the outer member, inner member and filter to be assembled at a different site from
30 that where filling and sealing of the cartridge takes place.

Preferably, the outer member has an opening for accessing the storage chamber, wherein the inner member and filter are conjoined to the outer member at a base remote from the opening.

5 Preferably, the inner member, outer member and filter are annular.

Preferably, the weld is substantially circular.

In one embodiment, the inner member and outer member are of plastics materials and the at least one weld is an
10 ultrasonically-formed weld.

In one example, the inner member comprises a frame and the at least one weld is formed round a periphery of said frame. This weld prevents outflow of beverage from the storage chamber other than through the filter. Preferably,
15 the frame comprises a plurality of webs extending upwardly from the frame towards a closed first end of the outer member to define one or more passages between the frame and the closed first end of the outer member and wherein welds are formed between the webs and the closed first end of the
20 outer member.

The present invention also provides a method of manufacturing a cartridge containing one or more beverage ingredients and being formed from substantially air- and water-impermeable materials, the cartridge comprising an
25 outer member defining a storage chamber in which is stored the one or more beverage ingredients, an inner member having a discharge spout forming an outlet for outflow of beverage formed from the one or more beverage ingredients, and a filter, characterised by the method comprising conjoining
30 the inner member and the filter in one step to the outer member by means of at least one welding step.

Preferably, the welding step is by ultrasonic welding.

Preferably, the method further comprises forming a first welding line around a periphery of the inner member and filter.

5 Preferably, the method further comprises forming a second welding line around the inner member and filter at or near the discharge spout.

It will be understood that by the term "cartridge" as used herein is meant any package, container, sachet or
10 receptacle which contains one or more beverage ingredients in the manner described. The cartridge may be rigid, semi-rigid or flexible.

The cartridge of the present invention contains one or more beverage ingredients suitable for the formation of a
15 beverage product. The beverage product may be, for example, one of coffee, tea, chocolate or a dairy-based beverage including milk. The beverage ingredients may be powdered, ground, leaf-based or liquid. The beverage ingredients may be insoluble or soluble. Examples include roast and ground
20 coffee, leaf tea, powdered chocolate and soup, liquid milk-based beverages and concentrated fruit juices.

The present invention also provides a cartridge containing one or more beverage ingredients and being formed from substantially air- and water-impermeable materials, the
25 cartridge comprising an inlet for the introduction of an aqueous medium into the cartridge and an outlet for discharge of a beverage produced from the one or more beverage ingredients, characterised in that the cartridge comprises an outer member and an inner member conjoined on
30 assembly with the outer member, the inner member defining the outlet of the cartridge, wherein a snap-fit arrangement

is provided to conjoin the outer member and the inner member on assembly of the cartridge.

The cartridge of the present invention is easily assembled with the main components being the inner member and the outer member. By using separate components for the inner and outer members which are then conjoined on assembly by a snap-fit arrangement the manufacture of each component and the assembly of the cartridge can be optimised. This is particularly advantageous in the cartridge of the present invention where very small tolerances are desirable since the beverage flow path through the cartridge is defined by the interface between the outer member and the inner member. In addition the components of the inner member and the outer member may more easily be sterilised prior to assembly when they are separated. Once the components are snap-fitted together a number of small-apertured, tortuous pathways are created which cannot effectively be sterilised using known methods. The ability to sterilise the components is a particularly advantageous feature where the cartridges are used for dispensing dairy-based beverages. A snap-fit arrangement provides a quick to assemble but secure method of conjoining the inner member and outer member. Advantageously, the snap-fit arrangement avoids the need for glues or other such adhesives in the interior of the cartridge which will be exposed to the beverage ingredients.

Typically, the snap-fit arrangement comprises co-operating formations on the inner member and the outer member. Preferably, the outer member comprises a closed first end and an open second end, wherein with the inner member snap-fitted to the outer member the outlet of the inner member is directed towards the open second end. Also

preferably, the inlet is directed towards the open second end of the outer member. Thus the inlet and outlet are directed to the same side of the cartridge. This allows the cartridge to be used in a low-profile machine where piercing means for forming the inlet and the outlet, in use, project from a single plane of the beverage preparation machine.

Preferably, the outer member and inner member are snap-fitted together at or near the closed first end of the outer member. Thus, the conjoining of the inner and outer members is achieved at a point remote from the open end, or mouth, of the outer member. Advantageously, the snap-fitting step can be done before beverage ingredients are filled into the cartridge and before sealing of the open end or mouth of the cartridge. This simplifies the assembly process since the inner and outer members may first be snap-fitted together to form a cartridge sub-assembly which may then be transferred to a filling station on the packing line where the one or more beverage ingredients are inserted. The filled cartridge is then sealed, for example, by a laminated sheet which is heat welded to the open end of the outer member. This assembly process avoids the difficult task of aligning and keeping in alignment an outer member, inner member and laminate during the heat-welding step.

Advantageously, the snap-fit between the inner member and the outer member forms a water-tight seal.

In one embodiment the inner member further comprises a skirt surrounding the outlet, the skirt comprising an upper extension having an upper rim which engages, on assembly of the cartridge, a co-operating formation of the outer member to form the snap-fit arrangement for conjoining the inner member to the outer member. Typically, the co-operating

formation of the outer member is an inwardly directed extension.

Preferably, the outer member comprises an inwardly directed extension which is received in a proximal end of the discharge spout on conjoining of the outer member and the inner member.

Advantageously, the inner member comprises a discharge spout. The discharge spout serves to direct the discharged beverage into a receptacle such as a cup. The discharge spout avoids excessive splashing or spraying of the beverage and is also useful in adjusting the flow characteristics of the beverage as it is transferred from the cartridge into the receptacle. For example, the discharge spout can be shaped to reduce the degree of turbulence imparted to the beverage to avoid unnecessary reduction in the quantity of bubbles contained in the beverage. Also advantageously, the cartridge itself comprises the discharge spout rather than providing a separate discharge spout in a beverage preparation machine. Thus, there is no danger of cross-contamination of beverage types between dispense cycles since each discharge spout is used only once and then disposed of with the remainder of the cartridge. Also, preferably, the beverage discharged through the discharge spout will not contact the outlet mechanism of the beverage preparation machine thus avoiding soiling of the beverage preparation machine. Preferably, the discharge spout is integral with the inner member. Advantageously, the discharge spout and inner member are moulded or otherwise formed as an integral, single unit which reduces the manufacturing cost of the cartridge and reduces the number of components which require assembly.

In one embodiment the discharge spout comprises a tapered portion. In an alternative embodiment, the discharge spout comprises a cylindrical portion. In a further optional variation, the discharge spout comprises a partition
5 extending at least part way along the length of the discharge spout. The partition reduces the amount of spraying and splashing of beverage on discharge.

Preferably, the cartridge is disc-shaped. Optionally, the cartridge further comprises means for producing a jet of
10 the beverage, which means comprises an aperture in a beverage flow path between the inlet and the outlet. The outer member and/or inner member are formed, for example, from polypropylene.

In the following description the terms "upper" and
15 "lower" and equivalents will be used to describe the relational positioning of features of the invention. The terms "upper" and "lower" and equivalents should be understood to refer to the cartridge (or other components) in its normal orientation for insertion into a beverage
20 preparation machine and subsequent dispensing as shown, for example, in Figure 4. In particular, "upper" and "lower" refer, respectively, to relative positions nearer or further from a top surface 11 of the cartridge. In addition, the terms "inner" and "outer" and equivalents will be used to
25 describe the relational positioning of features of the invention. The terms "inner" and "outer" and equivalents should be understood to refer to relative positions in the cartridge (or other components) being, respectively, nearer or further from a centre or major axis X of the cartridge 1
30 (or other component).

Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is cross-sectional drawing of an outer member
5 of first and second embodiments of cartridge according to the present invention;

Figure 2 is a cross-sectional drawing of a detail of the outer member of Figure 1 showing an inwardly directed cylindrical extension;

10 Figure 3 is a cross-sectional drawing of a detail of the outer member of Figure 1 showing a slot;

Figure 4 is a perspective view from above of the outer member of Figure 1;

Figure 5 is a perspective view from above of the outer
15 member of Figure 1 in an inverted orientation;

Figure 6 is a plan view from above of the outer member of Figure 1;

Figure 7 is a cross-sectional drawing of an inner member of the first embodiment of cartridge;

20 Figure 8 is a perspective view from above of the inner member of Figure 7;

Figure 9 is a perspective view from above of the inner member of Figure 7 in an inverted orientation;

Figure 10 is a plan view from above of the inner member
25 of Figure 7;

Figure 11 is a cross-sectional drawing of the first embodiment of cartridge in an assembled condition;

Figure 12 is a cross-sectional drawing of an inner member of the second embodiment of cartridge;

30 Figure 13 is a cross-sectional drawing of a detail of the inner member of Figure 12 showing an aperture;

Figure 14 is a perspective view from above of the inner member of Figure 12;

Figure 15 is a perspective view from above of the inner member of Figure 12 in an inverted orientation;

5 Figure 16 is another cross-sectional drawing of the inner member of Figure 12;

Figure 17 is a cross-sectional drawing of another detail of the inner member of Figure 12 showing an air inlet;

10 Figure 18 is a cross-sectional drawing of the second embodiment of cartridge in an assembled condition;

Figure 19 is cross-sectional drawing of an outer member of third and fourth embodiments of cartridge according to the present invention;

15 Figure 20 is a cross-sectional drawing of a detail of the outer member of Figure 19 showing an inwardly directed cylindrical extension;

Figure 21 is a plan view from above of the outer member of Figure 19;

20 Figure 22 is a perspective view from above of the outer member of Figure 19;

Figure 23 is a perspective view from above of the outer member of Figure 19 in an inverted orientation;

25 Figure 24 is a cross-sectional drawing of an inner member of the third embodiment of cartridge;

Figure 25 is a plan view from above of the inner member of Figure 24;

30 Figure 26 is a cross-sectional drawing of a detail of the inner member of Figure 24 showing an in-turned upper rim;

Figure 27 is a perspective view from above of the inner member of Figure 24;

Figure 28 is a perspective view from above of the inner member of Figure 24 in an inverted orientation;

5 Figure 29 is a cross-sectional drawing of the third embodiment of cartridge in an assembled condition;

Figure 30 is a cross-sectional drawing of an inner member of the fourth embodiment of cartridge;

10 Figure 31 is a plan view from above of the inner member of Figure 30;

Figure 32 is a perspective view from above of the inner member of Figure 30;

Figure 33 is a perspective view from above of the inner member of Figure 30 in an inverted orientation;

15 Figure 34 is a cross-sectional drawing of the fourth embodiment of cartridge in an assembled condition;

Figure 35a is a graph of concentration vs. operating cycle time;

20 Figure 35b is a graph of foamability vs. operating cycle time; and

Figure 35c is a graph of temperature vs. operating cycle time.

25 As shown in Figure 11, the cartridge 1 of the present invention generally comprises an outer member 2, an inner member 3 and a laminate 5. The outer member 2, inner member 3 and laminate 5 are assembled to form the cartridge 1 which has an interior 120 for containing one or more beverage ingredients, an inlet 121, an outlet 122 and a beverage flow
30 path linking the inlet 121 to the outlet 122 and which passes through the interior 120. The inlet 121 and outlet

122 are initially sealed by the laminate 5 and are opened in use by piercing or cutting of the laminate 5. The beverage flow path is defined by spatial inter-relationships between the outer member 2, inner member 3 and laminate 5 as discussed below. Other components may optionally be included in the cartridge 1, such as a filter 4, as will be described further below.

A first version of cartridge 1 which will be described for background purposes is shown in Figures 1 to 11. The first version of the cartridge 1 is particularly designed for use in dispensing filtered products such as roast and ground coffee or leaf tea. However, this version of the cartridge 1 and the other versions described below may be used with other products such as chocolate, coffee, tea, sweeteners, cordials, flavourings, alcoholic beverages, flavoured milk, fruit juices, squashes, sauces and desserts.

As can be seen from Figure 5, the overall shape of the cartridge 1 is generally circular or disc-shaped with the diameter of the cartridge 1 being significantly greater than its height. A major axis X passes through the centre of the outer member as shown in Figure 1. Typically the overall diameter of the outer member 2 is 74.5 mm $\pm$ 6mm and the overall height is 16 mm $\pm$ 3mm. Typically the volume of the cartridge 1 when assembled is 30.2 ml $\pm$ 20%.

The outer member 2 generally comprises a bowl-shaped shell 10 having a curved annular wall 13, a closed top 11 and an open bottom 12. The diameter of the outer member 2 is smaller at the top 11 compared to the diameter at the bottom 12, resulting from a flaring of the annular wall 13 as one traverses from the closed top 11 to the open bottom 12. The

annular wall 13 and closed bottom 11 together define a receptacle having an interior 34.

A hollow inwardly directed cylindrical extension 18 is provided in the closed top 11 centred on the major axis X.

5 As more clearly shown in Figure 2, the cylindrical extension 18 comprises a stepped profile having first, second and third portions 19, 20 and 21. The first portion 19 is right circular cylindrical. The second portion 20 is frusto-conical in shape and is inwardly tapered. The third portion

10 21 is another right circular cylinder and is closed off by a lower face 31. The diameter of the first, second and third portion 19, 20 and 21 incrementally decreases such that the diameter of the cylindrical extension 18 decreases as one traverses from the top 11 to the closed lower face 31 of the

15 cylindrical extension 18. A generally horizontal shoulder 32 is formed on the cylindrical extension 18 at the junction between the second and third portions 20 and 21.

An outwardly extending shoulder 33 is formed in the outer member 2 towards the bottom 12. The outwardly

20 extending shoulder 33 forms a secondary wall 15 co-axial with the annular wall 13 so as to define an annular track forming a manifold 16 between the secondary wall 15 and the annular wall 13. The manifold 16 passes around the circumference of the outer member 2. A series of slots 17

25 are provided in the annular wall 13 level with the manifold 16 to provide gas and liquid communication between the manifold 16 and the interior 34 of the outer member 2. As shown in Figure 3, the slots 17 comprise vertical slits in the annular wall 13. Between 20 and 40 slots are provided.

30 In the embodiment shown thirty-seven slots 17 are provided generally equi-spaced around the circumference of the

manifold 16. The slots 17 are preferably between 1.4 and 1.8 mm in length. Typically the length of each slot is 1.6 mm representing 10% of the overall height of the outer member 2. The width of each slot is between 0.25 and 0.35 mm.

- 5 Typically, the width of each slot is 0.3 mm. The width of the slots 17 is sufficiently narrow to prevent the beverage ingredients passing therethrough into the manifold 16 either during storage or in use.

An inlet chamber 26 is formed in the outer member 2 at the periphery of the outer member 2. A cylindrical wall 27 is provided, as most clearly shown in Figure 5, which defines the inlet chamber 26 within, and partitions the inlet chamber 26 from the interior 34 of the outer member 2. The cylindrical wall 27 has a closed upper face 28 which is formed on a plane perpendicular to the major axis X and an open lower end 29 co-planar with the bottom 12 of the outer member 2. The inlet chamber 26 communicates with the manifold 16 via two slots 30 as shown in Figure 1. Alternatively, between one and four slots may be used to communicate between the manifold 16 and the inlet chamber 26.

A lower end of the outwardly extending shoulder 33 is provided with an outwardly extending flange 35 which extends perpendicularly to the major axis X. Typically the flange 35 has a width of between 2 and 4 mm. A portion of the flange 35 is enlarged to form a handle 24 by which the outer member 2 may be held. The handle 24 is provided with an upturned rim 25 to improve grip.

The outer member 2 is formed as a single integral piece from high density polyethylene, polypropylene, polystyrene, polyester, or a laminate of two or more of these materials.

A suitable polypropylene is the range of polymers available from DSM UK Limited (Redditch, United Kingdom). The outer member may be opaque, transparent or translucent. The manufacturing process may be injection moulding.

5 The inner member 3 as shown in Figures 7 to 10, comprises an annular frame 41 and a downwardly extending cylindrical funnel 40. A major axis X passes through the centre of the inner member 3 as shown in Figure 7.

As best shown in Figure 8, the annular frame 41
10 comprises an outer rim 51 and an inner hub 52 joined by ten equi-spaced radial spokes 53. The inner hub 52 is integral with and extends from the cylindrical funnel 40. Filtration apertures 55 are formed in the annular frame 41 between the radial spokes 53. A filter 4 is disposed on the annular
15 frame 41 so as to cover the filtration apertures 55. The filter is preferably made from a material with a high wet strength, for example a non-woven fibre material of polyester. Other materials which may be used include a water-impermeable cellulosic material, such as a cellulosic
20 material comprising woven paper fibres. The woven paper fibres may be admixed with fibres of polypropylene, polyvinyl chloride and/or polyethylene. The incorporation of these plastic materials into the cellulosic material renders the cellulosic material heat-sealable. The filter 4
25 may also be treated or coated with a material which is activated by heat and/or pressure so that it can be sealed to the annular frame 41 in this way.

As shown in the cross-sectional profile of Figure 7, the inner hub 52 is located at a lower position than the
30 outer rim 51, resulting in the annular frame 41 having a sloping lower profile.

The upper surface of each spoke 53 is provided with an upstanding web 54 which divides a void space above the annular frame 41 into a plurality of passages 57. Each passage 57 is bounded on either side by a web 54 and on a lower face by the filter 4. The passages 57 extend from the outer rim 51 downwardly towards, and open into, the cylindrical funnel 40 at openings 56 defined by the inner extremities of the webs 54.

The cylindrical funnel 40 comprises an outer tube 42 surrounding an inner discharge spout 43. The outer tube 42 forms the exterior of the cylindrical funnel 40. The discharge spout 43 is joined to the outer tube 42 at an upper end of the discharge spout 43 by means of an annular flange 47. The discharge spout 43 comprises an inlet 45 at an upper end which communicates with the openings 56 of the passages 57 and an outlet 44 at a lower end through which the prepared beverage is discharged into a cup or other receptacle. The discharge spout 43 comprises a frusto-conical portion 48 at an upper end and a cylindrical portion 58 at a lower end. The cylindrical portion 58 may have a slight taper such that it narrows towards the outlet 44. The frusto-conical portion 48 helps to channel beverage from the passages 57 down towards the outlet 44 without inducing turbulence to the beverage. An upper surface of the frusto-conical portion 48 is provided with four support webs 49 equi-spaced around the circumference of the cylindrical funnel 40. The support webs 49 define channels 50 therebetween. The upper edges of the support webs 49 are level with one another and perpendicular to the major axis X.

The inner member 3 may be formed as a single integral piece from polypropylene or a similar material as described above and by injection moulding in the same manner as the outer member 2.

5 Alternatively, the inner member 3 and/or the outer member 2 may be made from a biodegradable polymer. Examples of suitable materials include degradable polyethylene (for example, SPITEK supplied by Symphony Environmental, Borehamwood, United Kingdom), biodegradable polyester amide
10 (for example, BAK 1095 supplied by Symphony Environmental), poly lactic acids (PLA supplied by Cargil, Minnesota, USA), starch-based polymers, cellulose derivatives and polypeptides.

 The laminate 5 is formed from two layers, a first layer
15 of aluminium and a second layer of cast polypropylene. The aluminium layer is between 0.02 and 0.07 mm in thickness. The cast polypropylene layer is between 0.025 and 0.065 mm in thickness. In one embodiment the aluminium layer is 0.06 mm and the polypropylene layer is 0.025 mm thick. This
20 laminate is particularly advantageous as it has a high resistance to curling during assembly. As a result the laminate 5 may be pre-cut to the correct size and shape and subsequently transferred to the assembly station on the production line without undergoing distortion. Consequently,
25 the laminate 5 is particularly well suited to welding. Other laminate materials may be used including PET/Aluminium/PP, PE/EVOH/PP, PET/metallised/PP and Aluminium/PP laminates. Roll laminate stock may be used instead of die cut stock.

 The cartridge 1 may be closed by a rigid or semi-rigid
30 lid instead of a flexible laminate.

Assembly of the cartridge 1 involves the following steps:

- a) the inner member 3 is inserted into the outer member 2;
 - 5 b) the filter 4 is cut to shape and placed onto the inner member 3 so to be received over the cylindrical funnel 40 and come to rest against the annular frame 41;
 - c) the inner member 3, outer member 2 and filter 4
10 are joined by ultrasonic welding;
 - d) the cartridge 1 is filled with one or more beverage ingredients;
 - e) the laminate 5 is affixed to the outer member 2.
- These steps will be discussed in greater detail below.
- 15 The outer member 2 is orientated with the open bottom 12 directed upwards. The inner member 3 is then inserted into the outer member 2 with the outer rim 51 being received as a loose fit in an axial extension 14 at top 11 of the cartridge 1. The cylindrical extension 18 of the outer
20 member 2 is at the same time received in the upper portion of the cylindrical funnel 40 of the inner member 3. The third portion 21 of the cylindrical extension 18 is seated inside the cylindrical funnel 40 with the closed lower face 31 of the cylindrical extension 18 bearing against the
25 support webs 49 of the inner member 3. The filter 4 is then placed over the inner member 3 such that the filter material contacts the annular rim 51. An ultrasonic welding process is then used to join the filter 4 to the inner member 3 and at the same time, and in the same process step, the inner
30 member 3 to the outer member 2. The inner member 3 and filter 4 are welded around the outer rim 51. The inner

member 3 and outer member 2 are joined by means of weld lines around the outer rim 51 and also the upper edges of the webs 54.

As shown most clearly in Figure 11, the outer member 2 and inner member 3 when joined together define a void space 130 in the interior 120 below the annular flange 41 and exterior the cylindrical funnel 40 which forms a filtration chamber. The filtration chamber 130 and passages 57 above the annular frame 41 are separated by the filter paper 4.

10 The filtration chamber 130 contains the one or more beverage ingredients 200. The one or more beverage ingredients are packed into the filtration chamber 130. For a filtered style beverage the ingredient is typically roast and ground coffee or leaf tea. The density of packing of the
15 beverage ingredients in the filtration chamber 130 can be varied as desired. Typically, for a filtered coffee product the filtration chamber contains between 5.0 and 10.2 grams of roast and ground coffee in a filtration bed of thickness of typically 5 to 14 mm. Optionally, the interior 120 may
20 contain one or more bodies, such as spheres, which are freely movable within the interior 120 to aid mixing by inducing turbulence and breaking down deposits of beverage ingredients during discharge of the beverage.

The laminate 5 is then affixed to the outer member 2 by
25 forming a weld 126 around the periphery of the laminate 5 to join the laminate 5 to the lower surface of the outwardly extending flange 35. The weld 126 is extended to seal the laminate 5 against the lower edge of the cylindrical wall 27 of the inlet chamber 26. Further, a weld 125 is formed
30 between the laminate 5 and the lower edge of the outer tube 42 of the cylindrical funnel 40 such that the inner member 3

spans between the outer member 2 and the laminate 5. The laminate 5 forms the lower wall of the filtration chamber 130 and also seals the inlet chamber 26 and cylindrical funnel 40. However, a small gap 123 exists prior to dispensation between the laminate 5 and the lower edge of the discharge spout 43. A variety of welding methods may be used, such as heat and ultrasonic welding, depending on the material characteristics of the laminate 5.

Advantageously, the inner member 3 spans between the outer member 2 and the laminate 5. The inner member 3 is formed from a material of relative rigidity, such as polypropylene. As such, the inner member 3 forms a load-bearing member that acts to keep the laminate 5 and outer member 2 spaced apart when the cartridge 1 is compressed. It is preferred that the cartridge 1 is subjected to a compressive load of between 130 and 280N in use, the load being applied by a beverage preparation machine into which the cartridge is inserted. However, with some arrangements of cartridge and machine a lower force of greater than 50N may be utilised. The compressive force acts to prevent the cartridge failing under internal pressurisation and also serves to squeeze the inner member 3 and outer member 2 together. This ensures that the internal dimensions of passageways and apertures in the cartridge 1 are fixed and unable to change during pressurisation of the cartridge 1.

To use the cartridge 1 it is first inserted into a beverage preparation machine and the inlet 121 and outlet 122 are opened by piercing members of the beverage preparation machine which perforate and fold back the laminate 5. An aqueous medium, typically water, under pressure enters the cartridge 1 through the inlet 121 into

the inlet chamber 26 at a pressure of between 0.1-2.0 bar. From there the water is directed to flow through the slots 30 and round the manifold 16 and into the filtration chamber 130 of the cartridge 1 through the plurality of slots 17.

5 The water is forced radially inwardly through the filtration chamber 130 and mixes with the beverage ingredients 200 contained therein. The water is at the same time forced upwardly through the beverage ingredients. The beverage formed by passage of the water through the beverage

10 ingredients passes through the filter 4 and filtration apertures 55 into the passages 57 lying above the annular frame 41. The sealing of the filter 4 onto the spokes 53 and the welding of the rim 51 with the outer member 2 ensures that there are no short-circuits and all the beverage has to

15 pass through the filter 4.

The beverage then flows downwardly along the radial passages 57 formed between the webs 54 and through the openings 56 and into the cylindrical funnel 40. The beverage passes along the channels 50 between the support webs 47 and

20 down the discharge spout 43 to the outlet 44 where the beverage is discharged into a receptacle such as a cup.

Preferably, the beverage preparation machine comprises an air purge facility, wherein compressed air is forced through the cartridge 1 at the end of the operating cycle to

25 flush out the remaining beverage into the receptacle.

A second version of cartridge 1 is shown in Figures 12 to 18. The second version of the cartridge 1 is particularly designed for use in dispensing espresso-style products such as roast and ground coffee where it is desirable to produce

30 a beverage having a froth of tiny bubbles known as a crema. Many of the features of the second version of the cartridge

1 are the same as in the first version and like numerals have been used to reference like features. In the following description the differences between the first and second versions will be discussed. Common features which function
5 in the same manner will not be discussed in detail.

The outer member 2 is of the same construction as in the first version of cartridge 1 and as shown in Figures 1 to 6.

The annular frame 41 of the inner member 3 is the same
10 as in the first version. Also, a filter 4 is disposed on the annular frame 41 so as to cover the filtration apertures 55. The outer tube 42 of the cylindrical funnel 40 is also as before. However, there are a number of differences in the construction of the inner member 2 of the second version
15 compared to the first version. As shown in Figure 16, the discharge spout 43 is provided with a partition 65 which extends part way up the discharge spout 43 from the outlet 44. The partition 65 helps to prevent the beverage spraying and/or splashing as it exits the discharge spout 43. The
20 profile of the discharge spout 43 is also different and comprises a stepped profile with a distinct dog-leg 66 near an upper end of the tube 43.

A rim 67 is provided upstanding from the annular flange 47 joining the outer tube 42 to the discharge spout 43. The
25 rim 67 surrounds the inlet 45 to the discharge spout 43 and defines an annular channel 69 between the rim 67 and the upper portion of the outer tube 42. The rim 67 is provided with an inwardly directed shoulder 68. At one point around the circumference of the rim 67 an aperture 70 is provided
30 in the form of a slot which extends from an upper edge of rim 67 to a point marginally below the level of the shoulder

68 as most clearly shown in Figures 12 and 13. The slot has a width of 0.64 mm.

An air inlet 71 is provided in annular flange 47 circumferentially aligned with the aperture 70 as shown in Figures 16 and 17. The air inlet 71 comprises an aperture passing through the flange 47 so as to provide communication between a point above the flange 47 and the void space below the flange 47 between the outer tube 42 and discharge spout 43. Preferably, and as shown, the air inlet 71 comprises an upper frusto-conical portion 73 and a lower cylindrical portion 72. The air inlet 71 is typically formed by a mould tool such as a pin. The tapered profile of the air inlet 71 allows the mould tool to be more easily removed from the moulded component. The wall of the outer tube 42 in the vicinity of the air inlet 71 is shaped to form a chute 75 leading from the air inlet 71 to the inlet 45 of the discharge spout 43. As shown in Figure 17, a canted shoulder 74 is formed between the air inlet 71 and the chute 75 to ensure that the jet of beverage issuing from the slot 70 does not immediately foul on the upper surface of the flange 47 in the immediate vicinity of the air inlet 71.

As in the first embodiment, the inner member 3 acts as a load-bearing member.

The assembly procedure for the second version of cartridge 1 is similar to the assembly of the first version. However, there are certain differences. As shown in Figure 18, the third portion 21 of the cylindrical extension 18 is seated inside the support rim 67 rather than against support webs. The shoulder 32 of the cylindrical extension 18 between the second portion 20 and third portion 21 bears against the upper edge of the support rim 67 of the inner

member 3. An interface zone 124 is thus formed between the inner member 3 and the outer member 2 comprising a face seal between the cylindrical extension 18 and the support rim 67 which extends around nearly the whole circumference of the cartridge 1. The seal between the cylindrical extension 18 and the support rim 67 is not fluid-tight though since the slot 70 in the support rim 67 extends through the support rim 67 and downwardly to a point marginally below the shoulder 68. Consequently the interface fit between the cylindrical extension 18 and the support rim 67 transforms the slot 70 into an aperture 128, as most clearly shown in Figure 18, providing gas and liquid communication between the annular channel 69 and the discharge spout 43. The aperture is typically 0.64 mm wide by 0.69 mm long.

Operation of the second version of cartridge 1 to dispense a beverage is similar to the operation of the first version but with certain differences. Beverage in the radial passages 57 flows downwardly along the passages 57 formed between the webs 54 and through the openings 56 and into the annular channel 69 of the cylindrical funnel 40. From the annular channel 69 the beverage is forced under pressure through the aperture 128 by the back pressure of beverage collecting in the filtration chamber 130 and passages 57. The beverage is thus forced through aperture 128 as a jet and into an expansion chamber formed by the upper end of the discharge spout 43. As shown in Figure 18, the jet of beverage passes directly over the air inlet 71. As the beverage enters the discharge spout 43 the pressure of the beverage jet drops. As a result air is entrained into the beverage stream in the form of a multitude of small air bubbles as the air is drawn up through the air inlet 71. The

jet of beverage issuing from the aperture 128 is funnelled downwards to the outlet 44 where the beverage is discharged into a receptacle such as a cup where the air bubbles form the desired crema. Thus, the aperture 128 and the air inlet 5 71 together form an eductor which acts to entrain air into the beverage. Flow of beverage into the eductor should be kept as smooth as possible to reduce pressure losses. Advantageously, the walls of the eductor should be made concave to reduce losses due to 'wall effect' friction. The 10 dimensional tolerance of the aperture 128 is small. Preferably the aperture size is fixed plus or minus 0.02 mm². Hairs, fibrils or other surface irregularities can be provided within or at the exit of the eductor to increase the effective cross-sectional area which has been found to 15 increase the degree of air entrainment.

A third version of cartridge 1 is shown in Figures 19 to 29. The third version of the cartridge 1 is particularly designed for use in dispensing soluble products which may be in powdered, liquid, syrup, gel or similar form. The soluble 20 product is dissolved by or forms a suspension in, an aqueous medium such as water when the aqueous medium is passed, in use, through the cartridge 1. Examples of beverages include chocolate, coffee, milk, tea, soup or other rehydratable or aqueous-soluble products. Many of the features of the third 25 version of the cartridge 1 are the same as in the previous versions and like numerals have been used to reference like features. In the following description the differences between the third and previous versions will be discussed. Common features which function in the same manner will not 30 be discussed in detail.

Compared to the outer member 2 of the previous versions, the hollow inwardly directed cylindrical extension 18 of the outer member 2 of the third version has a larger overall diameter as shown in Figure 20. In particular the diameter of the first portion 19 is typically between 16 and 18 mm compared to 13.2 mm for the outer member 2 of the previous versions. In addition, the first portion 19 is provided with a convex outer surface 19a, or bulge, as most clearly shown in Figure 20, the function of which will be described below. The diameter of the third portions 21 of the cartridges 1 are however the same resulting in the area of the shoulder 32 being greater in this, the third version of the cartridge 1. Typically the volume of the cartridge 1 when assembled is 32.5 ml $\pm$ 20%.

The number and positioning of the slots in the lower end of the annular wall 13 is also different. Between 3 and 5 slots are provided. In the embodiment as shown in Figure 23, four slots 36 are provided equi-spaced around the circumference of the manifold 16. The slots 36 are slightly wider than in the previous versions of the cartridge 1 being between 0.35 and 0.45 mm, preferably 0.4 mm wide.

In other respects the outer members 2 of the cartridges 1 are the same.

The construction of the cylindrical funnel 40 of the inner member 3 is the same as in the first version of cartridge 1 with an outer tube 42, discharge spout 45, annular flange 47 and support webs 49 being provided. The only difference is that the discharge spout 45 is shaped with an upper frusto-conical section 92 and a lower cylindrical section 93.

In contrast to the previous versions and as shown in Figures 24 to 28, the annular frame 41 is replaced by a skirt portion 80 which surrounds the cylindrical funnel 40 and is joined thereto by means of eight radial struts 87 which adjoin the cylindrical funnel 40 at or near the annular flange 47. A cylindrical extension 81 of the skirt portion 80 extends upwardly from the struts 87 to define a chamber 90 with an open upper face. An upper rim 91 of the cylindrical extension 81 has an in-turned profile as shown in Figure 26. An annular wall 82 of the skirt portion 80 extends downwardly from the struts 87 to define an annular channel 86 between the skirt portion 80 and the outer tube 42.

The annular wall 82 comprises at a lower end an exterior flange 83 which lies perpendicular to the major axis X. A rim 84 depends downwardly from a lower surface of the flange 83 and contains five apertures 85 which are circumferentially equi-spaced around the rim 84. Thus, the rim 84 is provided with a castellated lower profile.

Apertures 89 are provided between the struts 87 allowing communication between the chamber 90 and the annular channel 86.

As in the first embodiment, the inner member 3 acts as a load-bearing member.

The assembly procedure for the third version of cartridge 1 is similar to the assembly of the first version but with certain differences. The outer member 2 and inner member 3 are push-fitted together as shown in Figure 29 and retained by means of a snap-fit arrangement rather than welded together. On joining the two members the inwardly directed cylindrical extension 18 is received inside the

upper cylindrical extension 81 of the skirt portion 80. The inner member 3 is retained in the outer member 2 by frictional interengagement of the convex outer surface 19a of the first portion 19 of the cylindrical extension 18 with the in-turned rim 91 of the upper cylindrical extension 81. With the inner member 3 located in the outer member 2 a mixing chamber 134 is defined located exterior to the skirt portion 80. The mixing chamber 134 contains the beverage ingredients 200 prior to dispensation. It should be noted that the four inlets 36 and the five apertures 85 are staggered circumferentially with respect to one another. The radial location of the two parts relative to each other need not be determined or fixed during assembly since the use of four inlets 36 and five apertures 85 ensures that misalignment occurs between the inlets and apertures whatever the relative rotational positioning of the components. Other numbers of inlet and outlet apertures can be provided as found by the formula:

$$X_o = X_i + C$$

where

X_i = the number of inlet apertures

X_o = the number of outlet apertures

C = the set of positive or negative integers not including 0 or nX_i

n = any integer.

Alternatively, the same number of inlet and outlet apertures can be provided non-equispaced around the

cartridge to ensure that the inlets and outlets are not aligned.

The one or more beverage ingredients are packed into the mixing chamber 134 of the cartridge. The density of
5 packing of the beverage ingredients in the mixing chamber 134 can be varied as desired.

The laminate 5 is then affixed to the outer member 2 and inner member 3 in the same manner as described above in the previous versions.

10 In use, water enters the mixing chamber 134 through the four slots 36 in the same manner as previous versions of the cartridge. The water is forced radially inwardly through the mixing chamber and mixes with the beverage ingredients contained therein. The product is dissolved or mixed in the
15 water and forms the beverage in the mixing chamber 134 and is then driven through the apertures 85 into the annular channel 86 by back pressure of beverage and water in the mixing chamber 134. The circumferential staggering of the four inlet slots 36 and the five apertures 85 ensures that
20 jets of water are not able to pass radially directly from the inlet slots 36 to the apertures 85 without first circulating within the mixing chamber 134. In this way the degree and consistency of dissolution or mixing of the product is significantly increased. The beverage is forced
25 upwardly in the annular channel 86, through the apertures 89 between the struts 87 and into the chamber 90. The beverage passes from chamber 90 through the inlets 45 between the support webs 49 into the discharge spout 43 and towards the outlet 44 where the beverage is discharged into a receptacle
30 such as a cup. The cartridge finds particular application with beverage ingredients in the form of viscous liquids or

gels. In one application a liquid chocolate ingredient is contained in the cartridge 1 with a viscosity of between 1700 and 3900mPa at ambient temperature and between 5000 and 10000mPa at 0°C and a refractive solids of 67 Brix $\pm$ 3. In
5 another application liquid coffee is contained in the cartridge 1 with a viscosity of between 70 and 2000mPa at ambient and between 80 and 5000mPa at 0°C where the coffee has a total solids level of between 40 and 70%%. The liquid coffee ingredient may contain between 0.1 and 2.0% by weight
10 sodium bicarbonate, preferably between 0.5 and 1.0% by weight. The sodium bicarbonate acts to maintain the pH level of the coffee at or below 4.8 enabling a shelf-life for coffee-filled cartridges of up to 12 months.

A fourth version of cartridge 1 is shown in Figures 30
15 to 34. The fourth version of the cartridge 1 is particularly designed for use in dispensing liquid products such as concentrated liquid milk. Many of the features of the fourth version of the cartridge 1 are the same as in the previous versions and like numerals have been used to reference like
20 features. In the following description the differences between the fourth and previous versions will be discussed. Common features which function in the same manner will not be discussed in detail.

The outer member 2 is the same as in the third version
25 of cartridge 1 and as shown in Figures 19 to 23.

The cylindrical funnel 40 of the inner member 3 is similar to that shown in the second version of cartridge 1 but with certain differences. As shown in Figure 30 the discharge spout 43 is shaped with an upper frusto-conical
30 section 106 and a lower cylindrical section 107. Three axial ribs 105 are provided on the inner surface of the

discharge spout 43 to direct the dispensed beverage downwards towards the outlet 44 and prevent the discharged beverage from spinning within the spout. Consequently, the ribs 105 act as baffles. As in the second version of
5 cartridge 1, an air inlet 71 is provided through the annular flange 47. However, the chute 75 beneath the air inlet 71 is more elongated than in the second version.

A skirt portion 80 is provided similar to that shown in the third version of the cartridge 1 described above.

10 Between 5 and 12 apertures 85 are provided in the rim 84. Typically ten apertures are provided rather than the five provided in the third version of cartridge 1.

An annular bowl 100 is provided extending from and integral with the flange 83 of the skirt portion 80. The
15 annular bowl 100 comprises a flared body 101 with an open upper mouth 104 which is directed upwards. Four feed apertures 103 shown in Figures 30 and 31 are located in the body 101 at or near the lower end of the bowl 100 where it joins the skirt portion 80. Preferably, the feed apertures
20 are equi-spaced around the circumference of the bowl 100.

As in the first embodiment, the inner member 3 acts as a load-bearing member.

The laminate 5 is of the type described above in the previous embodiments.

25 The assembly procedure for the fourth version of cartridge 1 is the same as that for the third version.

Operation of the fourth version of cartridge is similar to that of the third version. The water enters the cartridge 1 and the mixing chamber 134 in the same manner as
30 before. There the water mixes with and dilutes the liquid product which is then forced out below the bowl 100 and

through the apertures 85 towards the outlet 44 as described above. The proportion of the liquid product initially contained within the annular bowl 100 as shown in Figure 34 is not subject to immediate dilution by the water entering the mixing chamber 134. Rather, the diluted liquid product in the lower part of the mixing chamber 134 will tend to exit through apertures 85 rather than be forced up and into the annular bowl 100 through upper mouth 104. Consequently, the liquid product in the annular bowl 100 will remain relatively concentrated during the initial stages of the operating cycle compared to the product in the lower part of the mixing chamber 134. The liquid product in the annular bowl 100 drips through the feed apertures 103 under gravity into the stream of product exiting the mixing chamber 134 through the apertures 85 and below the bowl 100. The annular bowl 100 acts to even out the concentration of the diluted liquid product entering the cylindrical funnel 40 by holding back a proportion of the concentrated liquid product and releasing it into the exiting liquid stream flow path steadily throughout the dispensation operating cycle as illustrated in Figure 35a where the concentration of the milk measured as a percentage of the total solids present is shown during an operating cycle of approximately 15 seconds. Line a illustrates the concentration profile with the bowl 100 whilst line b illustrates a cartridge without the bowl 100. As can be seen the concentration profile with the cup 100 is more even during the operating cycle and there is no immediate large drop in concentration as occurs without the bowl 100. The initial concentration of the milk is typically 30-35% SS and at the end of the cycle 10% SS. This results in a dilution ratio of around 3 to 1, although dilution

ratios of between 1 to 1 and 6 to 1 are possible with the present invention. For other liquid beverage ingredients the concentrations may vary. For example for liquid chocolate the initial concentration is approximately 67% SS and at the
5 end of the cycle 12-15% SS. This results in a dilution ratio (ratio of aqueous medium to beverage ingredient in dispensed beverage) of around 5 to 1, although dilution ratios of between 2 to 1 and 10 to 1 are possible with the present invention. For liquid coffee the initial concentration is
10 between 40-67% and the concentration at the end of dispense 1-2% SS. This results in a dilution ratio of between 20 to 1 and 70 to 1, although dilution ratios of between 10 to 1 and 100 to 1 are possible with the present invention.

From the annular channel 86 the beverage is forced
15 under pressure through the aperture 128 by the back pressure of beverage collecting in the filtration chamber 134 and chamber 90. The beverage is thus forced through aperture 128 as a jet and into an expansion chamber formed by the upper end of the discharge spout 43. As shown in Figure 34, the
20 jet of beverage passes directly over the air inlet 71. As the beverage enters the discharge spout 43 the pressure of the beverage jet drops. As a result air is entrained into the beverage stream in the form of a multitude of small air bubbles as the air is drawn up through the air inlet 71.
25 The jet of beverage issuing from the aperture 128 is funnelled downwards to the outlet 44 where the beverage is discharged into a receptacle such as a cup where the air bubbles form the desired frothy appearance.

Advantageously, the inner member 3, outer member 2,
30 laminate 5 and filter 4 can all be readily sterilised due to the components being separable and not individually

comprising tortuous passageways or narrow crevices. Rather, it is only after conjoining the components, after sterilisation, that the necessary passageways are formed. This is particularly important where the beverage ingredient
5 is a dairy-based product such as liquid milk concentrate.

The fourth embodiment of beverage cartridge is particularly advantageous for dispensing a concentrated dairy-based liquid product such as liquid milk. Previously, powdered milk products have been provided in the form of
10 sachets for adding to a pre-prepared beverage. However, for a cappuccino-style beverage it is necessary to foam the milk. This has been achieved previously by passing steam through a liquid milk product. However this necessitates the provision of a steam supply which increases the cost and
15 complexity of the machine used to dispense the beverage. The use of steam also increases the risk of injury during operation of the cartridge. Accordingly the present invention provides for a beverage cartridge having a concentrated dairy-based liquid product therein. It has been
20 found that by concentrating the milk product a greater amount of foam can be produced for a particular volume of milk when compared to fresh or UHT milk. This reduces the size required for the milk cartridge. Fresh semi-skimmed milk contains approximately 1.6% fat and 10% total solids.
25 The concentrated liquid milk preparations of the present invention contain between 0.1 and 12% fat and 25 to 40% total solids. In a typical example, the preparation contains 4% fat and 30% total solids. The concentrated milk preparations are suitable for foaming using a low pressure
30 preparation machine as will be described below. In particular, foaming of the milk is achieved at pressures

below 2 bar, preferably approximately 1.5 bar using the cartridge of the fourth embodiment described above.

The foaming of the concentrated milk is particularly advantageous for beverages such as cappuccinos and milk shakes. Preferably the passing of the milk through the aperture 128 and over the air inlet 71 and the optional use of the bowl 100 enables foaming levels of greater than 40%, preferably greater than 70% for milk. For liquid chocolate foaming levels of greater than 70% are possible. For liquid coffee foaming levels of greater than 70% are possible. The foamability level is measured as the ratio of the volume of the foam produced to the volume of liquid beverage ingredient dispensed. For example, where 138.3ml of beverage is dispensed, of which 58.3ml is foam the foamability is measured as $[58.3/(138.3-58.3)]*100 = 72.9\%$. The foamability of the milk (and other liquid ingredients) is enhanced by the provision of the bowl 100 as can be seen in Figure 35b. The foamability of the milk dispensed with the bowl 100 present (line a) is greater than that of milk dispensed without the bowl present (line b). This is because the foamability of the milk is positively correlated to the concentration of the milk and as shown in Figure 35a the bowl 100 maintains a higher concentration of the milk a larger part of the operating cycle. It is also known that foamability of the milk is positively correlated to temperature of the aqueous medium as shown in Figure 35c. Thus the bowl 100 is advantageous since more of the milk remains in the cartridge until near the end of the operating cycle when the aqueous medium is at its hottest. This again improves foamability.

The cartridge of the fourth embodiment is also advantageous in dispensing liquid coffee products.

It has been found that the embodiments of beverage cartridge of the present invention advantageously provide an improved consistency of the dispensed beverage when compared to prior art cartridges. Reference is made to Table 1 below which shows the results of brew yields for twenty samples each of cartridges A and B containing roast and ground coffee. Cartridge A is a beverage cartridge according to the first embodiment of the present invention. Cartridge B is a prior art beverage cartridge as described in the applicant's document WO01/58786. The refractive index of the brewed beverage is measured in Brix units and converted to a percentage of soluble solids (%SS) using standard tables and formulae. In the examples below:

$$\%SS = 0.7774 * (\text{Brix value}) + 0.0569.$$

$$\% \text{ Yield} = (\%SS * \text{Brew Volume (g)}) / (100 * \text{Coffee Weight (g)})$$

Table 1

CARTRIDGE A

Sample	Brew Volume (g)	Coffee Weight (g)	Brix	% SS (*)	% Yield
1	105.6	6.5	1.58	1.29	20.88
2	104.24	6.5	1.64	1.33	21.36
3	100.95	6.5	1.67	1.36	21.05
4	102.23	6.5	1.71	1.39	21.80
5	100.49	6.5	1.73	1.40	21.67
6	107.54	6.5	1.59	1.29	21.39
7	102.70	6.5	1.67	1.36	21.41
8	97.77	6.5	1.86	1.50	22.61
9	97.82	6.5	1.7	1.38	20.75

10	97.83	6.5	1.67	1.36	20.40
11	97.6	6.5	1.78	1.44	21.63
12	106.64	6.5	1.61	1.31	21.47
13	99.26	6.5	1.54	1.25	19.15
14	97.29	6.5	1.59	1.29	19.35
15	101.54	6.5	1.51	1.23	19.23
16	104.23	6.5	1.61	1.31	20.98
17	97.5	6.5	1.73	1.40	21.03
18	100.83	6.5	1.68	1.36	21.14
19	101.67	6.5	1.67	1.36	21.20
20	101.32	6.5	1.68	1.36	21.24
				AVERAGE	20.99

CARTRIDGE B

Sample	Brew Volume (g)	Coffee Weight (g)	Brix	% SS (*)	% Yield
1	100.65	6.5	1.87	1.511	23.39
2	95.85	6.5	1.86	1.503	22.16
3	98.4	6.5	1.8	1.456	22.04
4	92.43	6.5	2.3	1.845	26.23
5	100.26	6.5	1.72	1.394	21.50
6	98.05	6.5	2.05	1.651	24.90
7	99.49	6.5	1.96	1.581	24.19
8	95.62	6.5	2.3	1.845	27.14
9	94.28	6.5	2.17	1.744	25.29
10	96.13	6.5	1.72	1.394	20.62
11	96.86	6.5	1.81	1.464	21.82
12	94.03	6.5	2.2	1.767	25.56
13	96.28	6.5	1.78	1.441	21.34
14	95.85	6.5	1.95	1.573	23.19
15	95.36	6.5	1.88	1.518	22.28
16	92.73	6.5	1.89	1.526	21.77
17	88	6.5	1.59	1.293	17.50
18	93.5	6.5	2.08	1.674	24.08
19	100.88	6.5	1.75	1.417	22.00
20	84.77	6.5	2.37	1.899	24.77
				AVERAGE	23.09

Performing a t-test statistical analysis on the above data gives the following results:

Table 2

t-Test: Two-Sample Assuming Equal Variances

	% Yield (Cartridge A)	% Yield (Cartridge B)
Mean	20.99	23.09
Variance	0.77	5.04
Observations	20	20
Pooled Variance	2.90	
Hypothesized Mean Difference	0	
df	38	
t Stat	-3.90	
P(T<=t) one-tail	0.000188	
t Critical one-tail	1.686	
P(T<=t) two-tail	0.000376	
t Critical two-tail	2.0244	
Standard Deviation	0.876	2.245

The analysis shows that the consistency of % yield, which equates to brew strength, for the cartridges of the present invention is significantly better (at a 95% confidence level) than the prior art cartridges, with a standard deviation of 0.88% compared to 2.24%. This means that beverages dispensed with the cartridges of the present invention have a more repeatable and uniform strength. This is preferred by consumers who like their drinks to taste the same time after time and do not want arbitrary changes in drink strength.

Whilst the first and second versions of the cartridge have been described as being assembled by means of a welding operation they may equally be assembled by means of a snap-fit arrangement in accordance with the present invention. For example, the outer member 2 could be provided with a formation which co-operates with the periphery of the annular frame 41 to form a snap-fit.

The materials of the cartridges described above may be provided with a barrier coating to improve their resistance to oxygen and/or moisture and/or other contaminant ingress. The barrier coating may also improve the resistance to

5 leakage of the beverage ingredients from within the cartridges and/or reduce the degree of leaching of extractibles from the cartridge materials which might adversely affect the beverage ingredients. The barrier coating may be of a material selected from the group of PET,

10 Polyamide, EVOH, PVDC or a metallised material. The barrier coating may be applied by a number of mechanisms including but not limited to vapour deposition, vacuum deposition, plasma coating, co-extrusion, in-mould labelling and two/multi-stage moulding.

Claims:

1. A cartridge (1) containing one or more beverage ingredients (200) and being formed from substantially
5 air- and water-impermeable materials, the cartridge comprising an inlet (121) for the introduction of an aqueous medium into the cartridge and an outlet (122) for discharge of a beverage produced from the one or more beverage ingredients, wherein the cartridge
10 comprises an outer member (2) and an inner member (3) conjoined on assembly with the outer member, characterised by the inner member comprising a discharge spout (43) defining the outlet of the cartridge.
15
2. A cartridge (1) as claimed in claim 1 wherein the discharge spout (43) is integral with the inner member (3).
- 20 3. A cartridge (1) as claimed in claim 1 or claim 2 wherein the discharge spout (43) comprises a tapered portion (45; 92).
4. A cartridge (1) as claimed in any preceding claim
25 wherein the discharge spout (43) comprises a cylindrical portion (58; 93).
5. A cartridge (1) as claimed in any preceding claim
30 wherein the discharge spout (43) comprises a partition (65) extending at least part way along the length of the discharge spout.

6. A cartridge (1) as claimed in any preceding claim wherein a snap-fit arrangement is provided to conjoin the outer member and the inner member.
- 5
7. A cartridge (1) as claimed in claim 6 wherein the snap-fit arrangement comprises co-operating formations (19, 91) on the inner member and the outer member.
- 10 8. A cartridge (1) as claimed in claim 6 or claim 7 wherein the outer member (3) comprises a closed first end (11) and an open second end (12), wherein with the inner member conjoined to the outer member the outlet (44) of the discharge spout is directed towards the
- 15 open second end.
9. A cartridge (1) as claimed in claim 8 wherein the inlet (121) is directed towards the open second end of the outer member.
- 20
10. A cartridge (1) as claimed in any of claims 8 to 9 wherein the outer member and inner member are conjoined at or near the closed first end (11) of the outer member.
- 25
11. A cartridge (1) as claimed in any of claims 6 to 10 wherein the outer member comprises an inwardly directed extension (18) which is received in a proximal end of the discharge spout on conjoining of the outer member
- 30 and the inner member.

12. A cartridge (1) as claimed in any of claims 6 to 11 wherein the inner member (3) comprises a frame (41) having a filter (4) disposed thereupon.
- 5 13. A cartridge (1) as claimed in claim 12 wherein one or more passages (57) are defined between the frame (41) and a closed first end (11) of the outer member when the inner member and outer member are conjoined.
- 10 14. A cartridge (1) as claimed in claim 13 wherein the one or more passages (57) are delimited by webs (54) extending upwardly from the frame to the closed first end of the outer member.
- 15 15. A cartridge (1) as claimed in claim 13 or claim 14 wherein the one or more passages (57) slope downwardly towards the discharge spout (43).
16. A cartridge (1) as claimed in any of claims 6 to 11
20 wherein the inner member (3) further comprises a skirt (80) surrounding the discharge spout.
17. A cartridge (1) as claimed in claim 16 wherein the skirt (80) comprises an upper extension (81) which, on
25 assembly of the cartridge, contacts the closed first end (11) of the cartridge.
18. A cartridge (1) as claimed in claim 17 wherein an upper rim (91) of the upper extension (81) engages a co-
30 operating formation (18, 19) of the outer member to

form a snap-fit arrangement for conjoining the inner member to the outer member.

19. A cartridge (1) as claimed in claim 18 wherein the co-
5 operating formation of the outer member is an inwardly directed extension (18).
20. A cartridge (1) as claimed in any preceding claim wherein the cartridge is disc-shaped.
- 10 21. A cartridge (1) as claimed in any preceding claim further comprising means for producing a jet of the beverage, which means comprises an aperture (70) in a beverage flow path between the inlet and the outlet.
- 15 22. A cartridge (1) as claimed in any preceding claim wherein the inlet (121) and/or outlet (122) is covered by a substantially air- and water-impermeable material prior to the formation, in use, of the inlet and/or
20 outlet in the cartridge.
23. A cartridge (1) as claimed in any preceding claim wherein the inlet and/or outlet is covered by a substantially air- and water-impermeable laminate (5).
- 25 24. A cartridge (1) as claimed in claim 23 wherein the laminate is polypropylene.
- 30 25. A cartridge (1) as claimed in any preceding claim wherein the outer member and/or inner member are formed from polypropylene.

26. A cartridge (1) as claimed in any preceding claim wherein the outer member and/or inner member are formed from a biodegradable polymer.
- 5
27. A cartridge (1) as claimed in any preceding claim wherein the outer member and/or inner member is formed by injection moulding.
- 10
28. A cartridge (1) as claimed in any preceding claim wherein the inner member forms a load-bearing member.
29. A plurality of cartridges (1), each cartridge as claimed in any preceding claim, wherein the percentage
- 15
- yield of the beverage produced from the one or more beverage ingredients contained in the cartridges is consistent to within 1.0 standard deviations.
30. A cartridge (1) containing one or more beverage
- 20
- ingredients (200) and being formed from substantially air- and water-impermeable materials, said cartridge comprising an inlet (121) for the introduction of an aqueous medium into the cartridge, and an outlet (122) for a beverage produced from said one or more beverage
- 25
- ingredients, wherein said cartridge comprises an outer member (2), an inner member (3) inserted in the outer member and means for producing a jet of the beverage, wherein said means for producing the jet of the beverage comprises an aperture (128) in a beverage flow
- 30
- path linking the inlet to the outlet, characterised in

that the aperture (128) is delimited by an interface between the inner member and the outer member.

31. A cartridge (1) as claimed in claim 30 wherein one of
5 the inner member (3) or outer member (2) comprises an opening (70) and the other of the inner member or outer member comprises an obstruction (18), wherein on insertion of the inner member in the outer member, the obstruction (18) partially obstructs the opening (70)
10 to so delimit the aperture (128).
32. A cartridge (1) as claimed in claim 31 wherein the opening (70) comprises an elongated slot.
- 15 33. A cartridge (1) as claimed in claim 32 wherein the inner member (3) comprises said elongated slot (70).
34. A cartridge (1) as claimed in claim 33 wherein the outer member (2) comprises the obstruction (18).
20
35. A cartridge (1) as claimed in claim 34 wherein the obstruction (18) comprises an extension of the outer member at least a part of which projects into the inner member.
25
36. A cartridge (1) as claimed in any of claims 33 to 35 wherein the elongated slot (70) is formed in a cylindrical wall (67) of the inner member.

37. A cartridge (1) as claimed in claim 36 wherein the elongated slot (70) extends to the upper edge of the cylindrical wall (67).
- 5 38. A cartridge (1) as claimed in claim 36 wherein the extension (18) of the outer member (2) is a cylindrical extension which is received as a sliding fit within the cylindrical wall (67) of the inner member.
- 10 39. A cartridge (1) as claimed in any of claims 30 to 38 wherein the aperture (128) has a cross-sectional area of 0.4 to 0.7 mm².
40. A cartridge (1) as claimed in any of claims 30 to 39
15 further comprising at least one inlet (71) for air and means for generating a pressure reduction of the jet of beverage, whereby, in use, air from the at least one air inlet (71) is incorporated into the beverage as a plurality of small bubbles.
- 20 41. A cartridge (1) as claimed in claim 40 wherein the at least one air inlet (71) is provided in the inner member (3) downstream of the aperture (128).
- 25 42. A cartridge (1) as claimed in claim 40 or claim 41 wherein the inner member (3) comprises a discharge spout (43) defining the outlet (122).
- 30 43. A cartridge (1) as claimed in claim 42 wherein the jet of beverage issuing from the aperture (128) is directed into the discharge spout (43).

44. A cartridge (1) as claimed in claim 43 wherein the jet
of beverage impinges a surface of the discharge spout
(43) between issuing from the aperture (128) and
5 exiting the outlet (122).
45. A cartridge (1) as claimed in claim 44 wherein the
surface is a concave wall of the discharge spout (43).
- 10 46. A cartridge (1) as claimed in claim 45 wherein the
concave wall is positioned on an opposite side of the
discharge spout (43) from the aperture (128).
47. A cartridge (1) as claimed in any of claims 30 to 46
15 wherein the aperture (128) directs the beverage to flow
at an angle substantially perpendicular to a flow of
beverage out of the outlet (122).
48. A cartridge (1) as claimed in any of claims 42 to 47
20 wherein the discharge spout (43) is integral with the
inner member (3).
49. A cartridge (1) as claimed in any of claims 30 to 48
wherein the cartridge is disc-shaped.
25
50. A cartridge (1) as claimed in any of claims 30 to 49
wherein the outer member (2) and/or inner member (3)
are formed from polypropylene.

51. A cartridge (1) as claimed in any of claims 30 to 50 wherein the outer member (2) and/or inner member (3) are formed from a biodegradable polymer.
- 5 52. A cartridge (1) as claimed in any of claims 30 to 51 wherein the outer member (2) and/or inner member (3) is formed by injection moulding.
- 10 53. A cartridge (1) containing one or more beverage ingredients (200) and being formed from substantially air- and water-impermeable materials, the cartridge comprising a compartment (134) containing the one or more beverage ingredients, the compartment comprising a plurality of inlet apertures (36) for the introduction of an aqueous medium into the compartment and a plurality of outlet apertures (85) for a beverage produced from the one or more beverage ingredients, wherein at least a proportion of the inlet apertures are out of alignment with the outlet apertures such that at least a proportion of the aqueous medium entering the compartment through the inlet apertures is forced to circulate within the compartment before exiting the compartment through the outlet apertures, characterised in that the inlet apertures (36) are arranged around the periphery of the compartment.
- 15 20 25
54. A cartridge (1) as claimed in claim 53 wherein the inlet apertures (36) are equi-spaced around the compartment periphery.

55. A cartridge (1) as claimed in any of claims 53 to 54 wherein the outlet apertures (85) are located towards a centre of the compartment relative to the inlet apertures.

5

56. A cartridge (1) as claimed in claim 55 wherein the outlet apertures (85) are equi-spaced around the centre of the compartment.

10 57. A cartridge (1) as claimed in any of claims 53 to 56 comprising 3 to 10 inlet apertures (36).

58. A cartridge (1) as claimed in claim 57 comprising 4 inlet apertures (36).

15

59. A cartridge (1) as claimed in any of claims 53 to 58 comprising 3 to 10 outlet apertures (85).

20 60. A cartridge (1) as claimed in claim 59 comprising 5 outlet apertures (85).

61. A cartridge (1) as claimed in any of claims 53 to 60 comprising unequal numbers of inlet apertures (36) and outlet apertures (85).

25

62. A cartridge (1) as claimed in any of claims 53 to 61 wherein the number of inlet apertures (36) and outlet apertures (85) are given by the formula:

30 $X_o = X_i + C$

where

X_1 = the number of inlet apertures

X_0 = the number of outlet apertures

5 C = the set of integers not including 0 or nX_1

n = any integer.

63. A cartridge (1) as claimed in of claims 53 to 60
10 comprising equal numbers of inlet apertures (36) and
outlet apertures (85).

64. A cartridge (1) as claimed in any of claims 53 to 63
15 wherein the inlet apertures (36) are provided in an
outer member (2) of the cartridge and the outlet
apertures (85) are provided in an inner member (3) of
the cartridge.

65. A cartridge (1) as claimed in claim 64 wherein the
20 inner member (3) comprises a discharge spout (43)
communicating with the outlet apertures (85).

66. A cartridge (1) as claimed in any of claims 53 to 65
wherein the cartridge is disc-shaped.

25 67. A cartridge (1) as claimed in claim 66 wherein the flow
of aqueous medium through the inlet apertures (36) into
the compartment (134) is directed radially inwards
towards a centre of the cartridge.

68. A cartridge (1) as claimed in any of claims 53 to 67 wherein the one or more beverage ingredients (200) are soluble in the aqueous medium.
- 5 69. A cartridge (1) as claimed in claim 68 wherein the one or more beverage ingredients (200) is a liquid chocolate or coffee ingredient.
- 10 70. A cartridge (1) as claimed in any of claims 53 to 69 wherein the one or more beverage ingredients (200) is a concentrated liquid or gel.
- 15 71. A cartridge (1) as claimed in any of claims 53 to 70 wherein the liquid beverage ingredient (200) has a viscosity of between 70 and 3900mPa at ambient temperature.
- 20 72. A cartridge (1) as claimed in claim 71 wherein the liquid beverage ingredient (200) has a viscosity of between 1700 and 3900mPa at ambient temperature.
- 25 73. A cartridge (1) as claimed in claim 72 wherein the outer member (2) and/or inner member (3) are formed from polypropylene.
74. A cartridge (1) as claimed in claim 73 wherein the outer member (2) and/or inner member (3) is formed by injection moulding.

75. A cartridge (1) as claimed in any of claims 53 to 74 wherein the outer member (2) and/or inner member (3) are formed from a biodegradable polymer.
- 5 76. A cartridge (1) containing one or more beverage ingredients (200) and being formed from substantially air- and water-impermeable materials, the cartridge comprising an outer member (2) defining a storage chamber (130; 134) in which is stored the one or more
10 beverage ingredients and an inner member (3) having a discharge spout (43) forming an outlet (122) for outflow of beverage formed from the one or more beverage ingredients, characterised in that the inner member (3) forms a load-bearing member.
- 15 77. A cartridge (1) as claimed in claim 76 wherein the inner member (3) and outer member (2) are separate components which are conjoined during assembly of the cartridge.
- 20 78. A cartridge (1) as claimed in claim 76 or claim 77 further comprising a filter (4) conjoined to the inner member (3).
- 25 79. A cartridge (1) as claimed in any of claims 76 to 78 wherein the inner member (3) forms a load-bearing member of sufficient rigidity such that the cartridge can withstand a compressive load of greater than 130N.
- 30 80. A cartridge (1) as claimed in claim 79 wherein the load-bearing member is of sufficient rigidity such that

the cartridge can withstand a compressive force of greater than 200N.

- 5 81. A cartridge (1) as claimed in any of claims 76 to 80 wherein the load-bearing member is of sufficient rigidity such that the load-bearing member can withstand a compressive force of greater than 130N.
- 10 82. A cartridge (1) as claimed in any of claims 76 to 81 wherein the inner member (3) is formed from polypropylene.
- 15 83. A cartridge (1) as claimed in any of claims 76 to 82 wherein the outer member (2) and/or inner member (3) are formed from a biodegradable polymer.
- 20 84. A cartridge (1) as claimed in any of claims 76 to 83 wherein the inner member (3) and discharge spout (43) are formed as one piece.
- 25 85. A cartridge (1) containing one or more beverage ingredients (200) and being formed from substantially air- and water-impermeable materials, the cartridge comprising a housing having a closed first end (11) and an open second end (12), the housing defining a storage chamber (130; 134) in which is stored the one or more beverage ingredients, wherein the open second end of the housing is sealed by a lid (5), characterised by the cartridge further comprising a load-bearing member
- 30 spanning between the closed first end of the housing

and the lid, wherein the load-bearing member is located at or near a centre of the cartridge.

- 5 86. A cartridge (1) as claimed in claim 85 wherein the load-bearing member comprises a discharge spout (43) forming an outlet (122) for outflow of beverage formed from the one or more beverage ingredients.
- 10 87. A cartridge (1) as claimed in any of claims 85 to 86 wherein the load-bearing member is of sufficient rigidity such that the cartridge can withstand a compressive load of greater than 130N.
- 15 88. A cartridge (1) as claimed in claim 87 wherein the load-bearing member is of sufficient rigidity such that the cartridge can withstand a compressive force of greater than 200N.
- 20 89. A cartridge (1) as claimed in any of claims 85 to 88 wherein the load-bearing member is of sufficient rigidity such that the load-bearing member can withstand a compressive force of greater than 130N.
- 25 90. A cartridge (1) containing one or more beverage ingredients (200) and being formed from substantially air- and water-impermeable materials, the cartridge comprising an outer member (2) defining a storage chamber (130) in which is stored the one or more beverage ingredients, an inner member (3) having a discharge spout (43) forming an outlet (122) for outflow of beverage formed from the one or more
- 30

beverage ingredients, and a filter (4) disposed between the storage chamber and the discharge spout, characterised in that the inner member and filter are conjoined in one operation to the outer member by means of at least one weld.

91. A cartridge (1) as claimed in claim 90 wherein the outer member (2) has an opening (12) for accessing the storage chamber (130), wherein the inner member and filter are conjoined to the outer member at a base (11) remote from the opening.

92. A cartridge (1) as claimed in claim 90 or claim 91 wherein the inner member, outer member and filter are annular.

93. A cartridge (1) as claimed in claim 92 wherein the weld is substantially circular.

94. A cartridge (1) as claimed in any of claims 91 to 93 wherein the inner member and outer member are of plastics materials and the at least one weld is an ultrasonically-formed weld.

95. A cartridge (1) as claimed in any of claims 90 to 94 wherein the inner member comprises a frame (41) and the at least one weld is formed round a periphery of said frame.

96. A cartridge (1) as claimed in claim 95 wherein the frame (41) comprises a plurality of webs (54) extending

upwardly from the frame towards a closed first end (11) of the outer member to define one or more passages (57) between the frame and the closed first end of the outer member and wherein welds are formed between the webs and the closed first end of the outer member.

- 5
97. A method of manufacturing a cartridge (1) containing one or more beverage ingredients (200) and being formed from substantially air- and water-impermeable materials, the cartridge comprising an outer member (2) defining a storage chamber (130) in which is stored the one or more beverage ingredients, an inner member (3) having a discharge spout (43) forming an outlet for outflow of beverage formed from the one or more beverage ingredients, and a filter (4), characterised by the method comprising conjoining the inner member and the filter in one step to the outer member by means of at least one welding step.
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- 20 98. A method as claimed in claim 97 wherein the welding step is by ultrasonic welding.
- 25 99. A method as claimed in claim 97 or claim 98 further comprising forming a first welding line around a periphery of the inner member and filter.
100. A method as claimed in claim 99 further comprising forming a second welding line around the inner member and filter at or near the discharge spout.

101. A cartridge (1) containing one or more beverage ingredients (200) and being formed from substantially air- and water-impermeable materials, the cartridge comprising an inlet (121) for the introduction of an aqueous medium into the cartridge and an outlet (122) for discharge of a beverage produced from the one or more beverage ingredients, characterised in that the cartridge comprises an outer member (3) and an inner member (2) conjoined on assembly with the outer member, the inner member defining the outlet of the cartridge, wherein a snap-fit arrangement is provided to conjoin the outer member and the inner member on assembly of the cartridge.
102. A cartridge (1) as claimed in claim 101 wherein the snap-fit arrangement comprises co-operating formations (19a, 91) on the inner member and the outer member.
103. A cartridge (1) as claimed in claim 101 or claim 102 wherein the outer member comprises a closed first end (11) and an open second end (12), wherein with the inner member snap-fitted to the outer member the outlet (44) of the inner member is directed towards the open second end of the outer member.
104. A cartridge (1) as claimed in claim 103 wherein the inlet (121) is directed towards the open second end of the outer member.
105. A cartridge (1) as claimed in claim 103 or claim 104 wherein the outer member and inner member are snap-

fitted together at or near the closed first end of the outer member.

5 106. A cartridge (1) as claimed in any of claims 101 to 105 wherein the snap-fit between the inner member and the outer member forms a water-tight seal.

10 107. A cartridge (1) as claimed in any of claims 101 to 106 wherein the inner member further comprises a skirt (80) surrounding the outlet, the skirt comprising an upper extension (81) having an upper rim (91) which engages, on assembly of the cartridge, a co-operating formation (19a) of the outer member to form the snap-fit arrangement for conjoining the inner member to the
15 outer member.

20 108. A cartridge (1) as claimed in claim 107 wherein the co-operating formation of the outer member is an inwardly directed extension (18).

109. A cartridge (1) as claimed in any of claims 101 to 108 wherein the inner member comprises a discharge spout (43) defining the outlet.

25 110. A cartridge (1) as claimed in claim 109 wherein the outer member comprises an inwardly directed extension (18) which is received in a proximal end of the discharge spout (43) on conjoining of the outer member and the inner member.

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111. A cartridge (1) as claimed in claim 109 or claim 110 wherein the discharge spout (43) is integral with the inner member.
- 5 112. A cartridge (1) as claimed in any of claims 109 to 111 wherein the discharge spout (43) comprises a tapered portion (45; 106).
- 10 113. A cartridge (1) as claimed in any of claims 109 to 112 wherein the discharge spout (43) comprises a cylindrical portion (93; 107).
- 15 114. A cartridge (1) as claimed in any of claims 109 to 113 wherein the discharge spout (43) comprises a partition (65) extending at least part way along the length of the discharge spout.
- 20 115. A cartridge (1) as claimed in any of claims 101 to 114 wherein the cartridge is disc-shaped.
- 25 116. A cartridge (1) as claimed in any of claims 101 to 115 further comprising means for producing a jet of the beverage, which means comprises an aperture (70) in a beverage flow path between the inlet and the outlet.
117. A cartridge (1) as claimed in any of claims 101 to 116 wherein the outer member and/or inner member are formed from polypropylene.

118. A cartridge (1) as claimed in any of claims 101 to 117 wherein the outer member and/or inner member is formed by injection moulding.