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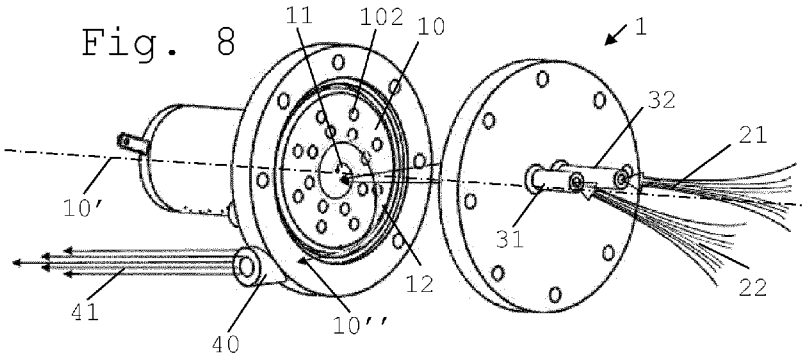
(54) Title: BEVERAGE PREPARATION WITH ROTATING IMPELLER

Fig. 8



(57) Abstract: A device (1) is configured for processing at least one beverage ingredient fluid (21,22). The device (1) has: a processing surface (10,10A,10B) that is rotatable about a rotational axis (10'); an actuator (20) configured to actuate the processing surface (10,10A,10B) to rotate about the rotational axis (10'); at least one fluid input line (30,30A,30B,31,32,33) having a fluid delivery aperture (30',30A',30B') configured to deliver the beverage ingredient fluid (21,22) to the processing surface (10,10A,10B); and at least one fluid output line (40,40B) having a receiving aperture (40',40B') configured to guide a fluid (41) away from the processing surface (10,10A,10B). The processing surface (10,10A,10B) has a central area (11,11A,11B) at the rotational axis (10') and a peripheral area (12,12A,12B) remote from the rotational axis (10') so as to extend between the central area (11,11A,11B) and the peripheral area (12,12A,12B). The central area (11,11A,11B) is located closer to the or each fluid delivery aperture (30',30A') than to the or each receiving aperture (40',40B').

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BEVERAGE PREPARATION WITH ROTATING IMPELLER

Field of the Invention

The field of the invention pertains to beverage preparation machines with a rotating impeller used to process the beverage or a component of the beverage.

For the purpose of the present description, a "beverage" is meant to include any human-consumable liquid substance, such as tea, coffee, hot or cold chocolate, milk, soup, baby food, etc… A "capsule" is meant to include any container such as a packaging for containing a pre-portioned beverage ingredient, e.g. a flavouring ingredient, the packaging forming an enclosure of any material, in particular an airtight or pervious material, porous or non-porous material, e.g. plastic, aluminium, recyclable and/or biodegradable packagings, and of any shape and structure, including soft pods or rigid cartridges for containing the ingredient.

Background Art

Speciality beverages in which at least a portion is made up of frothed or heated milk are becoming more and more popular. The best-known beverage of this type is a coffee of the cappuccino type. It comprises a liquid portion consisting of coffee topped by a layer of frothed milk which, because of its very much lower density, floats atop the surface of the liquid. In general, preparing one takes time, manipulation operations and cleaning.

Especially in the field of coffee preparation, machines have been widely developed in which a capsule containing beverage ingredients is inserted in a brewing device. The brewing device is tightly closed about the capsule, water is injected at the first face of the capsule, the beverage is produced in the closed volume of the capsule and a brewed beverage can be drained from a second face of the capsule and collected into a receptacle such as a cup or mug or carafe. Examples of such beverage machines are disclosed in EP 1 767 129, WO

2005/004683, WO 2007/135136, WO 2009/043630, WO 2012/093107 and WO 2013/127906.

US Patent 6,318,247 relates to an appliance for preparing hot beverages or food with stirring such as hot chocolate, for example. Other devices for stirring food products are described in patent documents WO 2004/043213, DE 89 15 094, DE 196 24 648, US 2,932,493, DE 1 131 372, US 3,356,349, US 4,537,332 and US 6,712,497. Improved appliances for preparing froth from a milk-based liquid or milk have been proposed in WO 2006/050900, WO 2008/142154, WO 2009/074555, WO 2010/023313, WO 2011/039222, WO 2011/039224, WO 2011/144647, PCT/EP20/069482 and PCT/EP20/069485. Such devices have typically: an inner tank for receiving the liquid that is to be frothed, in which a rotatable stirrer is positioned; an outer stand holding the tank; drive and control means which are in a cavity located between the inner tank and the outer stand, and which communicate with a switch and electrical connections located on the outer surface of the stand; and disturbance means to optimise circulation of the milk during frothing. Further devices for stirring food products such as milk-based products are disclosed in WO 2016/202814, WO 2016/202815, WO 2016/202816, WO 2016/202817, WO 2016/202818, WO 2017/098037, WO 2018/108804, WO 2018/108807, WO 2018/108808, WO 2019/101764, WO 2019/101765, WO 2019/185782, WO 2019/185784, WO 2019/185785 and WO 2019/211213. Further mixers are disclosed in WO 2014/096183, WO 2015/197505, WO 2015/197509, WO 2016/102218, WO 2016/102219, WO 2017/029267, WO 2017/076997, WO 2017/081308, WO 2017/097674, WO 2017/216015 and WO 2017/220436.

It is also known to use rotatory processing for preparing coffee, as for example disclosed in EP2021216965 that relies on centrifugation and may involve a conditioning of the coffee involving rotary sheering. Preparing coffee by centrifugation is further disclosed for example in WO 2008/148601, WO 2008/148650, US 5,566,605, WO 2013/007776, WO 2013/007779, WO 2013/007780, WO 2017/046294, WO 2017/068134 and WO 2017/202746.

There is still a need to provide a beverage processing device to combine beverage ingredients in a desired fashion.

Summary of the Invention

The invention relates to a device processing at least one beverage ingredient fluid. Normally such device is configured to or incorporated in a beverage machine configured to dispense to a user, e.g. to a user-cup or user-mug, a beverage prepared by using the processing device.

An aspect of the invention relates to a device for processing at least one beverage ingredient fluid.

Such device comprises: a processing surface that is rotatable about a rotational axis; an actuator, e.g. a motor such as an electric motor, configured to actuate the processing surface to rotate about the rotational axis; at least one fluid input line having a fluid delivery aperture configured to deliver the beverage ingredient fluid to the processing surface, optionally each line of the fluid input lines having such a delivery aperture; and at least one fluid output line having a receiving aperture configured to guide a fluid (typically the processed beverage ingredient fluid(s)) away from the processing surface.

Such device may further comprise a thermal conditioner, such as a heater and/or cooler, configured to condition thermally the beverage ingredient fluid(s) upon delivery by the delivery aperture and prior to reception by the receiving aperture. The thermal conditioner may be an electric device, e.g. resistive or inductive heater or a cooling pump or a thermocouple, or a heating or cooling liquid or gas such as glycol.

The fluid(s) may be in a liquid form, e.g. syrup or milk or tea or coffee, or a solid particulate form, e.g. vegetable or milk or sugar or salt or flavoring powder, or a gaseous form, e.g. N_2 or CO_2, or any combination thereof e.g. an emulsion or foam.

The beverage ingredient fluid delivered from a delivery aperture may be delivered as a single ingredient, e.g. coffee, or as a combination of ingredients, e.g. milk and gas such as air, or e.g. coffee and syrup and/or sweetener such as sugar. The milk may be of animal origin, e.g. cow or goat, or vegetable origin, such as from soy, almond, oat, coconut, hazelnut, rice, cashew, hemp, walnut, peanut, macadamia nut, flax…

The rotatable processing surface can extend continuously or can be provided with one or more discontinuities, such as protrusions or recesses, e.g. through-holes and/or blind holes. Such discontinuities may be used to increase an actuation of the above beverage ingredient fluid(s) by the processing surface during its rotation.

The actuator may be coupled to the processing surface via a mechanical coupling and/or a magnetic coupling. A mechanical coupling may be achieved by an axle with or without a transmission, e.g. gears, extending from the actuator to processing surface. A magnetic coupling, e.g. to avoid leakage issues, may be achieved by using magnets between the processing surface and the actuator with or without a mechanical coupling between the magnetic coupling and the actuator, e.g. as described in WO 2006/050900 and WO 2016/202814.

The actuator can be configured to actuate the processing surface so as to rotate the processing surface about the rotational axis at a speed in the range of 500 to 25000 RPM, such as 1000 to 20000 RPM, for example 2000 to 18000 RPM, e.g. 3000 to 16000 RPM.

The processing surface has a central area at the rotational axis and a peripheral area remote from the rotational axis so as to extend between the central area and the peripheral area. The central area is located closer to the or each fluid delivery aperture than to the or each receiving aperture.

Hence, during operation of the device, the fluid or fluids are delivered towards a central part of the processing surface and then rotationally driven towards a

peripheral area where it is evacuated from the processing surface. Such a device may be used to mix liquid together and/or combine liquid with gas, e.g. to form foam, froth or crema. It is also possible to use the device as a pump for pumping one or more liquids. Furthermore, by multiplying the sources of liquids in fluid communication with the processing surface via the fluid input lines it is not only possible to mix different liquids but also to prepare layered beverages by non-simultaneous processing.

It is for example possible to prepare a coffee that is topped by milk or foamed milk.

A sweetener, e.g. sugar or a substitute sweetener, may or may not be integrated, e.g. as a syrup, via a liquid feed line.

A fluid delivered via a delivery aperture may be formed of one or more ingredients. When such fluid includes more than one ingredient, it may be pre-mixed in the device upstream the delivery aperture, e.g. milk and gas such as air, or it may be supplied as a pre-mix to the device, e.g. cacao and sweetener syrup. Needless to say that such ingredients, e.g. air and milk or coffee and milk, may also be delivered separately to the processing surface, either sequentially via the same of different delivery apertures or in parallel via different delivery apertures.

The or at least one or all of the fluid delivery aperture(s) may be configured to face the processing surface.

The processing surface may extend substantially planarly or conically or spherically or ellipsoidally from the central area to the peripheral area. The processing surface can have substantially the shape of a flat disc, e.g. formed by a base of a cylinder such as a short cylinder, or of a conical surface with an obtuse aperture angle or of spherical or ellipsoidal cap. Such an obtuse aperture angle may be of at least 120 deg., for instance at least 135 deg., e.g. at least 150 deg., for example at least 165 deg,.

The processing surface may typically have a circular periphery, e.g. as substantially formed by a disc or a cone with a circular base.

The device may include a plurality of distinct processing surfaces, each formed of such a fluid processing surface.

Two such distinct processing surfaces may each have a corresponding central area at the rotational axis and a corresponding peripheral area remote from the rotational axis so as to extend between its central area and its peripheral area.

Two such distinct processing surfaces may each be associated with at least one corresponding fluid input line having a fluid delivery aperture configured to deliver to the corresponding processing surface a beverage ingredient fluid, e.g. each line of the fluid input lines having a corresponding delivery aperture. The central area may be located closer to the or each fluid delivery aperture than to the or each receiving aperture.

Two such distinct processing surfaces can be for instance formed by a common substantially wall-shaped member, e.g. a member extending substantially planarly or conically or spherically or ellipsoidally, such as substantially shaped as a coin. The distinct processing surfaces may be formed by opposite faces of the member. For example, the member includes one or more through-holes extending from one to the other of the two distinct processing surfaces to fluidically connect them through the member.

Via such through-holes the fluids may combine and be processed together on a rotating processing surface. Different fluid pressure levels on each processing surface may be used to direct the fluids to be processed together predominantly on one processing surface. For example, milk and air may be supplied on one processing surface at a higher pressure and coffee on the other processing surface at a lower pressure so that milk and air get pre-frothed on the processing surface and then passed to the other processing surface via the through-

holes to be combined and processed with the coffee fed directly onto the other processing surface.

Two such distinct processing surfaces can be for instance formed by distinct wall-shaped members, e.g. each member extending substantially planarly or conically or spherically or ellipsoidally, such as substantially shaped as a coin. For instance, the wall-shaped members may be located and rotatable in distinct processing cavities.

For example, milk and air can be processed for frothing on one processing surface of a wall-shaped member in a first cavity and evacuated by a first output line while coffee can be processed with air for foam formation on another processing surface of a wall-shaped member in a second cavity and evacuated by a second output line. Hence, the coffee/air fluid and the milk/are fluid can be dispensed by separate output lines to a user-receptacle, e.g. cup or mug or carafe, simultaneously or successively or partly successively and partly simultaneously.

The actuator can actuate two or more of the processing surfaces to rotate about the rotational axis.

The processing surfaces may rotate at a same speed or at different speeds (for example by being connected via a movement conversion transmission such as gears).

The processing surface can face a confinement wall, e.g. a confinement wall that extends substantially in parallel over the processing surface, to define therebetween a fluid processing chamber, the processing surface rotating relative to the confinement wall about the rotational axis.

The confinement wall may form or be part of a casing comprising the confinement wall.

The confinement wall can be spaced, e.g. axially, from the processing surface by a distance in the range of 0.1 to 3 mm, such as 0.2 to 2.5 mm, for example less than 2 mm, e.g. in the range of 0.5 to 1.5 mm. The distance may be sufficiently small to generate a couette flow of the beverage ingredient fluid(s) between the processing

surface and the confinement wall during relative rotation thereof about the rotational axis.

The or one of the fluid input lines may be fluidically connected to a source of gas configured to supply gas at ambient pressure or compressed gas to the processing surface. For example, the source of gas is a source of air or a carbonated gas.

The or one of the fluid input lines may be fluidically connected to a source of liquid milk or of a milk-based liquid.

The or one of the fluid input lines can be fluidically connected to a source of liquid coffee or tea or chocolate.

The or one of the fluid input lines may be fluidically connected to a source of syrup, such as plain syrup or syrup flavoured with a flavouring ingredient e.g. coffee, tea or chocolate.

The or at least one of the fluid input lines can be fluidically connected to a valve configured to control a flow along such line to the processing surface. For example, each line of the fluid input lines is fluidically connected to such a valve.

The valve may be a multi-way valve for combining different ingredients, e.g. air and milk or coffee and syrup, upstream the fluid delivery aperture.

The or at least one output line may be fluidically connected to a valve configured to control a flow along such line from the processing surface. For example, each line of the fluid output lines is fluidically connected to such a valve. Such an output line valve may be used to generate or control a pressure build-up on the processing surface and/or to prevent dripping out of the output line and the end of a serving.

The or at least one of the receiving aperture can face the processing surface and/or can be adjacent the peripheral area, the output line extending from the receiving aperture in a direction that can be:

- non-orthogonal to the rotational axis, such as parallel to the rotational axis or at an angle thereto in the range of 0 to 60°, such as 15 to 45°; or
- non-parallel to the rotational axis, such as orthogonal to the rotational axis or at an angle thereto in the range of 0 to 60°, such as 15 to 45°.

The or at least one output line may extend from the receiving aperture:

- in line with a direction of rotation of the processing surface or at an acute angle thereto, to facilitate an output of the fluid away from the processing surface; or
- in opposite line with a direction of rotation of the processing surface or at an acute angle thereto, to slow down an output of the fluid away from the processing surface.

A device according to the invention may include an output line in line with a direction of rotation and another output line in opposite line with a direction of rotation of the processing surface about the rotational axis.

A device according to the invention may be configured to rotate the processing surface in both directions of rotation about the rotational axis. For example, an output line that is in line with one direction of rotation can be in opposite line with an opposite direction of rotation.

The or at least one output line may extend from the receiving aperture substantially in parallel to the rotational axis.

The device of the invention may include a control unit that is connected to one or more of:

- the actuator to control an output of the actuator to the processing surface, such as at least one of speed, direction, torque and power;
- the one or more fluid input lines to control a feed of the fluid therealong to the processing surface, such as at least one of: an opening and closing of the

input line(s); a flow rate of fluid along the input line(s); a volume of fluid along the input line(s); and a mass of fluid along input line(s); and

- the at least one fluid output line to control a passage of fluid away from the processing surface, such as at least one of: an opening and closing of the output line; a flow rate of fluid along the line; a volume of fluid along the output line; and a mass of fluid along the output line.

The control unit may be configured to control a rotation of the processing surface and/or other device part(s) in order to mix on the processing surface at least two liquids supplied via separate fluid input lines to the processing surface.

The control unit may be configured to control a rotation of the processing surface and/or other device part(s) in order to mix on the processing surface at least one liquid and one gas, such as gas at ambient pressure or compressed gas. The gas may be air or a carbonated gas. The liquid can be frothed with the gas. For example, the liquid is milk or coffee or chocolate (beverage) and the gas is air. As mentioned above, a layered or sequentially-formed beverage may be prepared, e.g. a cappuccino or a latte macchiato.

The control unit may be configured to control a rotation of the processing surface and/or other device part(s) in order to pump along the processing surface one or more liquids from the fluid input line(s) to the fluid output line(s).

The control unit may be configured to control a rotation of the processing surface and/or other device part(s) in order to rinse or clean the device with a rinsing or a cleaning fluid, typically supplied by the or one or more of the fluid input line(s) and/or evacuated by the or at least one of the fluid output line(s). Hence a fluid input line may be temporarily or permanently be connected to a source of rinsing or cleaning fluid.

The device may form a beverage machine configured for preparing a beverage and dispensing such beverage to a user-receptacle such as a cup or mug or carafe.

The device can have one or more fluid sources, such as at least one of: fluid containers; and connectors to external fluid sources. The or each fluid line can be connected to the or one of the fluid sources. The or at least one fluid source may be connected to its fluid line via one or more component selected from: a thermal conditioner, e.g. a heater and/or cooler; a pump; a valve; and a fluid sensor, such as a flow meter, a thermal sensor, a pressure sensor; and a device configured to extract an ingredient capsule, e.g. of the type described above.

For instance, the above beverage machine is a coffee, tea, chocolate, cacao, milk or soup preparation machine. For example, the machine is arranged for preparing within a beverage processing module that includes an ingredient holder, a beverage by passing hot or cold water or another liquid through the ingredient held in the holder, such as a flavouring ingredient of the beverage to be prepared, such as ground coffee or tea or chocolate or cacao or milk powder.

Such beverage preparation typically includes the mixing of a plurality of beverage ingredients, e.g. water and milk powder, and/or the infusion of a beverage ingredient, such as an infusion of ground coffee or tea with water. Particulate ingredients may be contained in a capsule that is extracted by the machine. One or more of the ingredients may be supplied in loose and/or agglomerate powder form and/or in liquid form, in particular in a concentrate form. A carrier or diluent liquid, e.g. water, may be mixed with such ingredient to form the beverage. Typically, a predetermined amount of beverage is formed and dispensed on user-request, which corresponds to a portion (e.g. a serving). The volume of such a serving may be in the range of 15 to 1000 ml such as 25 to 600 ml for instance 40 to 250 ml, e.g. the volume for filling a cup or mug or carafe, depending on the type of beverage. Formed and dispensed beverages may

be selected from ristrettos, espressos, lungos, cappuccinos, café latte, americano coffees, teas, etc... For example, a coffee machine may be configured for dispensing espressos, e.g. an adjustable volume of 20 to 60 ml per serving, and/or for dispensing lungos, e.g. a volume in the range of 70 to 200 ml per serving, and/or for dispensing americanos, e.g. a volume in the range of 150 to 750 ml.

Typically, the machine includes one or more of the following components:

a) a fluid system in fluid communication with the an ingredient during beverage preparation;

b) an in-line heater and/or cooler for thermally conditioning a flow of liquid circulated to the flavouring ingredient or a batch heater and/or cooler for circulating thermally conditioned liquid from the batch heater and/or cooler to the flavouring ingredient;

c) a pump for pumping liquid to an ingredient, in particular a pressure pump operating within a range of 1 to 25 bar, such as 10 to 20 bar or 1 to 5 bar, e.g. 1.5 to 3 bar;

d) an electric control unit, in particular comprising a printed circuit board (PCB), for receiving instructions from a user via an input user-interface and for controlling the heater and/or cooler, pump, motor(s) and valve(s); and

e) one or more sensors for sensing at least one characteristic selected from characteristics of fluid system, the heater and/or cooler, the pump, a liquid tank, an ingredient collector, a flow of the liquid (e.g. by a flowmeter), a pressure of the liquid and a temperature of the liquid, and for communicating such characteristic(s) to the control unit.

When the ingredient is supplied within a capsule, the capsule can have a body containing an ingredient and a peripherally projecting flange, e.g. a body in the shape of a cup and a lid covering the mouth of the cup

and extending beyond the mouth to form the peripherally projecting flange.

The capsule may have a body that is symmetric or asymmetric, conical or frusto-conical or cylindrical or spherical or hemispherical or frusto-spherical, containing the ingredient, e.g. ground coffee, tea or cacao or another beverage ingredient.

The capsule may be of the type described above under the header "field of the invention". The capsule may be a capsule that has a container-body, e.g. a generally cup-shaped or hemispherical or hemi-ellipsoidal body, having a flange to which a cover lid (or membrane) is attached, in particular sealed. Typically the capsule contains a beverage ingredient. Examples of suitable capsules are disclosed in WO 2008/148601, WO 2008/148604, WO 2008/148646, WO 2008/148650, WO 2008/148656, WO 2008/148834, WO 2011/141532, WO 2011/141535, WO 2013/072239, WO 2013/072297, WO 2013/072326, WO 2015/044400. The capsule may be of the variety commercialised by Nespresso under the brand "Vertuo Line", "Original Line" or "Professional Line".

The invention also relates to a method for processing, in a device as described above, at least one beverage ingredient fluid. The method comprises: actuating with the actuator the processing surface to rotate about the rotational axis; delivering the beverage ingredient fluid(s) via the delivery aperture(s) of the fluid input line(s) to the processing surface so as to process the beverage ingredient fluid(s); and guiding the fluid away from the processing surface via the receiving aperture of the fluid output line(s). The processing surface has a central area at the rotational axis and a peripheral area remote from the rotational axis so as to extend between the central area and the peripheral area. The central area is located closer to the or each fluid delivery aperture than to the or each receiving aperture.

Brief Description of the Drawings

The invention will now be described with reference to the schematic drawings, wherein:

- Figures 1 and 2 are perspective views of an embodiment of a device according to the invention;
- Figure 3 is a sideview of the device shown in Fig. 1;
- Figure 4 is a cross-sectional view of the device shown in Fig. 3;
- Figure 5 is a perspective view of another embodiment of a device according to the invention;
- Figure 6 is a cross-sectional view of the device shown in Fig. 5;
- Figure 7 is a partly exploded view of a further embodiment of a device according to the invention during operation;
- Figure 8 is a partly exploded view of yet another embodiment of a device according to the invention during operation;
- Figure 9 is a schematic view of yet a further embodiment of a device according to the invention having a pair of fluid processing surfaces located on opposite sides of a substantially wall-shaped rotatable member; and
- Figure 10 is a schematic view of another embodiment of a device according to the invention having a plurality of substantially wall-shaped rotatable members, each member being provided with a fluid processing surface.

Detailed description

Figures 1 to 10 illustrate different exemplary embodiments of devices 1 in accordance with the invention.

Generally speaking, such a device 1 is configured for processing at least one beverage ingredient fluid 21,22. Device 1 includes: a processing surface 10,10A,10B that is rotatable about a rotational axis 10'; an actuator 20, e.g. a motor such as an electric motor,

configured to actuate processing surface 10,10A,10B to rotate about rotational axis 10'; at least one fluid input line 30,30A,30B,31,32,33 having a fluid delivery aperture 30',30A',30B' configured to deliver beverage ingredient fluid 21,22 to processing surface 10,10A,10B, for example each line of fluid input lines 30,30A,30B,31, 32,33 having such a delivery aperture; and at least one fluid output line 40,40B having a receiving aperture 40',40B' configured to guide a fluid 41 (typically the processed beverage ingredient fluid(s)) away from processing surface 10,10A,10B.

Such device 1 may further comprise a thermal conditioner, such as a heater and/or cooler, configured to condition thermally the beverage ingredient fluid 21,22 upon delivery by the delivery aperture and prior to reception by the receiving aperture. The thermal conditioner may be an electric device, e.g. resistive or inductive heater or a cooling pump or a thermocouple, or a heating or cooling liquid or gas such as glycol.

Fluid(s) 21,22 may be in a liquid form, e.g. syrup or milk or tea or coffee, or a solid particulate form, e.g. vegetable or milk or sugar or salt or flavoring powder, or a gaseous form, e.g. N_2 or CO_2, or any combination thereof e.g. an emulsion or foam.

Beverage ingredient fluid 21,22 delivered from a delivery aperture 30',30A',30B' may be delivered as a single ingredient, e.g. coffee, or as a combination of ingredients, such as milk and gas (e.g. air) or coffee and syrup.

Processing surface 10,10A,10B may extend continuously or be provided with one or more discontinuities, such as protrusions or recesses, e.g. through-holes 101 and/or blind holes 102.

Actuator 20 may be coupled to processing surface 10,10A,10B via a mechanical coupling and/or a magnetic coupling. A mechanical coupling may be achieved by an axle with or without a transmission, e.g. gears, extending from actuator 20 to processing surface 10,10A,10B. A magnetic coupling, e.g. to avoid leakage

issues, may be achieved by using magnets between processing surface 10,10A,10B and actuator 20B with or without a mechanical coupling between the magnetic coupling and actuator 20.

Actuator 20 can be configured to actuate processing surface 10,10A,10B so as to rotate processing surface 10,10A,10B about rotational axis 10' at a speed in the range of 500 to 25000 RPM, such as 1000 to 20000 RPM, for example 2000 to 18000 RPM, e.g. 3000 to 16000 RPM.

Processing surface 10,10A,10B may extend continuously or being provided with one or more discontinuities such as protrusions or recesses e.g. through-holes 101 and/or blind holes 102.

Processing surface 10,10A,10B has a central area 11,11A,11B at rotational axis 10' and a peripheral area 12,12A,12B remote from rotational axis 10' so as to extend between central area 11,11A,11B and peripheral area 12,12A,12B. Central area 11,11A,11B is located closer to the or each fluid delivery aperture 30' than to the or each receiving aperture 40',40B'.

The or at least one or all of fluid delivery aperture(s) 30',30A',30B' may be configured to face processing surface 10,10A,10B.

Processing surface 10,10A,10B may extend substantially planarly or conically or spherically or ellipsoidally from central area 11,11A,11B to peripheral area 11,11A,11B. Processing surface 10,10A,10B can have substantially a shape of a flat disc or of a conical surface with an obtuse aperture angle or of spherical or ellipsoidal cap. Such an obtuse aperture angle may be of at least 120 deg., for instance at least 135 deg., e.g. at least 150 deg., for example at least 165 deg.

Device 1 may include a plurality of distinct processing surfaces 10,10A,10B, e.g. a pair of processing surfaces. Each processing surfaces 10,10A,10B can be formed by such a fluid processing surface as described above. Two such distinct processing surfaces 10,10A,10B may have each a corresponding central area 11,11A,11B at rotational axis 10' and a corresponding peripheral area

12,12A,12B remote from rotational axis 10' so as to extend between its central area 11,11A,11B and its peripheral area 12,12A,12B. Two such distinct processing surfaces 10,10A,10B may be each associated with at least one corresponding fluid input line 30,30A,30B having a fluid delivery aperture 30',30A',30B' configured to deliver to the corresponding processing surface 10,10A,10B a beverage ingredient fluid 21,22, e.g. each line of fluid input lines 30,30A,30B having a corresponding delivery aperture 30',30A',30B'. Central area 11,11A,11B may be located closer to the or each fluid delivery aperture 30,30A',30B' than to the or each receiving aperture 40',40B'.

Two such distinct processing surfaces 10,10A can be formed by a common substantially wall-shaped member 100, e.g. a member extending substantially planarly or conically or spherically or ellipsoidally, such as substantially shaped as a coin. Distinct processing surfaces 10,10A may be formed by opposite faces of member 100. For example, member 100 has one or more through-holes 101 extending from one 10 to the other 10A of these two distinct processing surfaces 10,10A to fluidically connect them through member 100.

Two such distinct processing surfaces 10,10B may be formed by distinct wall-shaped members 100,100B, e.g. each member 100,100B extending substantially planarly or conically or spherically or ellipsoidally, such as substantially shaped as a coin. For instance, wall-shaped members 100,100B can be located and rotatable in distinct processing cavities 50',50B'.

In either configuration (involving one or more wall-shaped members 100,100B), actuator 20 may actuate two or more of processing surfaces 10,10A,10B to rotate about rotational axis 10', e.g. processing surfaces 10,10A,10B rotating at a same speed or at different speeds (for example by being connected via a movement conversion transmission to different wall-shaped members 100,100B).

Processing surface 10,10A,10B can face a confinement wall 51, e.g. a confinement wall 51 that extends substantially in parallel over processing surface

10,10A,10B, to define therebetween a fluid processing chamber 10a. Processing surface 10,10A,10B rotates typically relative to confinement wall 51 about rotational axis 10'.

Confinement wall 51 may form or be part of a casing 50 comprising confinement wall 51.

Confinement wall 51 may be spaced, e.g. axially 10' spaced, from processing surface 10,10A,10B by a distance in the range of 0.1 to 3 mm, such as 0.2 to 2.5 mm, for example less than 2 mm, e.g. in the range of 0.5 to 1.5 mm. For instance, such distance is sufficiently small to generate a couette flow of beverage ingredient fluid(s) 21,22 between processing surface 10,10A,10B and confinement wall 51 during relative rotation thereof about axis 10'.

The or one of fluid input lines 30,30A,30B,31,32,33 can be fluidically connected to a source of gas configured to supply gas at ambient pressure or compressed gas to processing surface 10,10A,10B. For instance, the source of gas is a source of air or a carbonated gas.

The or one of fluid input lines 30,30A,30B,31,32,33 may be fluidically connected to a source of liquid milk or of a milk-based liquid.

The or one of fluid input lines 30,30A,30B,31,32,33 can be fluidically connected to a source of liquid coffee or tea or chocolate.

The or one of fluid input lines 30,30A,30B,31,32,33 may be fluidically connected to a source of syrup.

The or at least one of fluid input lines 30,30A,30B,31,32,33 may be fluidically connected to a valve configured to control a flow along such line 30,30A,30B,31,32,33 to processing surface 10,10A,10B. For instance, each line of fluid input lines 30,30A,30B,31,32,33 can be fluidically connected to such a valve.

The or at least one output line 40,40B may be fluidically connected to a valve configured to control a

flow along such line 40,40B from processing surface 10,10A,10B. For instance, each line of fluid output lines 40,40B can be fluidically connected to such a valve.

The or at least one of receiving aperture 40',40B may face processing surface 10,10A,10B (Figs 1 to 7; 9 and 10) and/or be adjacent peripheral area 12,12A,12B (Figs 1 to 10).

Output line 40,40B can extend from receiving aperture 40',40B' in a direction that is non-orthogonal to rotational axis 10' (Figs 7, 9 and 10), such as parallel to rotational axis 10' or at an angle thereto in the range of 0 to 60°, such as 15 to 45°.

Output line 40 may extend from receiving aperture 40' in a direction that is non-parallel to rotational axis 10' (Fig. 8), such as orthogonal to rotational axis 10' or at an angle thereto in the range of 0 to 60°, such as 15 to 45°.

The or at least one output line 40 may extend from receiving aperture 40' in line with a direction of rotation 10'' of processing surface 10 or at an acute angle thereto (Fig. 8), to facilitate an output of fluid 41 away from processing surface 10.

The or at least one output line 40 can extend from receiving aperture 40' in opposite line with a direction of rotation 10'' of processing surface 10 or at an acute angle thereto, to slow down an output of fluid 41 away from processing surface 10.

The or at least one output line 40,40B may extend from receiving aperture 40' substantially in parallel to rotational axis 10' (Figs 5 to 7 and 9 to 10).

Device 1 may include a control unit 60.

Control unit 60 can be connected to actuator 20 to control an output of actuator 20 to processing surface 10,10A,10B such as at least one of speed, direction, torque and power.

Control unit 60 may be connected to the one or more fluid input lines 30,30A,30B,31,32,33 to control a feed of fluid therealong to processing surface 10,10A,10B.

Control unit 60 may control at least one of: an opening and closing of input line(s) 30,30A,30B,31,32,33; a flow rate of fluid along input line(s) 30,30A,30B,31,32,33; a volume of fluid along input line(s) 30,30A,30B,31,32,33; and a mass of fluid along input line(s) 30,30A,30B,31, 32,33.

Control unit 60 can be connected to the at least one fluid output line 40,40B to control a passage of fluid away from processing surface 10,10A,10B, such as at least one of: an opening and closing of output line 40,40B; a flow rate of fluid along line 40,40B; a volume of fluid along output line 40,40B; and a mass of fluid along output line 40,40B.

Control unit 60 may be configured to control a rotation of the processing surface 10,10A,10B and/or other device part(s) to mix on processing surface 10,10A,10B at least two liquids supplied via separate fluid input lines 30,30A,30B,31,32, 33 to surface 10,10A,10B.

Control unit 60 can be configured to control a rotation of the processing surface 10,10A,10B and/or other device part(s) to mix on processing surface 10,10A,10B at least one liquid and one gas, such as gas at ambient pressure or compressed gas. The gas can be air or a carbonated gas. For example, the liquid is frothed with the gas.

Control unit 60 may be configured to control a rotation of processing surface 10,10A,10B and/or other device part(s) to pump along processing surface 10,10A,10B one or more liquids from fluid input line(s) 30,30A,30B,31,32,33 to fluid output line(s) 40,40B.

Device 1 may have one or more fluid sources, such as at least one of fluid containers and connectors to external fluid sources, the or each fluid line 30,30A,30B,31,32,33 being connected to the or one of said fluid sources. The or at least one fluid source can be connected to its fluid line 30,30A,30B,31,32,33 via one or more component selected from: a thermal conditioner, e.g. a heater and/or cooler; a pump; a valve; and a fluid

sensor, such as a flow meter, a thermal sensor, a pressure sensor; and a device configured to extract an ingredient capsule.

During operation of device 1, the following steps are carried out:

- actuator 20 actuates processing surface 10,10A,10B to rotate about the rotational axis 10';
- beverage ingredient fluid(s) 21,22 is/are delivered via delivery aperture(s) 30',30A',30B' of fluid input line(s) 30,30A,30B,31,32,33 to processing surface 10,10A,10B so as to process the beverage ingredient fluid(s); and
- fluid 41 (typically the processed beverage ingredient fluid(s)) is guided away from processing surface 10,10A,10B via receiving aperture 40',40B' of fluid output line(s) 40,40B.

Processing surface 10,10A,10B has a central area 11,11A,11B at rotational axis 10' and peripheral area 12,12A,12B remote from rotational axis 10' so as to extend between central area 11,11A,11B and peripheral area 12,12A,12B. Central area 11,11A,11B is located closer to the or each fluid delivery aperture 30',30A',30B' than to the or each receiving aperture 40',40B'.

Claims

1. A device (1) for processing at least one beverage ingredient fluid (21,22), comprising:

- a fluid processing surface (10,10A,10B) that is rotatable about a rotational axis (10'), optionally the processing surface (10,10A,10B) extending continuously or being provided with one or more discontinuities such as protrusions or recesses e.g. through-holes (101) and/or blind holes (102);
- an actuator (20), e.g. a motor such as an electric motor, configured to actuate the processing surface (10,10A,10B) to rotate about the rotational axis (10') e.g. via a mechanical and/or magnetic coupling, optionally the actuator (20) being configured to actuate the processing surface (10,10A,10B) so as to rotate the processing surface (10,10A,10B) about the rotational axis (10') at a speed in the range of 500 to 25000 RPM, such as 1000 to 20000 RPM, for example 2000 to 18000 RPM, e.g. 3000 to 16000 RPM;
- at least one fluid input line (30,30A,30B,31,32,33) having a fluid delivery aperture (30',30A',30B') configured to deliver said beverage ingredient fluid (21,22) to the processing surface (10), optionally each line of the fluid input lines (30,30A, 30B,31,32,33) having such a delivery aperture (30', 30A',30B'), for instance the beverage ingredient fluid (21,22) is delivered as a single ingredient or as a combination of ingredients; and
- at least one fluid output line (40,40B) having a receiving aperture (40',40B') configured to guide a fluid (41) away from the processing surface (10,10A,10B),

such device (1) optionally further comprising a thermal conditioner, such as a heater and/or cooler, configured to condition thermally said beverage ingredient fluid(s) (21,22) upon delivery by the delivery aperture and prior to reception by the receiving aperture (40',40B'),

characterised in that the processing surface (10,10A,10B) has a central area (11,11A,11B) at the rotational axis

(10') and a peripheral area (12,12A,12B) remote from the rotational axis (10') so as to extend between the central area (11,11A,11B) and the peripheral area (12,12A,12B), the central area (11,11A,11B) being located closer to the or each fluid delivery aperture (30',30A',30B') than to the or each receiving aperture (40',40B'), optionally the or at least one or all of the fluid delivery aperture(s) (30',30A',30B') facing the processing surface (10,10A,10B).

2. The device of claim 1, wherein the processing surface (10,10A,10B) extends substantially planarly or conically or spherically or elliptoidally from the central area (11,11A,11B) to the peripheral area (12,12A,12B), optionally the processing surface (10,10A,10B) having substantially a shape of: a flat disc; a spherical or ellipsoidal cap; or a conical surface with an obtuse aperture angle, for instance an obtuse angle of at least 120 deg., such as at least 135 deg., e.g. at least 150 deg., for example at least 165 deg.

3. The device of claim 1 or 2, which comprises a plurality of distinct processing surfaces (10,10A,10B), each formed of such a fluid processing surface, two such distinct processing surfaces (10,10A,10B) having each a corresponding central area (11,11A,11B) at the rotational axis (10') and a corresponding peripheral area (12,12A,12B) remote from the rotational axis (10') so as to extend between its central area (11,11A,11B) and its peripheral area (12,12A,12B), two such distinct processing surfaces (10,10A,10B) being each associated with at least one corresponding fluid input line (30,30A,30B) having a fluid delivery aperture (30',30A',30B') configured to deliver to the corresponding processing surface (10,10A,10B) a beverage ingredient fluid (21,22), e.g. each line of the fluid input lines (30,30A,30B) having a corresponding delivery aperture (30',30A',30B'), the central area (11,11A,11B) being located closer to the or each fluid delivery aperture (30,30A',30B') than to the or each receiving aperture (40',40B'), two such distinct processing surfaces (10,10A,10B) being for instance formed by:

- a common substantially wall-shaped member (100), e.g. a member extending substantially planarly or conically or spherically or ellipsoidally such as substantially shaped as a coin, the distinct processing surfaces (10,10A) being formed by opposite faces of the member (100), for example the member (100) comprising one or more through-holes (101) extending from one (10) to the other (10A) of said two such distinct processing surfaces (10,10A) to fluidically connect them through the member (100); or
- distinct wall-shaped members (100,100B), e.g. each member (100,100B) extending substantially planarly or conically or spherically or ellipsoidally such as substantially shaped as a coin, for instance the wall-shaped members (100,100B) being located and rotatable in distinct processing cavities (50',50B'),

optionally the actuator (20) actuating two or more of the processing surfaces (10,10A,10B) to rotate about the rotational axis (10'), e.g. the processing surfaces (10,10A,10B) rotating at a same speed or at different speeds.

4. The device of any preceding claim, wherein the processing surface (10,10A,10B) faces a confinement wall (51), e.g. a confinement wall (51) that extends substantially in parallel over the processing surface (10,10A,10B), to define therebetween a fluid processing chamber (10a), the processing surface (10,10A,10B) rotating relative to the confinement wall (51) about the rotational axis (10'), for instance the confinement wall (51):

- forming or being part of a casing (50) comprising the confinement wall (51); and/or
- being spaced, e.g. axially (10'), from the processing surface (10,10A,10B) by a distance in the range of 0.1 to 3 mm, such as 0.2 to 2.5 mm, for example less than 2 mm, e.g. in the range of 0.5 to 1.5 mm, optionally said distance being sufficiently small to generate a couette flow of said beverage ingredient fluid(s) (21,22) between the processing surface (10,10A,10B)

and the confinement wall (51) during relative rotation thereof about the rotational axis (10').

5. The device of any preceding claim, wherein the or one of the fluid input lines (30,30A,30B,31,32,33) is fluidically connected to a source of gas configured to supply gas at ambient pressure or compressed gas to the processing surface (10,10A,10B), optionally the source of gas being a source of air or a carbonated gas.

6. The device of any preceding claim, wherein the or one of the fluid input lines (30,30A,30B,31,32,33) is fluidically connected to a source of liquid milk or of a milk-based liquid.

7. The device of any preceding claim, wherein the or one of the fluid input lines (30,30A,30B,31,32,33) is fluidically connected to a source of liquid coffee or tea or chocolate.

8. The device of any preceding claim, wherein the or one of the fluid input lines (30,30A,30B,31,32,33) is fluidically connected to a source of syrup.

9. The device of any preceding claim, wherein the or at least one of the fluid input lines (30,30A,30B,31,32,33) is fluidically connected to a valve configured to control a flow along such line (30,30A,30B,31,32,33) to the processing surface (10,10A,10B), optionally each line of the fluid input lines (30,30A,30B,31,32,33) being fluidically connected to such a valve.

10. The device of any preceding claim, wherein the or at least one output line (40,40B) is fluidically connected to a valve configured to control a flow along such line (40,40B) from the processing surface (10,10A,10B), optionally each line of the fluid output lines (40,40B) being fluidically connected to such a valve.

11. The device of any preceding claim, wherein the or at least one of the receiving aperture (40',40B') faces the processing surface (10,10A,10B) and/or is adjacent the peripheral area (12,12A,12B), said output line (40,40B) extending from the receiving aperture (40') in a direction that is:

- non-orthogonal to the rotational axis (10'), such as parallel to the rotational axis (10') or at an angle thereto in the range of 0 to 60°, such as 15 to 45°; or
- non-parallel to the rotational axis (10'), such as orthogonal to the rotational axis (10') or at an angle thereto in the range of 0 to 60°, such as 15 to 45°.

12. The device of any preceding claim, wherein the or at least one output line (40,40B) extends from the receiving aperture (40',40B'):

- in line with a direction of rotation (10'') of the processing surface (10,10A,10B) or at an acute angle thereto, to facilitate an output of said fluid (41) away from the processing surface (10,10A,10B); or
- in opposite line with a direction of rotation (10'') of the processing surface (10,10A,10B) or at an acute angle thereto, to slow down an output of said fluid (41) away from the processing surface (10,10A,10B).

13. The device of any preceding claim, which comprises a control unit (60) that is connected to one or more of:

- the actuator (20) to control an output of the actuator (20) to the processing surface (10,10A,10B), such as at least one of speed, direction, torque and power;
- the one or more fluid input lines (30,30A,30B,31,32,33) to control a feed of said fluid therealong to the processing surface (10,10A,10B), such as at least one of: an opening and closing of the input line(s) (30,30A,30B,31,32,33); a flow rate of fluid along the input line(s) (30,30A,30B,31,32,33); a volume of fluid along the input line(s) (30,30A,30B,31,32,33); and a mass of fluid along input line(s) (30,30A,30B,31,32,33); and
- the at least one fluid output line (40,40B) to control a passage of fluid away from the processing surface (10,10A,10B), such as at least one of: an opening and closing of the output line (40,40B); a flow rate of

fluid along the line (40,40B); a volume of fluid along the output line (40,40B); and a mass of fluid along the output line (40,40B),

optionally the control unit (60) being configured to control a rotation of the processing surface (10,10A,10B) and/or other device part(s) in order to achieve at least one of:

- mixing on the processing surface (10,10A,10B) at least two liquids supplied via separate fluid input lines (30,30A,30B,31,32,33) to the processing surface (10,10A,10B);
- mixing on the processing surface (10,10A,10B) at least one liquid and one gas, such as gas at ambient pressure or compressed gas, for instance the gas being air or a carbonated gas, optionally the liquid being frothed with the gas; and
- pumping along the processing surface (10,10A,10B) one or more liquids from the fluid input line(s) (30,30A,30B,31,32,33) to the fluid output line(s) (40,40B).

14. The device of any preceding claim, which has one or more fluid sources, such as at least one of fluid containers and connectors to external fluid sources, the or each fluid line (30,30A,30B,31,32,33) being connected to the or one of said fluid sources, optionally the or at least one fluid source being connected to its fluid line (30,30A,30B,31,32,33) via one or more component selected from: a thermal conditioner, e.g. a heater and/or cooler; a pump; a valve; and a fluid sensor, such as a flow meter, a thermal sensor, a pressure sensor; and a device configured to extract an ingredient capsule.

15. A method for processing, in a device as defined in any preceding claim, at least one beverage ingredient fluid (21,22), such method comprising:

- actuating with the actuator (20) the processing surface (10,10A,10B) to rotate about the rotational axis (10');

- delivering the beverage ingredient fluid(s) (21,22) via the delivery aperture(s) (30',30A',30B') of the fluid input line(s) (30,30A,30B,31,32,33) to the processing surface (10,10A,10B) so as to process the beverage ingredient fluid(s); and
- guiding the fluid (41) away from the processing surface (10,10A,10B) via the receiving aperture (40',40B') of the fluid output line(s) (40,40B),

whereby the processing surface (10,10A,10B) has a central area (11,11A,11B) at the rotational axis (10') and a peripheral area (12,12A,12B) remote from the rotational axis (10') so as to extend between the central area (11,11A,11B) and the peripheral area (12,12A,12B), the central area (11,11A,11B) being located closer to the or each fluid delivery aperture (30',30A',30B') than to the or each receiving aperture (40',40B').

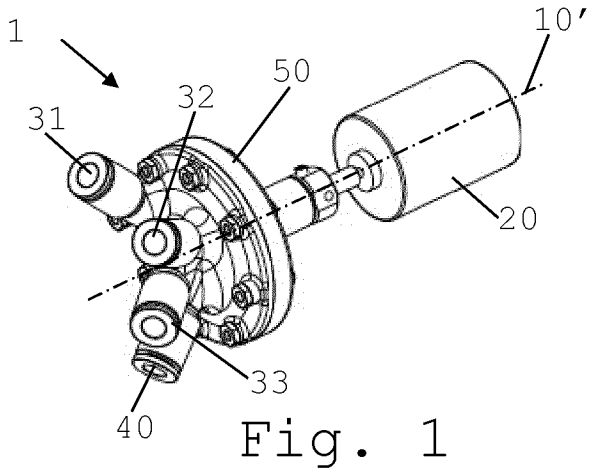

Fig. 1

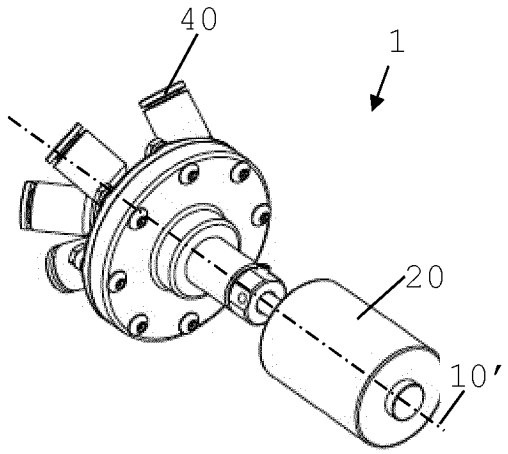

Fig. 2

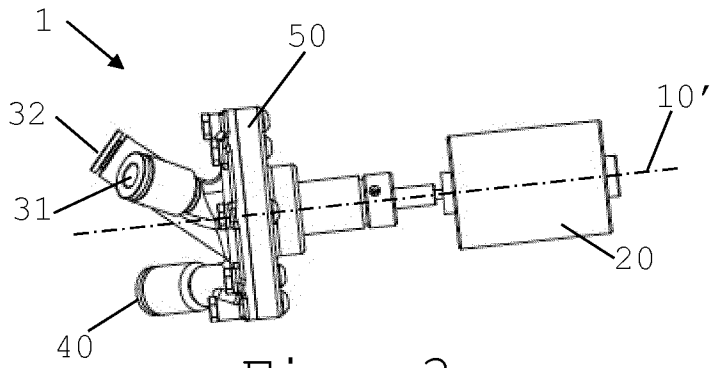

Fig. 3

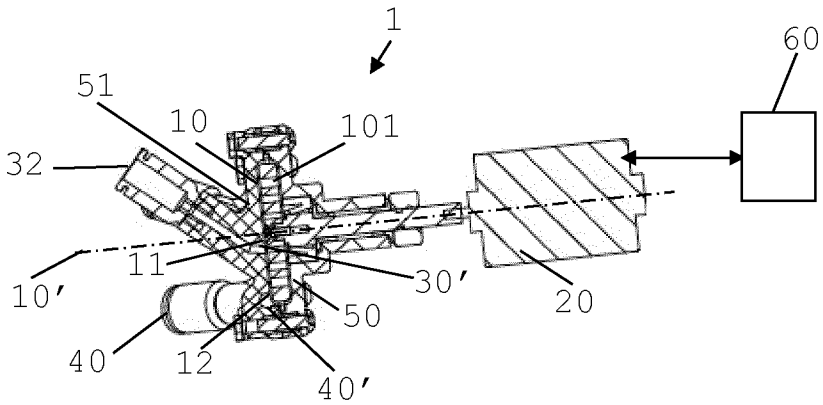

Fig. 4

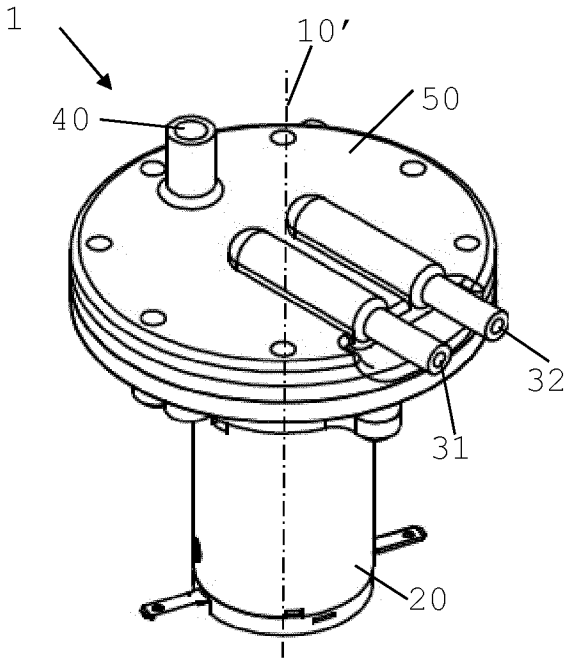

Fig. 5

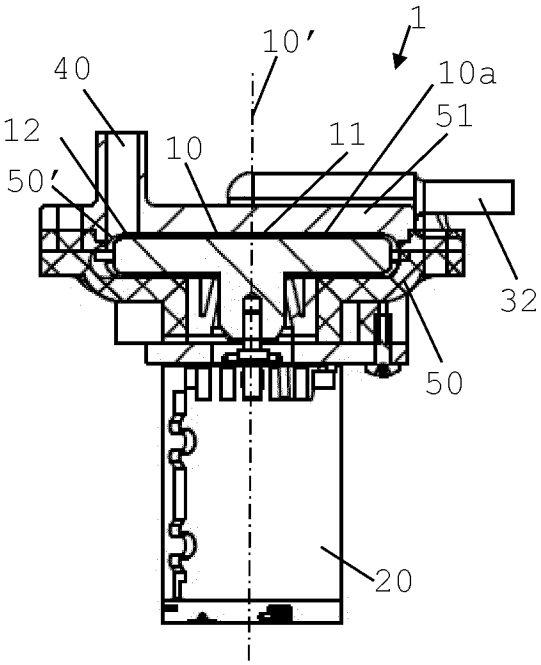

Fig. 6

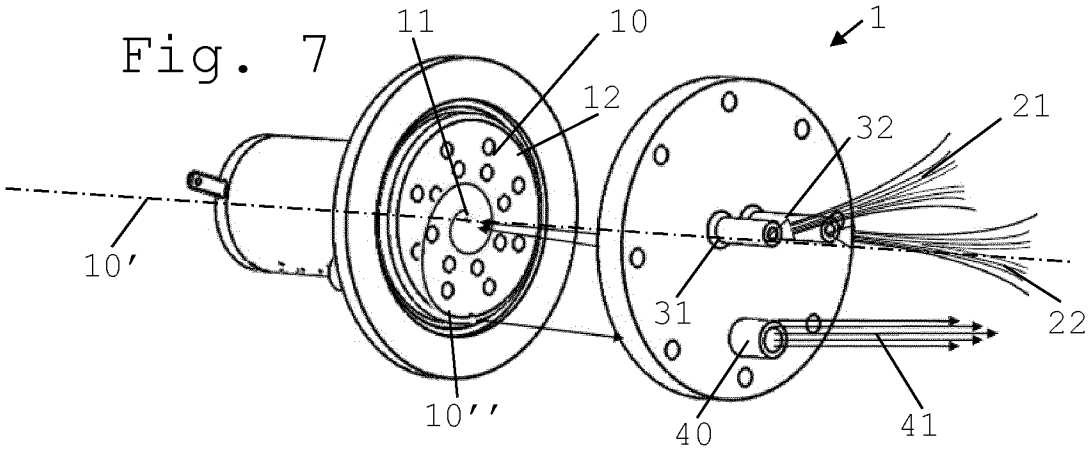

Fig. 7

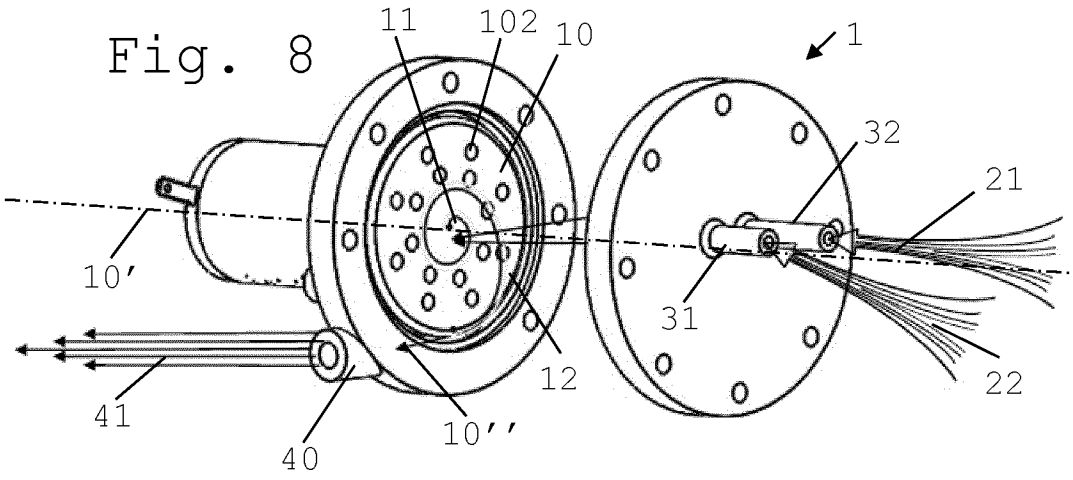

Fig. 8

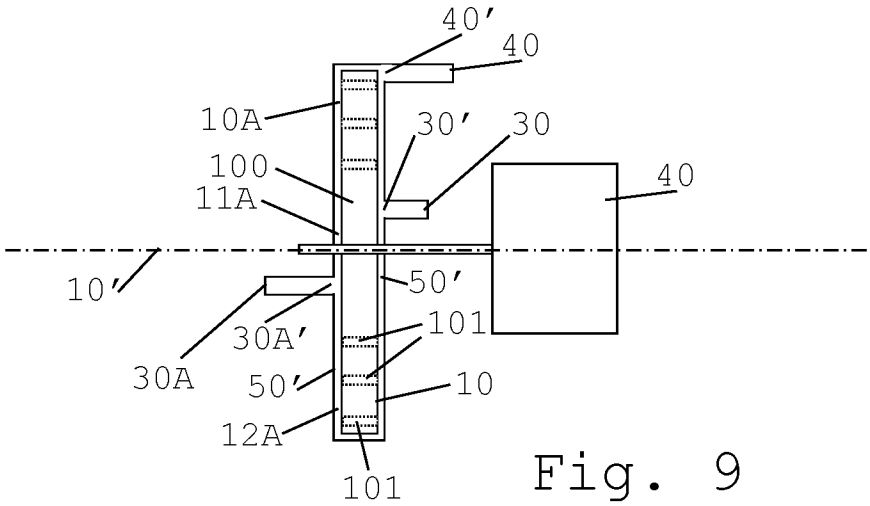
40'
40
10A
30'
30
100
11A
40
10'
50'
30A'
101
30A
50'
10
12A
101

Fig. 9

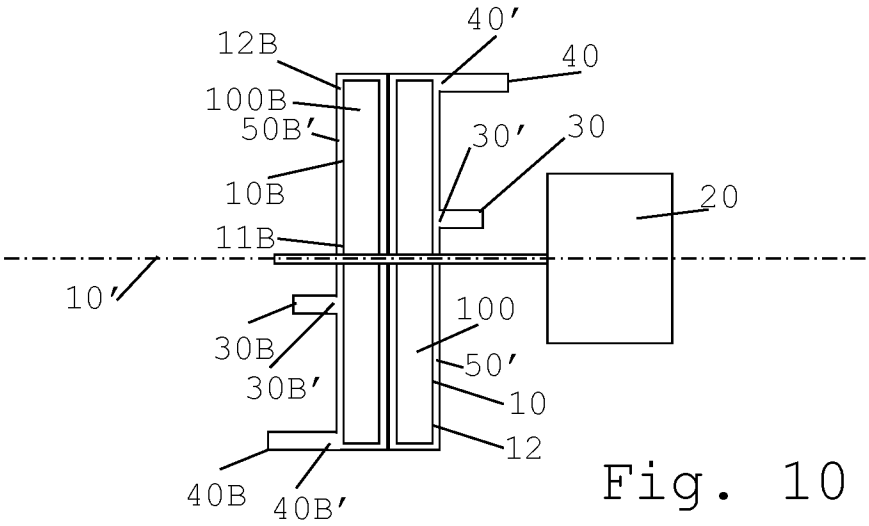
40'
12B
40
100B
50B'
30'
30
10B
20
11B
10'
100
30B
50'
30B'
10
12
40B
40B'

Fig. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2023/086274

A. CLASSIFICATION OF SUBJECT MATTER
INV. A47J31/41 A47J31/40 A47J31/44
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A47J

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 10 898 023 B2 (NESTEC SA [CH]; NESTLE SA [CH]) 26 January 2021 (2021-01-26)	1,2,4-15
A	column 4, lines 34-40 column 5, line 9 - column 6, line 4; figure 2 column 7, lines 27-34 column 2, line 4 column 7, lines 35-37	3
A	US 2017/215645 A1 (DOGLIONI MAJER ANDREA [IT] ET AL) 3 August 2017 (2017-08-03) paragraphs [0034] - [0039]; figures 4,5	1-15

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

☒ See patent family annex.

* Special categories of cited documents :

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

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Date of the actual completion of the international search	Date of mailing of the international search report
28 February 2024	15/03/2024

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 10898023 B2	26-01-2021	CN 108289569 A	17-07-2018
		EP 3386355 A1	17-10-2018
		US 2018368611 A1	27-12-2018
		WO 2017097674 A1	15-06-2017
US 2017215645 A1	03-08-2017	CN 107073414 A	18-08-2017
		EP 3174383 A1	07-06-2017
		JP 2017529123 A	05-10-2017
		US 2017215645 A1	03-08-2017
		WO 2016016743 A1	04-02-2016