(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 543 205 A1**

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
25.09.2019 Bulletin 2019/39

(51) Int Cl.:
B67C 3/28 *(2006.01)*

(21) Application number: **18305307.3**

(22) Date of filing: **20.03.2018**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(71) Applicant: **Sidel Participations**
76930 Octeville-sur-Mer (FR)

(72) Inventors:
- **D'ERRICO, Stefano**
  43126 Parma (IT)
- **BANDINI, Filippo**
  43126 Parma (IT)

(74) Representative: **Siloret, Patrick**
Sidel Participations
Avenue de la Patrouille de France
CS60627 Octeville-sur-mer
76059 Le Havre Cedex (FR)

(54) FILLING VALVE, FILLING MACHINE AND METHOD FOR FILLING RECEPTACLES

(57) There is described a filling valve (5; 105) for a filling machine (1) configured to fill a receptacle (2) with a pourable product; the filling valve (5; 105) comprises a flow channel (11; 111) having an inlet opening (15) for receiving the pourable product and an outlet opening (18) for feeding the pourable product into the receptacle (2); the filling valve (5; 105) comprises a closing member (12) arranged within the flow channel (11; 111) and configured to be controlled at least between a full closing position, in which the closing member (12) is configured to prevent a fluid connection between the inlet opening (15) and the outlet opening (18), a full opening position, in which the closing member (12) is configured to allow the fluid connection between the inlet opening (15) and the outlet opening (18) through a full opening passage, and at least one intermediate position, defining a respective intermediate opening passage for the pourable product; the closing member (12) is configured to be controlled towards the full closing position in a direction against the flow direction (D) of the pourable product within the flow channel (11; 111).

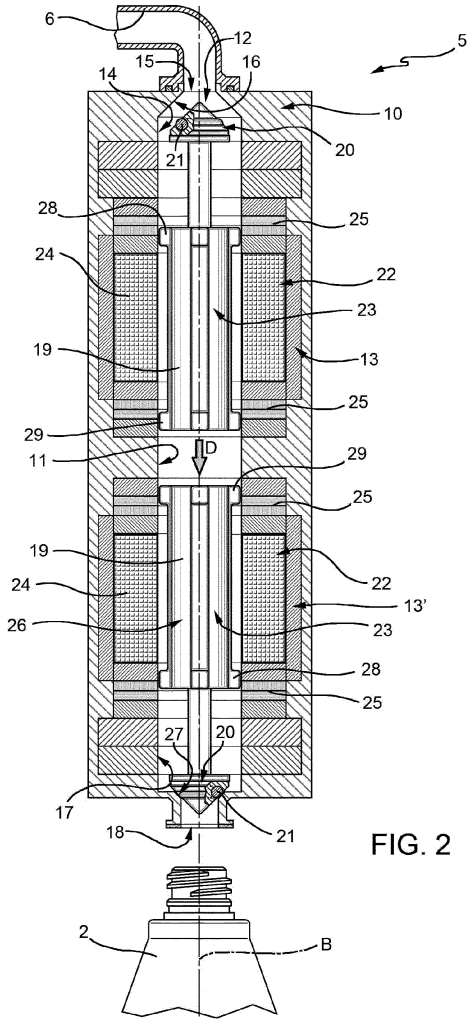

FIG. 2

EP 3 543 205 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a filling valve for a filling machine configured to fill receptacles, in particular bottles, with a pourable product, in particular a pourable food product such as water, carbonated beverages, or the like.

[0002] The present invention also relates to a filling machine comprising a plurality of filling valves for filling receptacles, in particular bottles, with a pourable product, in particular a pourable food product.

[0003] The present invention also relates to a method for filling receptacles, in particular bottles, with a pourable product, in particular a pourable food product.

BACKGROUND ART

[0004] Rotary-type filling machines are known to comprise a carousel rotatable around a vertical axis, a reservoir containing the pourable product and a plurality of filling valves. In detail, such filling valves are peripherally carried by the carousel, are connected to the reservoir by means of respective ducts and are advanced by the carousel along a circumferential transfer path.

[0005] Each filling valve is configured to feed a predetermined volume of pourable product into one respective receptacle at a time, while being advanced along the transfer path due to the rotary motion imparted by the carousel.

[0006] A typical filling machine also comprises an inlet conveyor for feeding a succession of empty receptacles to the carousel and an outlet conveyor receiving the filled receptacles from the carousel and configured to feed the filled receptacles to further treatment devices.

[0007] A typical filling valve comprises:

- a longitudinal tubular body mounted on a peripheral portion of the carousel and internally defining a flow channel for feeding the pourable product into a respective empty receptacle arranged under the tubular body;
- a shutter, which engages the tubular body in a sliding manner and is movable along the flow channel so as to allow or prevent the outflow of the pourable product towards the respective receptacle; and
- actuator means configured to control the movement of the shutter within the flow channel.

[0008] In general, the flow channel has a longitudinal axis parallel to the carousel axis and terminates, at a lower end portion, with an axial outlet opening configured to allow, in use, the outflow of the pourable product and the filling of the respective receptacle to be filled.

[0009] In particular, the flow channel comprises a tapered-section portion narrowing in the direction of the outlet opening, up to a minimum-diameter section.

[0010] The shutter is movable inside the flow channel between:

- a full closing position, in which the shutter sealingly engages the minimum-diameter section, thereby interrupting the outflow of the pourable product towards the respective receptacle; and
- a full opening position, in which the shutter delimits, together with the tapered-section portion of the flow channel, an annular passage fluidly connected to the outlet opening.

[0011] It is known in the field to control the shutter in a modulating manner. According to this latter configuration, the shutter is movable within the flow channel in a plurality of intermediate positions ranging between the full closing position and the full opening position. The shutter delimits, together with the tapered-section portion, an annular opening passage having varying sizes in dependence of whether the shutter is controlled into the full opening position or into one of the intermediate positions. The opening passage is at its maximum when the shutter is controlled into the full opening position; in the latter condition, the flow rate of the pourable product is the highest possible (maximum flow rate).

[0012] Conversely, when the shutter is in a particular intermediate position it delimits, together with the tapered-section portion, corresponding intermediate annular opening passages with varying dimensions, so as to allow the pourable product to flow at an intermediate flow rate (lower than the maximum flow rate) towards and into the respective receptacle.

[0013] In order to ensure a proper separation between the inner aseptic environment of the flow channel and the external non-sterile environment, it is preferable to remotely control the movement of the shutter by means of the action of a magnetic field, without mechanical interfaces entering into the aseptic environment of the filling valve.

[0014] To this end, the shutter is controlled by magnetic actuator means. Known magnetic actuator means comprise a magnetic actuator including a magnetic stator, i.e. a coil, which is arranged in a fixed position around the flow channel, and an inner core, which is made of a ferromagnetic material and is movable within the flow channel. In particular, the inner core is usually included in the shutter, or the shutter itself is entirely made of ferromagnetic material and, hence, defines the inner core.

[0015] The magnetic stator, i.e. the coil, is configured to be magnetically coupled with the inner core, so as to control the movement of the shutter inside the flow channel, due to variations in the magnetic field produced by the electric current flowing inside the coil in one or another direction.

[0016] In particular, when the coil is not energized, the inner core, i.e. the shutter, is arranged in a rest position (which defines one intermediate position), usually symmetric with respect to the coil itself.

[0017] When the coil is energized with respective opposite electrical currents, the shutter will move along a positive partial stroke towards and into the full closing position, or along a negative partial stroke towards and into the full opening position.

[0018] However, when the shutter moves along the positive partial stroke, i.e. from the rest position to the full closing position, fluid-dynamic instabilities may arise.

[0019] In particular, as the shutter approaches the full closing position, the intermediate opening passage shrinks more and more, thereby causing a Venturi effect on an end portion of the shutter configured to engage the outlet opening.

[0020] This unwanted effect prevents the whole shutter to be perfectly stable near the full closing position, as its end portion is subject to the so-called hydrodynamic paradox (Venturi effect) and, consequently, to the deriving Bernoulli forces: due to this phenomenon, the pressure decreases around the intermediate opening passage when this latter is shrinking, i.e. when the shutter is controlled near the full closing position, due to the high speed of the pourable product through the same intermediate opening passage. Therefore, Bernoulli forces arise, acting on the end portion of the shutter together with the pressure of the pourable product, which is flowing in the same direction. Hence, the shutter is pushed towards the full closing position, whereas the magnetic force exerted by the magnetic actuator means is trying to keep the shutter at the wanted intermediate position. This causes the aforementioned instabilities, until the magnetic force is overcome and the shutter completely closes the outlet opening.

[0021] In order to avoid such an unwanted behavior, in one approach the filling valve is designed such that the rest position of the modulating shutter (i.e. when the coil is not energized) is set as the full closing position. However, this limits the total available stroke.

[0022] Another solution known in the art is to oversize the coil, thereby leading to increased costs and a cumbersome configuration.

[0023] Consequently, only the partial negative stroke can be efficiently used for allowing to operate the filling valve, i.e. the shutter, in a modulating manner, thereby allowing only a partial regulation of the flow rate of the pourable product.

DISCLOSURE OF INVENTION

[0024] It is therefore an object of the present invention to provide a filling valve, which allows to overcome at least one of the above-mentioned drawbacks in a straightforward and low-cost manner.

[0025] This object is achieved by a filling valve as claimed in claim 1.

[0026] It is a further object of the present invention to provide a filling machine, which is designed to overcome at least one of the above-mentioned drawbacks in a straightforward and low-cost manner.

[0027] This object is achieved by a filling machine according to claim 10.

[0028] It is an even further object of the present invention to provide a method for filling receptacles allowing to overcome at least one of the above-mentioned drawbacks in a straightforward and low-cost manner.

[0029] This object is achieved by a method for filling according to claim 12.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] Two non-limiting embodiments of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a schematic top view of a filling machine comprising a plurality of filling valves according to the teaching of the present invention;

Figure 2 is a partially sectioned side view of a filling valve according to a first embodiment of the present invention, with parts removed for clarity; and

Figure 3 is a partially sectioned, schematic side view of a filling valve according to a second embodiment of the present invention, with parts removed for clarity.

BEST MODE FOR CARRYING OUT THE INVENTION

[0031] With reference to Figure 1, number 1 indicates as a whole a filling machine for filling a plurality of receptacles 2, such as bottles, containers and the like, with a pourable product, in particular a pourable food product, such as non-carbonated beverages (e.g. water, fruit juices,...), carbonated beverages (e.g. sparkling water, soft drinks, beer,...), or the like.

[0032] In particular, filling machine 1 comprises:

- a conveying device, in particular a carousel 3 rotatable around a central axis A, preferably having a vertical orientation, and being adapted to advance receptacles 2 along an advancement path P, preferably being arc-shaped;
- a reservoir 4 containing the pourable product; and
- a plurality of filling valves 5, configured to fill receptacles 2 during their advancement along path P.

[0033] In detail, each filling valve 5 is configured to feed a predetermined volume of pourable product into one respective receptacle 2 at a time, while the respective receptacle 2 is advanced along path P, in particular due to the rotary motion of carousel 3.

[0034] More specifically, each filling valve 5 is peripherally carried by carousel 3 and is fluidly connected to reservoir 4 by means of a respective duct 6 of filling machine 1.

[0035] As visible in Figure 1, filling machine 1 further comprises an inlet conveyor, preferably a star wheel 7, adapted to feed a succession of empty receptacles 2 to

carousel 3, and an outlet conveyor, preferably a star wheel 8, adapted to receive filled receptacles 2 from carousel 3.

[0036] In particular, star wheel 7 and star wheel 8 are rotatable around respective rotation axes A' and A" , preferably being substantially parallel to axis A.

[0037] In the following, as filling valves 5 are identical to one another and for the sake of brevity, only one single filling valve 5 according to a first embodiment of the present invention will be described.

[0038] However, all the features disclosed hereinafter for such filling valve 5 are applicable to each filling valve 5 of filling machine 1.

[0039] With particular reference to Figure 2, the respective receptacle 2 is arranged, in particular during the filling operation, below filling valve 5.

[0040] In the preferred embodiment shown, filling valve 5 is configured to operate in the non-contact mode.

[0041] In an alternative embodiment not shown, filling valve 5 could be configured to operate in the contact mode, i.e. in use, filling valve 5 establishes contact with a top neck portion of receptacles 2 in the area of outlet opening 18.

[0042] In the specific and non-limiting embodiment of Figure 2, filling valve 5 comprises:

- a valve body, in particular a longitudinal tubular body 10, mounted on a peripheral portion of carousel 3 and internally defining a flow channel 11 configured for feeding the pourable product along a flow direction D into receptacle 2;
- a closing member 12, preferably a shutter 12, arranged, in particular movably arranged, within flow channel 11 so as to control, in particular allow or prevent, the outflow of the pourable product towards receptacle 2; and
- actuator means 13 configured to control, in particular to control the movement of, shutter 12 within flow channel 11.

[0043] In particular, flow channel 11 has a substantially circular cross section and extends along a longitudinal axis B, in particular parallel to axis A.

[0044] In more detail, flow channel 11 comprises, an (axial) inlet opening 15, fluidically connectable with the respective duct 6 and with receptacle 2. Preferably, flow channel 11 also comprises an engagement portion, in particular a tapered-section portion 16 narrowing in the direction of inlet opening 15, up to a minimum-diameter section defining the inlet opening 15 itself and, preferably being configured to interact at least with a portion of closing member 12.

[0045] Preferably, flow channel 11 further comprises an outlet opening 18 fluidically connectable to inlet opening 15 and, in use, to the respective receptacle 2.

[0046] Preferably, inlet opening 15 is arranged upstream of outlet opening 18 along flow direction D.

[0047] Even more preferably, inlet opening 15 and outlet opening 18 are respectively arranged in the area of an upstream (upper) end portion 14 and a downstream (lower) end portion 17 of flow channel 11.

[0048] In use, flow channel 11 is configured to allow the flow of the pourable product within itself along flow direction D, from inlet opening 15 to outlet opening 18.

[0049] Preferably, flow channel 11 is delimited by a respective inner wall, in particular a tubular wall of the valve body, in particular body 10. Even more preferably, flow channel 11 has a substantially cylindrical shape.

[0050] In the non-limiting example embodiment shown in Figure 2, shutter 12 is arranged downstream of inlet opening 15 and upstream of outlet opening 18, with respect to flow direction D.

[0051] According to the preferred embodiment shown in Figure 2, shutter 12, inlet opening 15 and outlet opening 18 are coaxially arranged with respect to axis B.

[0052] Shutter 12 is configured to be controlled, in particular moved, at least between:

- a full closing position, in which shutter 12 is configured to prevent a fluid connection between inlet opening 15 and outlet opening 18;
- a full opening position, in which shutter 12 is configured to allow the fluid connection between inlet opening 15 and outlet opening 18 and defines, in particular together with portion 16, a full opening passage for the pourable product; and
- one or more intermediate positions, located between the full closing position and the full opening position, in which shutter 12 delimits, in particular together with portion 16, respective intermediate opening passages for the pourable product.

[0053] In particular, in use, when shutter 12 is at the full opening position, the flow rate of the pourable product from inlet opening 15 to outlet opening 18 is the highest possible (maximum flow rate). When shutter 12 is at one of the intermediate positions, the intermediate opening passages, having different sizes, allow the pourable product to flow from inlet opening 15 to outlet opening 18 at respective intermediate flow rates, being lower than the maximum flow rate. When shutter 12 is at the full closing position, the pourable product flow rate is null.

[0054] In a preferred embodiment, shutter 12 is configured to operate in a modulating manner; i.e. shutter 12 is controlled between the full closing position, the intermediate opening position and the full opening position, so as to control the flow rate of the pourable product between the maximum flow rate, the intermediate flow rates, and the null flow rate.

[0055] According to an important aspect of the present invention, shutter 12 is configured to be controlled, in particular moved, towards the full closing position in a direction against the flow direction of the pourable product within flow channel 11.

[0056] More specifically, shutter 12 is configured to be moved, in particular through activation by actuator means

13, along axis B, in a direction away from outlet opening 18 and towards inlet opening 15 when being controlled towards the full closing position, thereby moving against flow direction D (countercurrent).

[0057] In particular, shutter 12 comprises a core 19 and an interaction portion 20, preferably a plunger 20, axially extending from core 19 towards inlet opening 15 and configured to engage with portion 16 of flow channel 11 when shutter 12 is in the full closing position.

[0058] In detail, core 19 comprises two opposite end portions 28, 29 having an external diameter substantially equal to that of flow channel 11, in particular so as to radially engage the inner wall delimiting flow channel 11 and being axially guided within flow channel 11.

[0059] In greater detail, plunger 20 carries (comprises) a sealing element 21 configured to sealingly engage portion 16 when shutter 12 is in the full closing position, thereby preventing any flow of the pourable product from inlet opening 15 towards outlet opening 18.

[0060] In the non-limiting embodiment shown in Figure 2, actuator means 13 are of the magnetic type.

[0061] This is advantageous, since it allows to easily maintain aseptic or ultra-clean conditions by providing for a proper separation between the inner aseptic environment of flow channel 11 and the external non-sterile environment. In the preferred embodiment, no mechanical interfaces enter into the inner aseptic environment of flow channel 11, thereby facilitating the maintenance of the aseptic or ultra-clean conditions.

[0062] In more detail, actuator means 13 comprise a driving magnetic assembly 22, arranged externally around flow channel 11, and a driven magnetic assembly 23, arranged within flow channel 11 and comprised in at least a portion of shutter 12, in particular in at least a portion of core 19, and preferably being made of a ferromagnetic material.

[0063] Preferably, shutter 12, in particular core 19, is entirely made in ferromagnetic material, thereby entirely defining assembly 23.

[0064] According to a further possible alternative not shown, assembly 23 could comprise a permanent magnet included within shutter 12, in particular within core 19.

[0065] Assembly 22 is configured to be magnetically coupled to assembly 23, so as to control the movement of shutter 12 between the full opening position, the full closing position and the intermediate positions.

[0066] According to the embodiment shown in Figure 2, assembly 22 comprises an electrically-supplied magnetic generator, for example a coil 24, in particular arranged coaxially to axis B in a fixed position around flow channel 11, and a pair of permanent magnets 25 arranged coaxially to axis B on respective opposite axial end sides of coil 24 and having corresponding magnetic poles axially facing each other.

[0067] In detail, coil 24 presents a cylindrical-annular shape and permanent magnets 25 are arranged respectively against a first (top) and a second (bottom) annular end surface of coil 24. In greater detail, coil 24 surrounds at least partially core 19, internally facing its external surface so as to have the lowest radial gap possible with the latter.

[0068] In particular, assembly 22 is configured to control the movement of shutter 12 within flow channel 11 in dependence of variations in the magnetic field produced by an electric current flowing through coil 24 in one or another direction.

[0069] Preferably, filling machine 1 comprises a control unit 26 (only schematically shown in Figure 1) configured to control the flow of electric current through coil 24.

[0070] Alternatively, each filling valve 5 comprises a respective control unit for controlling the flow of electric current through the respective coil 24.

[0071] In particular, assembly 22 is configured such that when coil 24 is not energized, i.e. no electric current flows, in use, through it, assembly 23 is not moved and shutter 12, i.e. core 19, is arranged in a rest position, which defines one respective intermediate position, as shown in Figure 2.

[0072] Preferably, assembly 22 is also configured such that:

- when coil 24 is energized with a determined electrical current, shutter 12 moves, in use, along a negative partial stroke with respect to the rest position, i.e. away from inlet opening 15 and towards the full opening position; and
- when coil 24 is energized with an electric current having opposite direction than the former electric current, shutter 12 moves, in use, along a positive partial stroke with respect to the rest position, i.e. towards inlet opening 15 and the full closing position (and against flow direction D).

[0073] In the latter condition, as shutter 12 approaches the full closing position and the size of the intermediate opening passage is reduced more and more, a Venturi effect arises, acting on plunger 20. Thanks to the above-described configuration of shutter 12 according to the present invention, the Bernoulli forces are acting against the pressure exerted by the pourable product on plunger 20, thereby limiting, or avoiding, the hydrodynamic instabilities, and allowing a more precise and stable control of shutter 12 and a more effective use of its total available stroke within flow channel 11.

[0074] Preferably, filling valve 5 further comprises an auxiliary closing member, in particular an auxiliary shutter 26, arranged, in particular movably arranged, within flow channel 11 so as to control, in particular to allow or prevent, the outflow of the pourable product through outlet opening 18 and towards (into) receptacle 2.

[0075] In the preferred embodiment shown in Figure 2, shutter 26 presents similar features to that of shutter 12; therefore only the distinguishing features of shutter 26 with respect to shutter 12 will be described in the following, using the same numerals for similar or equivalent parts.

[0076] In particular, shutter 26 is configured to be controlled, in particular moved, between:

- a closing position, in which shutter 26 is configured to prevent the flow of the pourable product from flow channel 11 through outlet opening 18, in particular into receptacle 2; and
- an opening position, in which shutter 26 is configured to allow the flow of the pourable product from flow channel 11 through outlet opening 18 into receptacle 2.

[0077] In detail, shutter 26 is configured to be controlled towards the closing position in a direction following the flow direction of the pourable product within flow channel 11.

[0078] More specifically, shutter 26 is configured to be moved, along axis B, in a direction away from inlet opening 15 and towards outlet opening 18 when being controlled towards the closing position, thereby moving into the same direction of the pourable product flow, i.e. concurrent to flow direction D.

[0079] Furthermore, shutter 26 is arranged downstream of shutter 12 and upstream of outlet opening 18 with respect to flow direction D and is configured to be controlled either into the closing position or into the opening position (without any intermediate position therebewteen).

[0080] In other words, preferably shutter 26 is configured to operate in an on-off mode.

[0081] With particular reference to Figure 2, flow channel 11 further comprises, in particular in the area of downstream end portion 17, a further engagement portion, in particular a further tapered-section portion 27 narrowing in the direction of outlet opening 18, up to a minimum-diameter section having the same diameter of the diameter of outlet opening 18.

[0082] In detail, sealing element 21 of plunger 20 of shutter 26 is configured to sealingly engage portion 27 when shutter 26 is controlled in the closing position.

[0083] Preferably, filling valve 5 further comprises auxiliary actuator means 13' of the magnetic type configured to control shutter 26 between the closing position and the opening position.

[0084] In the preferred embodiment shown, actuator means 13' presents similar features to that of actuator means 13; therefore only the distinguishing features of actuator means 13' with respect to actuator means 13 will be described in the following, using the same numerals for similar or equivalent parts.

[0085] In particular, actuator means 13' differ from actuator means 13 in controlling shutter 26, preferably in an on-off-mode.

[0086] Preferably, the respective assembly 22 is configured to control the respective coil 24 such that:

- in use, when the respective coil 24 is not energized, i.e. no electric current flows through it, the respective assembly 23 is immobile and shutter 26, i.e. the respective core 19, is arranged in a rest position, which preferably defines, as shown in Figure 2, the closing position; and
- in use, when the respective coil 24 is energized with a determined electrical current, shutter 26 moves along a negative partial stroke with respect to the rest (in particular closing) position, i.e. away from outlet opening 18 and towards the opening position.

[0087] In the latter condition, plunger 20 defines, together with portion 27, an opening passage for the pourable product, through which the latter can flow towards outlet opening 18 and, eventually, receptacle 2.

[0088] Preferably, assembly 22 comprises at least one further permanent magnet (not specifically shown) for keeping shutter 26 in the closing position without energizing coil 24. Even more preferably, assembly 22 also comprises an additional permanent magnet (not specifically shown) for keeping shutter 26 in the opening position without energizing coil 24.

[0089] It should be noted that, preferably shutter 26 ensures a strong and firm closure of outlet opening 18 when being, in use, controlled into the closing position and avoids energy consumption. In particular, in order to control shutter 26 a single respective energy spike is required to control shutter 26 between the opening position and the closing position. Preferably, at least the closing position is maintained by the further permanent magnet, without any need to continuously energize coil 24. Even more preferably, also the opening position is maintained by the additional permanent magnet, without any need to continuously energize coil 24.

[0090] In use, filling machine 1 fills receptacles 2, in particular during advancement of receptacles 2 along path P, with the pourable product.

[0091] In more detail, each receptacle 2 is filled with the pourable product through one respective filling valve 5.

[0092] The operation of filling valve 5 is described hereinafter with reference to a single empty receptacle 2 to be filled and placed below one respective filling valve 5.

[0093] In more detail, the filling of the respective receptacle 2 comprises the following steps:

- feeding the pourable product to flow channel 11 through inlet opening 15;
- controlling the flow of the pourable product through inlet opening 15 by controlling shutter 12 at least between the full closing position, the full opening position and the intermediate positions.

[0094] In even more detail, during the step of feeding, the pourable product flows from reservoir 4 through the respective duct 6 into flow channel 11.

[0095] In even more detail, during the step of controlling, shutter 12 is controlled towards (and into) the full closing position in a direction against flow direction D.

[0096] More specifically, during the step of controlling, the pourable product flows from inlet opening 15 through respectively the full opening passage and the intermediate opening passage into flow channel 11 and towards outlet opening 18 with shutter 12 being respectively in the full opening position and the intermediate position. Preferably, with shutter 12 being in the full closing position, the flow of pourable product from inlet opening 15 to outlet opening 18 is interrupted.

[0097] Even more preferably, the filling of the respective receptacle 2 further comprises the step of controlling the flow of the pourable product through outlet opening 18 by controlling auxiliary shutter 26 between the closing position and the opening position.

[0098] More specifically, during the step of controlling (in particular, at a pre-set moment which is pre-established in the filling recipe), shutter 12 is controlled to progressively move again towards the full closing position; in this condition, the maximum flow rate progressively decreases into the various intermediate flow rates corresponding to the intermediate positions progressively occupied by shutter 12.

[0099] Then, when the level of the pourable product inside receptacle 2 reaches or approaches the desired level, shutter 26 is controlled to immediately move into the closing position, thereby preventing any further amount of pourable product to flow through outlet opening 18. In this way, receptacle 2 can be filled with the exact desired amount of pourable product.

[0100] In the meantime, shutter 12 completes its partial positive stroke towards the full closing position.

[0101] In even more detail, during the step of controlling, shutter 12 is controlled by the respective assembly 22. Preferentially, shutter 26 is controlled by the respective assembly 22.

[0102] The entire operation is repeated cyclically for each filling valve 5 and for each receptacle 2 to be filled.

[0103] Number 105 in Figure 3 indicates as a whole a filling valve according to a second preferred embodiment of the present invention.

[0104] In particular, filling machine 1 could comprise a plurality of filling valves 105 instead of filling valves 5.

[0105] As filling valve 105 is similar to filling valve 5, only the differences with respect to filling valve 5 will be described, using the same numerals for similar or equivalent parts.

[0106] In particular, filling valve 105 differs from filling valve 5 in comprising flow channel 111 and actuator means 113.

[0107] More specifically flow channel 111 has a substantially circular cross section and presents a curved configuration.

[0108] In more detail, flow channel 111 comprises a first portion 130, extending along a longitudinal, preferably vertical, axis C, and a second portion 131, extending along an inclined axis E and being fluidically connected to portion 130, in particular by means of a curved portion 132.

[0109] In even greater detail, portion 130 and portion 131 are inclined with respect to one another.

[0110] More specifically, axis C and axis E may be oriented with respect to one another in any manner according to needs.

[0111] In the illustrated non-limiting example embodiment of Figure 3, the axes C and E form an angle comprised between 90° and 180°, and curved portion 132 is arranged downstream of portion 131 and upstream of portion 130, with respect to flow direction D.

[0112] In an alternative embodiment not shown, axes C and E may be arranged on a common (vertical) axis to minimize friction and wear.

[0113] Preferably, portion 130 carries inlet opening 15 and portion 131 carries outlet opening 18.

[0114] In more detail, actuator means 113 comprise a driving magnetic assembly 122, arranged externally around flow channel 111, and a driven magnetic assembly 123.

[0115] As driving magnetic assembly 122 and driven magnetic assembly 123 are similar to respectively assembly 22 and assembly 23, only the differences with respect to respectively assembly 22 and assembly 23 will be described, using the same numerals for similar or equivalent parts.

[0116] According to the non-limiting embodiment shown in Figure 3, assembly 122 comprises a first permanent magnet 133 arranged around inclined portion 131 of flow channel 111 and configured to move parallel to axis E by means of a linear actuator, such as a voice coil or a stepper motor 134, this latter being preferably arranged above inlet opening 15.

[0117] Preferably, assembly 122 further comprises a pair of second permanent magnets 125 arranged externally around portion 131 of flow channel 111 on respective opposite axial sides of first permanent magnet 133 and having corresponding magnetic poles axially facing each other.

[0118] In detail, permanent magnet 133 surrounds at least partially core 19 of shutter 12, facing its external surface so as to have the lowest radial gap possible with the latter.

[0119] In more detail, assembly 123 comprises at least one third permanent magnet 135, two in the preferred non-limiting shown in Figure 3, included in (in particular, being comprised in) core 19 of shutter 12 and configured to magnetically couple to permanent magnet 133.

[0120] In this way, a movement of permanent magnets 133 and 125 parallel to axis E, imparted by stepper motor 134 or a voice coil, will cause a corresponding movement of permanent magnets 135 and, consequently, of shutter 12 along the same axis E.

[0121] In particular, in use, when shutter 12 is controlled by means of a voice coil or stepper motor 134 and permanent magnets 133, 125 and 135 into the full closing position, plunger 20 engages portion 16 thereby preventing any flow of pourable product inside flow channel 111 (null flow rate). Preferentially, when plunger 20 is ar-

ranged in the closed position, shutter 12 is controlled into the respective rest position (i.e. one intermediate position). This allows to reduce the overall energy consumption as no energy is needed to maintain shutter 12 in the respective rest position, thereby reducing energy consumption.

[0122] When shutter 12 is controlled into the full opening position, plunger 20 defines, together with portion 16, a full opening passage, thereby allowing a maximum flow rate of pourable product to flow towards outlet opening 18; when shutter 12 is controlled into one of the intermediate positions, plunger 20 defines, together with portion 16, an intermediate opening passage, thereby allowing a corresponding intermediate flow rate of pourable product inside flow channel 111.Filling valve 105 further differs from filling valve 5 in that the respective shutter 26 is controlled by respective actuator means 113, in particular the respective assembly 122 and the respective assembly 123.

[0123] In particular, the respective shutter 26 of filling valve 105 is arranged within portion 130 of flow channel 111, hence in a position downstream of shutter 12 and upstream of the respective outlet opening 18, and configured to be controlled by actuator means 113 in an on-off manner, i.e. shutter 26 is configured to be controlled between the respective closing position and the respective opening position.

[0124] In particular, it should be noted, that the respective actuator means 113 controlling the respective shutter 26 are similar to the respective actuator means 113 controlling the respective shutter 12, with the only difference that they are configured to control shutter 26 in an on-off manner, i.e. between the closing position, in which the respective plunger 20 of shutter26 prevents the pourable product to flow through outlet opening 18, and the opening position, in which the product can flow through outlet opening 18. Preferably, the respective actuator means 113 controlling the respective shutter 26 are arranged in the area of portion 130.

[0125] Since the operation of filling valve 105 is similar to that of filling valve 5, only the distinguishing features of the operation of filling valve 105 with respect to the operation of filling valve 5 will be described in the following.

[0126] In particular, the movement of shutter 12 within portion 131 of flow channel 111 is controlled by means of the magnetic interaction between permanent magnets 133, 125 and 135.

[0127] In detail, a movement of permanent magnets 133 and 125 parallel to axis E, imparted by voice coil or stepper motor 134, will cause a corresponding movement of permanent magnets 135 and, consequently, of shutter 12 along axis E.

[0128] Preferentially, control of shutter 26 is similar to control of shutter 12 with the difference that shutter 26 is controlled by the respective actuator means 113.

[0129] The advantages of filling valves 5 and 105 according to the present invention will be clear from the foregoing description.

[0130] In particular, due to the above-described configuration of shutters 12 according to the present invention, the Bernoulli forces are acting against the pressure exerted by the pourable product on the respective plungers 20, thereby limiting, or avoiding, the hydrodynamic instabilities, and allowing a more precise and stable modulation of shutters 12 and a more effective use of their total available stroke within the respective flow channel 11 or 111.

[0131] Furthermore, since shutters 26 are controlled in an on-off manner, they ensure a strong and firm closure of the respective outlet openings 18 thereby avoiding any further energy consumption. In fact, they only use a respective single energy spike to move between the relative opening and closing positions.

[0132] In addition, when the level of the pourable product inside the respective receptacle 2 reaches the desired level, shutters 26 can be immediately controlled to move into their closing positions. This allows to precisely control the amount of the pourable product filled into the respective receptacle 2.

[0133] Clearly, changes may be made to labeling machine 1 as described herein without, however, departing from the scope of protection as defined in the accompanying claims.

[0134] In an alternative embodiment not shown, filling valve 5 could be designed such that flow channel 11 could comprise two portions being inclined with one another similar to what is disclosed with respect to filling valve 105.

[0135] In a further alternative embodiment not shown, filling valve 5 could comprise actuator means 113 replacing the respective actuator means 13 controlling shutter 26 or shutter 12.

[0136] In an even other alternative embodiment not shown, filling valve 5 could comprise actuator means 113 instead of actuator means 13 (i.e. both actuator means 13 are replaced by respective actuator means 113).

Claims

1. A filling valve (5; 105) for a filling machine (1) configured to fill a receptacle (2) with a pourable product; said filling valve (5; 105) comprising a flow channel (11; 111) having an inlet opening (15) for receiving said pourable product and an outlet opening (18) for feeding said pourable product into said receptacle (2) ;
   said filling valve (5; 105) comprising a closing member (12) arranged within said flow channel (11; 111) and configured to be controlled at least between:

   - a full closing position, in which said closing member (12) is configured to prevent a fluid connection between said inlet opening (15) and said outlet opening (18) ;

- a full opening position, in which said closing member (12) is configured to allow the fluid connection between said inlet opening (15) and said outlet opening (18) through a full opening passage for allowing said pourable product to flow into a flow direction (D) from said inlet opening (15) to said outlet opening (18) through said full opening passage; and
- at least one intermediate position, defining a respective intermediate opening passage for said pourable product for allowing said pourable food product to flow along said flow direction (D) from said inlet opening (15) to said outlet opening (18) through said intermediate opening passage;

characterized in that said closing member (12) is configured to be controlled towards said full closing position in a direction against said flow direction (D) of said pourable product within said flow channel (11; 111).

2. The filling valve as claimed in claim 1, wherein said closing member (12) is configured to operate in a modulating manner.

3. The filling valve as claimed in claim 1 or 2, wherein said closing member (12) comprises an interaction portion (20) configured to engage with an engagement portion (16) of said flow channel (11; 111) when said closing member (12) is in said full closing position.

4. The filling valve as claimed in any one of the claims 1 to 3, wherein said closing member (12) is arranged downstream of said inlet opening (15), with respect to said flow direction (D); said filling valve (5, 105) further comprising an auxiliary closing member (26), arranged within said flow channel (11; 111) and configured to be controlled between:

- a closing position, in which said auxiliary closing member (26) is configured to prevent the flow of said pourable product from said flow channel (11; 111) into said receptacle (2); and
- an opening position, in which said auxiliary closing member (26) is configured to allow the flow of said pourable product from said flow channel (11; 111) into said receptacle (2);

wherein said auxiliary closing member (26) is arranged downstream of said closing member (12), with respect to said flow direction (D).

5. The filling valve as claimed in any one of the foregoing claims, comprising magnetic actuator means (13; 113) configured to control said closing member (12) between said full opening position, said full closing position and said at least one intermediate position.

6. The filling valve as claimed in claim 5, wherein said magnetic actuator means (13; 113) comprise a driving magnetic assembly (22; 122), arranged externally around said flow channel (11; 111), and a driven magnetic assembly (23; 123), arranged within said flow channel (11; 111) and being comprised in at least a portion of said closing member (12); said driving magnetic assembly (22; 122) being configured to be magnetically coupled to said driven magnetic assembly (23; 123), so as to control said closing member (12) between said full opening position, said full closing position and said at least one intermediate position.

7. The filling valve as claimed in claim 6, wherein said flow channel (11) extends at least partially along a longitudinal axis (B); said driving magnetic assembly (22) comprising at least one electrically-supplied magnetic generator (24), arranged coaxially to said axis (B), and a pair of permanent magnets (25) arranged coaxially to said axis (B) on respective opposite axial sides of said magnetic generator (24) and having corresponding poles axially facing each other;
said driven magnetic assembly (23) defining integrally said closing member (12);
said inlet opening (15), said outlet opening (18) and said closing member (12) being coaxial to said axis (B).

8. The filling valve as claimed in claim 6, wherein said driving magnetic assembly (122) comprises a first permanent magnet (133), arranged around at least a portion (131) of said flow channel (111) and configured to move parallel to said flow channel (111) by means of a linear actuator (134); said driving magnetic assembly (122) further comprising a pair of second permanent magnets (125), arranged externally around said flow channel (111) on respective opposite sides of said first permanent magnet (133), with respect to the flow direction (D), and having corresponding poles facing each other, with respect to the flow direction (D); said driven magnetic assembly (123) comprising at least one third permanent magnet (135) included in said closing member (12).

9. The filling valve as claimed in any one of the claims from 6 to 8, further comprising auxiliary magnetic actuator means (13'; 113) configured to control said auxiliary closing member (26) between said opening position and said closing position; said auxiliary magnetic actuator means (13'; 113) comprising an auxiliary driving magnetic assembly (22; 122), arranged externally around said flow channel (11; 111), and an auxiliary driven magnetic assembly (23; 123), arranged within said flow channel (11; 111) and being

comprised in at least a portion of said auxiliary closing member (26); said auxiliary driving magnetic assembly (22; 122) being configured to be magnetically coupled to said auxiliary driven magnetic assembly (23; 123) so as to control said closing member (12) between said full opening position, said full closing position and said at least one intermediate position.

10. A filling machine (1) for filling a plurality of receptacles (2) with a pourable product; said filling machine (2) comprising a plurality of filling valves (5; 105) according to any one of the foregoing claims.

11. The filling machine as claimed in claim 10, further comprising a carousel (3) rotatable around a central axis (A), being adapted to advance said receptacles (2) along an advancement path and peripherally carrying said plurality of filling valves (5; 105);
wherein each one of said plurality of filling valves (5; 105) is configured to fill one respective receptacle (2) at a time during its advancement along said advancement path.

12. A method for filling a receptacle (2) with a pourable product by means of a filling valve (5; 105) comprising the steps of:

i) feeding said pourable product to a flow channel (11; 111) of said filling valve (5; 105) through an inlet opening (15) of said flow channel (11; 111);
ii) controlling the flow of said pourable product through said inlet opening (15) by controlling a closing member (12) arranged within said flow channel (11; 111) at least between:

- a full closing position, in which said closing member (12) prevents a fluid connection between said inlet opening (15) and an outlet opening (18) of said flow channel (11; 111); and
- a full opening position, in which said closing member (12) allows the fluid connection between said inlet opening (15) and said outlet opening (18) through a full opening passage, so that said pourable product flows along a flow direction (D) from said inlet opening (15) to said outlet opening (18) through said full opening passage;
- at least one intermediate position, defining a corresponding intermediate opening passage for said pourable product through which said pourable product flows;

characterized by further comprising the step of:

iii) controlling said closing member (12) towards said full closing position in a direction against said flow direction (D) of said pourable product within said flow channel (11; 111).

13. The method as claimed in claim 12, wherein said closing member (12) operates in a modulating manner.

14. The method as claimed in claim 12 or 13, wherein said closing member (12) comprises an interaction portion (20) engaging with an engagement portion (16) of said flow channel (11; 111) when said closing member (12) is in said full closing position.

15. The method as claimed in any one of the claims 12 to 14, wherein said closing member (12) is arranged downstream of said inlet opening (15), with respect to said flow direction (D);
the method further comprising the step of:

iv) controlling an auxiliary closing member (26), arranged within said flow channel (11; 111), between:

- an opening position, in which said auxiliary closing member (26) allows the flow of said pourable product from said flow channel (11; 111) into said receptacle (2) through said outlet opening (18); and
- a closing position, in which said auxiliary closing member (26) prevents the outflow of said pourable product from said flow channel (11; 111) through said outlet opening (18);

said auxiliary closing member (26) being arranged downstream of said closing member (12), with respect to said flow direction (D).

16. The method as claimed in any one of the claims 12 to 15, wherein the steps iii) and iv) further comprise the step of:

v) controlling said closing member (12) by means of magnetic actuator means (13; 113).

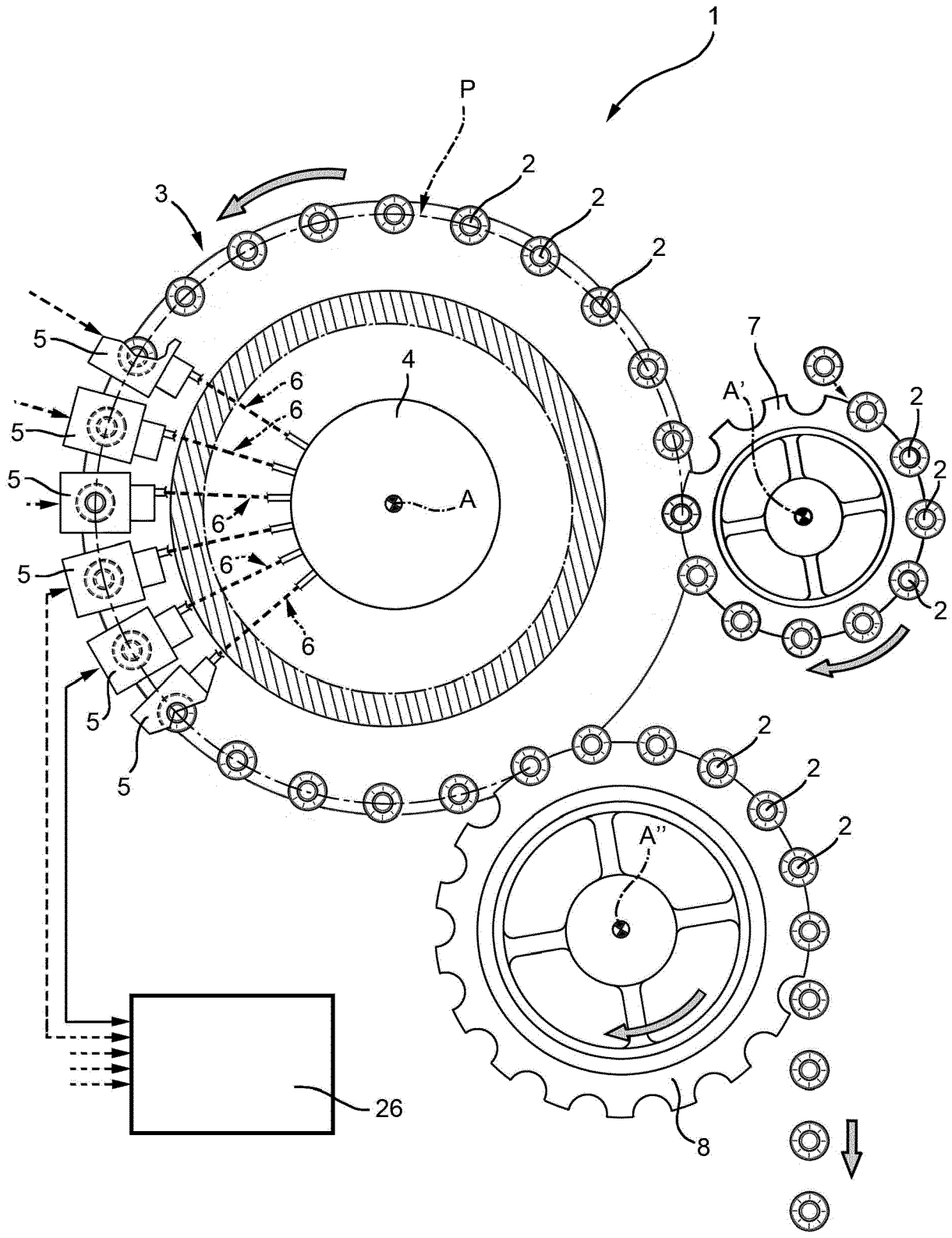

FIG. 1

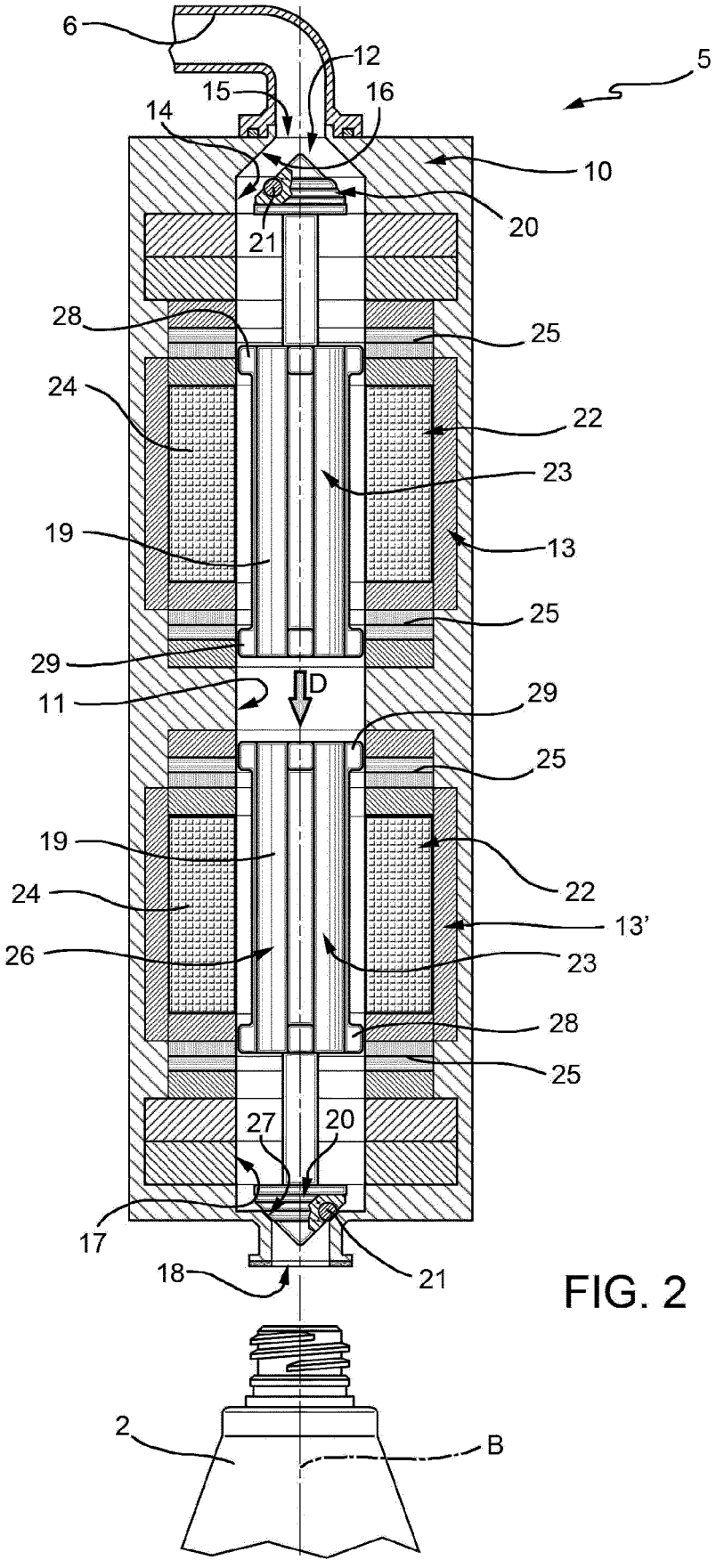
6
12
5
15
16
14
10
20
21
28
25
24
22
23
19
13
25
29
D
11
29
25
19
22
24
13'
26
23
28
25
27
20
17
18
21
2
B

FIG. 2

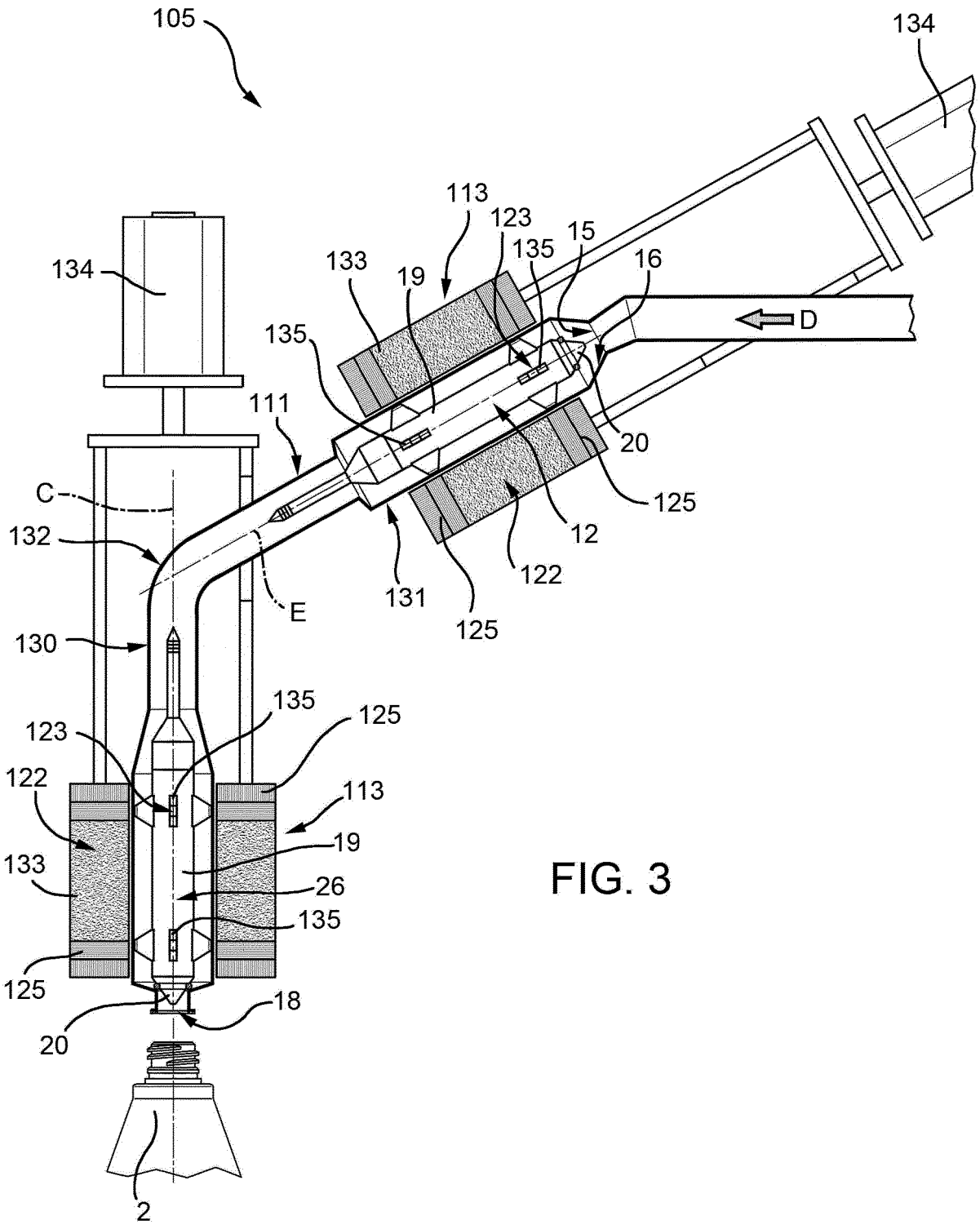
105
134
113
123
15
135
133
19
16
D
134
135
111
20
C
125
132
12
122
131
E
125
130
135
125
123
113
122
19
133
26
135
125
18
20
2

FIG. 3

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 18 30 5307

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	EP 3 165 500 A1 (SIDEL PARTICIPATIONS [FR]) 10 May 2017 (2017-05-10) * paragraphs [0026] - [0029], [0033], [0035], [0039]; figures 1, 2 * -----	1-3,5-8, 10-14,16 4,9,15	INV. B67C3/28
Y	WO 2013/057694 A1 (SIDEL SPA CON SOCIO UNICO [IT]) 25 April 2013 (2013-04-25) * page 20, line 3 - page 21, line 24; figures 1, 5 * -----	4,9,15	
X	EP 3 031 774 A1 (KRONES AG [DE]) 15 June 2016 (2016-06-15) * paragraphs [0034], [0035], [0037], [0048]; figures 2, 3 * -----	1-3,5-8, 10-14	
X	CN 101 941 665 A (JIANGSU ASG PACKAGING MACHINERY GROUP CO LTD) 12 January 2011 (2011-01-12) * abstract; figures 1, 2 * -----	1-3, 10-14	
			TECHNICAL FIELDS SEARCHED (IPC) B67C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	27 September 2018	Luepke, Erik

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 18 30 5307

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

27-09-2018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 3165500 A1	10-05-2017	CN 106672880 A	17-05-2017
		EP 3165500 A1	10-05-2017
		US 2017130860 A1	11-05-2017
WO 2013057694 A1	25-04-2013	CN 104066674 A	24-09-2014
		EP 2768764 A1	27-08-2014
		JP 2014534931 A	25-12-2014
		US 2014239209 A1	28-08-2014
		WO 2013057694 A1	25-04-2013
EP 3031774 A1	15-06-2016	CN 105668490 A	15-06-2016
		DE 102014118094 A1	09-06-2016
		EP 3031774 A1	15-06-2016
CN 101941665 A	12-01-2011	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82