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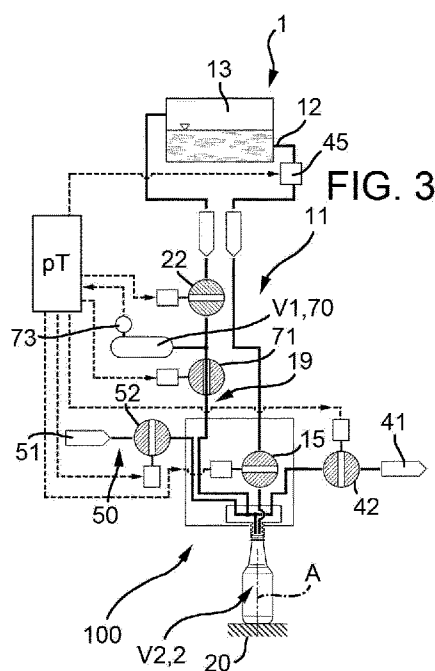
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16306551.9 24 November 2016 (24.11.2016) EP(71) Applicant: **SIDEL PARTICIPATIONS** [FR/FR]; Avenue de la Patrouille de France, 76930 OCTEVILLE-SUR-MER (FR).(72) Inventors: **D'ERRICO, Stefano**; Sidel S.p.A., Via La Spezia 241/A, 43126 Parma (IT). **PINI, Stefano**; Sidel S.p.A., Via La Spezia 241/A, 43126 Parma (IT). **BANDINI, Filippo**; Sidel S.p.A., Via La Spezia 241/A, 43126 Parma (IT).(74) Agent: **SILORET, Patrick** et al.; Sidel Participations, Avenue de la Patrouille de France, Octeville-sur-mer, CS 60627, 76059 LE HAVRE Cedex (FR).(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM,

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(54) Title: METHOD AND FILLING DEVICE FOR CONTACT FILLING AN ARTICLE WITH POURABLE PRODUCT



(57) Abstract: There is described a method for contact filling at least one article (2) with a pourable product, comprising the steps of: i) arranging a mouth (3) of article (2) in contact with a filling body (10), which defines a first fluidic line (11) for pourable product; ii) filling article (2), by creating a fluidic connection between first fluidic line (11) and article (2); and iii) measuring the amount of pourable product filling article (2) and interrupting fluidic connection when the measured amount equals a given set-point (Q); the given set-point (Q) being determined on the basis of the format of article (2); iv) estimating a first quantity (V2) associated to the volume of article (2); and v) correcting the given set-point (Q) on the basis of first quantity (V2) before step ii).

METHOD AND FILLING DEVICE FOR CONTACT FILLING AN ARTICLE
WITH POURABLE PRODUCT

The present invention relates to a method and filling device for contact filling of an article with pourable product, in particular a carbonated pourable food product such as beer or mineral water.

Filling machines are known comprising a filling station, which is fed at the input with empty articles, and supplies at the output articles filled with the pourable product.

The filling station substantially comprises a carousel conveyor rotating about an axis of rotation; a tank containing the pourable product; and a number of filling devices fluidly connected to the tank and fitted to the conveyor, radially outwards of the axis of rotation of the conveyor.

More specifically, the conveyor comprises a number of supports for positioning the mouths of the relative articles beneath the respective valves, and for moving the relative articles along an arc-shaped path about the axis of rotation and integrally with the respective valves.

Each support is also movable parallel to a respective second axis, which is parallel to and spaced from the axis of rotation of the carousel, between a lowered rest position and a raised operative position.

Each filling device substantially comprises a fastening body for attachment to the conveyor and defining a filling chamber connected fluidly to the tank; and a filling head fitted to the relative fastening body.

Each filling head comprises a first fluidic line which extends from the tank to the mouth article, and a shutter movable inside the chamber between a closed position cutting off flow of the pourable product along the first fluidic line, and an open position connecting the chamber fluidly to the mouth to allow flow of the pourable product along the first fluidic line.

Furthermore, each filling head comprises a second fluidic line, which extends between the tank or a collector filled with a gas and the inner volume of the article and is configured to allow the pressurization of the article before the filling thereof and the return of the gas contained inside the article, during the filling thereof.

Each support receives the article to be filled at an inlet station of the arc-shaped path and discharges the filled articles at an outlet station of the arc-shaped path. Furthermore, each article is filled by relative filling head with the pourable product, as it is advanced by relative support along the arc-shaped path.

Furthermore, each support is arranged in the respective lowered rest position at the inlet station and the outlet station of the arc-shaped path. When each support is arranged

in the relative lowered rest position, relative mouth is spaced along respective second axis from the body of the relative filling device.

Each support is arranged in the relative raised operative position along the arc-shaped path. Due to the fact that each article is contact filled by relative filling device, it is arranged in tight-fluid contact with the body of relative filling device along the arc-shaped path.

Still more precisely, when each support is in the relative raised operative position and the mouth of relative article tight-fluid contacts the corresponding filling body, the following operations are carried out:

- at first, each article is pressurized to the same pressure as the pourable product during the filling process, by feeding a gas, e.g. carbon dioxide, into it, with the shutter in the closed position;
- then, each article is filled with the pourable product, with the shutter in the open position; and
- finally, each article is depressurized, so that pressure above the pourable product level equals atmospheric pressure, by discharging the aeriform contained in the article and with the shutter in the closed position.

According to a known technique, the filling device comprises a flow-meter for measuring the flow of the pourable product which fills the article and the shutter is moved back into the closed position when the flow-meter has detected that a desired volume of pourable product has filled

the article.

However, especially when the pourable product is beer and the article is made of glass, the above-identified technique could lead to different levels in different filled articles, even if the desired volume of pourable product is the same.

This is due to the fact that the articles made in glass are generally re-cycled more times after the use and, therefore, are differently shaped.

A need is however felt in the sector to attain a constant level in the article of same format, for marketing reasons.

In order to ensure, also in this case, that the level of the filled articles is constant, it is known to provide the filling device with a probe, e.g. an inductive probe, for determining the level of the pourable product, and which projects inside the relative article once the article is positioned beneath the relative filling valve.

According to this technique, when the level of the pourable product reaches a desired value corresponding to the height of the probe, the shutter is moved in the closed position.

A first drawback of the filling devices of the type described above is that, given the position of the probes projecting inside the relative articles, the explosion of or damage to the articles during the filling process may easily result in damage to the probe, thus resulting in stoppage of

the filling machine.

For example, the glass of damaged articles can break the isolation of the probes and/or can remain between the corresponding probes and the corresponding filling bodies.

This situation is further exacerbated by the fact that the residues of glass tend to adhere to the probe.

A second drawback of the filling devices of the type described above is that they require a considerable stroke of the supports between the relative lowered rest position and the relative raised operative position.

This is due to that fact that the each probe protrudes downwardly into the relative article for a given height, associated to the desired level to be attained. As a result, the supports are required to move below the probe, when they are in the relative lowered rest position.

A third drawback of the filling devices of the type described above is that they require a longer cleaning device, commonly known as "dummy bottle" for sterilizing the probe with a sterilizing agent, with respect to the filling devices normally used for contact filling pourable product inside plastic articles. This is due to the fact that each cleaning device must be shaped to accommodate also the relative probe, which protrudes from the relative filling head.

A fourth drawback of the filling devices of the type

described above is that they require the whole replacement of the probe in order to vary the desired filling level to be attained.

A fifth drawback of the filling devices of the type described above is that they are quite different with respect to the filling devices normally used for contact filling pourable product inside plastic articles, mainly for comprising the probe.

As a result, they share a limited number of part numbers with the filling devices used for plastic articles, thus increasing the manufacturing and supplying cost.

EP-B-2949618 in the name of the same Applicant discloses a filling device which comprises a control unit programmed for measuring the empty volume of the article, i.e. the volume not-filled with pourable product, during the filling of the article.

In greater detail, the filling device comprises:

- an additional valve interposed along the second fluidic line and selectively movable between a first position in which it allows the return of the gas along the second fluidic line and a second position in which it prevents the return of the gas along the second fluidic line during the filling of the article; and

- a sensor which is provided to detect the pressure of the gas flowing along the second line.

In this way, the additional valves cyclically increases and reduces the pressure along the second fluidic line and the empty volume.

Furthermore, the first valve is controllable to interrupt the flow of the gas for a time interval necessary to obtain a given increase of pressure inside the empty volume.

The control unit is programmed for measuring the empty volume on the basis of this time interval, the given increase in pressure and the flow detected by the flow-meter.

Even if performing well, this solution leaves room for improvement.

In particular, the Applicant has found that the solution shown in EP-B-2949618 requires very narrow time interval and therefore requires to switch at a very high frequency the first valve between the open and the closed position.

Accordingly, a very accurate sensor is needed to correctly measure the pressure of the gas flowing along the second line.

It is an object of the present invention to provide a filling method designed to provide a cheap, easy solution to at least one of the above drawback typically associated with known filling device.

This object is achieved by a method for contact filling an article with a pourable product, as claimed in claim 1.

The present invention also relates to a filling for contact filling an article with a pourable product, as claimed in claim 13.

Three preferred, non-limiting embodiments of the present invention will be described by way of example with reference to the accompanying drawings, in which:

- Figures 1 to 5 are schematic views of subsequent steps of a first embodiment of a filling method in accordance with the present invention;

- Figures 6 to 10 are schematic views of subsequent steps of a second embodiment of the filling method in accordance with the present invention; and

- Figures 7 to 15 are schematic views of subsequent steps of a third embodiment of the filling method in accordance with the present invention.

With reference to Figures 1 to 5, number 1 indicates a filling device for contact filling an article, hereinafter referred to as container 2, with a pourable product, especially a carbonated food pourable product, beer in the embodiment shown.

Container 2 comprises, in a known manner, :

- a mouth 3, through which container 2 is filled by the filling machine, and the pourable product is subsequently poured from container 2;

- a bottom wall 6, which is opposite to mouth 3; and

- a neck 5, which extends from mouth 3 towards bottom

wall 6 and is detached by bottom wall 6.

Filling device 1 substantially comprises:

- a body 10 defining a filling opening 14;
- a fluidic line 11, which extends between an opening 12 fluidly connected with a tank 13 and filling opening 14, which is arranged on the opposite side of opening 12;

- a shutter 15 arranged inside body 10 and along fluidic line 11, and which can be set either in an open position (Figure 5) in which it fluidly connects openings 12, 14 or in a closed position (Figures 1 to 4) in which it fluidly isolates openings 12, 14 and prevents the flow of pourable product along fluidic line 11; and

- a support 20 which is adapted to contact wall 6 so as to move it parallel to an axis A between a rest position and an operative position.

Tank 13 is filled, in the embodiment shown, with the pourable product and with an aeriform, a gas formed by carbon dioxide in the embodiment shown.

Support 20 is movable parallel to axis A between:

- a lowered rest position, in which mouth 3 is spaced along axis A by body 10 and opening 14 of filling device 1; and

- a raised operative position, in which mouth 3 is in tight-fluid contact with body 10 and opening 14 of filling device 1, through the interposition of an annular gasket.

When support 20 is in the raised operative position, container 2 preferably undergoes the following operations according to the so-called contact filling modality:

- a vacuum generation step (not shown), during which vacuum is generated inside the inner volume of container 2 with the shutter 15 in the closed position, so as to prevent the risk of oxidation of the pourable product;

- a pressurization step (shown in Figure 4), during which the inner volume of container 2 is pressurized to the same pressure as the pourable product during the filling process with shutter 15 in the closed position, for example by feeding a pressurizing fluid, e.g. carbon dioxide, into it;

- a filling step (shown in Figure 5), during which shutter 15 moves to the open position, so as to fill container 2 with the pourable product, so as to fill container 2 according to the so-called "contact" modality, i.e. by isolating the inner volumes of cavity 11 and the inner volume of container 2 by the external environment during the filling of container 2; and

- finally a de-pressurization step (not shown), during which the inner volume of neck 5 of container 2 is de-pressurized to the environment pressure with shutter 15 in the closed position, e.g. by connecting the inner volume of container 2 to a discharge.

It is important to stress that not all the above-identified operations are necessarily carried out before or after the filling of container 2, and that some operations, e.g. the vacuum generation step and the pressurization step, can be repeated more than once.

Filling device 1 further comprises:

- a fluidic line 19, which extends between opening 14 and tank 13 filled with the pressurizing gas - carbon dioxide - in the embodiment shown - and is adapted to allow the flow of the pressurizing fluid before the filling of container 2 or the return of the aeriform contained inside container 2 during the filling of container 2; and

- a valve 22 interposed along fluidic line 19.

Alternatively, fluidic line 19 extends between opening 14 and a collector distinct from tank 13 and filled with the pressurizing gas.

In greater detail, valve 22 can be selectively set either in:

- a respective open position, in which it fluidly connects tank 13 with filling opening 14 and container 2 (Figures 2, 4 and 5); and

- a respective closed position, in which it fluidly isolates tank 13 from filling opening 14 and container 2 (Figures 1 and 3).

Furthermore, valve 22 is set in the respective open

position, during the pressurization step of container 2 (Figure 4) and the filling step of container 2, while it is set in the respective closed positions when the vacuum-generation step and during the de-pressurization step.

Body 10 further comprises:

- a fluidic line 40, which extends between opening 14 and a discharge collector 41; and

- a valve 42, which is interposed along fluidic line 40 and can be selectively set in an open position (not shown) in which it fluidly connects vacuum collector 41 with opening 14, or in a closed position (Figures 1 to 5) in which it fluidly isolates collector 41 and opening 14.

Valve 42 is set in the open position, during the de-pressurization step of container 2, while is set in the closed position while the other operations are carried out on container 2.

Furthermore, body 10 comprises:

- a fluidic line 50, which extends between opening 14 and vacuum collector 51; and

- a valve, which is interposed along fluidic line 50 and can be selectively set in an open position (not shown) in which it fluidly connects vacuum collector 51 with opening 14 and a closed position (Figures 1 to 5) in which it fluidly isolates collector 51 and opening 14.

Valve 52 is set in the open position during the vacuum

generation step of container 2; and is set in the closed position during the other operations on container 2.

Filling device 1 further comprises a flow-meter 45, which is arranged along fluidic line 11 and upstream of shutter 15, with reference to the advancing direction of the pourable product from tank 13 to container 2.

Flow-meter 45 is adapted to measure the flow - and, therefore, the quantity - of pourable product filled inside container 2, when shutter 15 is in the open position.

Filling device 1 also comprises a control unit 60 (only schematically shown in Figures 1 to 5), which is programmed for comparing the measure of the flow delivered by flow-meter 45 with a set-point value Q and to displace shutter 15 in the closed position when the flow measured by flow-meter 45 equals a set-point value Q .

The set-point value Q is determined on the basis of the format of container 2 to be filled and defines, therefore, an objective filling amount for flow-meter 45.

Advantageously, control unit 60 is programmed for calculating actual volume $V2$ of container 2 and for correcting given set-point value Q on the basis of actual volume $V2$ of container 2.

Thanks to this correction, a substantially constant filling level is achieved in containers 2, even though respective actual volumes $V2$ are different from one another.

For example, in case of the format of container 2 is 1 litre, set-point value Q equals 1 litre and is corrected, for example, to 1.01 litre on the basis of actual volume V_2 .

Preferably, filling device 1 comprises:

- a chamber 70 having a given volume V_1 ; and
- a valve 71, which can be set by control unit 60 either in an open position (Figure 1 and 3 to 5) or in a closed position (Figure 2).

When it is set in the open position, valve 71 establishes a fluidic connection between chamber 70 and filling opening 14 and, therefore, between chamber 70 and container 2.

When it is in the closed position, valve 71 prevents the fluidic connection between chamber 70 and filling opening 14 and, therefore between chamber 70 and container 2.

In the embodiment shown in Figures 1 to 5, chamber 70 and valve 71 are arranged along fluidic line 19. Valve 71 is interposed between filling opening 14 and chamber 70 along fluidic line 11.

Chamber 70 is interposed between valves 22, 71 along fluidic line 11.

Furthermore, volume V_1 of chamber 70 is smaller than volume V_2 of container 2.

When valve 22 is set by control unit 60 in the open position (Figures 2, 4 and 5), chamber 70 is fluidly

connected with tank 13.

When valve 22 is set by control unit 60 in the closed position (Figures 1 and 3), chamber 70 is fluidly isolated from tank 13.

Filling device 1 also comprises a sensor 73 which is adapted to measure the pressure inside chamber 70.

In the embodiment shown, sensor 73 is arranged at chamber 70 and has a sensible element arranged inside chamber 70.

Preferably, control unit 60 is programmed, when shutter 15 is in the closed position and before the filling of container 2, to:

- set valve 71 in the closed position (Figure 2);
- generate pressure p_2 inside filling opening 14 and container 2, and pressure p_1 inside chamber 70 (Figure 2);
- set valve 71 in the open position, so as to generate an equalizing pressure p_T inside chamber 70, filling opening 14 and container 2 (Figure 3); and
- estimate actual volume V_2 on the basis of volume V_1 of chamber 70, pressure p_2 , pressure p_1 and pressure p_T (Figure 3).

In other words, control unit 60 is programmed to estimate actual volume V_2 on the basis of volume V_1 of chamber 70; pressures p_2 , p_1 existing in chamber 70 and container 2 respectively when they are fluidly isolated from

one another; and equalizing pressure p_T existing in both chamber 70 and container 2 when they are fluidly connected with one another.

For the sake of clarity, pressures p_1 , p_2 and p_T sensed by sensor 73 in each of the step shown in Figures 1 to 5 is indicated in the schematic representation of control unit 60 in Figures 1 to 5.

In the embodiment shown, control unit 60 estimates volume V_2 on the basis of the following formula:

$$V_2 = V_1 * \frac{p_1 - p_T}{p_T - p_2} \quad (1)$$

This formula can be justified by assuming that the aeriform inside container 2 and chamber 70 behaves as a perfect gas and that it undergoes an isothermal transformation, as it will be evident from the foregoing of the present description.

In the embodiment shown, pressure p_2 is the pressure existing in both chamber 70 and container 2 due to the previous not-shown operations, and pressure p_1 is the pressure existing inside tank 13. Pressure p_1 is higher than pressure p_2 and equalizing pressure p_T is lower than pressure p_1 and higher than pressure p_2 .

Furthermore, control unit 60 is programmed to subsequently:

- set valve 71 in the open position and valve 22 in the closed position, so as to generate same pressure p_2 in

chamber 70, filling opening 14 and container 2 (see Figure 1);

- set valve 71 in the closed position and valve 22 in the open position, so as to fluidly connect tank 13 with chamber 70 and generate pressure p_1 greater than pressure p_2 in chamber 70 while leaving pressure p_2 inside container 2 and filling opening 14 (Figure 2);

- set valve 71 in the open position and valve 22 in the closed position, so as to generate equalizing pressure p_T in chamber 70, filling opening 14 and container 2 (see Figure 3).

In particular, in the condition of Figure 3 the following formula is valid:

$$p_T * (V_1 + V_2) = (n_1 + n_2) * RT \quad (2)$$

where n_1 and n_2 are the number of moles inside chamber 70 and container 2, R is the ideal constant gas and T is the temperature inside chamber 70 and container 2.

Under isothermal conditions, n_1 and n_2 can be derived by the following formulas which apply to conditions of Figures 1 and 2:

$$p_2 * (V_2) = (n_2) * RT \quad (3); \text{ and}$$

$$p_1 * (V_1) = (n_1) * RT \quad (4).$$

Formula (3) can be derived by the fact that container 2 remains at pressure p_2 when valve 22 is set in the closed position by control unit 60 (Figure 1).

Formula (4) can be derived by the fact chamber 70 is pressurized at pressure p_1 when valve 22 is set in the open position by control unit 60 (Figure 2).

By substituting (3) and (4) in (2), formula (1) is obtained.

Control unit 60 is also programmed to subsequently:

- set valves 71 and 22 in the open position while keeping shutter 15 in the closed position, so as to pressurize container 2 (Figure 4); and

- set shutter 15 in the open position, so as to fill container 2 with the pourable product and to allow the return of the aeriform contained in container in tank 13 (Figure 5).

Filling device 1 is preferably incorporated in a filling station 100, which substantially comprises:

- a carousel (not-shown), which is rotatable about an axis, which is in vertical, in use; and

- a plurality of filling devices 1, which are fitted to a periphery of the carousel.

Filling devices 1 are spaced from and extend along respective axes parallel to the axis of rotation of carousel.

Supports 20 are driven in rotation by carousel, receive relative empty containers 2 at an inlet station (not-shown), convey relative containers 2 along an arc-shaped trajectory, and output filled containers 2 at an outlet station (not-

shown).

In particular, each support 20 is arranged in the relative rest position at inlet station and at the outlet station, and moves from the relative rest position to the lowered position and vice-versa along the arc-shaped trajectory.

Filling station 100 further defines a single tank 13, a single flow-meter 45 and single collectors 41, 51 for all filling devices 1.

The operation of the filling device 1 will be described as of the condition shown in Figure 1, with reference to only one filling device 1 and to relative container 2.

Very briefly, the operation of filling device 1 can be summarized in this way:

- on the basis of the format of container 2, control unit 60 memorizes a set-point value Q for the amount of pourable product to be filled in container 2 and sets shutter 15 in the closed position;

- control unit 60 estimates volume V_2 of container 2 and corrects set-point Q on the basis of volume V_2 ;

- container 2 is pressurized with the aeriform contained in tank 13 up to reach the pressure of the pourable product inside tank 13 (Figure 4);

- control unit 60 sets shutter 15 in the open position and container 2 is filled with the pourable product while the aeriform contained in container 2 returns back in tank

13 (Figure 5);

- when flow-meter 45 has sensed that container 2 has been filled an amount of pourable product equals to corrected set-point Q , control unit 60 sets shutter 15 in the closed position, thus interrupting the filling of container 2; and
- container 2 is de-pressurized in a not shown way.

In the condition of Figure 1, support 20 is in the operative position and mouth 3 of empty container 2 is tight-fluid contact with opening 14 and body 10.

Furthermore, control unit 60 sets shutter 15, 22, 42, 52 in the closed position and valve 71 in the open position.

The pressure inside chamber 70 is pressure p_2 , which corresponds to the pressure from the previous operations of filling device.

Thanks to the fact that valve 71 is set in the open position, pressure p_2 is generated also in container 2 and sensed by sensor 73.

With reference to Figure 2, control unit 60 sets valve 22 in the open position and valve 71 in the closed position. Thus, chamber 70 is fluidly connected to tank 13 and pressurized at pressure p_1 while container 2 is fluidly isolated from chamber 70 and remains at pressure p_2 .

In this condition, sensor 73 senses pressure p_1 inside chamber 70.

With reference to figure 3, control unit 60 sets valve 22 in the closed position and valve 71 in the open position. Thus, chamber 70 is fluidly connected to container 2. Chamber

70 and container 2 reach an equalization pressure p_T which is sensed by sensor 73.

Control unit 60 estimates volume V_2 of article 2 on the basis of volume V_1 of chamber 70, pressures p_1 , p_2 and equalizing pressure p_T .

In detail, control unit 60 estimates actual volume V_2 of container 2 by means of the following formula (1):

$$V_2 = V_1 * \frac{p_1 - p_T}{p_T - p_2}$$

At this stage (Figure 4), control unit 60 sets also valve 22 in the open position. Thus, the gas contained in tank 13 flows along fluidic line 21 and pressurizes container 2.

Finally, control unit 60 sets also shutter 15 in the open position (Figure 5). Thus, the pourable product contained in tank 13 flows along fluidic line 11 inside article 2, up to when flow-meter 45 detects that the corrected amount of pourable product has filled container 2.

At this stage, control unit 60 sets shutter 15 in the closed position and the filling of container 2 is completed.

With reference to figure 6 to 10, 1' indicates, as a whole, a filling device according to a second embodiment of the present invention. The filling device 1' is similar to filling device 1 and will be described hereinafter only as far as it differs therefrom; corresponding or equivalent parts of filling devices 1 and 1' will be indicated where possible by the same reference numbers.

In particular, filling device 1' differs from filling

device 1 in that sensor 73 is configured to detect the pressure at filling opening 14 and, therefore, inside container 2. In particular, sensor 73 is arranged on body 10 has a sensible element fluidly connected to filling opening 14.

Furthermore, the operation of filling device 1' differs from the operation of filling device 1 in that pressure p_1 is sensed by sensor 73 during the pressurization step (Figure 9) and, therefore, volume V_2 is estimated by control unit 60 during pressurization step (Figure 9) and after chamber 70 and container 2 have reached equalization pressure p_T .

In this respect, it is important to point out that chamber 70 is at the same pressure p_1 :

- when control unit 60 sets valve 22 is set in the open position and valve 70 is set in the closed position (Figure 7); and

- when control unit 60 sets both valves 22, 70 in the respective open positions (Figure 9).

This is because chamber 70 is, in both the cases, fluidly connected to tank 13 by means of valve 22.

With reference to figure 11 to 15, 1'' indicates, as a whole, a filling device according to a second embodiment of the present invention. The filling device 1'' is similar to filling device 1 and will be described hereinafter only as far as it differs therefrom; corresponding or equivalent

parts of filling devices 1'' and 1 will be indicated where possible by the same reference numbers.

Filling device 1'' differs from filling device 1 in that sensor 73 is configured to detect the pressure at filling opening 14 and, therefore, inside container 2. In particular, sensor 73 is arranged on body 10 has a sensible element fluidly connected to filling opening 14.

Furthermore, filling device 1'' differs from filling device 1 in that chamber 70'' is arranged along fluidic line 40 between opening 14 and valve 42, for comprising a valve 80'' interposed between opening 14 and chamber 70'', and for not comprising valve 71.

Filling device 1'' also differs from filling device 1 in that control unit 60'' is configured to:

- keep shutter 15 in the closed position;
- set valves 22, 42 in the closed position and valve 80'' in the open position, so as to generate same pressure p_2 in chamber 70'', filling opening 14 and container 2 (see Figure 11);

- set valve 22 in the open position and valve 80'' in the closed position, so as to fluidly connect tank 13 with filling opening 14 and container 2 and generate pressure p_1 greater than pressure p_2 in container 2 and filling opening 14 while leaving pressure p_1 chamber 70'' (Figure 12);

- set valve 80'' in the open position, so as to generate equalizing pressure p_T in chamber 70, filling opening 14 and

container 2 (see Figure 13).

Control unit 60 is also programmed to subsequently:

- set valve 22 in the open position, so as to pressurize container 2 at the pressure of pourable product contained in tank 13 (Figure 14); and

- set shutter 15 in the open position, so as to fill container 2 with the pourable product and to allow the return of the aeriform contained in container in tank 13 (Figure 15).

In the embodiment shown in Figures 11 to 15, control unit 60 is programmed to estimate volume V2 on the basis of the following formula:

$$V2 = V1 * \frac{pT - p2}{p1 - pT} \quad (5).$$

The formula (5) can be justified in the following way.

In the conditions of Figure 13, the following relation is valid:

$$pT * (V1 + V2) = (n1 + n2) * RT \quad (6)$$

where n1 and n2 are the number of moles inside chamber 70 and container 2, R is the ideal constant gas and T is the temperature inside chamber 70 and container 2.

Under isothermal conditions, n1 and n2 can be derived by the following formulas which apply to conditions of Figures 11 and 12:

$$p2 * V1 = (n1) * RT \quad (7); \text{ and}$$

$$p1 * V2 = (n2) * RT \quad (8).$$

By substituting (7) and (8) in (6), formula (5) is obtained.

The operation of filling device 1''' differs from that of filling device 1 for the steps carried out by control unit 60 to estimate volume V2 of container 2.

In greater detail and with reference to the condition shown in Figure 11, control unit 60 sets valves 22, 42 and shutter 15 in the closed position and sets valve 80''' in the open position.

In this way, the pressure inside container 2 and chamber 70 is pressure p2, which corresponds to the pressure from the previous operations of filling device.

Then, control unit 60 sets valve 22 in the open position and valve 80''' in the closed position (Figure 12). Thus, container 2 is fluidly connected to tank 13.

In this way, a pressure p1 greater than pressure p2 is generated inside container 2 while chamber 70 remains at pressure p1.

With reference to Figure 13, control unit 60 sets valve 22 in the closed position and valve 80''' in the open position.

In this way, equalizing pressure pT is generated in both container 2 and chamber 70.

In the meanwhile, control unit 60 estimates volume V2 of container 2 by means of the formula:

$$V2 = V1 * \frac{pT - p2}{p1 - pT} \quad (5).$$

With reference to Figure 14, control unit 60 sets valve 22 in the open position, so as to pressurize container 2 at the pressure of pourable product contained inside tank 3.

Finally, with reference to Figure 15, control unit 60 sets valve 22 in the closed position and shutter 15 in the open position, so as to fill container 2 with the pourable product.

The advantages of filling device 1, 1', 1'' and the filling method according to the present invention will be clear from the above description.

In particular, control unit 60, 60'' is programmed for calculating volume V_1 of container 2 and for correcting amount Q , which corresponds to the quantity of pourable product to be detected by flow-meter 45 for displacing shutter 15 in the closed position.

In this way, it is possible to fill containers 2 having different volume at the same level in a highly precise way and without requiring to switch at very high volume any control valve, contrary to the solutions described in the introductory part of the present description.

This is particularly advantageous when filling device 1, 1', 1'' is used for filling containers 2 in glass with beer. As a matter of fact, these containers 2 are generally re-cycled more times after the use and are, therefore, differently shaped.

Furthermore, filling device 1, 1', 1'' reaches this technical effect without requiring to substantially redesign

the known filling device. It is therefore only required to add a chamber 70, 70'' to known filling device and to selectively fluidly connect/isolate it with/from the inner volume of container 2, so as to generated pressure p_1 , p_2 and equalizing pressure p_T .

Filling device 1, 1', 1'' advantageously makes use of the aeriform in tank 13 to generate pressure p_1 inside chamber 70 or container 2. Thus, there is no need for an additional hydraulic circuits to generate pressure p_2 inside chamber 70 or container 2.

Chamber 70'' of filling device 1'' is fed with aeriform escaping from container 2, when valve 80'' is set in the open position to generate equalizing pressure p_T in container 2 and chamber 70''.

Thanks to the fact that the pressure p_1 higher than equalizing pressure p_T is generated in a volume defined by container 2, which is then depressurized at equalizing pressure p_T in a little higher volume defined by chamber 70'' and container 2, the isothermal assumption on the behavior of the aeriform is particularly plausible.

Finally, it is apparent that modifications and variants not departing from the scope of protection of the claims may be made to filling device 1, 1', 1'' and method disclosed herein.

CLAIMS

1. A method for contact filling at least one article (2) with a pourable product, comprising the steps of:

i) arranging a mouth (3) of said article (2) in contact with a filling body (10), which defines a first fluidic line (11) for said pourable product;

ii) filling said article (2), by creating a fluidic connection between said first fluidic line (11) and said article (2); and

iii) measuring the amount of pourable product filling said article (2) and interrupting said fluidic connection when said measured amount of pourable product equals a given set-point (Q); said given amount (Q) being determined on the basis of the format of said article (2);

characterized by comprising the steps of:

iv) estimating a first quantity (V2) associated to the volume of said article (2); and

v) correcting said given set-point (Q) on the basis of said first quantity (V2) before said step ii).

2. The method of claim 1, characterized in that said step iv) comprises the steps of:

vi) fluidly isolating said article (2) and a chamber (70, 70'') having a given volume (V1);

vii) generating a first pressure (p2; p1) inside said

article (2) and a second pressure (p_1 ; p_2) inside said chamber (70, 70'');

viii) fluidly connecting said article (2) and said chamber (70, 70''), so as to generate a third equalizing pressure (p_T) inside both said article (2) and said chamber (70, 70''), by fluidly connecting said article (2) and said chamber (70, 70''); and

ix) estimating said first quantity (V_2) on the basis of:

- a second quantity associated to said volume (V_1);
- a third quantity associated to said first pressure (p_2 ; p_1);
- a fourth quantity associated to said second pressure (p_1 ; p_2); and
- a fifth quantity associated to said third equalizing pressure (p_T).

3. The method of claim 2, characterized said step iv) comprises the steps of subsequently:

x) fluidly connecting said chamber (70, 70'') and said article (2), so as to generate in both of them the lower (p_2) of said first pressure (p_2 ; p_1) and second pressure (p_1 ; p_2) before said step vi);

said step vii) comprising the step xi) of increasing the pressure in one of said chamber (70, 70'') and said article (2), so as to generate in it the higher (p_1) of said

first pressure (p2; p1) and second pressure (p1; p2).

4. The method of claim 2 or 3, characterized by comprising a step xii) of pressurizing said article (2) with an aeriform contained in a tank (13) at said higher (p1) of said first and second pressure (p2; p1) by connecting along a second fluidic line (19) said tank (13) and said article (2); said step xii) being carried out before said step ii);

said step x) comprising the step xiii) of feeding said one of said chamber (70, 70'') and said article (2) with an aeriform by means of said second fluidic line (19).

5. The method of claim 3 or 4, characterized in that said step xi) comprises the step xiv) of increasing the pressure inside said chamber (70) so as to generate therein said higher (p1) of said first and second pressure (p2; p1);

said step viii) comprising the step xv) of conveying said aeriform from said chamber (70) to said article (2).

6. The method of claim 5, characterized in that said step xiv) comprises the steps of:

xvi) fluidly isolating said chamber (70) from said tank (13) during said step x);

xvii) fluidly connecting said chamber (70) to said tank (13), so as to generate said higher (p1) of said first and second pressure (p1, p2) inside said chamber (70) before said step viii).

7. The method of claim 5 or 6, characterized by

comprising the step xviii) of sensing the pressure existing inside said chamber (70).

8. The method of claim 7, characterized in that said step xviii) comprises the steps of:

xix) sensing said lower (p2) of said first and second pressure (p1, p2; p2, p1) existing inside said chamber (70) during said step x); and/or

xx) sensing said higher (p1) of said first and second pressure (p1, p2; p2, p1) existing inside said chamber (70) before said step xii) and/or before said step viii).

9. The method of claim 5 or 6, characterized by comprising the step xxi) of sensing the pressure existing inside said article (2).

10. The method of claim 9, characterized in that said step xxi) comprises the steps of:

xxii) sensing said lower (p2) of said first and second pressure (p1, p2; p2, p1) existing inside said article (2) during said step x); and/or

xxiii) sensing said higher (p1) of said first and second pressure (p1, p2; p2, p1) existing inside said article (2) during said step xii) and/or said after said step viii).

11. The method of claim 3 or 4, characterized in that said step xi) comprises the step xxiv) of increasing the pressure inside said article (2), so as to generate therein said second pressure (p1);

said step viii) comprising the step xxv) of conveying said aeriform from said article (2) to said chamber (70);

and/or characterized by comprising the step xxvi) of sensing said pressure inside article (2).

12. The method of any one of claims 2 to 11, characterized in that said step viii) comprises the step xxvii) of considering the aeriform inside said article (2) and said chamber (70, 70'') as a perfect gas undergoing isothermal transformations.

13. A filling device (1, 1', 1'') for contact filling at least one article (2) with a pourable product, comprising:

- a body (10), which defines a first fluidic line (11) for said pourable product; said first fluidic line (11) having a filling mouth (14) adapted to be set in tight-fluid contact, in use, against said article (2);

- a shutter (15), which can be selectively set either in a respective open position in which it allows said pourable product to flow from said fluidic line (11) up to said filling mouth (14) so as to fill said article (2) with said pourable product, or in a respective closed position, in which it prevents said pourable product from flowing from said fluidic line (11) up to said filling mouth (14) inside said article (2);

- a flow-meter (45), which is adapted to measure the amount of pourable product flowing along said first fluidic

line (11) and filling said article (2); and

- a control unit (60), which is programmed for displacing said shutter (15) in said respective closed position when the amount of pourable product flowing along first fluidic line (11) measured by said flow-meter (45) equals a given set-point (Q); said given set-point (Q) being determined on the basis of the format of said article (2);

characterized in that said control unit (60) is programmed for calculating a first quantity (V2) associated to the volume of said article (2) and for correcting said given set-point (Q) on the basis of said first quantity (V2).

14. The filling device of claim 13, characterized by comprising:

- a chamber (70, 70'') having a given volume (V1); and
- first valve means (71, 80''), which can be selectively set either in a respective open position or in a respective closed position; said valve means (71, 80'') establishing, in use, a fluid connection between said chamber (70, 70'') and said filling mouth (14) when set in said respective open position, and interrupting, in use, said fluid connection when set in said respective closed position;

said control unit (60) being programmed to:

- set said first valve means (71, 80'') in said respective closed position, so as to fluidly isolate said chamber (70, 70'') and said filling mouth (14);

- generate a first pressure (p2; p1) inside said filling mouth (14) and a second pressure (p1; p2) inside said chamber (70, 70'');

- set said first valve means (71, 80'') in said open position, so as to generate a third equalizing pressure (pT) inside both said filling mouth (14) and said chamber (70, 70''), by fluidly connecting said filling mouth (14) and said chamber (70, 70''); and

- estimate said first quantity (V2) on the basis at least of:

- a second quantity associated to said volume (V1);

- a third quantity associated to said first pressure (p2; p1);

- a fourth quantity associated to said second pressure (p1; p2); and

- a fifth quantity associated to said third pressure (pT).

15. The filling device of claim 14, characterized by comprising:

- a tank (13) fillable, in use, with an aeriform at the higher (p1) of said first and second pressure (p1, p2; p2, p1); and

- second valve means (22) interposed between said tank (13) and one of said filling mouth (14) and said chamber (70, 70'');

- said second valve means (22) being selectively settable

by said control unit (60) either in a respective closed position in which it prevents said aeriform from flowing from said tank (13) to said one of said chamber (70, 70'') filling mouth (14) or in a respective open position in which it allows said flow of said aeriform;

said control unit (60) being programmed to:

- at first set said second valve means (22) in respective said closed position and set said first valve means (71, 80'') in respective said open position, so as to generate in said one of said chamber (70, 70'') or said article (2) said lower (p2) of said first pressure (p1; p2) and said second pressure (p2; p1); and

- then set said second valve means (22) in respective said open position and set said first valve means (71, 80'') in respective said closed position, so as to generate in said one of said chamber (70, 70'') or said article (2) said higher (p1) of said first pressure (p1; p2) and said second pressure (p2; p1).

16. The filling device of claim 13 to 15, characterized by comprising a second fluidic line (19), which extends between said tank (13) and said filling mouth (14) and is adapted to pressurize said article (2) to be filled when said shutter (15) is set in said second position;

second valve means (22) being arranged along said second fluidic line (19) in a position interposed between said

chamber (70) and said tank (13); said chamber (60) and said first valve means (71') being arranged along said second fluidic line (19).

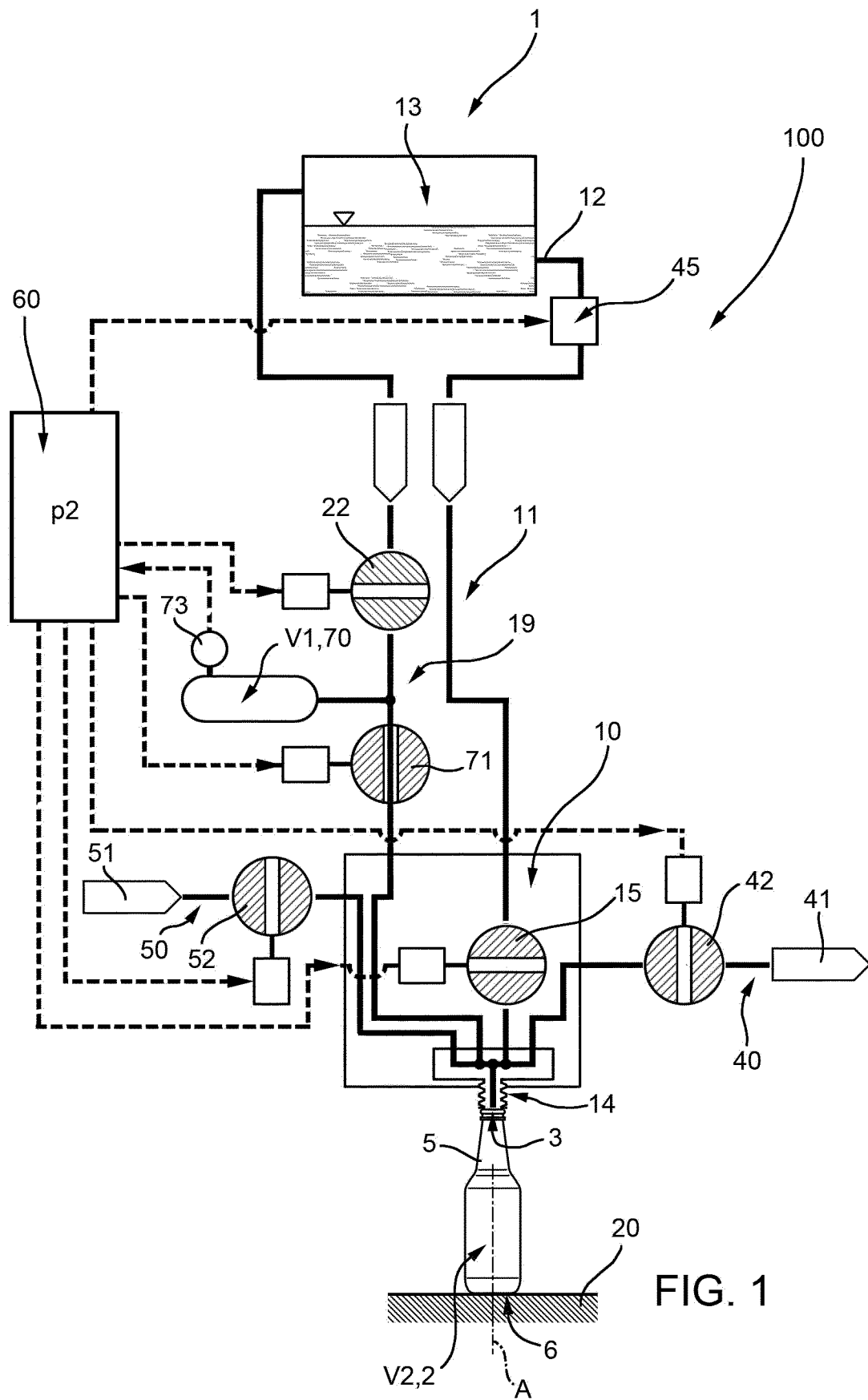
17. The filling device of claim 13 to 15, characterized by comprising:

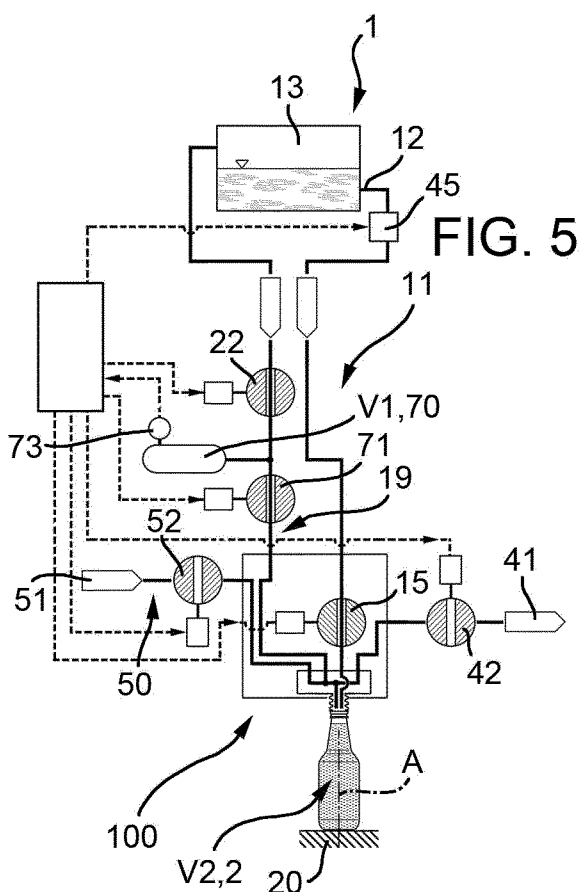
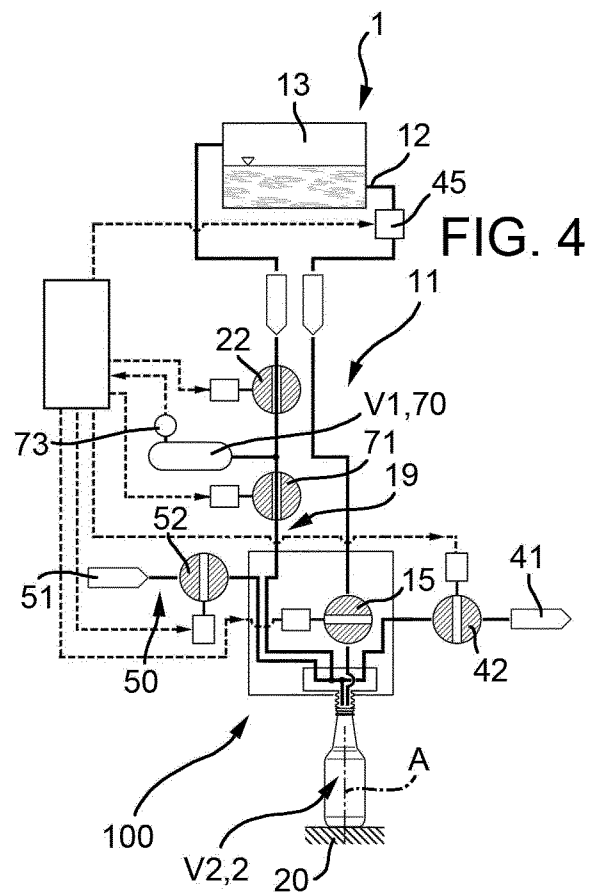
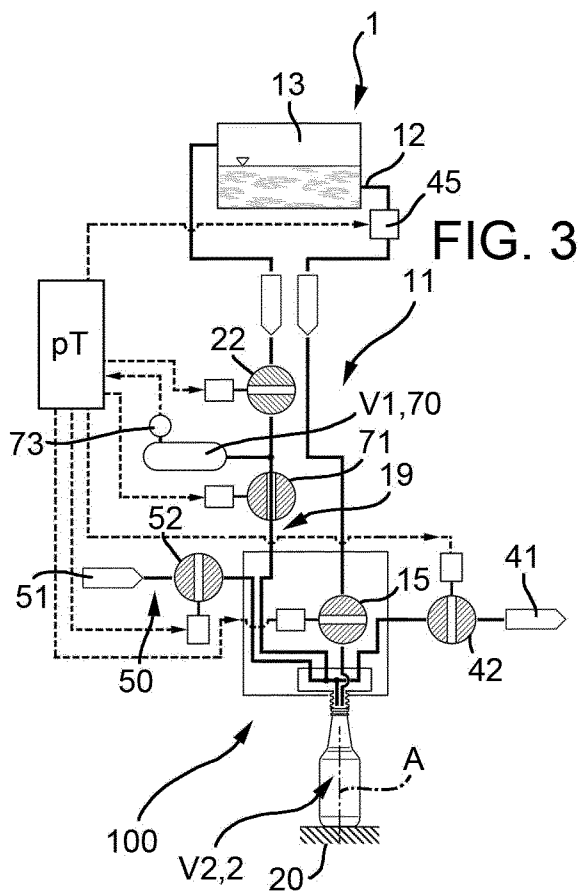
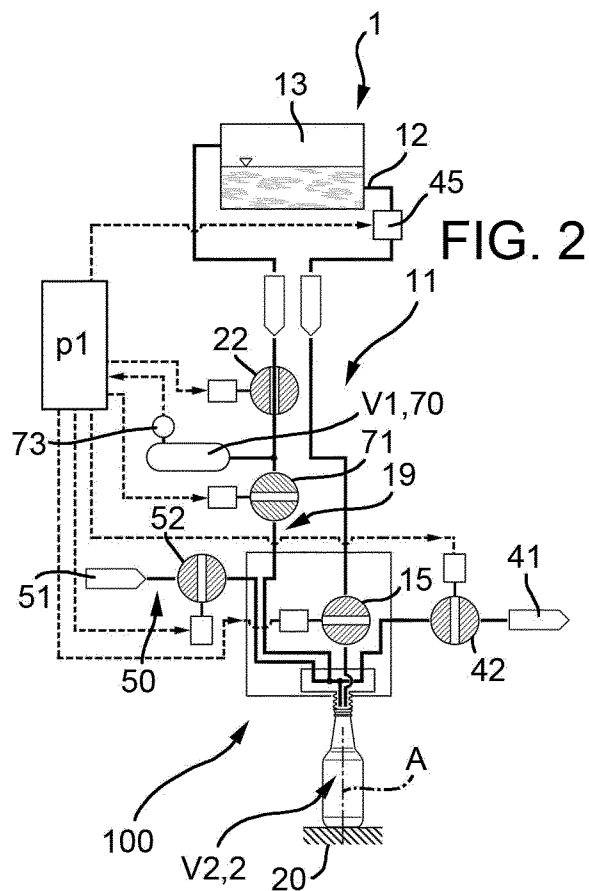
- a discharge (41);
- a third fluidic line (40) which extends between said filling mouth (14) and said discharge (41), and is adapted to depressurize said filled article (2) when said shutter (!5) is, in use, in said second position;

- fourth valve means (42), which are arranged along said third fluidic line (40) and may be selectively settable either in a respective closed position in which they prevent said aeriform from flowing from said filling mouth (14) to said discharge (41) or in a respective open position in which they allow said flow of said aeriform; and

said chamber (70'') and said first valve means (80'') being arranged along said third fluidic line (40).

18. The filling device of any one of claims 13 to 17 characterized by comprising a pressure sensor (73), which is configured to sense, the pressure, existing in said chamber (70, 70'') or in said filling mouth (14).





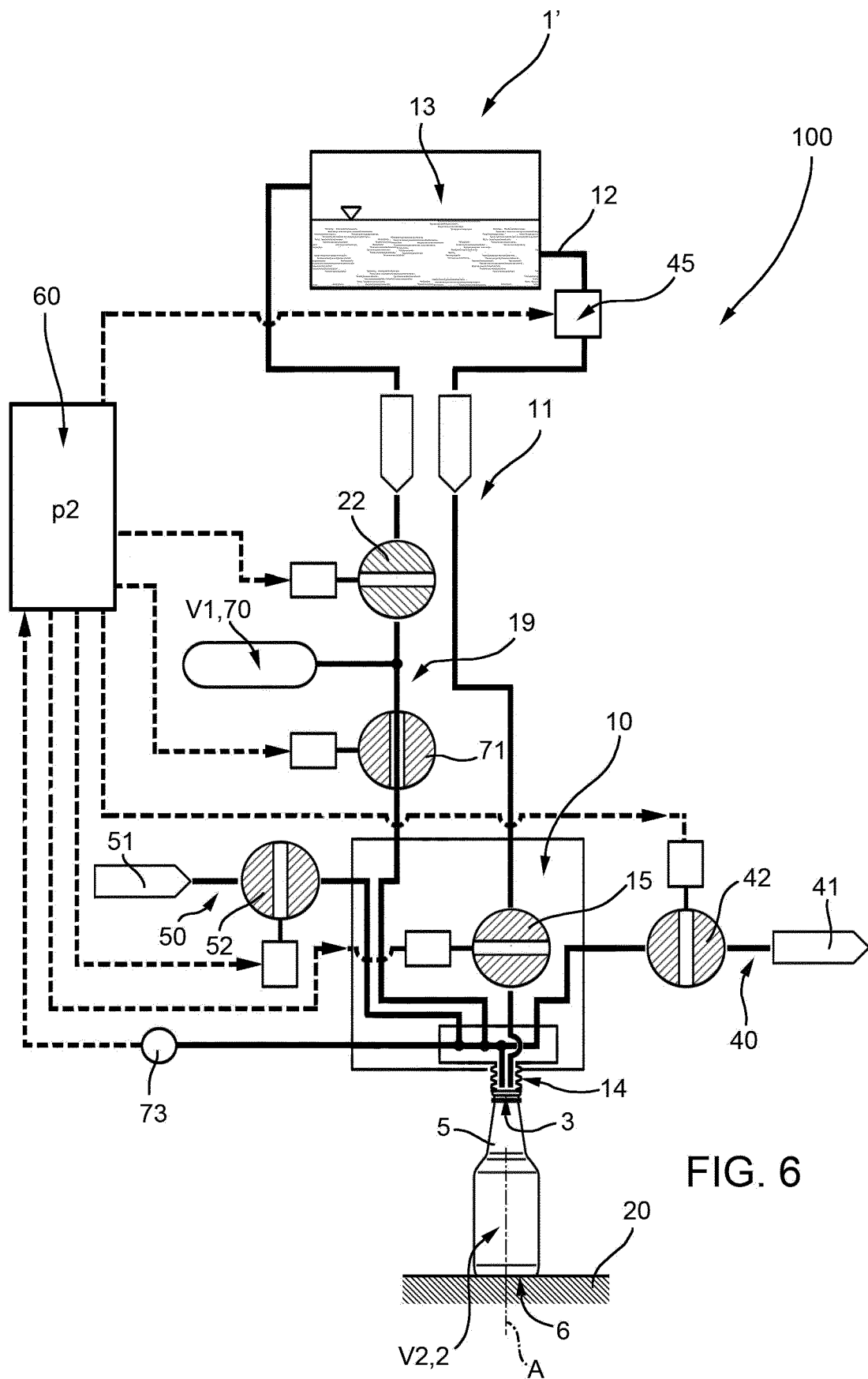
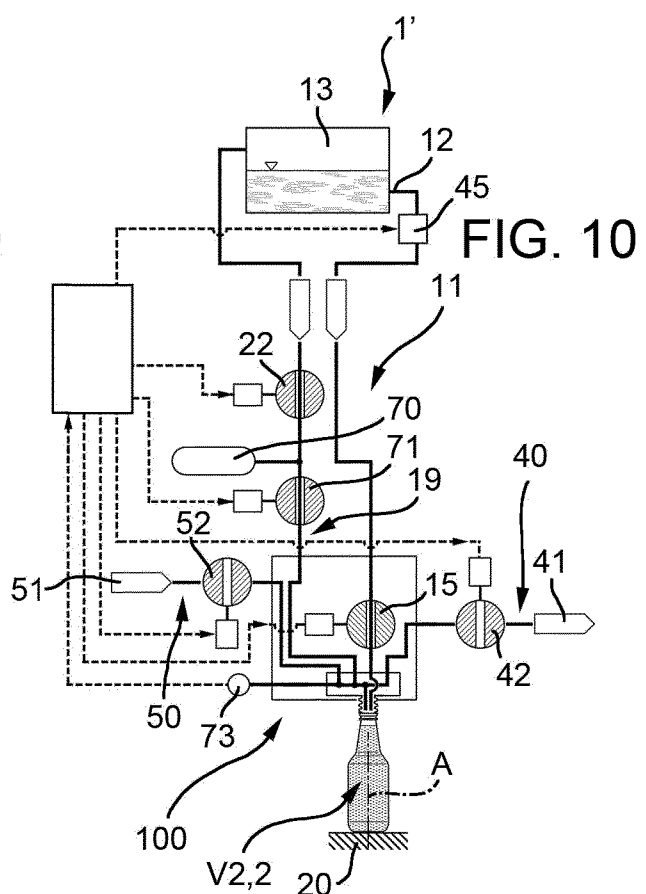
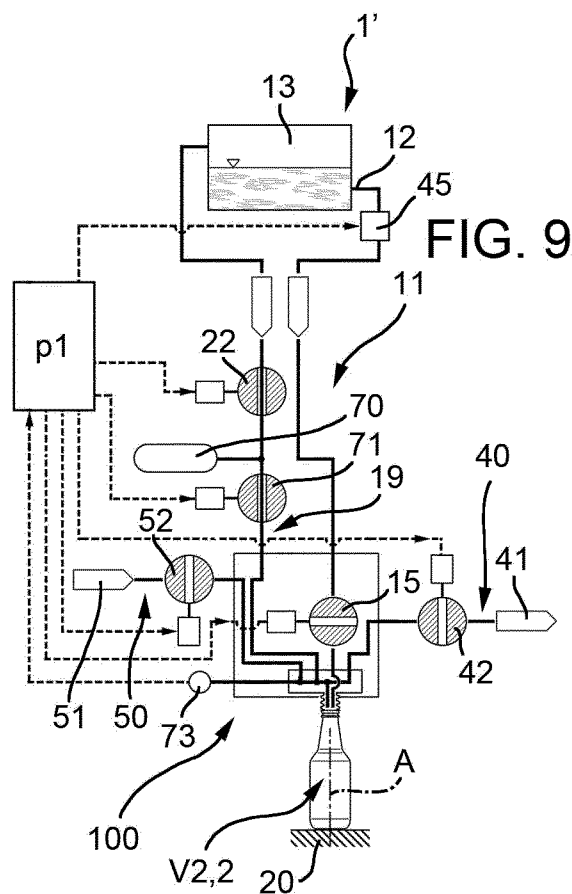
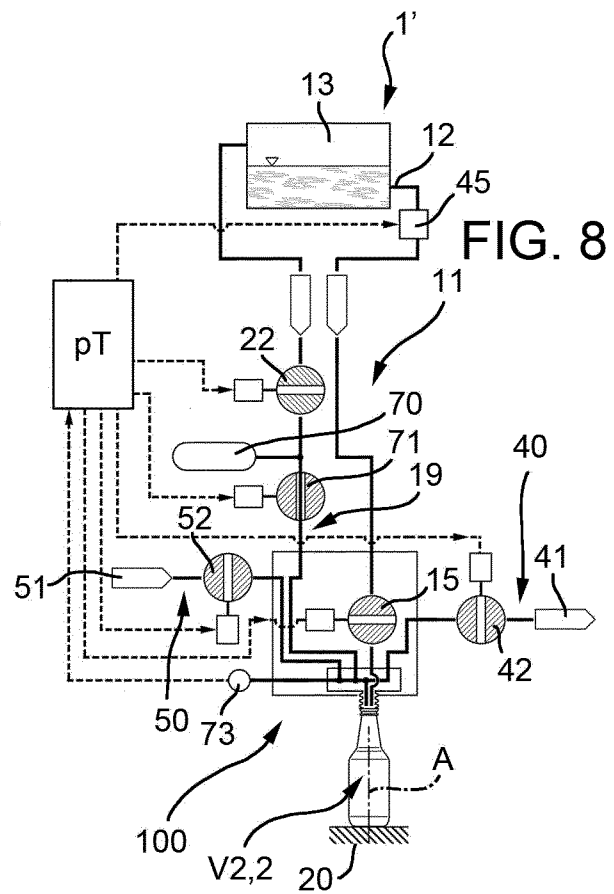
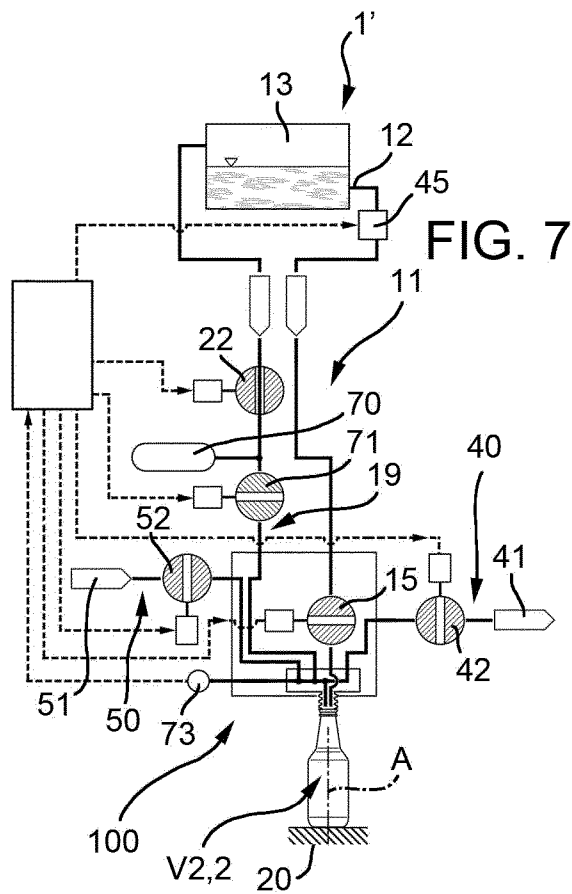


FIG. 6



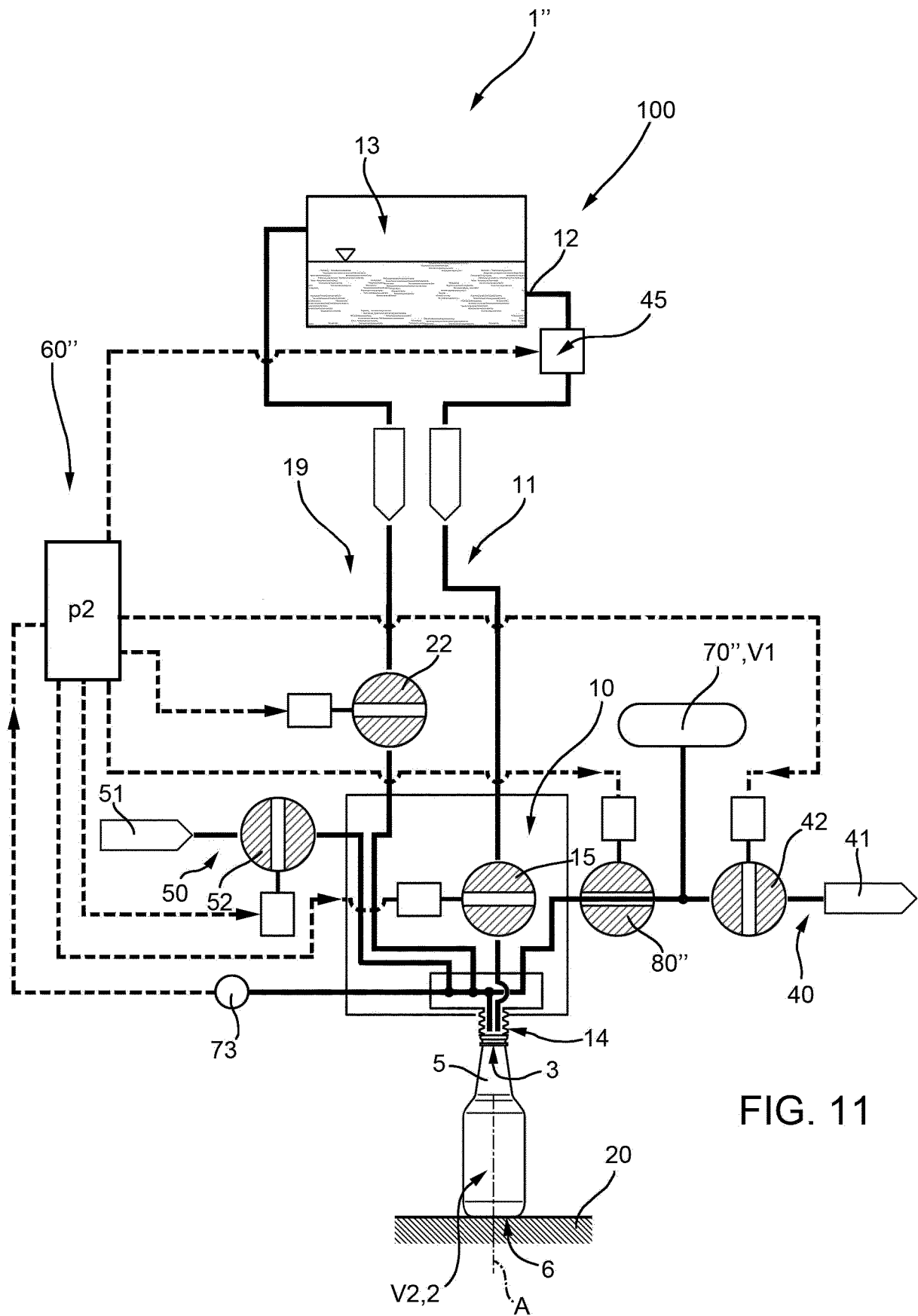
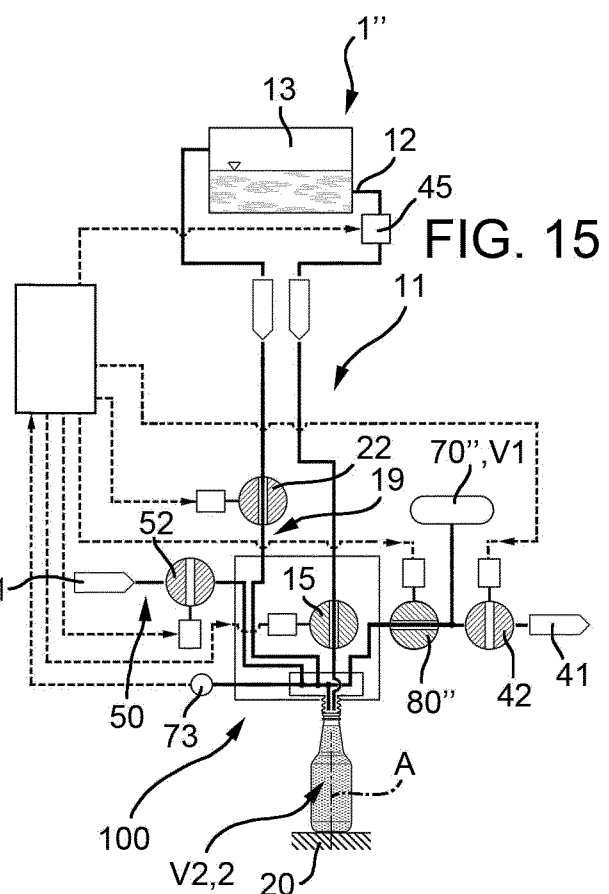
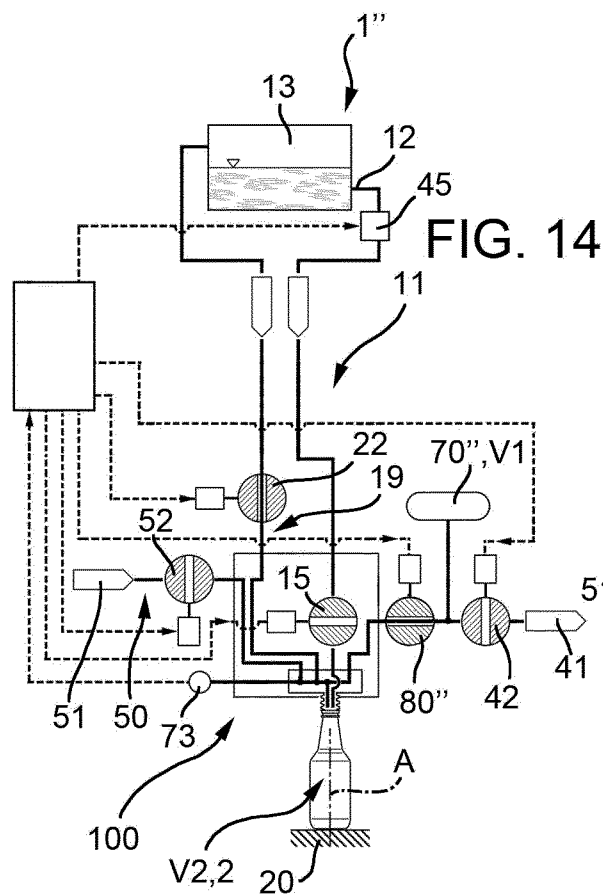
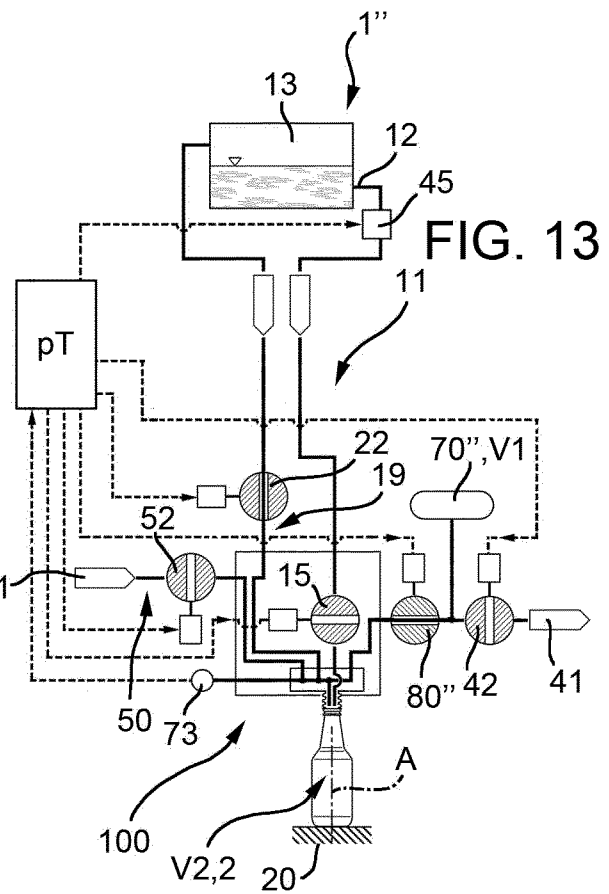
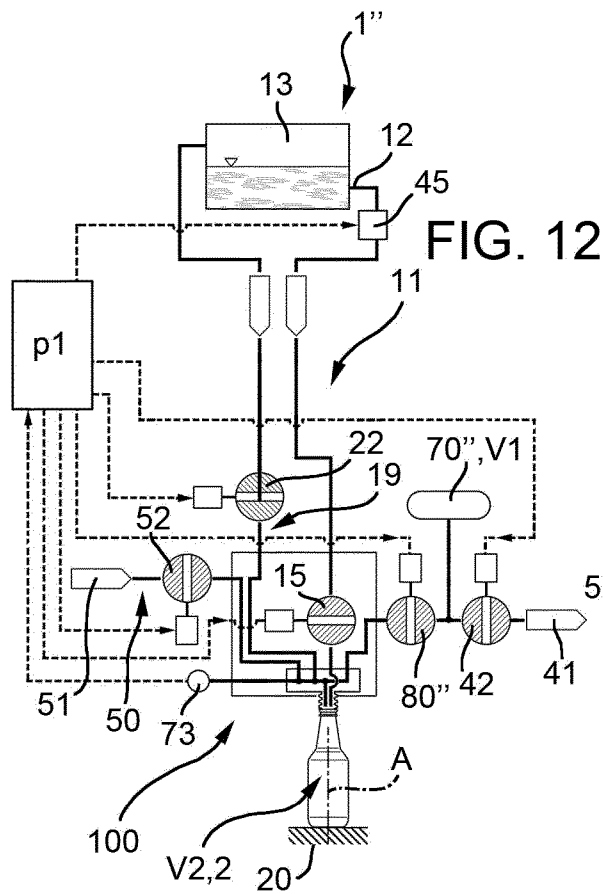


FIG. 11



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/078282

A. CLASSIFICATION OF SUBJECT MATTER
INV. B67C3/28
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)
B67C

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 5 273 082 A (PAASCHE SIEGFRIED [DE] ET AL) 28 December 1993 (1993-12-28) column 6, line 31 - line 53 column 6, line 64 - column 7, line 27; figure 1	1,13
X	US 2012/255644 A1 (CLUESSERATH LUDWIG [DE]) 11 October 2012 (2012-10-11) paragraphs [0012], [0051], [0052]; figures 1,2	1,13
A	EP 2 949 618 B1 (SIDEL SPA CON SOCIO UNICO [IT]) 31 August 2016 (2016-08-31) cited in the application the whole document	1-18
A	GB 2 288 168 A (BWI DAWSON [GB]) 11 October 1995 (1995-10-11) page 4, line 20 - line 36; figure	1-18



Further documents are listed in the continuation of Box C.



See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search

23 January 2018

Date of mailing of the international search report

31/01/2018

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Wartenhorst, Frank

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2017/078282

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